The Ultimate Guide to Self-Reliant Living

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Edited by **Jay Cassell**

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10 9 8 7 6 5 4 3 2 1

Library of Congress Cataloging-in-Publication Data is available on file.

ISBN: 978-1-62636-093-8

Printed in Canada

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Introduction

JAY CASSELL

Hundreds of years ago, the majority of the world's population was self-sufficient. People made their own clothing, tools, weapons, boats, and shelters; they hunted, fished, trapped, and grew and harvested their own food. Energy was supplied by animal power, then by wind and water. But as the human population of the world grew, the wild food supply dwindled and people began to rely more on herding and farming than on hunting and gathering. Today, most people in the world depend on a relatively small number of farmers to grow food for them. Many people in developed nations work in jobs that have little to do with the essentials of living, instead trading the money they make to buy food, clothes, and shelter.

Food, clothes, shelter, warmth, energy – if you were tossed into the middle of the woods and told to survive on your own, I'm guessing you probably could not. Could you find your own food? Build a shelter that would keep you warm and dry? Start a fire without a butane lighter? Harness energy to provide power?

Despite this, there is a growing movement across this country, led by people who want to get off the grid, go back to basics, and live a simple life free from the constraints of modern civilization. Some people are doing it for peace of mind; others object to living in a fast-paced world where no one is independent, where everyone depends on others; a third, growing group feels that Armageddon may be upon us, and that only those who are prepared to live on their own will survive.

In this book, you'll find all the information you'll need to survive—be it on your own plot of land somewhere out in the wilderness, or the home you're in now, once all the power goes out and you need to fend for yourself. In these pages, you'll learn about starting fires, in multiple ways with multiple sources; growing and harvesting not only fruits and vegetables, but pigs, chickens, and even fish. There are tips and tactics in here on hunting, trapping, and fishing, outdoor skills everyone should know; and there is useful, solid information on staying alive and thriving in true survival situations.

It's my hope that everyone who reads this book will come away being much smarter and able to survive anywhere, in any situation. Because you know what? You may need to.

Jay Cassell
Katonah, New York
August 2, 2013

The Ultimate Guide to Self-Reliant Living

Buying Property and Building on It

Buying Country Property

Realizing the Dream of Owning a Place in the Country

With careful planning and a modest investment, almost anyone can turn the dream of owning a small farm or a few acres of country land into a reality. And with some effort this land may provide a significant portion of life's amenities: wood for the fireplace, fresh produce for the table, a pond for fishing or swimming—even waterpower to generate electricity. But as with any other major purchase, care and caution are required.

The first step is to have, in general terms, a strong notion of what it is you want. Those desiring year-round warmth will obviously have different priorities than those who wish to see the seasons change. Prospective part-time farmers will look for one kind of land, whereas weekend sojourners will look for another. Whether you enjoy isolation or prefer neighbors near is another consideration to ponder. And, of course, there is the matter of money: how much you can afford to put down, how much you can pay each month for a mortgage and taxes. Once you have made these decisions, pick an area or two to investigate. Get the catalogs of the Strout and United Farm real estate agencies, and look for ads in the Sunday paper real estate section. Also subscribe to local papers from the regions of your interest; these may provide lower-priced listings plus information on land auctions.

When a property appeals to you, investigate—first by phone and then in person. When looking, do not neglect small matters, such as television reception, the contours of the land, and the style of the farmhouse; but never lose sight of your ultimate goals or basic priorities, and gauge the property in that light.

To buy or not to buy—resist that impulse. Once you have found a piece of property that appears to meet your needs, resist the temptation to come to terms. This is the time for an in-depth investigation rather than a purchase. After leaving the parcel, think about it, talk about it, try to remember its contours, and list all the things you do not like as well as the things you do. If after a week or so the land is still appealing, arrange to spend an entire day tramping about it.

Walk slowly about the property in the company of your family. Among the subjects of discussion should be these: Is the ratio of meadow to woodlot about what you have in mind? (The former are generally more valuable as timber and fuel.) Is the meadow overlain with ground cover, indicating some fertility? Is it swampy? Is there a usable residence on the property? If not, can you afford to build? Is there a road that cuts across the property into a neighbor's driveway? If so, there is likely to be an easement on the parcel, conferring on the neighbor the right to cross at will. If there is no electricity, gas, or telephone service, ask yourself honestly how well you can get along without these conveniences. And if your goal is to be a part-time farmer and full-time resident, check into employment possibilities in the area.

If the answers to most of these questions are satisfactory, then begin a more formal survey of the property. For those who plan to grow vegetables, grains, or fruits, the question of soil fertility becomes a major factor in any ultimate decision. Take a spade and dig down—way down—in several widely scattered places. Ground that is adequate for good crops will have a layer of topsoil at least 10 inches deep; 12 or 15 inches deep is better. The topsoil should be dark, and when handled it should feel soft, loose, and crumbly to the touch. If the topsoil seems rich and deep enough, make doubly certain by taking several samples to the nearest county agent; he can analyze it for acidity (pH) and mineral content and tell you what crops are best to grow on it. Another way of discovering what crops the soil will support is to find out what the neighbors are growing. If the farm over the fence has a healthy stand of corn, and a thriving vegetable garden, the chances are good that the land you are looking at will also accommodate those crops.

When walking the land, look for evidence of soil erosion. Gullies are a sign of erosion, as are bared roots of trees and bushes. Parched, stony, light-colored soils indicate that erosion has carried off the rich topsoil. If you are only planning a small kitchen garden, erosion and lack of topsoil can be repaired. But if extensive cropping is your goal, the cost of restoring scores of acres to fertility may be beyond your reach.

Check the drainage capacity of the land. If the subsoil is so compacted or rocky that it cannot quickly absorb water, then the plants you sow are likely to drown. Also bear in mind that poor drainage can make it difficult to install a septic system, since sewage will tend to back up or rise to the surface. Inspect the property in the wake of a heavy rainstorm. In the surface is muddy or even very spongy, it is a sign that the drainage is poor. Dig several widely spaced holes in the ground, each one about 8 inches around and 3 to 4 feet deep. Check the soil near the bottoms. If it is hard-packed and unyielding to the touch, chances are it is relatively impermeable to water. Or pour a bucket of water on the ground, wait 10 minutes, and dig to see how far the water has penetrated. For the most accurate information, a percolation test by a soil engineer is necessary.

If you are planning on building a house, carefully inspect possible construction sites. The land for the house should be reasonably flat, with easy access to a public road. Do not overlook the site's relationship to the winter sun. A house with a northern exposure, particularly if it is on a slope, is likely to cost considerably more to heat than one with a southern exposure that can take advantage of the warming rays of the low-lying winter sun.

Finally, there is the all-important matter of water—the lack of a reliable source of water for drinking and irrigation can make an otherwise desirable site worthless. The subject is discussed in detail below.

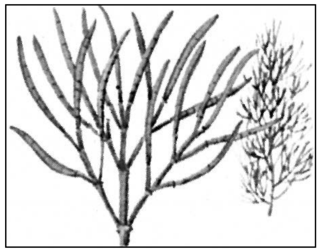
In all events, try to delay a commitment until you see the land in all seasons; both the blooms of spring and the snows of winter can hide a multitude of evils.

Buildings Are Important But Water Is Vital

In assessing country property, the most important single consideration is the availability of an adequate supply of fresh, potable water. With water virtually anything is possible; without it virtually nothing. Consider for example, that a single human being uses between 30 and 70 gallons per day; a horse between 6 and 12; a milk cow about 35; and a 500-square-foot kitchen garden, if it is to thrive, must have an average of 35 gallons of water per day. Even if the property is to be used only as a

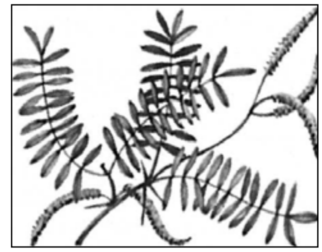
Plants that provide clues to water in dry country

Rushes and cattails are a sign of marshland or of water very near the surface.



Pickleweed indicates the presence of salty water at or just below the surface.

Saltbush indicates water near the surface, but the quality may be poor.



Mesquite indicates that water is to be found from 10 to 50 ft. beneath the ground.

Reeds signify the existence of good quality water very close to the surface.

Black greasewood generally means that mineralized water exists 10 to 40 ft. down.

Rabbit brush will grow only where there is water no more than 15 ft. below the ground.

Elderberry shrubs are a fairly good sign that there is water about 10 ft. down.

country retreat, a family of four will require a bare minimum of 100 gallons every day for such basic needs as drinking, washing, cooking, and sanitation. In short, complete information about water availability is an imperative when assessing country property. This is not to say, however, that a piece of land should, in all cases, be rejected if the existing water supply is inadequate, since a water system can be developed in most instances. Nevertheless, this can be an expensive, laborious, and time-consuming effort, and it is far more satisfactory if a water system is already in place.

Existing systems. If there is a well or other water source, along with plumbing in the house, in the out buildings, and at the fields, test the system out as completely as possible. Try all of the taps: one at a time, several at once, all at once. Is the flow sufficient for your purposes? Does the water pressure drop significantly when several taps are on at once? Has the water been tested for potability and for minerals, particularly salt? Water with even a relatively low salt content may be useless for drinking or irrigation. Remember that a fast flow in spring may become but a trickle in the dog days of summer. This is another reason to visit a property in different seasons before purchase.

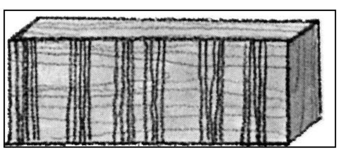
Aboveground water. A river, stream, brook, pond on the property may provide adequate water, particularly for irrigation. A freshwater spring bubbling up from the earth can usually provide drinking water, but again, such sources may dry up during the summer. If you plan to use a river or pond for recreational purposes, such as swimming or fishing, make certain that pollutants from logging operations, sewage treatment plants, and factories are not being dumped upstream. Pollutants, of course, can make the water unusable for irrigation as well. Check with local and state authorities on the amount of water you may take from a watercourse. Also make sure that the source is properly positioned to allow you to get the water from where it is to where it will be needed. A stream below a building site and garden plot will be useful only with the installation of pumps. Even one above these areas may require siphons and considerable piping if it is to be useful.

Marshlands. Though marshes and swamps indicate a high water table and, under the proper conditions, a possible pond site, they are considered negative factors by most builders, since they provide breeding grounds for mosquitoes and other insect pests and the land is useless for construction unless drained and filled.

Public water supplies. In a number of rural areas water is supplied by an outside utility company. Some utilities are owned by the government, others are owned privately with rates established by law, and still others are associations of landowners who have pooled their resources to bring water in from distant sources so that they can irrigate their lands and provide for themselves and their livestock. Hookups to any of these water utilities can be expensive and, in the case of the landowners' associations, impossible to obtain. It may be, however, that the owner from whom you are obtaining the land already has shares in the local cooperative water association. If so, make sure that the transfer of these shares is included as part of the purchase price and that you know in advance the amount of water to which your shares will entitle you.

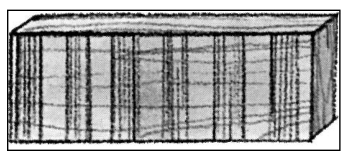
Water rights. The fact that a parcel has water either aboveground or underground is not necessarily a guarantee that the owner has the right to exploit the resource. In some states even underground water must be shared. Before purchasing any property, have your lawyer check on your water rights.

Clues to a building's age

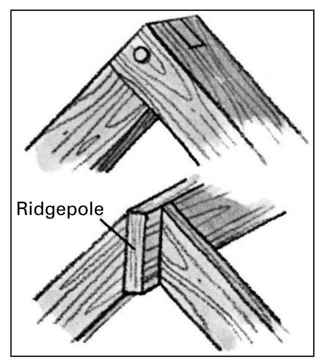


Irregular lath marks on beams indicate building dates from 18th or early 19th century.

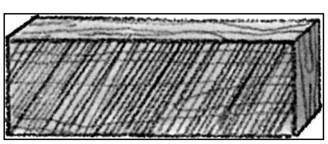
Accordion lath marks (rarely seen) were produced by a technique not used after 1830.



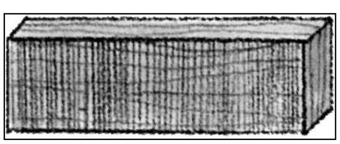
Straight lath marks, regularly spaced, indicate post-1850 construction



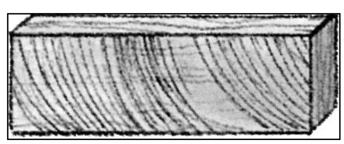
No ridgepole on roof (top) usually means pre-1800; presence of ridgepole indicates later date.



Hand-sawed beams, with irregular, slanted saw marks, date from before the 1750s.



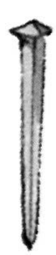
Vertical cuts in regular patterns usually indicate lumber was sawed before 1860.



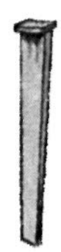
Curving saw marks point to post-1860s construction—the more even, the later.

Blunt wood screws with no taper were not made after 1840. Hand-cut notches in heads can give clues to age of screws.

Tapered screws with pointed ends were made after 1840. Notches in heads were cut by machine rather than by hand.



Wrought nails, with square, tapered shanks and hand-forged heads bearing hammer marks, were made before 1800.



Cut nails, sliced from a sheet of iron, were not made before 1800. They are still manufactured for use in flooring.

Benchmarks for the Buyer

Major points to consider when contemplating the purchase of a piece of country property are listed below. Use them as a checklist to avoid costly mistakes.

Contract of sale. The contract describes the terms under which the property is being sold. It should include a description of all encumbrances on the property and should be made contingent upon a successful title search and the ability of the buyer to secure adequate financing. Have your lawyer draw up the contract of sale rather than accept a real estate agent's standard form.

Easements. If the land has no direct access to a highway, make sure you have an easement (legally binding right-of-way) across intervening properties. Know also if neighbors have an easement on the property you plan to buy.

Eminent domain. Many public and quasi-public agencies have the right to condemn land (with compensation to owners) for roads, drainage canals, dams, airports, school construction, power lines, rights-of-way into bordering state-owned property, and the like. Check with the local planning board to ascertain if any condemnation proceedings are contemplated.

Land contracts and mortgages. Land contracts are the least advantageous means of buying land because the seller of a financing agency holds title until the purchase is fully paid off. The title holder may, during this interval, encumber the property by using it as collateral; the purchaser can lose the land if the title holder fails to make payments. Mortgages in which the buyer has title to the property and uses it as collateral offer greater protection against foreclosure.

Mineral and other encumbrances. The seller or an earlier owner may have sold or reserved the right to exploit minerals, timber, or even the water on the land. These encumbrances, if properly recorded, are legally binding.

Survey. Check with county recorder to determine if a legally binding map of the property has been made. If not, insist that a licensed surveyor draw such a map, preferably at the seller's expense.

Taxes. Check with local authorities to find out the amount of taxes (property, school, water, sewer) on the property you contemplate buying. Also try to determine if these taxes have been rising rapidly in recent years. Some states tax standing timber, mineral deposits, and water rights. Make sure there are no liens for unpaid taxes on the property.

Title search and insurance. Have your lawyer or a title insurance company check records to make sure you are buying land free of liens and encumbrances. Purchase title insurance—a one-time expense—that will guarantee the accuracy of the title search.

Water rights. A contract of sale should include a clause in which the seller guarantees a minimum water supply. Make sure the clause is in accordance with state laws on water rights.

Zoning laws. Check with the local zoning board to be certain you may use your land in the manner you intend. Also check building and health codes for the same purpose.

Sizing Up the House and Barns

The extent and condition of improvements play a large role in determining the worth of any piece of property. Direct access to a county highway via well-maintained internal roads is a major factor when considering a piece of land. A house, barn, and other outbuildings in good condition, the presence of primary utilities, and a central heating system all add to the market value of any parcel. When assessing improvements, look beyond the appearances and into such matters as structural soundness, electrical service capacity, the age of the heating system, and the relationship of the house to the winter sun.

First examine the house as a whole. Is it big enough for your needs? Does it afford sufficient privacy? Does it appear to be well maintained? Very important is the placement of the house. To take full advantage of the low-lying winter sun, it should present a broad front to the south and have a large proportion of its window openings facing south. Look at the windows themselves. Are storm windows and tight-fitting screens installed? Make notes as you move along the outside of the house and as you inspect the inside. Check for wood rot both inside and out, using an ice pick to jab at the beams and supports. If the pick goes in easily, there is probably wood rot, an expensive condition to repair. Look for signs of termites and carpenter ants, particularly along the baseboards of the ground floor and in the exposed joists in the basement. Also check the main fuse box to see if the electrical service is sufficient for your needs (modern service is at least 100 amps at 240 volts), then inspect the water heater as to age and capacity. A four-person family requires a 30-gallon gas water heater or a 50-gallon electric model. As you move from room to room, look up and down as well as around. Stains on the ceilings or evidence of recent plastering may mean roof leaks; horizontal stains on the lower part of basement or ground floor walls indicate flooding. Finally, hire a building engineer for an in-depth analysis. The deficiencies he finds may not necessarily be overwhelming, but they could provide you with a strong bargaining position for lowering the price by thousands of dollars.

Many people considering a move to the country seek out the charm of 18th- or 19th-century structures. Real estate agents recognize this and often emphasize that a house is one or two centuries old. Generally, it is best to verify such claims. Some tips on what to look for in dating a house are given on the opposite page.

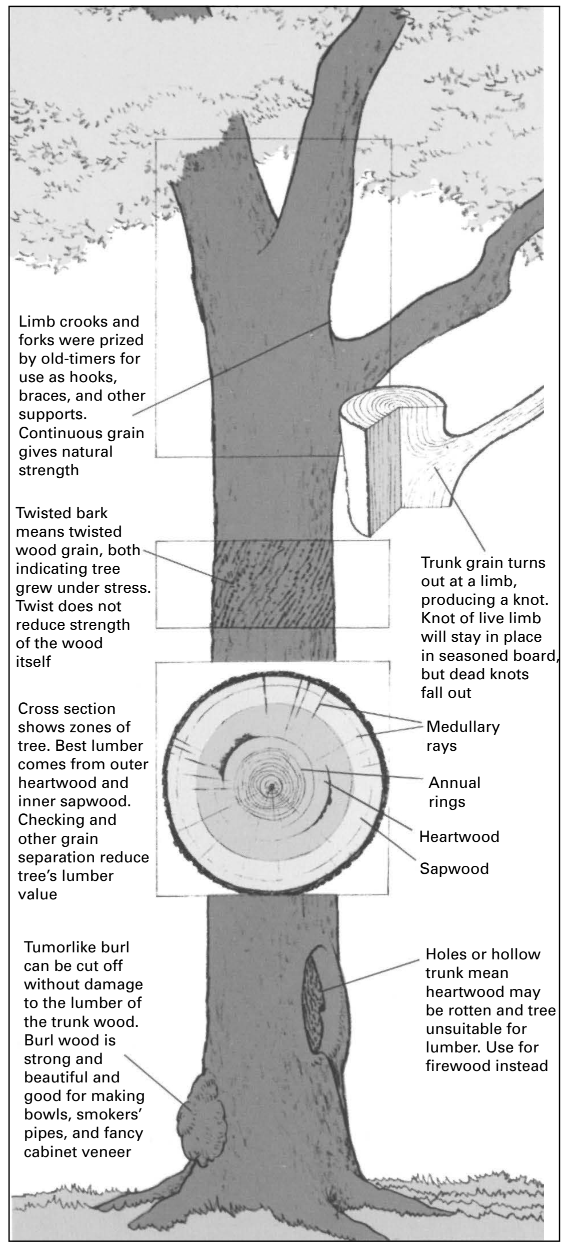
Converting Tress into Lumber

Processing Your Timber into Hand-Hewn Beams and Top-Grade Lumber

Making your own lumber is practical and economical. You not only save the cost of buying wood but of having it delivered. You can cut your lumber to the sizes you need rather than shaping your projects to the sizes available. And you can use you timber resources to the fullest, harvesting trees when they are mature, converting the best stock into valuable building or woodworking material, and burning imperfect or low-quality wood in your fireplace.

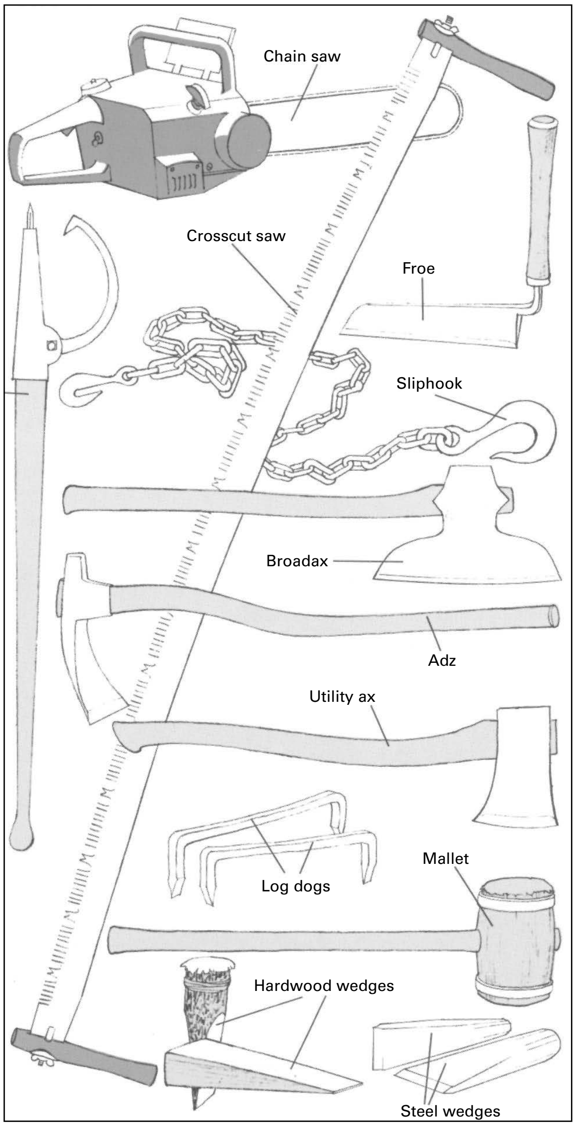
Most important of all is the quality of the wood you get. Air-dried lumber of the type demanded over the years by furnituremakers, boatbuilders, and other craftsmen is rare and expensive—lumbermills today dry their wood in kilns rather than wait for years while it seasons in the open. The lumber you cut and stack yourself can match the finest available and in some cases may be your only means of

Horsepower is often the best way to log rugged timberland.

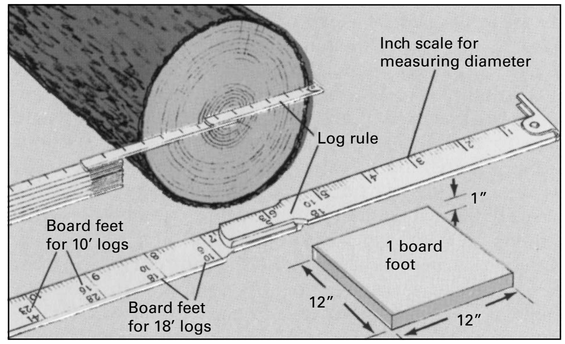


For best lumber and greatest yield per log, select trees with smooth, straight trunks at least 1 ft. in diameter. Trees that have branches at the top only are best, since limbs cause knots in finished boards. Avoid hollow trees or trunks with splits; both probably signal extensive interior decay.

The lumbermen's tools



Many home-lumbering tools are available from hardware stores. Some, however, such as froes, broadaxes, and adzes, are manufactured by only a few firms and are difficult to find. Wooden mallets can be homemade; log dogs can be fashioned from steel reinforcing rod (rebar) sharpened at both ends.



Use a log rule to estimate board feet. Varying scales exist, each yielding slightly different results; the Doyle rule shown above is typical. To use a log rule, determine length of log, measure diameter at small end, then read board feet directly from tables on rule corresponding to those measurements.

obtaining superior wood or specially cut stock at a reasonable cost. You may even be able to market surplus homemade lumber to local craftsmen.

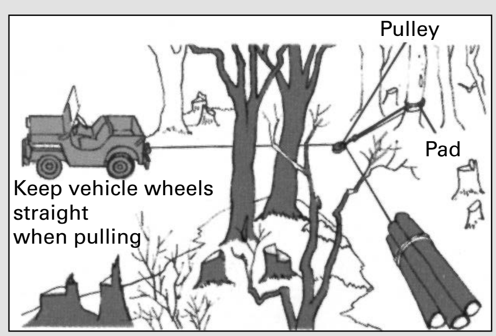
Logs and Logging Techniques

Once a tree has been felled and trimmed of limbs, it is generally hauled elsewhere for conversion into boards. Trunks that are too long or heavy to move must be bucked into sections. Make your cuts near crooks or defects to preserve good board wood. Log lengths may range from 2 to 16 feet, depending on intended use and your ability to haul them.

A good deal of lumbering is still done with horses, especially in hilly areas inaccessible to motor vehicles or where there is a risk of environmental damage. Horses are ideal when only a few trees are

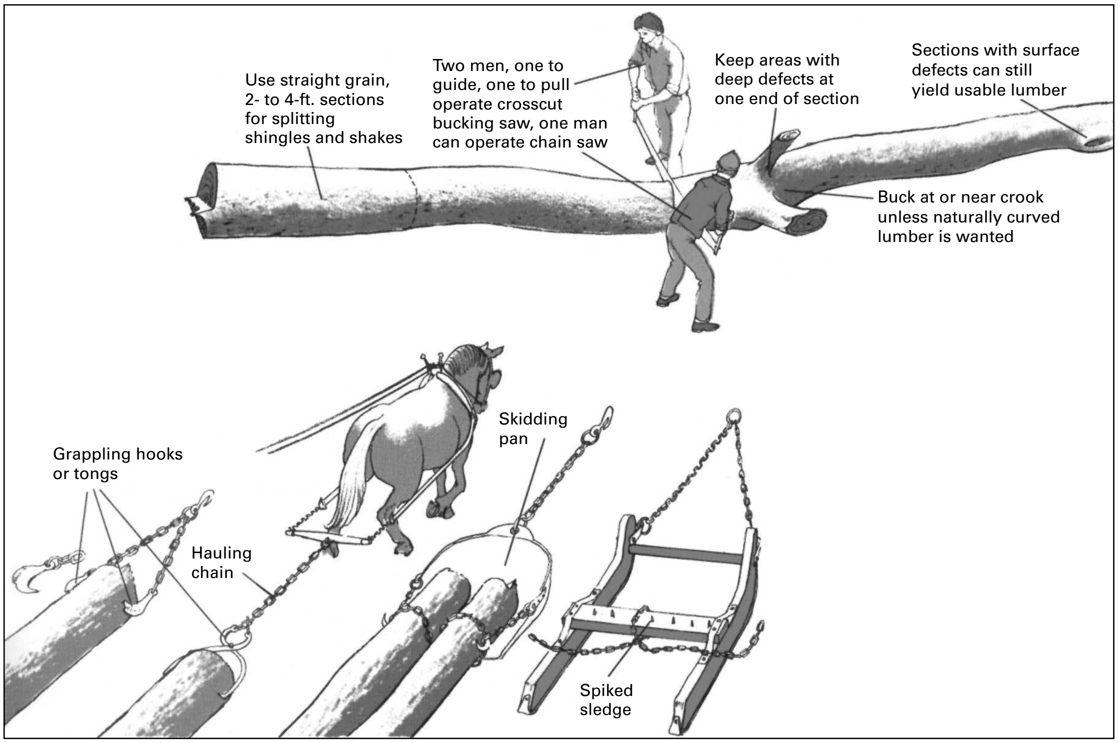
Using a Vehicle

Four-wheel-drive vehicle that has tire chains and power winch is efficient but less maneuverable than a draft animal. Keep the vehicle away from deep mud, heavy show, and thick woods. Use a pulley chained to a tree to maneuver logs around sharp turns. Pad the chain to prevent damage to tree trunk.



Tips on bucking

Plan bucking cuts to avoid wasting wood. Group defects together to minimize scrap; allow only enough extra length for trimming logs to final board dimensions.



Hauling logs

Horses and oxen are versatile haulers, good in deep woods or over rough terrain. Shovellike skidding pan or heavy sledge with spikes holds log end and eases the job. Tongs or hooks on hauling chain grip the log. Keep the animal moving forward slowly and steadily, and avoid following routes that take you along the side slopes of hills. Never haul logs down an icy or steep grade; instead, unhook the log at the top of the slope and let it roll or slide down.

being culled or where forest growth is dense. In flat country a four-wheel-drive vehicle with tire chains can be more efficient. Buy a good tree identification handbook and use it to identify your trees so that you will know what you are cutting. Pay particular attention to bark characteristics, since logging is often done in winter, when there are no leaves. (Logs can be moved more easily on snow, and winter-cut logs season better.)

Common Woods for Lumber

Beech is hard, strong, heavy, and shock resistant. It is good for furniture, floors, and woodenware and can be steam bent. Beeches grow in all states east of the Mississippi River.

Shagbark hickory is strong, tough, and resilient, making it ideal for tool handles and sports equipment. It can be steam bent. Hickory grows in most of the eastern and central United States.

Black cherry, or wild cherry, is medium weight, strong, stiff, and hard. Straight-grained cherry is excellent for making furniture or cabinets. It grows in the eastern United States.

Shortleaf or yellow pine is a tough softwood with good grain. Formerly used for sailing ship masts and planking, it makes good clapboards. It grows in the southeastern United States.

Black walnut is medium weight has beautiful grain, is easy to work, and is strong and stable. Reserve this wood for special paneling and furniture. It grows throughout the United States.

Sugar maple is hard, strong, easy to work and extremely shock resistant. It is excellent for furniture, floors, and woodenware. It grows in New England and the north-central United States.

Douglas fir is light easy to work, and very strong. A leading structural wood (building timber, plywood), it is also used for Christmas trees. It grows on the Pacific Coast and in the Rockies.

Western white pine, similar to Eastern, resists harsh weather and is a good board wood for house frames and panels. It grows best in the mountains of the northwestern United States.

Eastern red cedar is light, bright, easy to work, and decay resistant. It grows in the eastern two-thirds of the country and is used for fence posts and as mouthproof closet or chest lining.

Northern red oak is tough and strong but heavy and hard to work. It is excellent for use in timber framing and as flooring. It grows in the northeastern third of the United States.

Eastern white pine is light, semisoft, easy to work but strong, and has been used for everything from clapboards to furniture since colonial days. It grows mostly in the northeastern United States.

White spruce is light, strong, and easy to work. It can be used for house framing and paneling but is not decay resistant. It grows in the northern United States from Maine to Wisconsin.

White oak is similar to red but stronger and more resistant to moisture. It can be steam bent and is often used in boats. It grows in the eastern United States from Canada to the gulf.

Yellow birch is heavy, hard, and strong, with a close, even grain. It is excellent for furniture, interior work, and doors. It is easy to work. It grows in the Northeast and the north-central states.

Building the Home Camp

BY E. H. KREPS

The first camp I remember making, or remodeling, was an old lumber camp, one side of which I partitioned off and floored. It was clean and near appearing, being made of boards, and was pleasant in warm weather, but it was cold in winter, so I put up an extra inside wall which I covered with building paper. Then I learned the value of a double wall, with an air space between, a sort of neutral ground where the warmth from the inside could meet the cold from without, and the two fight out their differences. In this camp I had a brick stove with a sheet iron top, and it worked like a charm.

But that was not really a wilderness camp, and while I realize that in many of the trapping districts where it is necessary to camp, there are often these deserted building to be found, those who trap or hunt in such places are not the ones who must solve the real problems of camp building. It is something altogether different when we get far into the deep, silent forest, where the sound of the axe has never yet been heard, and sawed lumber is as foreign as a linen napkin in a trapper's shack. But the timber is there, and the trapper has an ax and the skill and strength to use it, so nothing more is really needed.

Let us suppose we are going to build a log cabin for a winter's trapping campaign. While an axe is the only tool necessary when two people work together, a narrow crosscut saw is a great labor-saver, and if it can be taken conveniently, the trappers or camp-builders will find that it will more than pay for the trouble. Other things very useful in this work are a hammer, an auger, a pocket measuring tape, and a few nails, large, medium and small sizes. Then, to make a really pleasant camp, a window of some kind must be provided, and for this purpose there is nothing equal to glass.

Right here a question pops up before us. We are going on this trap far back into the virgin forest, and the trail is long and rough; how then can we transport an unwieldy crosscut saw and such fragile stuff as glass? We will remove the handles from the saw and bind over the tooth edge a grooved strip of wood. This makes it safe to carry, and while still somewhat unhandy it is the best we can do, for we cannot shorten its length. For the window, we will take only the glass—six of corrugated packing board, and the whole is packed in a case, with more of the same material in top and bottom. This makes a package which may be handled almost the same as any other merchandise, and we can scarcely take into the woods anything that will give greater return in comfort and satisfaction.

If we are going to have a stove in this cabin we will also require a piece of tin or sheet iron about 18 inches square, to make a sage stovepipe hole, but are we going to have a stove or a fireplace? Let us consider this question now.

On first thought the fireplace seems the proper thing, for it can be constructed in the woods where the camp is made, but a fireplace so made may or may not be satisfactory. If we know the principles of proper fireplace construction, we can make one that will not smoke the camp, will shed the proper amount of heat, and will not consume more fuel than a well-behaved fireplace should, but if one of these principles be violated, trouble is sure to result. Moreover, it is difficult to make a neat and satisfactory fireplace without a hammer for dressing the stones, and a tool of this will weigh as much as a sheet iron stove, therefore, it is almost as difficult to take into the woods. Then there is one or two days' work, perhaps more, in making the fireplace and chimney, with the added uncertainty of its durability, for there are only a few kinds of stones that will stand heat indefinitely without cracking. On the other hand the fireplace renders the use of a lamp unnecessary, for it will throw out enough light for all ordinary needs.

The good points of the stove are than it can be made by anybody in a half days' time; it does not smoke the camp, does not black the cooking utensils, gives the maximum amount of heat from the minimum quantity of fuel, and will not give out or go bad unexpectedly in the middle of the winter. If you leave it to me our camp will be equipped with a sheet iron stove. While the stove itself is

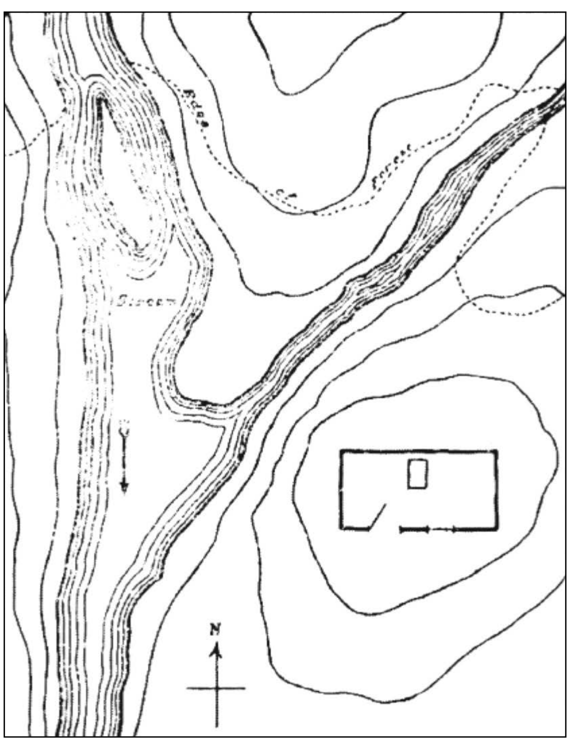
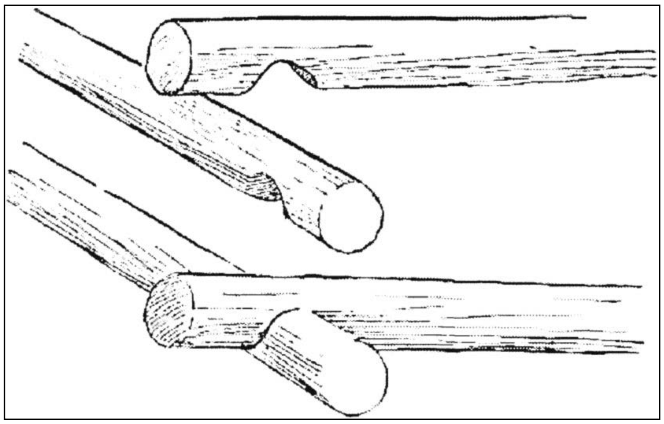


Chart showing location of camp

not now to be considered, we must know before we commence to build what form of heating and cooking apparatus will be installed.

Having decided on which part of the country is to be the center of operations, we look for a suitable site for our cabin. We find it near a stream of clear water. Nearby is a stretch of burned land covered thinly with second growth saplings, and near the edge of the evergreen forest in which we will build a camp stands plenty of dead timber, tamarack, white spruce, and a few pine stuff all of which will make excellent firewood. In the forest itself we find straight spruce trees, both large and small, balsam, and a few white birches, the loose of which will make the best kindling. Within three rods of the stream and 50 yards from the burn is a rise of ground, high enough to be safe from the spring freshets, and a gravelly ground which is firm and dry. This is the spot on which we will construct our cabin, for here we have good drainage, shelter from the storms, water and wood near at hand, and material for the construction of the camp right on the spot.

The first thing to settle is the size of the proposed building. Ten by fourteen feet, inside measurement, is a comfortable size for a home cabin for two men. If it is to be used merely as a stopping point now and then, it should be much smaller, for a small shack is easier warmed and easier to build. I have used camps for this purpose measuring only six-and-a-half by eight feet, and found them plenty large for occasional use only. But this cabin is to be our headquarters where we will store our supplies and spend the stormy days, so we will make it ten by fourteen feet. There is just one spot clear of trees where we can place a cabin of this size, and we commence here felling trees from which to make logs for the walls. With the crosscut saw we can throw the straight spruce trees almost anywhere we want them, and we drop them in places which will be convenient and save much handling. As soon as a tree is cut we measure it off and saw it into logs. These must be cut thirteen and seventeen feet long, and as they will average a foot in diameter at the stump there will be an allowance of three feet for wall and overlap, or 18 inches at each end. We cut the trees as near the ground as we conveniently can and each tree makes two or three logs. All tall trees standing near the camp site must be cut and used, if possible, for there is always the danger that a tree will blow over on the camp some time, if it is within reach.



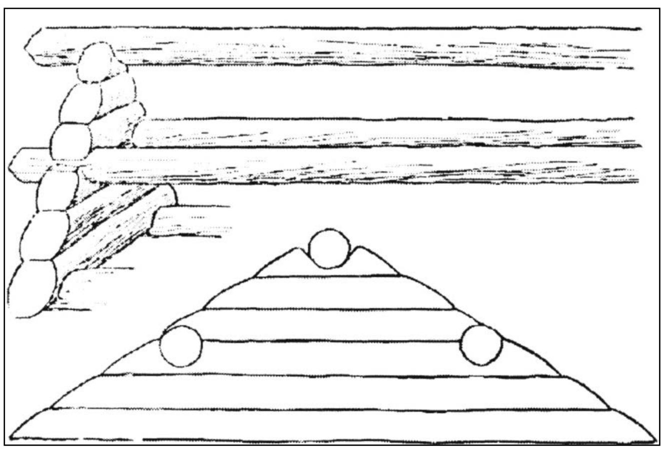
The corner construction

On the spot chosen for the camp we now place two of the long logs, parallel with each other and exactly ten feet apart. We block them on the outside so they cannot be moved easily out of position. Then we place two of the short logs across the ends and in these we cut semicircular notches directly over the places where they rest on the long logs, and almost half through each piece. After cutting these notches we turn the logs notched side down, and these cuts, if they have been properly done, fit snugly over the long logs, thus binding the four pieces together and forming the first wound of the walls.

Before going farther now we must decide just where we are going to have doorway of our cabin. We will place it on the south side, for we like to have the warm sun rays come in when the door is open, and if placed on the north or west sides it admits too much cold. We will place it near one end and then we can also put our window in the same side. About two or three feet from the corner we will cut out a section from the top of the log, making the cut four inches deep and two and a half feet wide, the bottom being hewn smooth and the ends sawed down square. Then we cut one of the balsam trees and saw a section from the butt the length of the proposed doorway. This should be not than five feet so we make it this length. Then we split though the center with the axe and a pair of wooden wedges, and hew the two halves into two smooth planks. We also make a plank two and a half feet long. When these planks are finished, we stand the two long ones upright in the place cut in the log and nail them firmly. We see that they stand perfectly plumb and in line with one another, the we nail the short plank across the top, thus completing our doorway. On this side, as the walls are laid up, we saw each log off squarely at the proper place and push it up against the door frame, fastening it there by nailing through the plank. The notches are cut to such a depth at the corners that the logs fit one against the other and this leaved no large cracks to close.

To make our cabin comfortable it must have a floor and we have this in mind as we work. Before building the wall higher we will lay our sills for the floor, for it is difficult to get these cut to the proper length and fitted in place after the walls are completed and the timber must be brought in through the doorway. We cut three straight logs about eight inches thick in the middle and 14 feet long. These are bedded into the ground in the cabin, one along each side wall and the other in centre. They must be placed at an even height and this is determined by means of a straight ten-foot pole, which when placed across these logs should rest on each. If one of them is too high in spots we dress these places down with the axe.

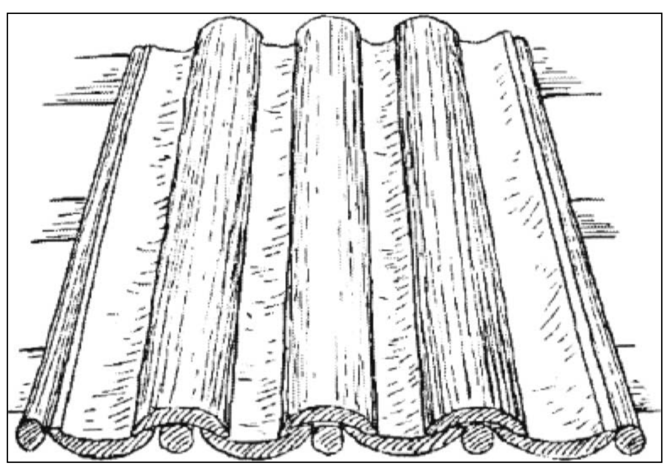
We will now leave the floors and proceed with building the walls. Round by round the logs are notched and fitted into place, until the walls have reached a height of about four feet. Then we make a window boxing of planks and fasten it in the wall in the same way we did the door frame. The ends of the logs are butted against the window frame and fastened with large nails, driven through the planks into the logs. But before making the window frame, the size of the proposed window must be determined, and this is done by measuring the width of the glass and making the proper allowance for the sash. When the logs are placed in the wall we try to select timbers of such a size that one round of log will come within about three inches of the top of the window boxing, and the next log is cut out to fit down over this window and the frame is nailed fast this log. The same thing is done when the top of the door frame is reached, and this gives a greater degree of rigidity to the walls.



The cables

When the walls have been raised to a height of about six and a half feet about the floor sills we commence work on the gables. These are constructed by placing a full length log across the end, a shorter one on top of this, continuing thus far high enough. This is best done by setting a pole up in the end of the camp exactly in the middle of the end wall, the top being just the height of the proposed gab. From the top of this straight pole, poles are run down to each corner and then give the slope of the gables, also of the roof. The logs are then cut at an angle at the ends to conform with the line of this pole, and are fastened one on top of another by boring holes and driving wooden pins into them. When both gables have been raised to half their height we cut two 17-foot binding poles, each logs or poles not only given more stability to the gables, but they also make support for the roof, and are a nice foundation for a loft on which to store articles after the camp is finished. When the ends are brought up to within about eight inches of the required height a stout, straight ridge pole of the same length as the binding poles is placed on top, and notched lightly into the top log.

Our camp is now ready for the roof, and what are we to use for this most important part? I have no doubt that camp roofs have caused more gray hairs for woodsmen than any of the other problems they have to solve. If it were each summer when the bark could be peeled from cedar and spruce trees we would have no trouble, but bark is not available now. About the only style of roof the we can make now is what is called a scoop roof, made from split logs. We must find a straight-grained, free-splitting wood for this, and of the woods at hand we find balsam the best, so we cut balsam trees about eight or ten inches in diameter, and make logs from the butt of each, about seven feet long, so that they will reach from the top of the ridge-pole to the walls and extend a



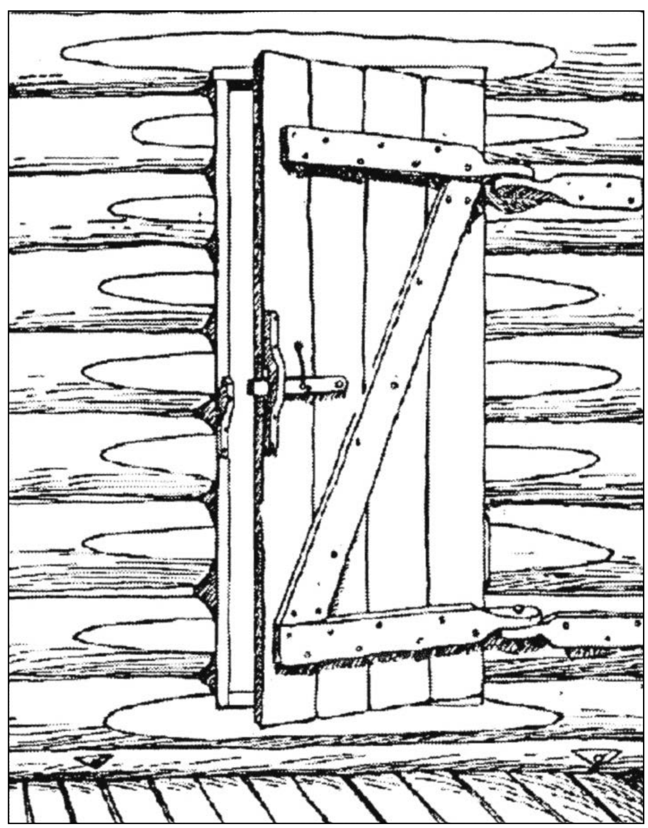
The roof

foot beyond. These were split through the center and hollow out each in a trough form, by cutting notches in the flat side, without cutting the edges, and splitting out the sections between. We place a layer of these the entire length of the roof, hollow side up, and notch each in place so that it cannot slip or rock. Between each set of these troughs we will place a three-inch pole, and on top of the pole we place marsh moss. Then we place over these poles a second layer of the troughs, hollow side down, and over the ridge pole we place a large, full-length trough. The latter we must make by hewing a log flat on one side and then hollowing it out, for we cannot find a tree with such a straight grain that we can split a 17-foot length without more or less of a twist.

Before completing our roof, in fact when the first layer of scoops are placed on, we must make provision for our stove pipe, for it must have an outlet through the roof, and the location the stove is to have in the cabin must be determined. A hole 12 or 14 inches square is left in the roof, by using a few short scoops, and this hole is covered with the sheet of tin we brought for the purpose, and a slightly oblong hole is cut in this for the stove pipe. The edge of this hole we turn up with the hammer, which makes it waterproof, and when finished it is such a size that the pipe makes a snug fit. The whole thing is so arranged that water cannot run under from the top, but this is difficult to explain.

A roof like this take a lot of work, in fact as much as the rest of the camp in some cases, but if carefully made it is a good roof, warm and waterproof. It must be well mossed or snow will sift in, and the lower ends of the troughs, from where they cross the walls, should be cut deeper than the portion above. If this is not done the ice which forms in the ends of these troughs will back the water up until it runs over the edges and down the walls of the cabin. It may even be necessary occasionally during the winter to clean the snow off the lower edge of the roof and clip the ice from the troughs with a hatchet. The steeper the roof the less trouble there will be from this source.

With the roof completed our cabin becomes a real shelter and we can camp inside at night. If necessary the flooring may be postponed for a few days, but we may as well finish it at once, so we clean out the chips and commence laying the floor. This we make of straight spruce poles about four or five inches thick. In the end of the camp where our beds are to be we leave them in their natural circular state, merely flattening them on the underside where they rest on the sill to make them fit and lie firmly in their places. But when the floor has grown at this end to a width of about four feet we adopt a different plan. We now hew the poles straight and smooth on one side their entire length, and flatten the underside where they rest on the sills, also straighten the sides so they fit snugly against one another. At the place where the stove is to be placed we leave an opening



The door

of two and a half by four feet, and around this place we fasten smooth pieces of wood about four inches thick, so that it makes of the opening a sort of box. When our floor is completed we nail down along each wall a pole, which covers the ends of the floor poles and holds them all firmly in place.

To complete our cabin now we need only a door, a window, and something to close the cracks. For a door we split cedar or balsam wood into planks, which we place on edge in notches cut in a log, and a hew down smoothly on both sides with the axe. Then we straighten the edges and measuring our door frame carefully we fit the boards into the opening, binding them all together by nailing across near each end a narrow board. We also place a strip diagonally across the door from near one corner to the opposite, to stiffen the door and prevent warping. Hinges we make of wood, fasten them together with a single large nail through each, and fasten the door to the wall. Then on the outside we hew the ends of the logs until they are flush with the edges of the door from flattened strip along both sides of the doorway. This is not absolutely necessary, but it gives the doorway a more finished appearance and increases the rigidity of the wall.

Our window sash also takes considerable work. For this we split soft, dead cedar and hew it into three-inch strips. From these we make a frame that will fit inside the window boxing, and make the strips of this frame flush at the corners by cutting away half of each. Then at the proper places we fit our lighter cross strips, sinking them into the wood at the ends, and fastening with small nails. Grooves are then cut in the strips and the frame itself to receive the sheets of glass, which are put in place and fastened with tacks. The window is then placed in the wall and secured by nailing narrow strips of wood against it. As a window at its best it apt to admit a lot of cold air it will pay well to spend some time at this work and make the window fit snugly.

All that now remains to be done is to close the cracks between the logs. Since logs were of a uniform size and have been well notched down there are no large cracks, no blocking is needed. The warmest chinking, outside of rags, which we do not have, is woods moss. That found growing on rocks and logs is best, for it does not dry out and shrink as much as march moss, and there is an abundance of this near at hand. We gather a few bags of this moss and with a piece of wood we drive it into the cracks all around the walls. We also keep a small quantity of this moss in the cabin, for no matter how firmly it is driven into the cracks it will shrink and become loose after awhile, and this must be tightened and more moss driven in.

Our little cabin is now complete. It has taken much hard work to build it, but it is worth the effort for it is a comfortable, home-like camp. The cold winter winds may howl through the forest and the snow may fall to a depth of several feet but here we can live as comfortably as woodsmen can expect to live in the wilds.

Energy

Leaving the Grid

BY DAVID BLACK

The ABCs of Energy

Unless you're a physicist or an electronics technician, in order to get through the next two chapters we're going to have to review all that stuff they tried to teach us in high school science class. This is the stuff that had us all saying, "Why in the world are they making us learn this crap? We'll never use this junk in our real lives." Well, surprise! Here it is, leering back at us like a smug mother-in-law.

Energy is needed in order for anything to happen, and when something happens, energy is converted from one form to another. Different forms of energy make different things happen. Energy comes in many flavors: electrical, heat, light, sonic, solar, chemical, kinetic, and potential, to name a few. *Chemical energy* is energy that is released during chemical reactions. Food, like that breakfast you ate this morning, and fuels like coal, gas, and oil are storages of chemical energy. So are batteries.

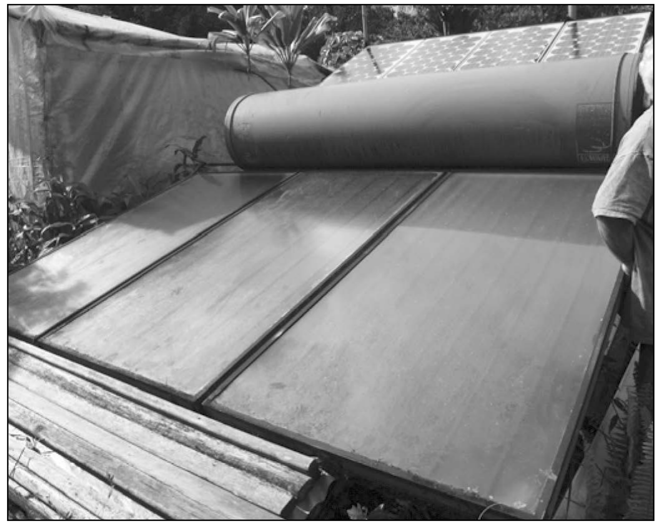
Kinetic energy is the energy of movement—the faster an object moves, the more kinetic energy it has, and the slower it moves, the less kinetic energy it has. When moving objects hit stationary objects, some of the kinetic energy is transferred to the stationary objects, making them move.

Potential energy is the energy objects have due to their position in a force field, such as an electrical field, gravity, or magnetism.

Plants use solar energy to create a bank of chemical energy that we refer to as "food."

Shooting pool is a good example of how kinetic energy is transferred from one object to another.

From left, a simplified solar water heater, the backpacker's solar shower, and a propane-heated camping shower.



A solar water heater ("collector panel"). Radiated electromagnetic energy from the sun is absorbed by a black absorber panel, which heats the water in pipes connected to the panel.

The Law of Conservation of Energy states that energy cannot be created or destroyed, but can change its form. As mentioned earlier, when something happens and energy is used, it is converted into a different form. The final forms in most energy conversions are heat and light. Even these final forms are not destroyed, but are so spread out into the environment that they become difficult to use. The *energy chain* of a flashlight is an example. Chemical energy in the batteries is changed to electrical energy. Electrical energy is changed to heat and light from the bulb, which is dispersed.

While much of our immediate energy needs are obtained by burning fuels, nearly all energy on earth comes directly or indirectly from the sun. *Solar energy* reaches the Earth in the form of electromagnetic energy, a form of energy that can travel across space. The sun warms the planet. Plants use energy from the sun to make their food, and therefore ours. And the sun's energy can be used to generate electricity using a solar cell, or to heat water using a solar collector.

Non-renewable energy sources are those that can only be used once to produce energy. They include fuels like wood, coal, natural gas, oil, etc. Sources of energy that are not used up (that is, can be produced faster than we can use them, such as sunshine, wind, and moving water, or that can be reproduced as needed) are called *renewable* sources.

Of the energy consumed by mankind, over 90% of it comes from the burning of fossil fuels—formed from fossilized plant and animal remains—and wood. The remainder is just about evenly spilt between nuclear energy and energy from *renewable* resources.

The burning of fossil fuels results in the release of significant amounts of carbon dioxide (CO_2) and other gasses. Even so, to this day there are rational people who deny that the greenhouse effect, global warming, and acid rain can be partially blamed on the intense use of fuels.

Biogas is an interesting renewable fuel. Rotting organic matter produces methane, which can be used for space water heating. It has also been used to power some automobiles and even jet aircraft. Among its negatives is the fact that although it's renewable, biogas is still a burned fuel.

A wind turbine. The propeller is turned to face the wind. As it spins, it turns the generator of the turbine to create electricity.

A solar panel with individual cells visible. The cells convert the sun's energy into electricity when sunlight falls on a special layer of silicon and makes electrons move, creating a potential difference between layers. In this picture, lying below the solar panel array are a couple of old solar collectors.

In addition to solar energy, mentioned above, other renewable energy resources include wind and water. In a hydroelectric plant, moving water turns turbines that generate electricity. A wind farm generates electricity when the wind spins propellers that turn turbines.

In the scientific world energy is measured in joules (J). Power is the energy used over a specified period of time, and is measured in watts (W). One watt is equal to one joule per second.

Appliances and machines operate by taking one form of energy and changing it into another. An appliance is considered efficient if most of the energy used to operated it is changed into the energy that is needed. Fluorescent tube lights, for example, are more efficient than standard lightbulbs because they change more energy (electricity) into light and less into heat.

Heat 101

When a substance absorbs heat, its internal energy increases. Internal energy is the kinetic plus the potential energy of the atoms the substance is made of.

Heat flows from warm objects to cold objects, changing the internal energy of both. It continues to flow until both objects are at the same temperature. The objects that lose heat also lose internal energy. The objects that gain heat, gain internal energy.

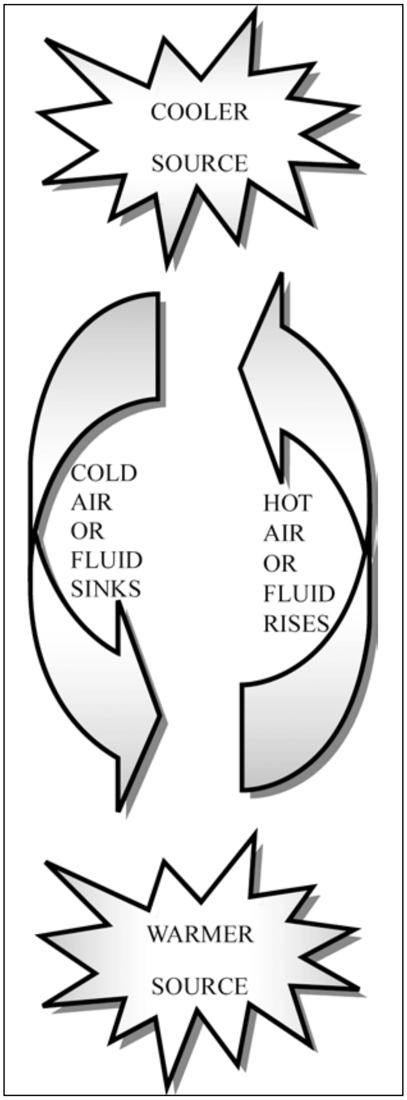
Heat flow (or heat transfer) can occur by conduction, convection, or radiation.

In *conduction*, heat is transferred by molecular excitation within a material without any motion of the object itself. Energy is transferred as the excited particles collide with slower particles and transfer their energy to them.

In *convection*, heat is transferred by the motion of a fluid or gas. Heated gas or fluid expands and becomes less dense, becoming more buoyant than the gas or fluid surrounding it. It rises, moving away from the source of heat and carrying energy with it. Cooler gas or fluid sinks, and a circuit of circulation called a convection current is formed.

Radiation occurs when heat is transferred by electromagnetic waves that carry energy away from the source.

It takes 4,200 joules to raise the temperature of one kilogram (2.2pounds) of water by 1 degree Celsius (1.8 degrees Fahrenheit). But some materials absorb heat better than others. Equal amounts of different materials require different amounts of heat to reach the same temperature. For example, it takes more heat energy to heat a quart of water to 100 degrees than it takes to heat a quart of oil to the same temperature.



Convection

Temperature is a measure of how hot a material is. Materials have different specific heat properties (thermal capacities). Two equal masses of different materials—for instance, a quart of oil and a liter of water—will reach different temperature when heated with the same amount of energy. The oil will actually be hotter than the water. It's the difference in heat capacity that causes land masses to heat up faster than bodies of water, leading to sea breezes. Air warmed by the more rapidly heated land mass rises, and cooler air blows in from the body of water. These concepts of thermal capacity and heat transfer are important to understand when trying to design heat-efficient structures.

Temperature can be measured in several different scales. The scales most commonly used by those of us who are not scientists are the Fahrenheit scale (F) and the Celsius scale (C). The steam point and the ice point (the points at which steam or ice are produced) are the reference points on these scales. The ice point is 32 degrees F and 0 degrees C. The steam point is 212 degrees F and 100 degrees C. A degrees of Fahrenheit is equal to 9/5 Celsius plus 32. For most of the world, Celsius is easier to use than Fahrenheit because one degree represents 1/100th of the difference between the steam and ice points.

The Shocking Truth about Electricity

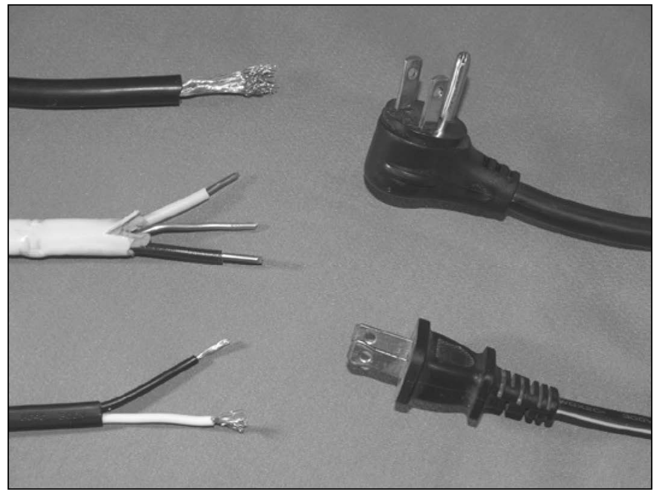
Remember what that science teacher tried to tell you back in high school about how the nuclei (specifically, the protons)of atoms are positively charged and the electrons around it are negative? Normally an atom has the same number of electrons as it does protons, so the atom is neutrally charged. But if an atom loses electrons to other atoms, it becomes positively charged, while the atoms that gain an electron have a negative charge. Electricity is a stream of negatively charged particles (electrons) flowing at the speed of light through a wire, similar to the way water flows through a pipe. Electrical forces exist between the charged objects, and the opposite charges "attract" (which simply means electrons want to flow *from* the negatively charged object to the positively charged object in order to get the objects in order to get the objects back to their neutrally charged states). Substances through which a current of electrons can flow are called *conductors*. Substances through which an electron current cannot easily flow are called *nonconductors* or *insulators*.

In conductors—for example, metal wires—the electrons are free to move, and their movement is called the *current*. The path the current takes from one location to another—again, for example, the wires—is called the *circuit*. A circuit is a continuous pathway between a power source and an appliance or device (commonly referred to as "the load"). If the circuit is interrupted by an open switch or a blown fuse, the current stops. This electricity is converted to other forms of energy by the appliance or device, such as heat, light, or sound.

So, electrical current is a flow of electrons from an area of high electric potential (too many electrons) to an area of low electric potential (not enough electrons). It's this difference that makes the electricity flow, sort of like the flow of water from high pressure to low pressure. The potential difference is basically electrical pressure, and is measured in volts (V).

You will often hear the terms *alternating current* (AC) and *direct current* (DC). DC is the flow of electricity in one direction. AC, on the other hand, intermittently reverses direction because of the way it's generated. Batteries and PV cells produce DC because the current always flows from a fixed negative point to a fixed positive point. AC comes from generators whose poles change 60 times per second, causing the current to reverse directions. It's the type of current that enters your home from the utility grid. DC can be converted to AC by passing it through an inverter. Inverters are available with high AC power outputs and with conversion efficiencies of 90 percent.

The amount of current flowing through a circuit depends on the strength of the potential difference (volts) and the resistance of the components in the circuit. Current is measured in *amperes*. All materials, even conductors, resist the current to a certain extent, reducing the amount of current that flows. The *ohm* is the unit of measure for resistance. An ampere ("amp") is the current that will flow through one ohm of resistance with a "pressure" of one volt.



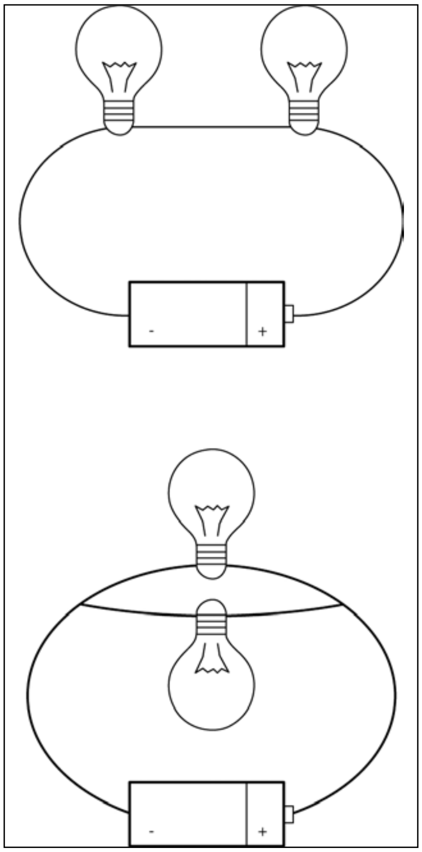
Left, a close-up of electrical cable and wire, made of a conductor (copper wire) and covered with an insulator (plastic). At right, plugs.

Some appliances use a 2-pin plug and receptacle or socket. Others use a 3-pin plug. When a plug is put into a socket the pins connect with hot (live) wires and neutral wires of the circuit. On most 2-pin plugs one prong is wider than the other. This keeps you from plugging the cord in incorrectly and reversing the polarity (the positive and negative parts of the circuit).

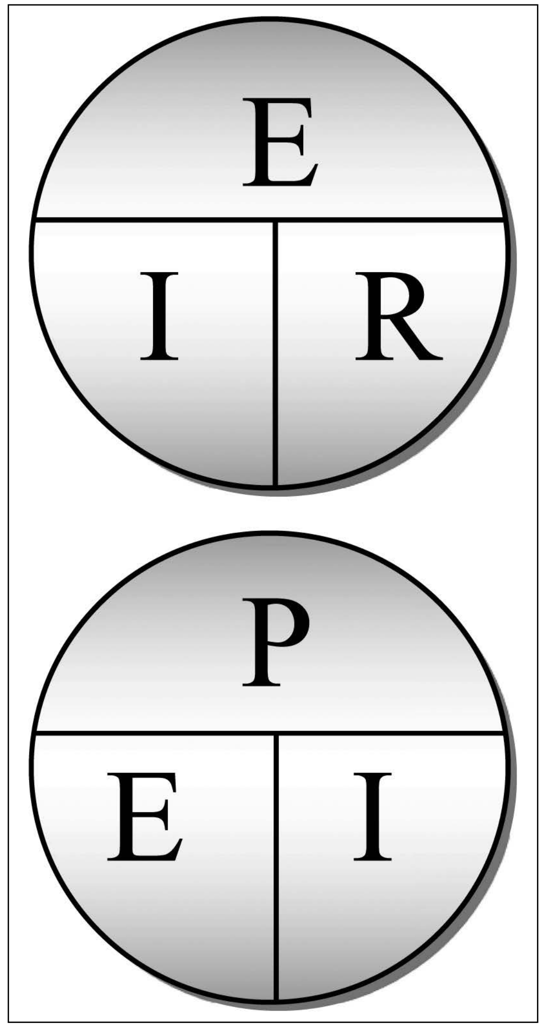
Components (such as lightbulbs) in an electrical circuit convert electrical energy carried by current into other forms of energy (heat and light). The components in a circuit can be arranged in two ways: series or parallel.

So what happens to voltages and current when they are stacked up in a series like the stack of batteries in a flashlight? In *series*, voltages add up, but the amps (current) don't. In *parallel,* the amps (current) add up, but the voltage doesn't. Don't worry; I'll explain this again later when we look at how battery banks and solar panels are wired.

The amount of power (P) delivered by a given current (I) in amps, under pressure, or volts (E), is measured in watts. The formula is *power equals voltage times amps,* or P = EI. As you can see, watts (P), volts (E), amps (I), and ohms (R) are all



Top, a series circuit. The current flows through the components one after another. If one component stops working and breaks the circuit, no current flows. It's why an entire string of cheap Christmas lights stops working when a single bulb burns out. Bottom, a parallel circuit has more than one path for the current. If a component in one path stops working and breaks the circuit, current continues to flow through the other path.



Use the circles to help remember the formulas for Ohm's Law (I = E/R, E = IR, R = E/I) and the for power (E = P/I, P = EI, I = E/P).

interrelated and must be dealt with mathematically in order to understand electrical circuits and electrical systems.

Let's talk about watts in a little more detail. A watt is the amount of energy used per second and should be thought of as the rate of speed that energy is being used. The watt rating of an appliance is the rate or speed at which the appliance is using energy. For example, a 100-watt lightbulb uses 100 watts per second.

The unit of measure for electricity consumption is the kilowatt-hour (kWh). Check it out on your next power bill. Kilowatt-hours are the amount of energy used, and are figured by multiplying the rate of usage in kilowatts by the time in hours that the device runs. Don't let this term confuse you about how much power your appliance uses. Again, wattage is a rate; kilowatt-hours are the amount used.

A battery is a storage unit of chemical energy that is converted to electrical energy. The batteries familiar to most people are the AAA, AA, C, and D batteries in their portable appliances and flashlights. These are called dry cells, and contain an electrolyte paste. An electrolyte is a substance that conducts electric current when used in a solution or paste. Chemical reactions make the charges separate and migrate to the appropriate terminal (positive or negative). When the necessary chemical properties of the electrolyte are depleted (when the battery "runs out of juice"), the battery is dead. Accumulators are batteries that can be recharged, like a car battery or like rechargeable flashlight batteries. Car batteries have a dilute sulfuric acid as the electrolyte that facilitates the potential difference between electrodes made of zinc and zinc oxide.

Household electricity is 110V (actually 110, 120, or 125V) or 240V, depending on what country you live in. Parallel circuits carry the electricity around the house. Appliances are often protected by fuses. The thin wire in a fuse melts under excessive current and breaks the circuit, stopping the flow of electricity.

Each parallel circuit in modern buildings contains three wires called the live ("hot"), neutral, and ground (or "earth") wires. The current is supplied by the live wires (usually black), and the neutral wires (usually white) carry the current back. The ground wire (usually green or bare copper) is a safety device that provides a path to the ground (earth) through which current can escape if the neutral wire is somehow broken or interrupted. The electricity would otherwise take the shortest path to the ground—which could be you.

A current flowing through a wire produces a magnetic field. A wire wrapped around an iron bar behaves like a bar magnet when current is passed through it. The wire and bar are called an electromagnet. And if moving current can produce electromagnetism, it stands to reason that moving magnetism could produce electric current. And so it can. A generator is a machine that converts the energy of magnetic movement into electricity.

In a power station, electricity is created by turbines spun by steam or by moving water. The turbines then spin the shaft of a generator that has coils of wire (the armature) turning between two magnets. Turning the coil between two magnets induces a current that changes direction every half-turn. This is called alternating current, or AC. The amount of voltage generated depends on the number of turns in the coil, the strength of the magnetic field, and the speed at which the coil or magnetic field rotates.

In smaller systems (micro-hydro or small wind systems) we sometimes see the terms *AC generator* (also called an alternator) and *DC generator.* DC generators use a bridge rectifier to convert AC to DC to serve the battery banks. A rectifier is the opposite of an inverter. It changes AC to DC in a process called rectification. Rectifiers and inverters are known collectively as power supplies. A *power supply* is a device that converts one form of electricity to another and distributes it to the rest of the system.

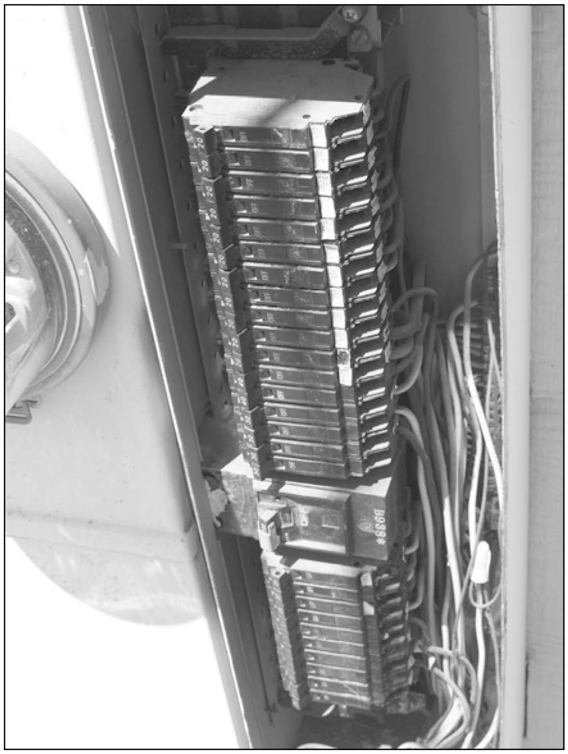
Although most ample AC sources can be used directly if properly governed by devices, with excess diverted to other useful purposes, many systems are dependent on storage batteries that require DC input. A properly governed AC generator can supply DC through a rectifier. But AC generator systems are commonly more expensive and complicated to set up than DC generating systems.

Electronics is the use of devices or components to control how electricity flows through a circuit. Components include anything within the circuit that alters the path or intensity of the electrical energy: resistors, LED lamps, diodes, speakers, capacitors, antennas, and transistors.

Resistance is the ability of a material to resist the flow of electric current. All parts of a circuit have some resistance, which reduces the amount of current that flows around the circuit. When a material resists electric current, it converts some of that energy into heat and light. Resistance is measure in units called *ohms.*

Getting Wired

For most people, this is the confusing part, and it's where most do-it-yourselfers get screwed up.



In a common household circuit, 120V AC flows from a hot bus bar in a main service panel through a hot wire to a fixed appliance such as a lightbulb or to a component like a power socket. From there are neutral wire completes the circuit path back to the panel's neutral bar, which is grounded. If a circuit malfunctions, the ground wire provides a safe path of the power source for abnormal current flow. The grounding wire keeps you and any metal surfaces containing appliances—such as your computer housing—from becoming the path of abnormal current flow. It also enables overcurrentprotection devices such as circuit breakers to work.

Most people move into houses that have been wired by electricians and construction experts. A few of us do it ourselves, and we take the risks. This book is not meant to coach you through the wiring of a home or building with local utility power as the main power source. Hire an electrician, or go to a building supply store or any decent bookstore to load up on do-it-yourself books on house wiring if that's what you intend to do. For those few of you who want to try alternative electrical sources (photovoltaic, hydroelectric, or wind turbine) as a primary or backup power source, you're highly likely to be working with battery banks, charge controllers, and inverters. You'll be doing most of the maintenance on them and you'll need to know how and why they work, and how they're wired.

Photovoltaic Cells

Within a solar panel, a *cell* is the smallest structural unit capable of independent generation of electricity. A cell is made up of sandwich of semiconductor materials, the same materials that are used in transistors. The first layer is made of phosphorous (an N-type, or negative semiconductor). The middle layer is the absorber (P-N junction). It's made of purified silicon. The third layer is made of boron (a P-type, or positive semiconductor). Each boron atom is missing an electron, and each phosphorous atom has one too many atoms. The energy of sunlight knocks some of the free phosphorous electrons off the layer, and current wants to flow as the extra electrons try to fill boron's deficit of electrons. In order to make this happen, the three middle layers are sandwiched in between two electrical contact layers that form a pathway for electron flow.

The cells are encased within a transparent material, like tempered glass on the front and a protective material on the back. Most panels are waterproofed, but there are some on the market that require the buyer to waterproof the panel with silicone around the edges of the frame, plugs, wire entries, and connections.

Each cell produces about half a volt. In a solar panel cells are wired in series to make panels with higher voltages. Your 18-watt solar panel is probably made up of 36 individual 0.5 amp cells. The total voltage and total amount of current generated is determined by the intensity of sunlight and the configuration (series versus parallel) of multiple solar panels called an *array*. The output of a solar panel in watts is determined by the rated voltage times the rated amperage. Today 12-, 24-, and 36-volt solar charging systems are the industry norm. For needs under 2 kWh, 12V is enough. A panel that is rated for a 12V system probably has an effective voltage of up to 17 volts. Larger needs will require 24 or 36V. Panels from different manufacturers can be added to the system if their voltage rate is comparable (within a volt or two).

There are basically four methods of producing solar cells:

Single crystalline is the traditional method of production and the most efficient of the four types of cells. It's also the most expensive process. The crystal is cut from a fat rod of silicon and is doped on the outside with phosphorous and the other side with boron.

Polycrystalline is also cut from a fat rod of a type of silicon that does not undergo the same cooling control or require the same purity of single crystalline silicon. The result is a matrix of many crystals. It's cheaper to produce, but since crystal boundaries tend to impede the flow of electrons, these cells are only 90 percent as efficient as single crystalline cells.

String ribbon cells are made by drawing string through liquid silicon to produce thin sheets which are then doped. These cells are cheap to produce but are only about 75 percent as efficient as single crystalline.

Amorphous or thin film cells are produced by vaporizing a silicon material and painting it on untempered glass or flexible stainless steel. These cells are somewhat less efficient than other types of cells and are easy to shatter. These are the cells you see on small RV and boat systems, and small panels are often sold at truck stops to trickle-charge your automotive batteries to keep them perky.

Solar cells have no storage capacity of their own. Neither do wind or water turbines. So if that's how you Plan to make your electricity, you'll be storing that electricity in a 12-, 24-, or 36V battery bank. Fortunately, setting up a PV system is relatively easy. The panels themselves have no moving parts and require very little maintenance.

The total amount of radiation energy available is expressed in hours of full sunlight per square meter, or peak sun hours. This amount, also known as *insolation value,* is the average amount of sun available per day throughout the year. At "peak sun," 1,000 watts per square meter reaches the earth's surface. One full hour of peak sun provides 1,000 watts, or 1 kW per square meter. To view a map that will help you determine the insolation value at your location, type "insolation map" into your search engine on the Internet and choose from hundreds.

The performance of solar modules is rated on the percentage of solar energy they capture at sea level on a clear day. Weather, temperature, air pollution, altitude, season, dust, and anything covering the panel (i.e., snow, ice, raindrops, dust, mud) all reduce the amount of solar energy a cell will receive. Cells are most efficient at higher altitudes. But at the average altitude of earth's surface (about 2,250 feet), clean cells will receive about 85 percent. Single crystalline and polycrystalline cells only manage to convert about 10 percent of that to electrical energy, and amorphous and string ribbon cells are even less efficient.

The life of a solar cell is decades. It takes two to four years for a single or polycrystalline cell to lose 1 percent of its efficiency. Maintenance of solar panels is easy. Since there are no moving parts, you simply protect them from shattering and keep them clean.

It *is* possible to overcharge a battery and damage it. When a battery is fully charged, the current from the charging device (be it wind, solar, or hydro) should be turned off or used to charge controller should be placed between the charging device and the battery bank to prevent overcharging. The controller opens the circuit to stop the flow of electricity. When the battery's charge starts to drop again, the controller closes the circuit to allow current from the charging device to serve the battery bank again. Your controller must be compatible with both the voltage of your battery bank and the amperage of your panel system.

Controllers can be simple or extremely complex. They're rated by the amps they can process from a solar array. Advanced controllers use pulse-width modulation (PWM), a process that ensures efficient charging and long battery life. Even more advanced controllers use maximum power point tracking (MPPT), a process that maximize the amps into the battery by lowering the output voltage. As described in Ohm's Law, if the wattage doesn't change, a decrease in voltage must result in an increase in current.

Some controllers have low voltage disconnect (LVD) and battery temperature compensation (BTC). An LVD permits the connecting of loads to its terminals, which are then voltage-sensitive. If the battery voltage drops too low, the loads are automatically disconnected, resulting in decreased damage to the batteries. Batteries are temperature-sensitive. BTC adjusts the charge rate based on temperature.

It is possible to lose some of the battery charge at night and on cloudy days through a process called *reverse current*. Some solar panels come with a diode that blocks reverse current. External diodes can be added to panels that do not have their own.

As you shop for solar panels, notice the wattage ratings. Most manufactures list the best-case rating, based on full sun and perfect conditions of sea level, temperature, and clear skies. Don't be fooled by this. Your panel will rarely function at that level for a number of reasons. First, full sun is tough to find. Even in the rural Southwest there is often enough haze in the sky on a windy but cloudless day to reduce the sunshine reaching your array. Cells get more sun at higher altitudes and in remote areas not affected by pollution.

Temperature is also a factor. Cells lose efficiency in a hot environment. If it's too warm outside for your comfort, it's probably too warm to get maximum efficiency from your array. The best defense against this is to mount your array in such a way that the backs of the panels are well ventilated and where the full array is not enclosed in a natural or artificial amphitheater that acts like a solar heater. Considering these factors, it should be obvious that solar electrical systems are going to be more successful in rural or remote, dry, high-altitude locations, which tend to be cooler, less cloudy, and less hazy.

The third and most important factor is shading and shadows. Anything placed between the cell and the sun will create a shadow and diminish the output of the panel. A small shadow has a cascading negative effect. Think of the array as a bucket, and the sunshine as a stream of water from a faucet. Your goal is to fill the bucket so full of water that it overflows. That's essentially what your array does. It fills with electricity and sends the "overflow" to the battery bank. Now . . . think about the bucket again. Along come some thirsty people who just keep filling their cups directly from the stream before it hits the bucket. The result? There's some water in the bucket, but it just doesn't fill quite enough to overflow. That's exactly what shadows and shade do to your array. With crystalline cells, a shadow the size of a basketball could shut down your entire array. There are two morals to this story: First, mount your array where it will get the best sun and the least shade—that is, perpendicular to the sun at solar noon (more on this later). Second, keep your panels clean.

Solar arrays do their best when they're set up to face at a right angle (90 degrees, or perpendicular) to the sun. You might as well fix your array so it's permanently at 90 degrees to solar noon, at an angle equal to your latitude, give or take a few degrees for winter or summer. This is easy with a clinometer (a device that measures angles of inclination) or a swing-arm protractor.

Mounting systems secure the panels in their proper position, preventing wind damage and allowing ventilation with cool air circulating behind them. There are several types of mounts available commercially, including ground or roof mounts, pole mounts, and flush mounts. Homemade mounts should be built using anodized aluminum or galvanized steel for corrosion resistance. Wood is fine, but won't last as long. Slotted steel angle stock is readily available and easy to work with. Make sure that no part of your mount will cast a shadow on the panel. Portable arrays can often be mounted on wide-base A-frame ladders or stepladders.

Adjustable tilt is nice for seasonal angle adjustments, but tracking systems that follow the sun across the sky are expensive and less effective than you would like them to be. The money would be better spent buying more panels and batteries. (For more information on mounting systems, see the appendices at the back of the book.)

Finally, solar power works very well for most appliances except large ones that use a large electric heating element (water heater, clothes dryer, electric stove, electric heater, etc.). To minimize the size of the photovoltaic system you'll need, consider using propane, natural gas, or another alternative to power these appliances.

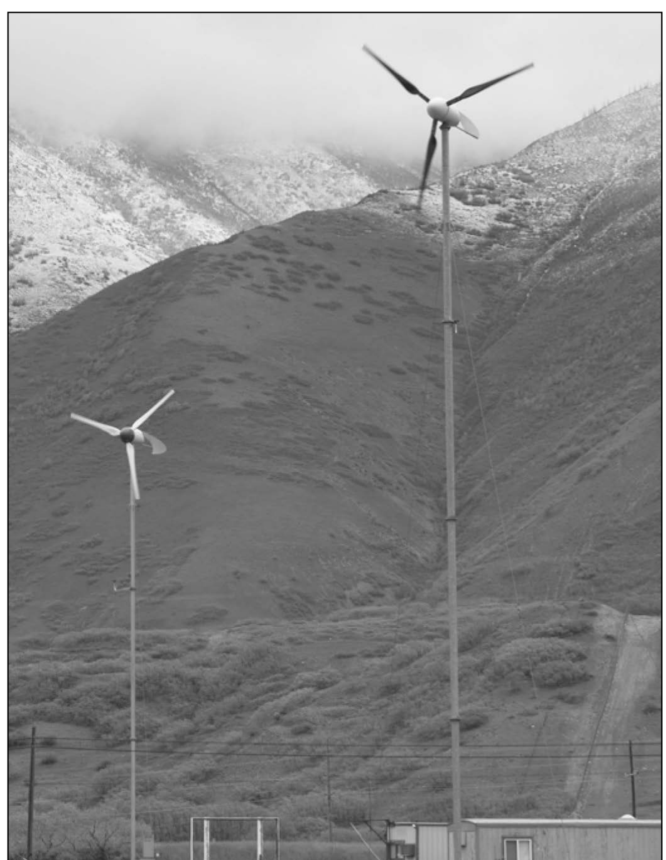
Wind Systems

Wind power is commonly used to turn an appliance on an axis or to move an object from one location to another. Common examples are sailboats and wind turbines that generate electricity. Since this book isn't about sailing, we'll concentrate on the turbines. In a wind turbine, the wind turns a set of blades, which causes a shaft to spin. The shaft is connected to an alternator or generator that uses the rotation of the shaft to produce electricity.

Wind turbines come in two common flavors: horizontal-axis turbines, which look like a propeller with two or three blades (rotors); and vertical-axis turbines that are often described as "eggbeater" turbines. Turbines are also described as being either upwind or downwind. Upwind turbines, like most three-blade horizontal-axis turbines, are operated with the blades facing toward the wind.

Horizontal-axis turbines with larger rotor diameters catch more wind and generate more electricity than those with small rotor diameters. An average- to large-size home will probably need a turbine with a rotor radius of at least 5 feet (a total wingspan of 10 feet) to generate enough electricity to be independent of the grid. Smaller turbines, called mini-turbines, have rotor radii of between 2.5 and 5 feet, and are suitable for smaller homes and vacation cabins. Tansient and recreational venues (boats, RVs) can use micro-turbines, which have rotor radii of 1.5 to 2.5 feet.

Two upwind, three-blade, horizontal-axis turbines. The main parts of such a system are the rotor (propeller blade), the shaft that turns the generator, and the nacelle that houses the generator and all the internal parts that sit atop the tower. To the rear of the turbine is a wind vane that orients the turbine toward the wind.



These giant turbines are located in Spanish Fork, Utah. The length of a single blade is 147 feet, and a single turbine is rated to 2.1 megawatts.

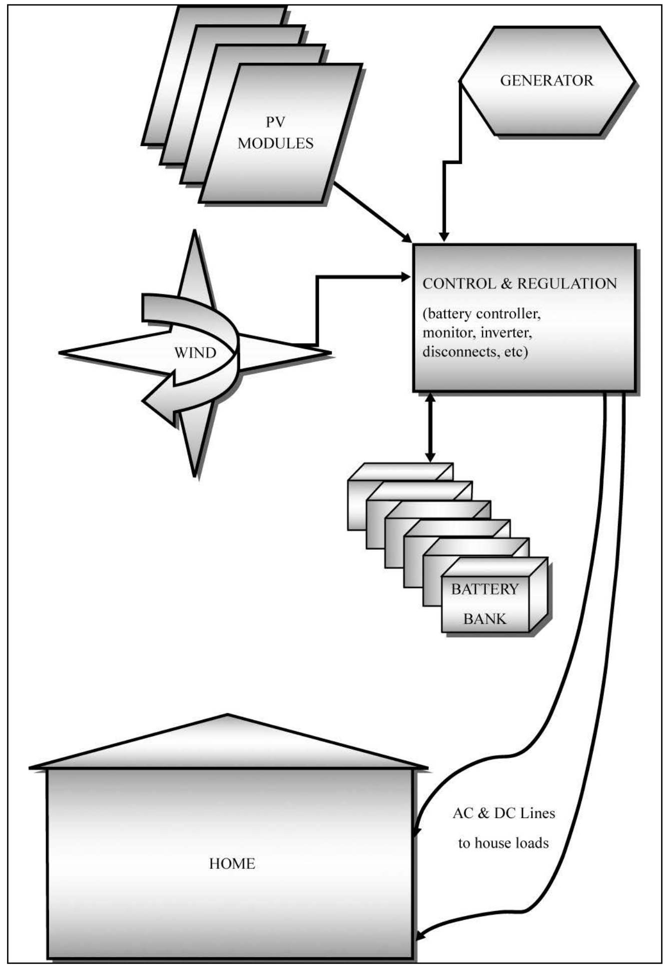


Diagram of a hybrid wind/PV system. Diagrams of various simple and complex systems can be found in the appendices in the back of the book.

It's interesting to note that small, heavy turbines (that is, turbines with all the parts densely) packed into a small nacelle) appear to be more durable than larger lightweight turbines (larger nacelle in comparison to rotor diameter).

Both wind and water systems are most often used as an adjunct for a PV system, often as a booster for power production in bad weather. These combination systems are referred to as *hybrid systems.*

A site that gets at least 8 mph of wind on a frequent basis can be a good site for a wind turbine. The turbines are mounted on towers, because wind increases with height. The drag at the wind-ground contact is eliminated. The difference at 100 feet may be as much as 60 percent.

Hybrid wind/PV systems include a control and regulation center with charge controller, monitor, regulator, battery bank, inverter, and disconnects. Hybrid systems often incorporate a small backup generator to reduce the number of batteries needed.

Turbines use permanent magnet alternators or coil induction generators. Whatever generator is used, the important factor will be its performance at the low wind speeds common to your location, and that will largely be determined by the rotor diameter (also known as the *swept area*) rather than the claims of the manufacturer.

So where do you mount the turbine? On a tower at least 200 feet away from wind obstacles. Remember, wind speed increases with altitude, and a 30-foot tower is considered a standard minimum. Higher is better.

Turbines are heavy and require a hefty tower that is well-guyed. The tower, turbine, and guys are assembled on the ground and then raised. Some towers for small turbines are tubular steel masts; others for larger turbines are complex framed structures. Many towers are hinged at the base for easy access. Others are constructed with gin poles, a crane-like device consisting of a vertical pole supported by guy ropes. A load (the next section of tower) is raised with a rope which goes through a pulley at the top and to a winch at the bottom.

Protect your electrical system from lightning by grounding. Be sure all the grounds in your wind and household systems are connected, giving the current a path outside your system. Also, consider a lightning arrestor, a device installed between the turbine and the battery bank, which directs excessive currents into the ground.

Water Systems

The nice thing about electricity produced from a stream is that it can work 24-7.

A simple micro-hydro system consists of a pipeline (penstock) that delivers the water to the turbine, which changes water flow to rotational energy. The alternator or generator changes rotational energy into electricity. A regulator controls the generator or diverts excess energy.

The hydroelectric systems used by homes and farms work like this: Water flow is collected into a pipeline. At the end of the pipe the water squirts out and strikes a wheel, which spins a generator, which makes electricity, which is then transmitted somewhere else by wire. The key piece to this is the *head* of the system—the distance the water falls from the collector to the turbine. The head determines the water pressure at the outlet of the pipe (pounds-per-square-inch, or psi). The pressures and the flow rate (gallons per minute) determine the amount of electricity the generator will produce. Energy can be collected from large volumes falling over small distances (low head systems), or small volumes falling over large distances (high head systems). Obviously the most effective sites are going to be in the watercourses of the mountains. Any site which could support a pipeline that gives 10 psi—or at least 20 to 30 feet of head delivering at least 2 gallons per minute—can produce substantial electricity.

DC generators are typically used for smaller residential systems, and AC generators are usually used for larger commercial systems. High-flow, low-head sites and AC sites are complicated and expensive.

An impulse turbine functions by using the impact of a spray of water from a nozzle or jet, also at the end of the pipeline. It sprays onto little cups on the turbine wheel. Kinetic energy from the water spins the wheel (runner). There are several impulse turbines available. Sites with at least 150 feet of head are best served by a Pelton wheel impulse turbine. The Pelton is a wheel on an axis that's perpendicular to the flow of the current. Cups attached to the wheel catch the spurting water and cause the wheel to spin, which spins the turbine. Axial flow turbines are like propellers, with the rotors spinning on an axis that's parallel to the flow of water. Pelton wheels are the best choice for high-pressure, low-volume systems (in other words, the typical mountain trickle). A Pelton system like this can be put in place for as little as $1,000.

The low voltage generated by micro-hydro systems is difficult to transmit in large quantities or over long distances. The battery bank should be as close as possible to the turbine. If the distance between the batteries and the turbine is over 100 feet, a 24- or 48-volt system will probably work better than a 12-volt system. Extreme distances will require larger-gauge wire and specialized technical expertise.

Micro-hydro systems require special change controllers or regulators. Their controllers divert excess power to a secondary load, usually a water or space heater. These diversion controllers can be used with wind turbines or PV cells, but solar controllers cannot be used with micro-hydro or wind systems.

To get started setting up a micro-hydro system, a few measurements are needed. First, the head; this is the difference in altitude between the collection point and the turbine. The easiest ways to measure this are with a topographic map (7.5 minute series) or with a GPS, or both. When using GPS for altitude, make sure the device has acquired at least three satellites to ensure accuracy. If pipe has already been installed between the collection point and the turbine site, use a pressure gauge at the turbine site and multiply the reading by 2.31 (feet of head = psi x 2.31).

Assuming the pipe has already been installed between the collection point and the turbine site, time how long it takes water from the pipe to fill a 5-gallon bucket. Divide the time by 5, then divide that into 60. This gives you the flow in gallons per minute. For example, if it takes 90 seconds to fill the 5-gallon bucket, divide 5 into 90 to get 18. Then divide 18 into 60 to get 3.33 gallons per minute (gpm).

Sizing Your System

To figure out how big a system needs to be, you first need to determine how many watts you'll be using and the amount of time those watts are used (watt-hours). You can then compare those figures to the amount of energy resources (sun, wind, water head, and flow, available at your geographic location). Use this information to determine the size and number of components you'll need to provide the amount of power you required (some system-sizing instructions are included in the appendices in the back of the book).

Finally, let's repeat the obvious: The size of your system can be drastically reduced by taking a few conservation measures. Use energy-efficient lighting and appliances, and consider nonelectric alternatives.

Batteries

Batteries, or battery banks, are required by all stand-alone and utility interface systems. The two most common rechargeable battery types are nickel-cadmium (NiCad) and lead-acid (L-A) batteries. Lead-acid batteries have plates of lead submerged in sulfuric acid. NiCad batteries have plates of nickel and cadmium in a potassium hydroxide solution.

Lead-acid batteries are the cheapest, and readily available. They come in several sizes and designs, but the most important thing to look for when choosing L-A batteries is the depth of the charging cycle.

Shallow-cycle batteries (car batteries) give high current for short periods. They do not tolerate repeated deep discharging (below 20 percent), so are not suitable for PV systems.

Deep-cycle batteries are made to be repeatedly discharged by as much as 80 percent. Even so, these batteries will have a longer life if they're cycled shallow. Try to stay above 50 percent capacity. All L-A batteries fail early if they're not recharged after each cycle. A long-discharged L-A battery is subject to sulfation of the positive plate and permanent loss of capacity. An electronic desulfater can be added to extend the battery life.

Nickel-cadmium batteries are expensive, but can last many times longer than L-A batteries. NiCads can be 100 percent discharged and can stay discharged without damaging their capacity. Also, their capacity does not decrease in cold temperatures and they are not damaged by freezing. The voltage is stable from full charge to discharge. Because of these factors, smaller batteries can be used.

NiCad charging efficiency is the same as L-A batteries, and their self-discharge rate is very slow. They require a higher voltage (16 to 17 volts for a 12V battery) than L-A batteries to bring them to a full charge. Many AC battery chargers cannot provide the higher voltage, but some solar panels do. Note that some 12-volt inverters may shut down temporarily with a battery at that voltage.

Additional NiCads can be added at any time to the bank. L-A banks will "dumb down" to match the least-efficient or weakest battery in the bank.

Nickel-iron batteries have charge and discharge voltages, life, and cold-temperature performance similar to NiCad batteries. However, they don't deliver the high amperage that NiCads do, so a larger battery will be needed for the same power. One other advantage of these batteries is that they are made without lead or cadmium.

A typical L-A battery contains liquid acid in cells that are not sealed. They can leak. Gel-cell, AGM, and sealed lead-acid are terms for batteries that are alternative choices in place of the traditional L-A battery.

A *gel-cell* uses acid in a semisolid gel form and is therefore less likely to leak. The disadvantage is that a coating can develop on the battery plates, which reduces performance.

Absorbent glass mat (AGM) batteries use internal glass mats to soak up the acid. There's a slightly higher chance of leakage from cracks with AGM than with gel-cell, but AGMs deliver a more consistent performance.

A *sealed lead-acid* battery can be any battery that uses lead-acid for electrolytes and is sealed. This includes both gel-cell and AGM batteries. The obvious advantages of sealed batteries are that the battery fluid is less likely to leak and does not have to be replaced. They are virtually maintenance-free.

The size of a battery bank is determine by the storage capacity required, the maximum discharge rate, and the minimum temperature at the bank site (for L-A batteries). At 40 degrees F, L-A batteries will only function at 75 percent of capacity, and at 0 degrees F, at 50 percent.

Storage capacity is expressed in amp-hours. The battery bank should have enough amp-hours capacity to supply needed power during a long period of cloudy weather. Add another 20 percent for L-A batteries. If there's backup source of power, such as a generator and battery charger, the battery bank can be smaller.

Charge Controllers

Let's summarize what we know about charge controllers: When a battery is fully charged, the current from the charging device should be turned off or used to charge or run another battery bank or appliance. A charge controller should be placed between the charging device and the battery bank to prevent overcharging. The controller opens the circuit to stop the flow of electricity. When the battery's charge starts to drop again, the controller closes the circuit to allow current from the charging device to serve the battery bank again. The controller must be compatible with both the voltage of the battery bank and the amperage of the charging device system.

Controllers are rated by the amps they can process from a solar array. Advanced controllers use pulse-width modulation (PWM), a process that ensures efficient charging and long battery life. More advanced controllers use maximum power point tracking (MPPT), a process that maximizes the amps into the battery by lowering the output voltage.

A low voltage disconnect LVD permits the connecting of loads to its terminals, which are then voltage-sensitive. If the battery voltage drops too low, the loads are automatically disconnected resulting in decreased damage to the batteries. Batteries are temperature-sensitive. Battery temperature compensation (BTC) adjusts the charge rate based on temperature.

"Monitor" or "regulator" units are charge controllers with additional bells and whistles. Typically they will include an ammeter for current measurement, adjustable voltage set points, and LED lights to show charge status.

Inverters

Inverters convert DC in batteries to on-demand AC through a process of transforming, filtering, and stepping voltages (changing them from one level to another). The more processing that happens, the cleaner the output, but this comes at the expense of conversion efficiency. When you shop for an inverter, you'll choose based on the following factors:

- Maximum continuous load. Inverters are rated by maximum continuous watt output.
- Maximum surge load. Asking an inverter for more power than it can give will simply shut it down or cook it. If your inverter will be expected to run induction motors (e.g., washer and dryer, dishwasher, large power tools, etc.), you will need a surge capacity of three to seven times that of the highest appliance wattage. For example, if your air conditioner runs at 1,500 watts, you'll need about 5,000 watts, of surge capacity to get the motor started.
- Input battery voltage (12, 24 or 48V).
- The output voltage needed (120 versus 240). If 240 volts is needed, either a transformer is added or two identical inverters are series-stacked to produce 240V.
- Purity of the AC waveform required.
- Whether you need a static inverter or a synchronous inverter. A synchronous inverter changes DC to AC and feeds it directly to the consumer on demand. Any excess power is fed into the grid (the utility company), which acts as a storage battery. When you need extra power, you take it back from the grid. These are also called grid intertie inverters.
- Optional features.

Inverters deliver current in one of three basic waveforms: square wave, modified square wave (modified sine wave), and pure sine wave (true sine wave). The closest waveform to grid waveform is pure sine wave.

Square wave inverters are inexpensive but also relatively inefficient, Modified square wave inverters allow greater surge capacity to start motors, but also allow economic power for running small appliances and electronics. Most appliances will accept them. However, they may damage or fail to run some printers and copiers and some rechargeable tools. They also cause a buzz in audio equipment, fans, and fluorescent lights. Pure sine wave inverters are the choice for running equipment that is sensitive to waveforms.

Some inverters have special features. An example is an internal battery charger that can rapidly charge batteries when an AC source is connected to the inverter input terminals. Another example is automated transfer switching, which enables switching from one AC source to another or from utility power to inverter power for designated loads. Other possible features are battery temperature compensation, internal relays to control loads, and automatic remote generator start-stop.

Note that efficiency losses between the source, wires, batteries, and inverter can be as high as 25 percent.

Power Centers

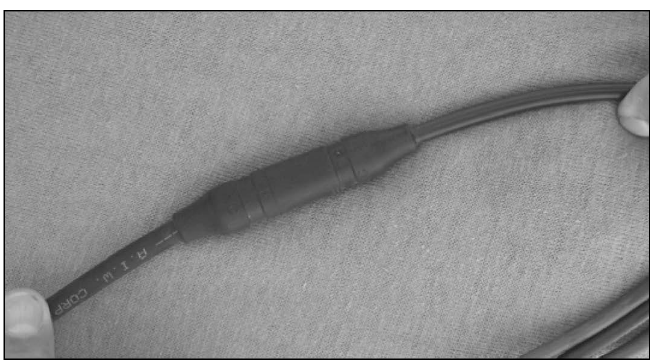
A power center is a panel into which the inverter, charge controller, safety disconnects, lightning arrestors, breakers, and system meters are mounted. For larger alternative energy systems, a power center is definitely advantageous.

Switches

A switch is a device used to break or open an electric circuit or to divert current from one conductor to another. This general category includes timers, switches, and relays. Some of the switches you might be working with include circuit breakers, transfer switches, power panel breakers, and auto transfer switches.

Connections

The clear standard for today's home-sized solar arrays are the MC connectors. MC stands for multi-contract, and the MC is a proprietary switch that has male and female ends and comes with various cable sizes. They provide clean, code-compliant, weather-tight connections. MC1 has been in common use, but the trend is toward the MC2 connector because it's considered a better connection, and is now required by most building codes. There are adapter kits for going form MC1 to MC2. The small panels you often find at truck stops, auto parts stores, and boat shops often use what are called universal connectors, or SAE connectors.



An MC connector

Electrical Safety Devices

Two of the most important safety components are good enclosures and overcurrent protection. Enclosures have many uses including a wiring point for energy sources, weather protection for overcurrent devices, and load disconnection. Overcurrent devices and switch gear provide safe means to disconnect power. Overcurrent devices include fuses, fuse blocks, and circuit breakers. Consult an electrician about electrical safety devices for your system.

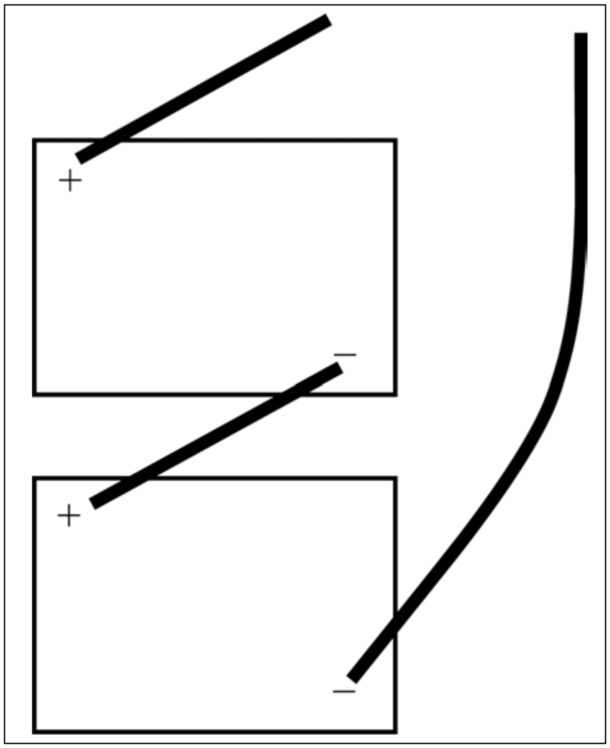
Wiring the System

First and foremost, make sure the batteries are matched to the voltage capabilities of the charge controller and the inverter (12V, 24V, 48V). Batteries and panels are similarly wired in series to achieve the correct voltage, and in parallel to achieve the correct current (amps).

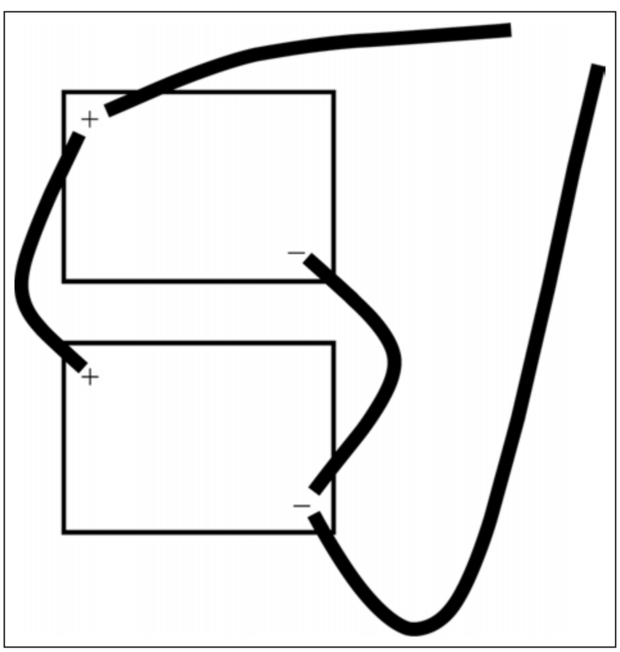
Series connections are made by connecting a pair of opposite poles or terminals of different batteries or PV panels (negative to positive.) This increases the total voltage. The voltages are added together, while the amp capacity remains the same as just one of the batteries or panels.

Parallel connections are made by connecting the same poles or terminals (positive to positive and

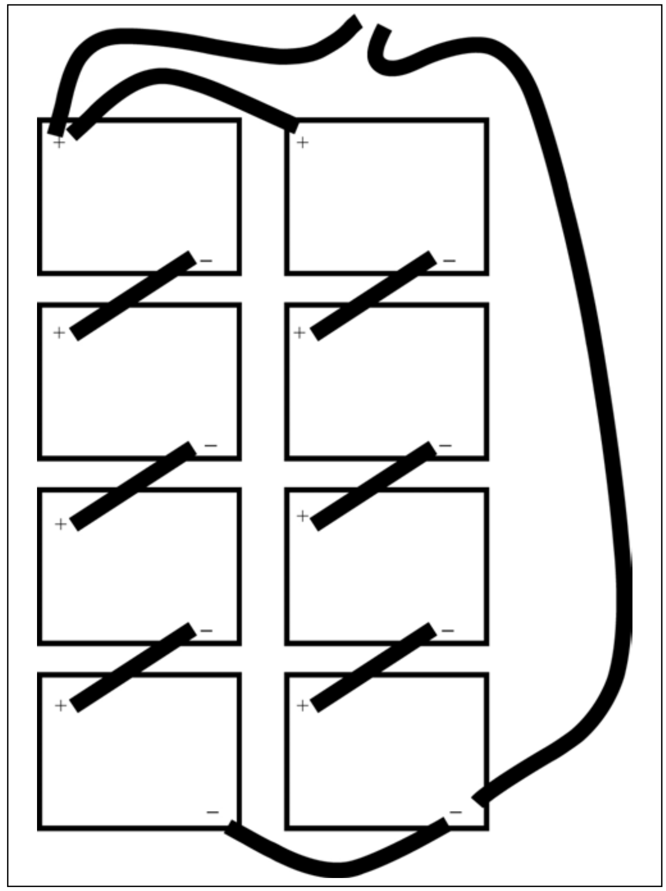
Portable emergency 12V system with two batteries in parallel and two, 1-amp 15-volt panels in parallel, making a 12V, 30W system. In this parallel PV panel array, all the red wires (+) are connected to the red controller wire, and all black (-) wires are connected to the black controller wire. The battery terminals in such a system would be connected with cables or jumper bars. Here the red terminals are connected to each other, the black terminals to each other, and the positive (red) and negative (black) outputs are taken from terminals on the opposite ends of the bank. Pulling the main output cables from opposite corners of the bank ensures that all the batteries in the bank are charged and discharged equally. This rig is mounted on a dolly for portability. Note the charge controller mounted to the front of the upper battery box, and a 400-watt, two-receptacle inverter mounted on top of the same box.



Power sources (batteries and solar panels) wired in series. The amperage stays the same, but the voltages are added. These two 12V, 120-amp batteries wired in series produce 24V at 120 amps.



Batteries or solar panels wired in parallel. The voltage stays the same. The amps are added. These two 12V, 120-amp batteries wired in parallel produce 12 volts at 240 amps. Note that in parallel systems, the main cables must come from opposite corners to ensure that batteries are charged and discharged equally.



To increase both amperage and voltage, batteries or solar panels can be configured with strings of series batteries wired in parallel. This shows a 48V, 240-amp system made with 12V, 120-amp batteries.

negative to negative) of multiple panels or batteries. The amperages are added together, but the voltage stays the same as one of the batteries or panels, or as one of the parallel battery or panel strings in a bank or array.

Battery banks often have batteries connected in both series and parallel.

Batteries are easy to wire when they're set in neat rows on long shelves. Make sure there's enough room above the battery to be able to access the caps to check and add water. Batteries can also be placed and oriented in different directions to fit tight or odd-shaped areas. However they are arranged, make sure the jumper cables or jumper bars don't obstruct the caps or threaten to contract the wrong terminal.

Energy from Wood, Water, Wind, and Sun

The energy joyride—that brief delusion of 20th-century man that the supply of cheap fuel was limitless—came to a sudden stop in 1973 with the Arab oil embargo and subsequent price rises. But long before then, farsighted individuals had been advocating a change to what have come to be called alternate energy source: waterpower, wind power, solar energy, wood, and other nonfossil fuels. Conservation was one reason, saving money was another, but equally important were ecological consideration, for the growing use of oil and coal was polluting the earth, the air, and the oceans. *Energy From Wood, Water, Wind and Sun* is both an overview and a detailed look at small scale application of these "new" sources of energy. The techniques needed to use them in the home are described as well as the methods for determining if a particular system—be it wood stove, waterwheel, windmill, or solar heater—makes good economic sense for the individual homeowner.

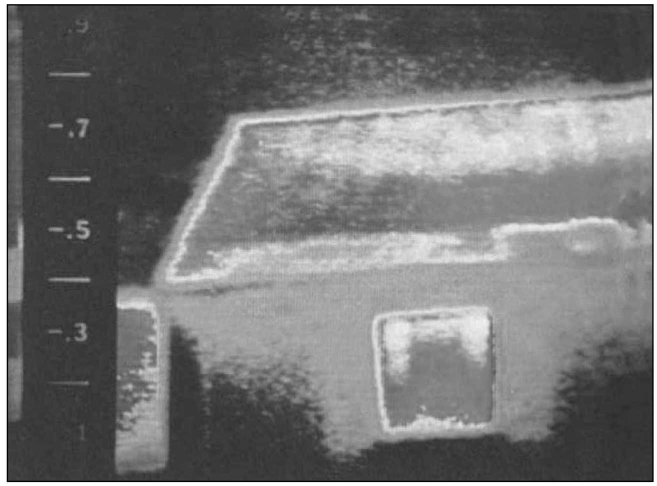
Making Your House Energy Efficient

Energy-Saving Measures That Cost the Least

The most effective way to save money on fuel bills is to use less fuel. At one time this philosophy was taken as a matter of course in America. Heavy shutters helped homeowners keep their houses warm in winter, cool in summer. Shrubbery was planted with an eye to protecting the home from weather and not used merely for decoration.

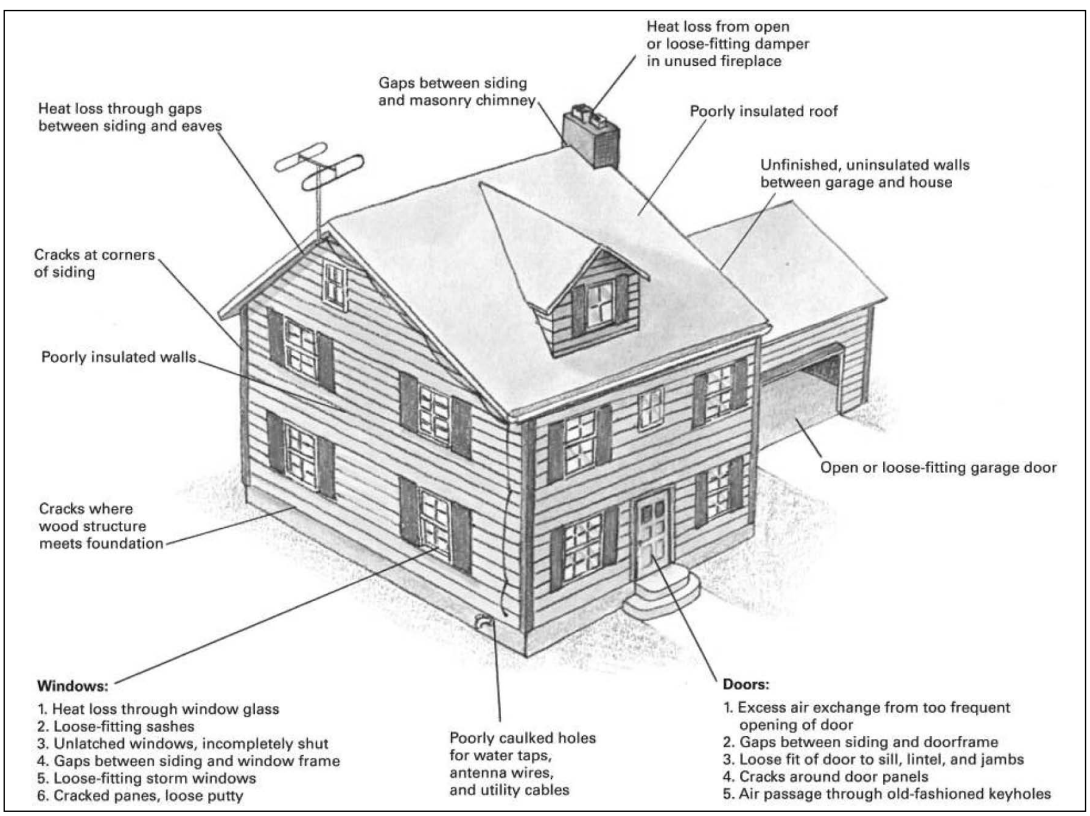
Chimneys ran through the center of the house rather than along the exterior. Homes were compact, not sprawling, and designed to draw family members together not only for conversation but also to share body heat. In many farm homes even animal heat was used occasionally by sharing living quarters with a goat or cow, or by housing large animals in a space alongside or beneath the family's living quarters. The need to save fuel influenced customs and manners too. Bundling, the practice of permitting unmarried couples to occupy the same bed without undressing, allowed courtships to proceed with a minimal cost in firewood.

With the advent of the energy crisis, many old practices are being revived. These techniques, when combined with modern insulation and weather stripping, allow us to immunize our homes against the vagaries of the weather to a degree unimagined by our ancestors.

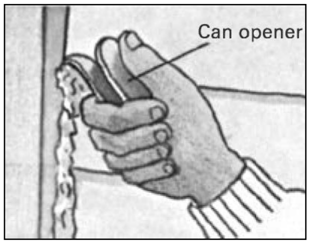


Thermographs of your house will show you where heat is being lost and how great the loss is. Bright yellow areas are locations of greatest heat loss, while read, light blue, and dark blue indicate progressively less loss. Typically, the poorly insulated roof shows up as a major source of leakage. Thermographs are taken at night to avoid misleading effects due to daylight, and a professional firm must be hired to take them because of the high cost (many thousands of dollars) of the special infrared scanner that is used. If you are planning to have new insulation and weather stripping installed in your home, ask the contractor if he will provide a thermograph. Some companies use before-and-after thermographs as a diagnostic tool and may include them free of cost.

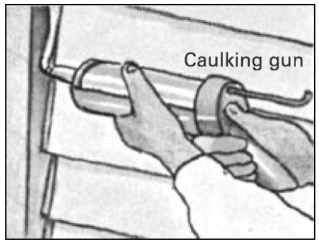
Where heat leaks out and cold leaks in



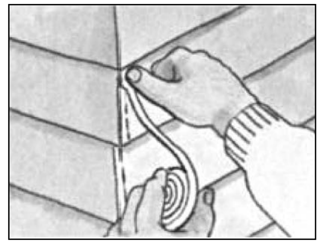
Caulking



Before caulking, clean away any crumbling old caulking, flaking paint, and dirt with either a putty knife or the point of a can opener.



Apply caulking in continuous bead, working it into cracks. To flow freely, caulking must be warm. In winter keep it indoors until you use it.



Rope-type caulking is less messy than cartridge caulking and does not require a gun to apply. Press caulking firmly into cracks.

Stuff large gaps more than ½ in. wide with oakum, fiberglass insulation, or other insect-proof material before sealing with caulking.

Reducing Air Infiltration

Every house has gaps and cracks through which outdoor air can enter and indoor air escape. In most houses air exchange takes place at a rate of one to two changes in an hour. Inevitably, this turnover of air causes a substantial loss of heated air in wintertime.

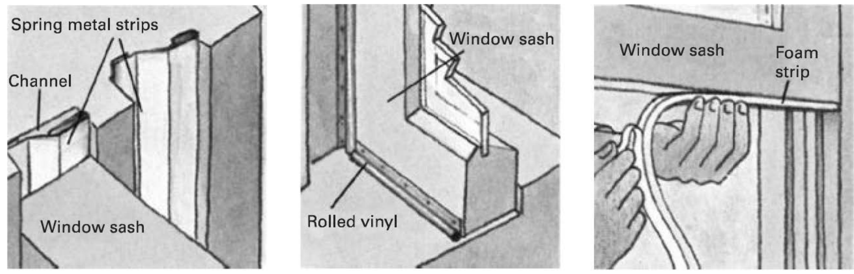
Caulking and weather stripping are the basic means of reducing this loss. Properly applied, they can lessen the air exchange rate by 50 percent and cut fuel bill by 5 to 20 percent, depending on how leaky your house is.

Caulking is used to seal construction cracks in the body of the house, such as those between window frame and siding. The usual way to apply caulking is with a caulking gun loaded with a cartridge of caulking compound. When the trigger is pressed, a continuous bead of compound is squeezed out, like toothpaste from a tube. The compound is also sold in a ropelike strip that can be pressed into place. Caulking is not a modern development. In pioneer days, homesteaders would plug leaky cabins with such materials as moss, mud, clay, and pitch-impregnated rope. Today's caulking compounds are superior. They are easier to apply, last longer, and insulate better. Oil-based compounds are still very common. Others include acrylic latex types that permit cleanup with water before they set. Butyl compounds are more flexible and stick to more materials.

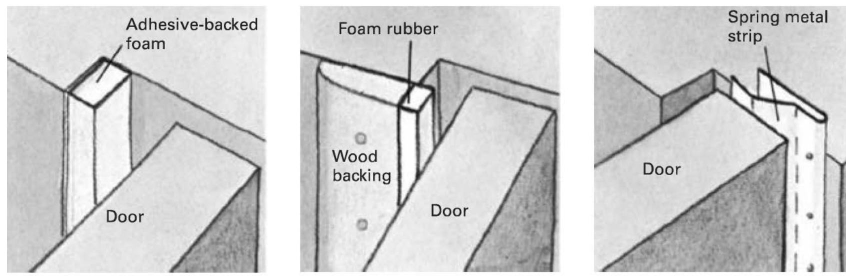
Weather stripping is used to seal gaps between moving parts, such as those between a window sash and frame, and at door closures. To minimize wear, match the weather stripping to the motion of the parts. For compressive contact, as in a door closing, use felt or foam. For a sliding motion select a tough plastic or metal strip. Whatever type you buy, be sure it is thick enough to fill the gap. Foam stripping is available with a wood backing or with a self-stick adhesive backing. Where considerable compression is likely, as in a front door closure gap, use an open-cell foam, such as urethane. For light compression use a closed-cell type, such as vinyl. Adhesive-backed weather stripping bonds best when the temperature is above 50°F. During cold weather warm the surface to which the stripping is to be applied with a heat lamp or hair dryer. In some cases inexpensive felt stripping can be used of sliding as well as compressive contact. Where sliding motion is involved, the felt must be mounted carefully so that contact pressure is adequate but not excessive, since friction shortens the felt's useful working life. Felt stripping is usually held in place by tacks or staples. Wherever possible, with any type of

Weather stripping

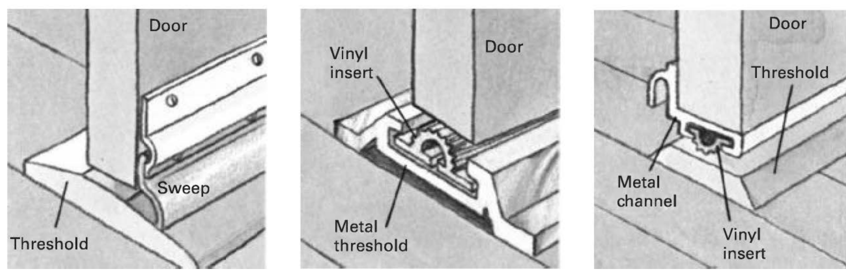
Windows can be sealed against the weather in a number of ways. The most effective method is to tack specially designed strips of spring meatl in the channel between sash and jamb. You can also nail rolled vinyl along sash border. Adhesive-foam strip can also be attached along border; it is simple to install but should not be used where window sash rubs against window frame.



Doors as well as windows can be weatherproofed by various methods. Adhesive-backed foam along the jamb is easy to install but wears out quickly. Longer lasting is a strip of foam rubber with wood backing nailed to fit snugle against the door when closed. More durable yet is a strip of spring metal.



Maximum toughness is a requirement for weather stripping put in between door and threshold. A sweep nailed to the door bottom works well if there is no carpet or rug to interfere with it. More troublesome to attach are channels of metals with vinyl inserts that you can screw either to the threshold or to the door bottom to seal space between door and threshold. Unless the threshold is worn out or absent entirely it is preferable to attach a channel to the door bottom.

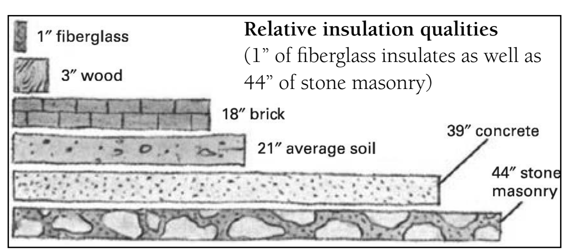


stripping, make a trial fit with a short length before doing the complete job. Check that the seal is snug enough to block drafts but not so tight that the window cannot open or the door catch fail to hold.

Keeping Heat In (and Cold Out)

One of the most effective ways to save energy in the home is by adding insulation. The concept is simple: keep the flow of heat through walls, ceilings, floors, and roofs to a minimum. As the chart (right) shows, different materials have a wide range of insulating abilities. Among traditional building materials, only wood—and that in thicknesses found in log cabins—is an effective insulator. The chart also indicates that stone masonry is a particularly poor insulator; a castle may be magnificent to look at, but it is a chilly place live.

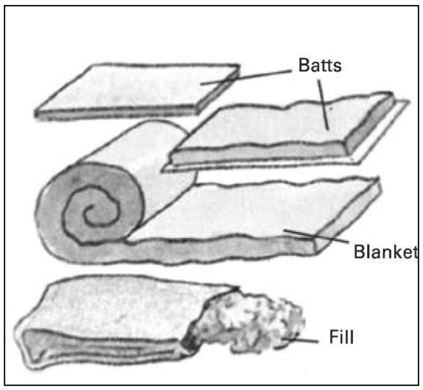
Because heat rises, the attic and roof are the first targets for insulation. Next in importance are walls and windows, then crawl spaces and basements. Insulating materials are rated in terms of their R value: the higher the R value, the more insulation they give. Typically, R-30 insulation might be used for an attic and R-20 insulation or the outside walls. However, the optimum values for you house can depart significantly from these. When selecting



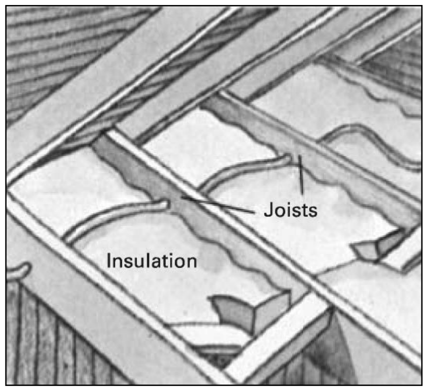
insulation, a key point to be aware of is that doubling the amount of insulation (using R-60, for example, instead of R-30) will not double fuel savings. More likely you will achieve barely enough savings to compensate for the cost of the added insulation.

When putting in insulation, it is important to install a vapor barrier to prevent moisture from condensing in the insulation. Blankets (rolls of insulation) and batts (precut lengths of blanket) often come with a vapor barrier already attached in the form of a waterproof layer of plastic or aluminum foil. Always install the barrier so that it faces toward the interior of the house. In older homes a vapor barrier can be created by applying tow coats of paint to the inside of walls to be insulated, and sealing penetrations. If there is wallpaper, remove it before painting.

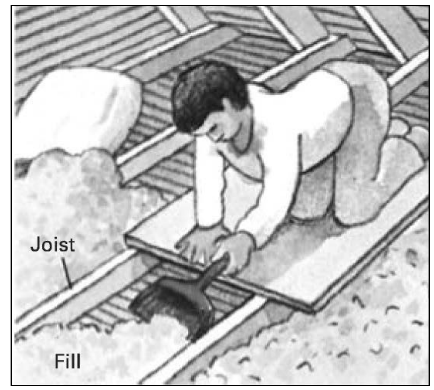
Floors and walls



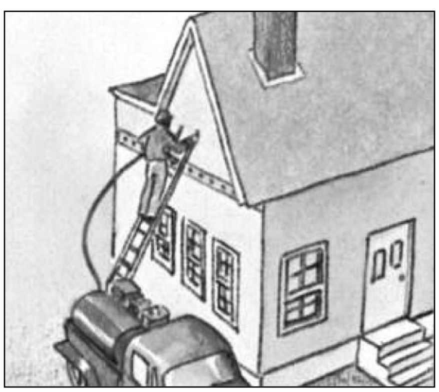
Insulation comes in different forms for different purposes. Batts and blankets fit well between joists na studs; loose fill and pumped-in foam are used for areas more difficult to reach.



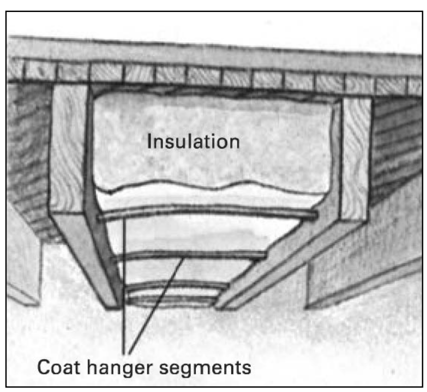
To insulate attic floor, select batts or blankets so that they fit snugly between attic joists. Place batts with vapor barrier face down. Be sure not to cover any attic vents or light fixtures.



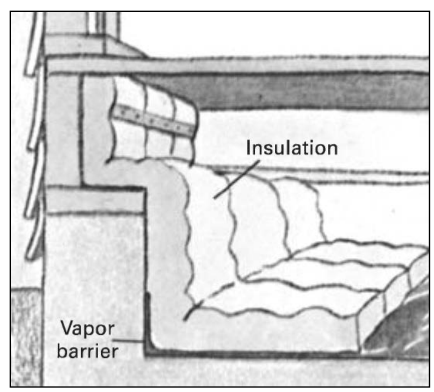
Loose fill works well on attic floors. Use a board or garden rake to spread it evenly. If joists are boarded over, hire a contractor to drill holes into boards and blow fill into spaces between joists.



Finished homes with wood-frame walls can be insulated with loose fill or foam that is blown or pumped in through holes drilled into outside walls. This job is best handled by professionals.



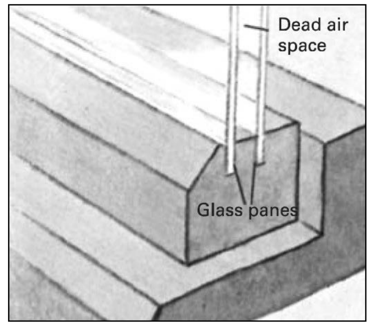
Floors over cold cellars are worth insulating. Press batts or blankets between joists, vapor barrier facing up, and secure with wire mesh or pieces of coat hanger cut to fit between joists.



Crawl spaces can be insulated with batts or blanets. Note: Becaue of possible frost heaving, always provide proper perimeter drainage.

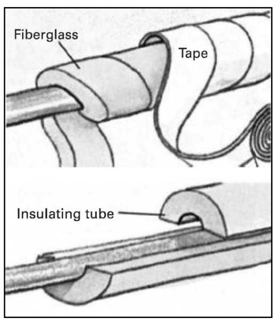
Windows

Shutters are a traditional means for containing house heat. Leave them open during daylight hours so that sunlight can get in; close them at hight to keep heat from radiating out through windows. Slatted shutters are used in summer for shade.

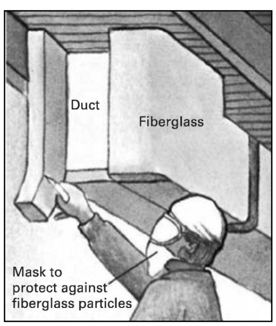


Double-pane windows (and storm windows fitted over existing windows) reduce heat loss by creating a layer of dead air between the panes that acts like insulation. For maximum benefit, windows should fit tightly and joints should be fully weatherproofed.

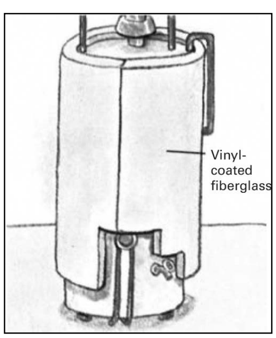
Pipes, ducts, and heaters



Hot-water pipes to distant faucets often waste heat. Wrap pipes with ⊙-in-thick fiberglass and seal with plastic tape or else install ready-to-use foam-type insulating tubes with self-sealing aluminum backing. Insulation also protects pipes from freezing. If used on cold-water pipes, it will keep water cool in summer and stop pipes from sweating.



Exposed heating and air-conditioning ducts in unused cellars or attic spaces raise fuel bills unnecessarily. To cut down on the waste, first seal joints and other leaky spots with aluminum-foil tape or silicone caulk. The cover ducts with 2 in of blanket-type fiberglass or similar insulation.



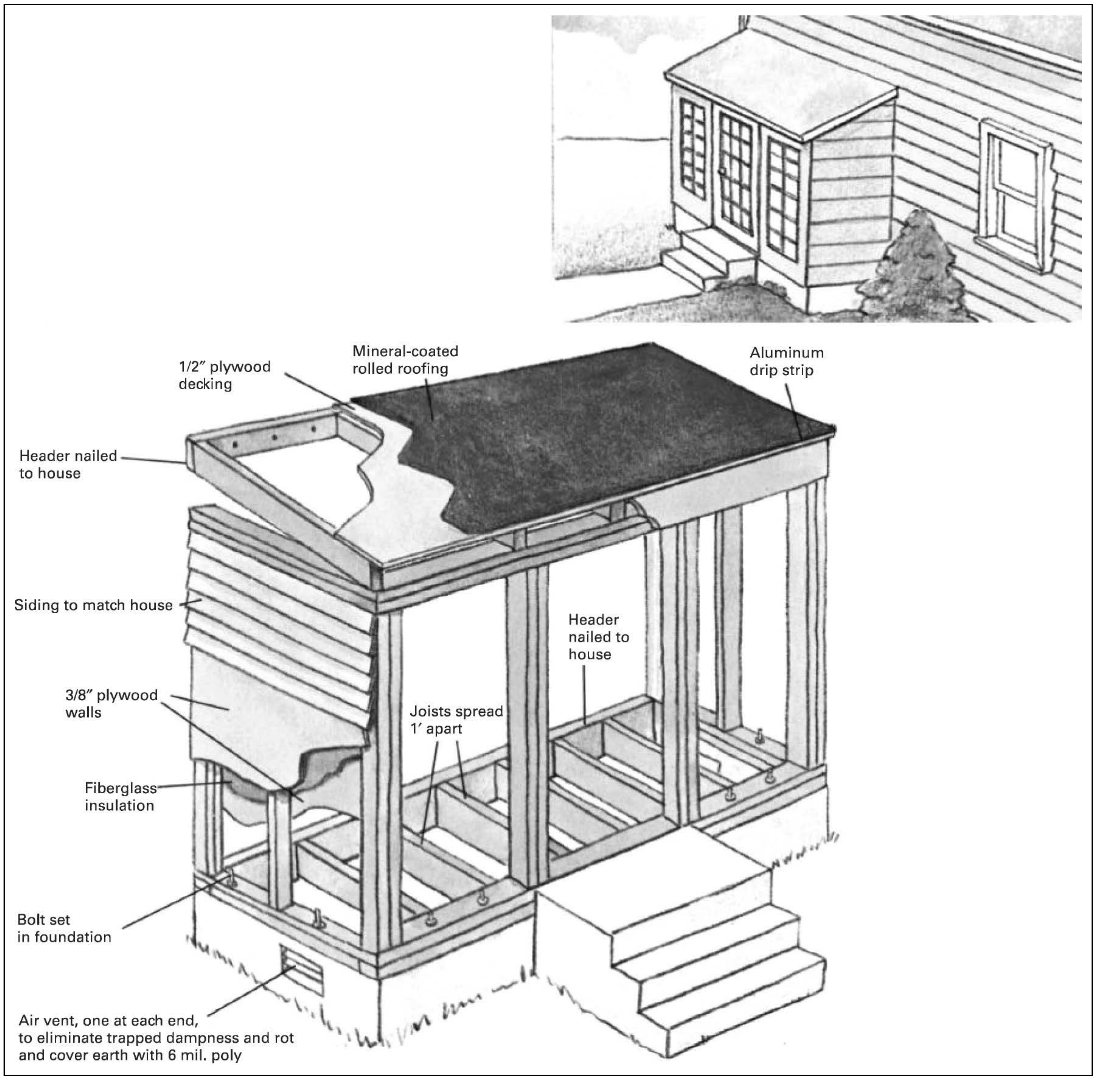
Hot-water heaters can waste fuel the year round. Special insulating material of 2-in-thick fiberglass with a vinyl outer coating should be used. Wrap entire heater in material except for bottom and controls. Complete water-heater insulation kits are available that can be slipped on, then trimmed to size.

Heat-Saving Vestibules

For years vestibules have been looked on solely as repositories for umbrellas, galoshes, dirty boots, old toys, and snow-covered children's togs. Lately, they have been rediscovered as the heat-conserving structural devices they were originally meant to be, and many owners of homes that lack vestibules are having them installed or building them onto their houses themselves.

A vestibule saves heat and increases the comfort of your house in two ways. First, it acts like an oversize storm door to provide a barrier between the front door and the outside. Second, it serves as an air lock, cutting to a minimum the transfer of cold air indoors as you enter or leave the house. And the same qualities that make a vestibule an efficient heat saver in winter also conserve energy in the summer, when the air conditioner is on. As an added bonus, a well-designed vestibule is an attractive addition to any home.

If you are thinking of adding on a vestibule, design it to blend in with the overall look of the house. The vestibule should have room for a bench and enough space for coats, overshoes, and other such items. Otherwise it need not be large—in fact, the smaller it is, the more efficiently it functions as an air lock.



This version of a vestibule uses 2 × 4's for structural members. Inside dimensions are 40 in. by 84 in. Prefarbricated door and window units will save time and work. You can use a conventional storm dor with a small window on each side or a fenestrated door with matching stationary windows, as in the picture. Door is hung on studs made of doubled 2 × 4's. A solid masonry foundation extending below the frost line is essential. The depth of the frost line for your area can be obtained from a local weather bureau. In many localities you can simply dig a trench the width of the vestibule wall and fill it with concrete. The foundation should protrude at least 8 in. above the ground. Install wiring before putting in inside wall.

Protecting Your Home with Trees and Earth

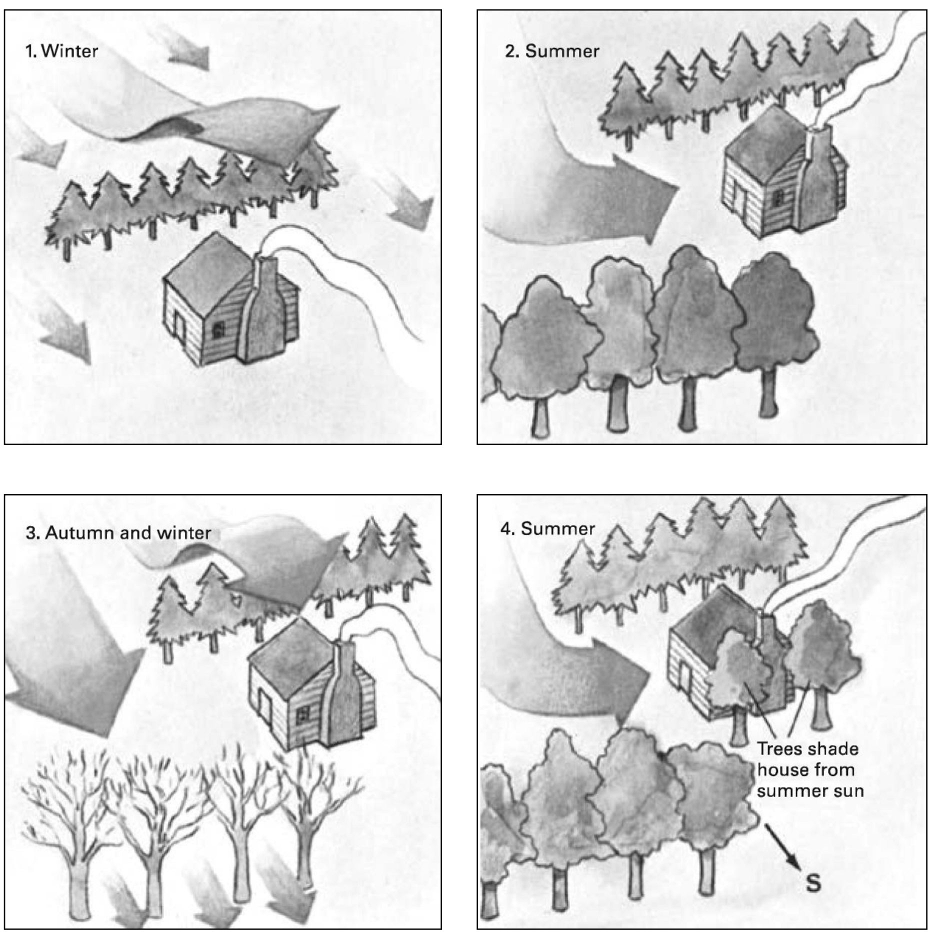
Winter winds, like a forced-air cooling system, can cause substantial heat loss from a house. The loss is due to various effects: lowered air pressure, conduction, and evaporative cooling. These combine to produce a temperature drop called the windchill factor. The chart at right shows how large the factor can be. For example if during January the average outdoor temperature in your area is 10°F, an average wind speed during the sam period of 10 miles per hour will make it seem like –9°F—a net difference of 19 degrees. If your house stands fully unprotected from the wind, the drop of 19 degrees that it is therefore subjected to might be virtually eliminated if you can find a way to block the wind. As an estimate of how much fuel such a step might save, check your fuel bills for January and for a month in which the average outdoor temperature was 19 degrees above January's temperature. The difference between these costs would be the saving for January. Such savings can range up to 30 percent in a year.

Various methods exist for keeping wind away from a house. One of the most esthetically pleasing is a strategic placement of trees and shrubbery to block the wind. Planted near the house, trees can also shade it in summer and save on air-conditioning costs. Walls, trellises, and parapets can also be built onto or near the house to deflect aire currents. When planning a new structure, consider the shape of the land—slopes and hills strongly affect the way the wind blows.

Windchill

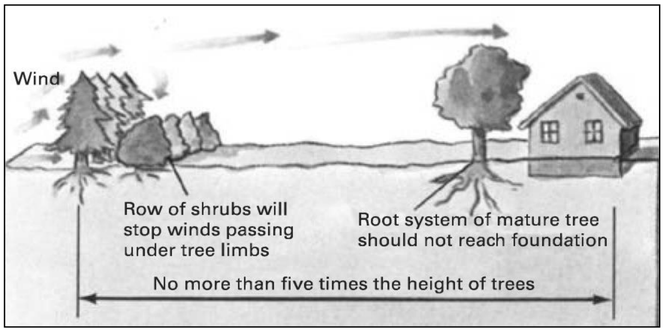
Wind Speed	Temperature when there is no Wind				
	50°F	**30°F**	**10°F**	**–10°F**	**–30°F**
5 mph	48	27	7	–15	–35
10	40	16	–9	–31	–58
15	36	11	–18	–45	–70
20	32	3	–24	–52	–81
25	30	0	–29	–58	–89
30	28	–2	–33	–63	–94
35	27	–4	–35	–67	–98
40	26	–6	–36	–69	–101

When the wind blows at speeds listed in left-hand column, your body—and outside walls of your house—will react as if the temperature were as given in the remaining columns.

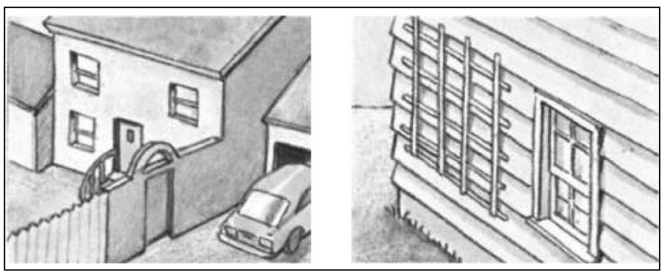


Trees and shrubs can be planted in a variety of ways to redirect the wind. If the cold winds of winter arrive mostly from one direction, a single line of evergreen trees will do a good job of blocking them (Fig.1); more rows at other angles to the house may be needed if the wind is variable. In the summer, however, these same trees may interfere with cooling breezes. One solution (Fig.2) would be to plant a row of deciduous trees (trees that shed their leaves in autumn) to deflect summer winds onto the house. Once autumn arrives and the leaves have fallen (Fig.3), the evergreens will function as before to protect the house. Deciduous trees are also valuable as shade tree (Fig.4) to keep the rays of the hot summer sun off the house. Their advantage over evergreens is that sunlight will be able to get through during the winter to warm the house.

A thoughtful, step-by-step approach to planting windbreaks is advisable. Wind patterns can vary considerably during the year. In many cases, not until the windbreak is in place can you be sure what its net effect will be. Phone or write your state energy office or local utility company for further information. Local agricultural extension offices can help and may provide you with lists of additional resources.



Shrubbery windbreaks most effective when planted no farther from the house than five times the height o the windbreak (150 ft., for example, for a windbreak with 30-ft.-high trees). The trees should be far enough away from foundations and sewer pipes to prevent root damage. The distance can be inferred from tree size; root systems of mature trees usually extend about as far as the trees branches.



Structures that impede air flow past the house, such as fences, walls, and parapets, can also serve as windbreaks. Even a trellis—which is normally used to support vines—or a similar wind-spoiling attachment serves this purpose.

Underground Houses

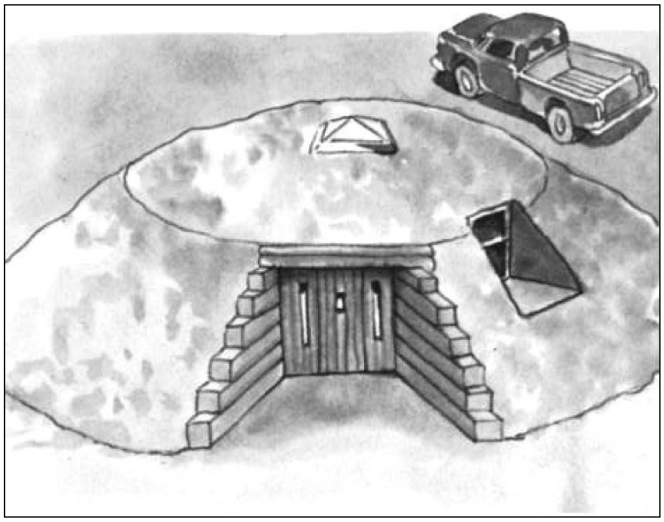
Houses that are built into the earth or beneath it are virtually immune to fuel shortages. This is because very little fuel is necessary to keep them heated comfortably above the surrounding temperature of the earth in which they are buried, a temperature that stays remarkably close to 55°F the year round.

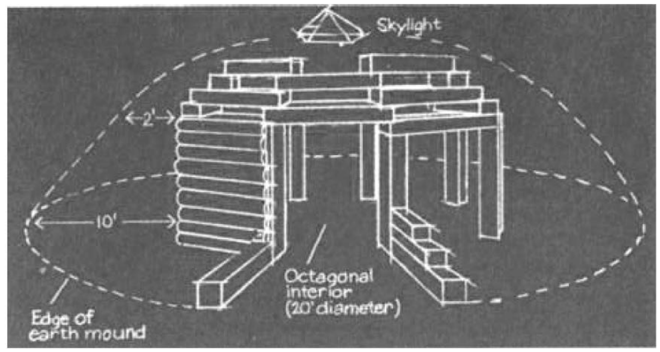
This impressive fuel-saving advantage is offset, however, by the desire of most people for open space and sunlight rather than the cavelike atmosphere of an underground dwelling. Moreover, since subsurface structures are surrounded by tons of earth, some individuals worry that the walls may collapse or that escape may be difficult in case of fire or other emergency.

Many underground houses have been built in this country. Those that have been are often only partly buried. This type of design can still achieve major fuel savings if the layout of the house permits the residents to live aboveground during the warm months of the year and belowground during the cold months. Even if a house is embedded more deeply in the earth, its design can still achieve a degree of airiness by incorporating skylights, sunken courtyards, and aboveground panels that deflect the sun's rays down light shafts. Another variant is to build the house into the side of a hill. That way one or more walls can be left exposed to let in sunlight and provide views of the countryside.

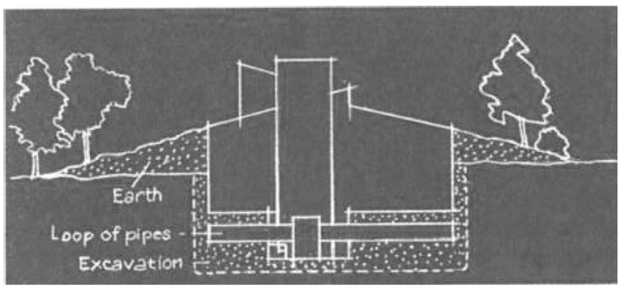
There are a number of special problems associated with underground structures. Erosion of the earth that covers the house must be kept in check. Usually this can be done by planting grass or shrubs that stabilize the soil. The shrubs should have short roots so they will not penetrate the walls or ceiling. An underground building must have enough strength to sustain the heavy load of earth pressing down on the dwelling. To achieve extra strength, underground houses are often built in the shape of a circle or octagon, designs that achieve a relatively even distribution of load. Roofs reinforced with steel beams and heavy concrete walls are also used.

Extra effort has to be made to keep belowground homes dry. Even with a waterproof vapor barrier around the structure that blocks moisture from the earth, the house must cope with condensation that accumulates inside. Surface houses have enough openings to let interior dampness quickly evaporate. Underground houses, however, need special ducts and blowers to keep them dehumidified. The problem is similar to the one many homeowners experience with their basements; but while a small portable dehumidifier will handle the moisture problem in the average basement, a much larger system is needed to control the humidity in an underground home.

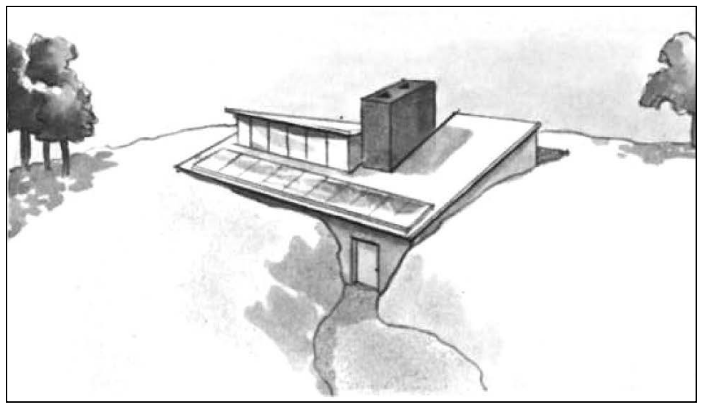


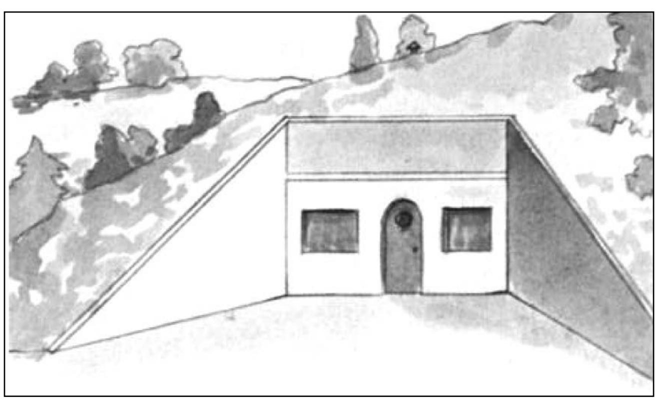


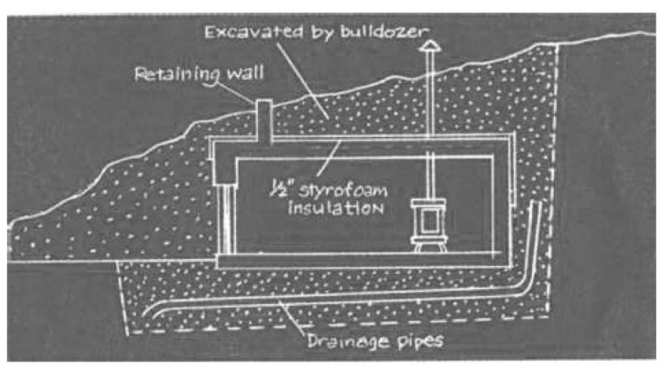
Traditional Navaho hogan is the basis for the design of this octagonal log-supported home in the southwest. The logs rest on footings of stone and form the roof as well. The structure is covered by a mixture of earth and pumice. A vapor barrier of asphalt paint and stucco protects the logs from moisture.



This New England structure is essentially a two-story house buried halfway in the earth. A sunken courtyard-greenhouse, like a solar collector, supplements the fossil-fuel heating system. In winter, heat is extracted by a heat pump from a deeply buried air pipe; in summer, cool air is pumped inside the same way.







Built into the side of a hill, this Midwest home is nearly impervious to the effects of wind, storms, and tornadoes. An asphalt coating waterproofs the concrete roof and walls, which support more than 1 million lb. of earth. Drainage tiles below footings channel away water that collects there as a result of soil seepage.

Wood as a Fuel

A Reliable, Renewable Home-Heating Fuel

Wood, as the old saying goes, warms two times: when you cut it and when you burn it. The saying sums up the chief virtues of heating by wood—healthy exercise, comforting warmth, and the homey pleasure of a wood fire. In addition, wood is widely available and economically competitive with fossil fuels. And if you gather your own firewood, the savings can be tremendous, cutting your yearly fuel bill from hundreds of dollars to practically nothing.

Managing a Woodlot

A woodlot can supply wood indefinitely if the quantity you take out of it each year is no more than the amount replaced by natural growth over the same period. As a rule of thumb, 1 acre of woodland can produce ⅔ cord of hardwood each year. (A cord is a stack measuring 4 feet by 4 feet by 8 feet.) If you own or have access to 10 acres of woodland, you should be able to harvest 6 to 7 cords a year—enough to heat an average three-bedroom house.

The better you manage your land, the less acreage you will need. Woodlot management is like tending a garden, except it takes longer to see the results—years instead of months. In execution, it is a program of selective cutting based on the age and condition of each tree and how closely one tree grows to the next. As in gardening experience is the greatest asset.

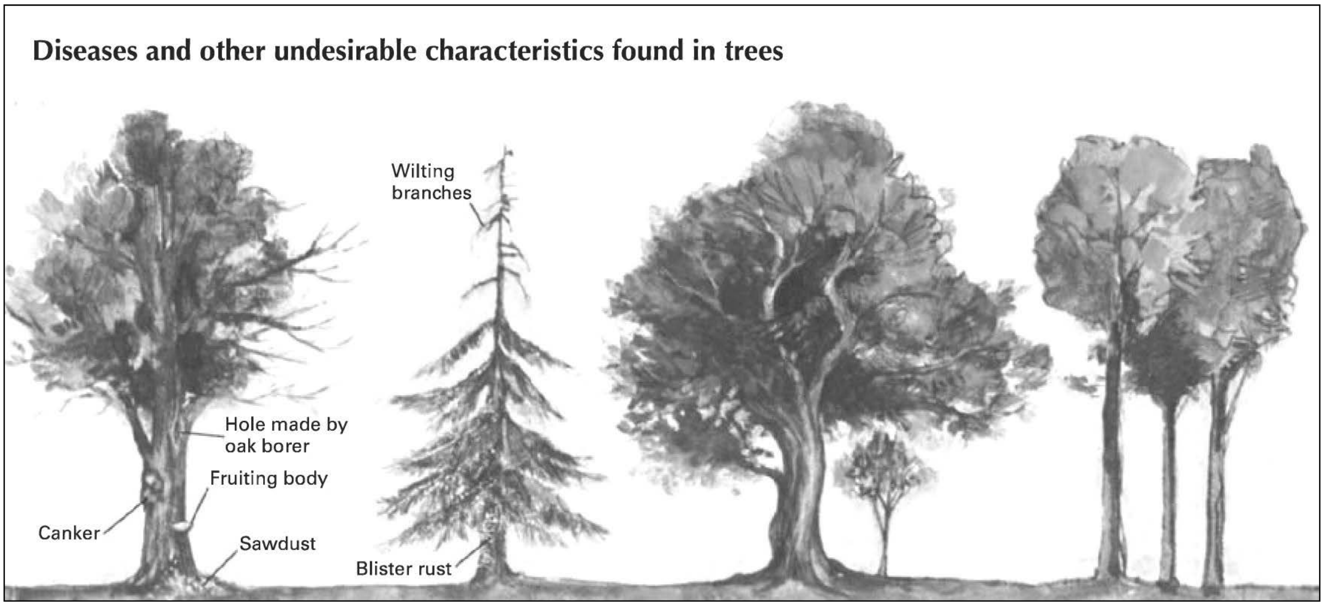
The first trees to cut down are those in an advanced state of decay and those damaged by disease or insects. These conditions are usually obvious, even to the inexperienced eye. As an exception, a tree with damage only to its leaves might be left for another season to see whether or not it is able to recover. Also, an occasional dead tree should be left standing as a home for wildlife. After damaged trees have been removed, harvest trees that have no potential value as lumber or trees that crowd others and inhibit their growth. Your county agent and state forester can both provide additional information on tree harvesting. The state forester may also be willing to go over your woodlot, marking the trees that should be culled.

Obtaining Wood

The cost of fuel wood depends very much on where you live and on the type of wood you are buying. In cities and treeless parts of the country you will probably have to pay much more for wood than in forested regions; and in either locale a cord of hardwood (generally more desirable for burning) is likely to be priced considerably higher than the same amount of softwood.

Wood is usually sold either by the cord or by the face cord. A cord is a stack of

Felling, bucking, splitting, and stacking a full cord of wood is a vigorous day's work for even the heartiest individual.



Fruiting body or a canker (an open wound caused by rot) on the trunk of a hardwood tree indicates serious disease. Damage by insects is typified by holes left by oak borers and a sawdustlike residue at the base of trunk that results from infestation by certain types of bark beetles.

Disease that often afflicts evergreen trees is blister rust. Wilting branches may indicate an attack by weevils, while extrusions of pitch from the trunk of the tree are signs that pine beetles are present. Even slight symptoms may mean extensive internal damage.

Wolf trees are trees that take up large amounts of space and are two twisted and gnarled to have value as lumber. Due to advanced age they grow very slowly, robbing smaller trees of sunlight and nutrients and underutilizing the sunlight that they do absorb.

Cull trees from groups that grow too closely together. Saplings, for example, should be about 6 ft. apart, trees with trunk diameter of 12in. Should be 18 ft. from each other. Sell straight, tall unblemished trees to a mill, since they are worth more as lumber than as fuel.

Unit	Dollar Cost for Equal Net Heat: Each column Shows the Fuel Unit Prices to Obtain Heat at the Same Cost Per Btu.										
gal.	$2.00	$2.10	$2.20	$2.30	$2.40	$2.50	$2.60	$2.70	$2.80	$2.90	$3.00
gal.	$1.25	$1.31	$1.38	$1.44	$1.50	$1.57	$1.63	$1.69	$1.75	$1.82	$1.88
gal.	$1.76	$1.97	$2.06	$2.16	$2.25	$2.34	$2.44	$2.53	$2.62	$2.72	$2.81
therm	$0.96	$1.46	$1.53	$1.60	$1.67	$1.74	$1.81	$1.87	$1.94	$2.01	$2.08
KWh	$0.00	$0.06	$0.06	$0.07	$0.07	$0.07	$0.08	$0.08	$0.08	$0.08	$2.09
cord	$267.35	$280.72	$294.09	$307.45	$320.82	$334.19	$347.56	$360.92	$374.29	$387.66	$401.03
ton	$236.31	$248.13	$259.94	$271.76	$283.57	$295.39	$307.20	$319.02	$330.84	$342.65	$354.47

This table compares prices of heating fuels on a Btu to Btu basis. Btus are units of heat energy. This approach is necessary because heating fuels are purchased in different kinds of units, such as gallons, therms, cords and kilowatt-hours (kWh), each containing a different amount of Btus. This table also factors in the different typical efficiencies of the heating systems that use the various fuels. The result is a more meaningful price comparison of the usable heat.

Find the price closest to the price for whatever fuel you are currently using. The alternative fuel you are considering will cost less per usable Btu if you can get it at a price LOWER than its price in the same column as the price for the fuel you are currently using. On the other hand, if the alternative fuel you are considering will cost you MORE than its price in the same column as the price you are paying for the fuel you are currently using, the alternative fuel with cost you more per unit of usable energy than the fuel you are currently using.

Characteristics of different kinds of firewood

Wood Species	Approx. Weight of 1 cord (in pounds)	Value of Air Drying	Resistance to Rot	Ease of splitting
Shagbark hickory	4,200	Little	Low	Intermediate
Black locust	4,000	Little	High	Intermediate
White oak	3,900	Some	High	Intermediate
American Beech	3,900	Some	Low	Difficult
Red oak	3,600	Some	Medium	Intermediate
Sugar maple	3,600	Some	Low	Intermediate
Yellow birch	3,600	Some	Low	Intermediate
White ash	3,500	Little	Low	Intermediate
Cherry	2,900	Little	High	Easy
American elm	2,900	High	Low	Difficult
Sycamore	2,800	High	Low	Difficult
Douglas fir	2,800	Variable	Medium	Easy
Eastern red cedar	2,700	Variable	High	Easy
Tulip (Yello poplar)	2,400	High	Medium	Easy
Hemlock	2,300	High	Low	Easy
White pine	2,100	Variable	Medium	Easy
BassWood	2,100	High	Low	Intermediate
Cottonwood	1,900	High	Low	Intermediate

Use the table at left when choosing firewood and making cost comparisons. When you buy by the cord, heavier wood gives more value per dollar, since weight is equivalent to heat. To find out how many pounds of wood of a particular species you get in a cord, look down the weight column. The figures assume that the wood has been air dried (20 percent of its weight remains water).

Before drying wood, check the column on value of air drying. Some woods have too little water in them to benefit much from drying; others should be dried six months or longer.

Dealers often describe the wood they are selling as hardwood. In general, hardwood is heavy and softwood is light. The division is only approximate, however. Some hardwoods are light, some softwoods heavy.

split or unsplit logs that measures 4 feet by 4 feet by 8 feet, but the amount you actually get in a cord will depend on how the wood is piled—in the old days some woodcutters developed an uncanny ability to stack cordwood with a maximum of airspace and a minimum of wood, and the practice, regrettably, has not entirely died out. The so-called face cord is not a cord at all but rather any pile that measures 4 feet high by 8 feet long. The width of the pile can be almost anything; sometimes it is no more than 12 inches and it is rarely more than 2 feet.

Wood is sometimes sold by the truckload. A ½-ton pickup will hold roughly ⅓ cord of wood. When buying by volume. Keep in mind that the heat value of wood is directly indicated by its dry weight. Unfortunately, when wood is still wet, it is not always easy to estimate the amount of water in it. Try to avoid woods with a high resin content; resin adds to creosote buildup in a chimney.

On many occasions you can obtain fuel wood at nominal cost or for free. Public parklands and forests, town dumps, and lumber mills are sources for such wood. Even private owners may let you on their land to clear dead or unusable timber.

Tools and Techniques for Harvesting Wood

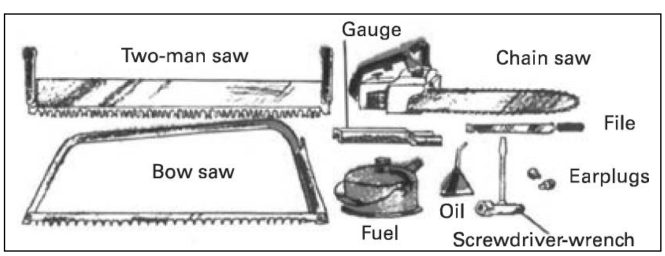
The best way to get fuel wood is to cut it yourself. Every step in the process—from felling the tree to bucking it into usable lengths to splitting and stacking it—provides vigorous outdoor exercise that is healthful and satisfying. With proper equipment and convenient access to the forest area in which you are working, you can harvest a cord of wood a day. A week or two of heavy work and you should have enough wood split and stacked to heat a reasonably well insulated house for one year (more wood will be needed, of course, in the colder parts of the nation, less in warmer climates).

Felling and bucking with a two-man saw can be quiet and sociable, but the efficient chain saw is the best choice for heavy work—it can cut through wood 10 to 30 times faster. Some chain saws run on gasoline, others on electricity. Gasoline models, although more expensive, are better for most purposes, since the electric versions require an extension cord (impractical in the deep woods) and are not as powerful. Chain saws can be dangerous. Make sure the model you get has all the available safety features, and read the instruction

Chain-saw operator is in process of making a 45° angle face cut, the second of three cuts made when felling a tree.

book carefully before using it. Chain saws are also noisy; operate them with consideration for your neighbors.

All your woodcutting tools, including the chain saw, should be kept sharp. Dull edges require much more labor and create hazards. Your chain saw will stay sharp longer if you avoid cutting through dirt-encrusted logs or allowing your saw to dig into the earth beneath a log. There are several signs of a dull chain saw: the chips become smaller, more force is required to make the saw bite into the wood, the wood smokes due to increased friction, and the saw does not cut straight.

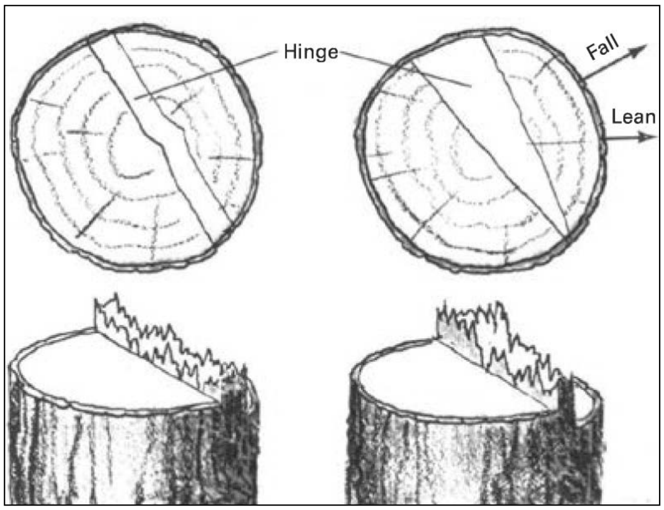


The blade of a bow saw is cheap. Replace blade when it gets dull. You can sharpen cutters on a chain saw, but be sure to use proper file and file guide and to follow instructions in your owner's manual. If in doubt, take chain saw to your dealer.

Felling a Tree

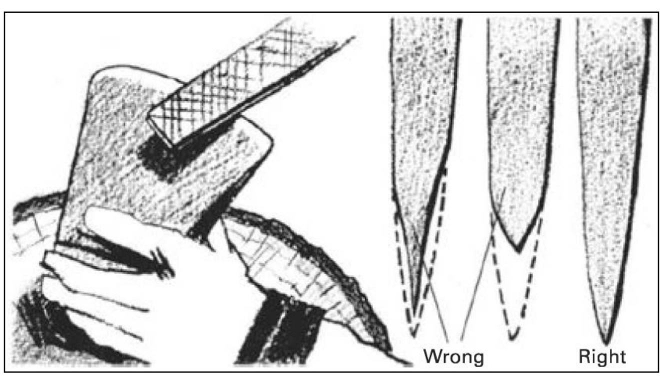
To get a tree to fall where you want, first make a notch on the side facing the desired direction of fall. This is done with two cuts: first the undercut, then the face cut. A third cut, the backcut, is then made at a slight angle downward, approaching the undercut about 1 inch above it. Leave an inch or two of uncut wood to act as a hinge to encourage the tree to tilt in the direction you want. If the tree does not fall of its own accord, push it with a long pole or peavey. Do not cut through the hinge.

Felling a tree can be dangerous. A side may be rotten, the tree may twist or bounce off another tree, or the trunk may rip loose and kick back in

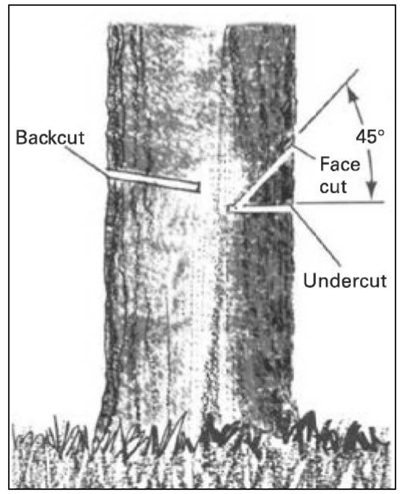


Pivoting technique lets you coax a tree to fall the way you want, even if it leans another way, provided the difference is not too great. Make backcut so that hinge is thicker at one end than the other. As tree falls, trunk will cling to wider end of hinge, causing it to pivot in that direction. Practice this technique in open woods before you try it in a tight spot.

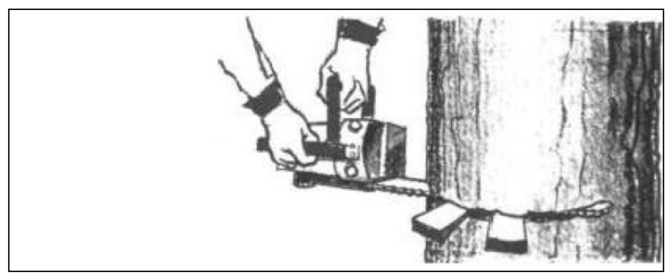
Keeping your ax sharp



Sharpen ax with carborundum file or use ax stone lubricated with light oil (avoid motor-driven grinders). Maintain original blunt taper. Do not try to take out every nick; you will only remove more metal than is necessary, shortening the life of ax.



A notch cut about one-third of way into trunk guides tree to fall in direction of notch. Set backcut higher than point of notch to prevent tree from falling backward. Tree will fall as planned unless it is leaning in some other direction. You can follow a similar cutting procedure with an ax, though control of fall will not be as precise.



Chain saw may bind when making backcut into a large tree. You should have a wood, plastic, or aluminum wedge with you to free the saw. Knock wedge into backcut until pressure is eased, then resume sawing. (By using more than one wedge, you can also encourage the tree to fall in the direction you want.)

the direction opposite to its fall. Dead branches may also fall on you. For these reasons it is vital to have at least one, preferably two, clear escape routes and to get out of the way as soon as the tree begins to fall.

From Tree to Firewood

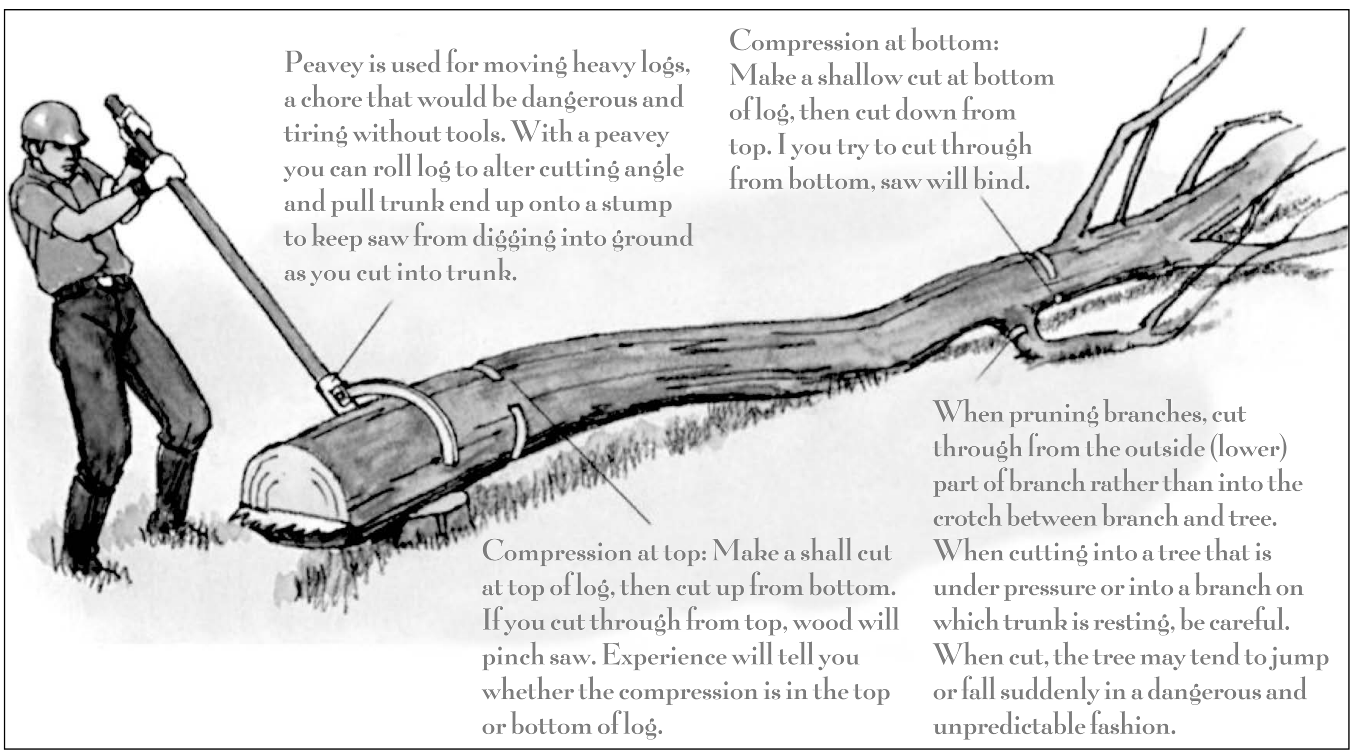
Winter is the best time for felling and bucking. The underbrush is thin, you sweat less, and there are no biting insects. Also, it is easier to spot dead trees and to choose safe paths of fall and good escape routes. Should there be snow on the ground, you will be able to slide logs about with less effort. On the average, a tree with a diameter of 12 to 14 inches will yield about ¼ cord of wood. One to two dozen such trees will probably satisfy the heating requirements of your house for one season.

When you cut a tree down, make sure the area is clear of people, particularly children. If the tree is near a house, attach a strong rope high up on the trunk and apply tension so that the tree will fall in a safe direction. You can get the rope up by weighing one end with a rock and throwing it over a limb. To apply tension, you can either have a helper pull on the rope from a safe distance or else attach the rope to another tree.

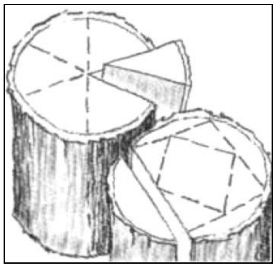
Once cut, a tree may hang up on another tree instead of falling all the way to the ground. If you cannot pry it loose with a peavey, tie a rope to its trunk and use a block and tackle attached to another tree to pull it loose.

When you remove a limb from a felled tree, make it a practice to stand on the side of the trunk *opposite* to the limb; that way you will minimize the risk of cutting your foot with the saw or ax. During the bucking operation (sawing the tree into logs), the weight of the tree as it sags can pinch your saw blade and bind it. The pinching is caused by compression, either along the top side of the fallen tree trunk or the bottom side. With practice, you will learn into which side to cut to avoid binding. When binding does occur, hammer a wedge into the cut to free the saw. The wedge should be made of wood, plastic, or other soft material to avoid damage to the saw.

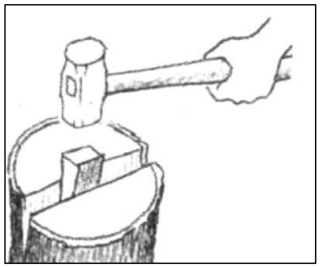
Limbing and bucking



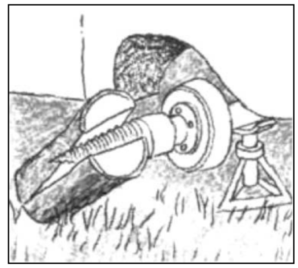
Splitting and stacking



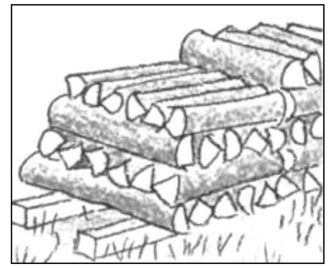
When splitting logs with an ax or splitting maul, proceed as if cutting a pie (left). However, if wood is twisted and fibrous (like elm), split it into tangential segments.



Heavy logs are better split with a sledgehammer and steel wedge. Never use the ax as a wedge or its poll (blunt end) as a hammer. You will ruin the ax.

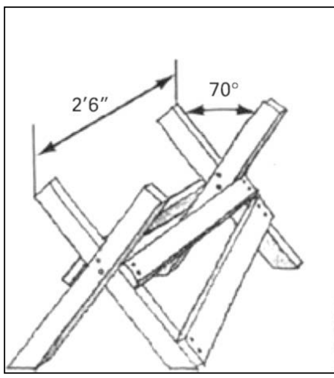


Splitting screw, Which attaches to the rear axle of a car, is one of several splitting devices on the market. Be sure to follow the manufacturer's instructions when using it.

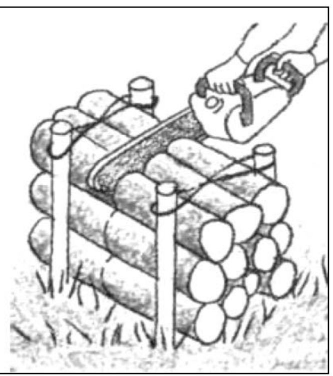


One way to stack woods so that pile does not topple is to build up the ends log cabin style, as show here. To protect from rain, place cordwood with bark up.

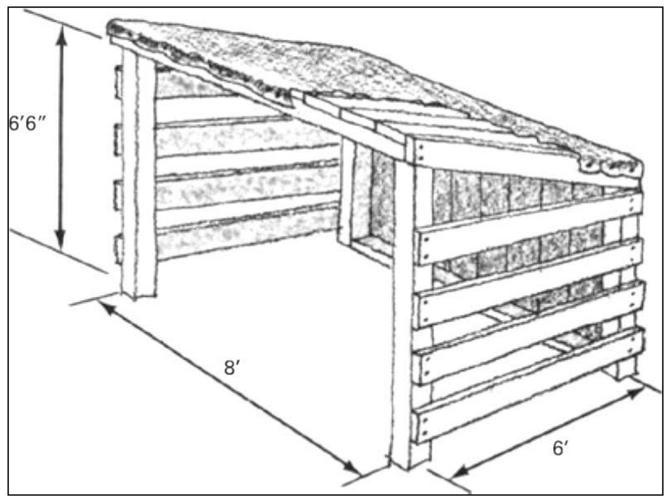
Sawbucks, cutting cribs, and woodsheds



Sawbuck holds log so that it will not shake or shift as you cut. Make sawbuck taller than necessary; use it, then trim it to most comfortable height.



Cutting crib lets you cut many logs at once. An easy way to make one is to drive four posts into ground, then rope tops together so posts do not spread.



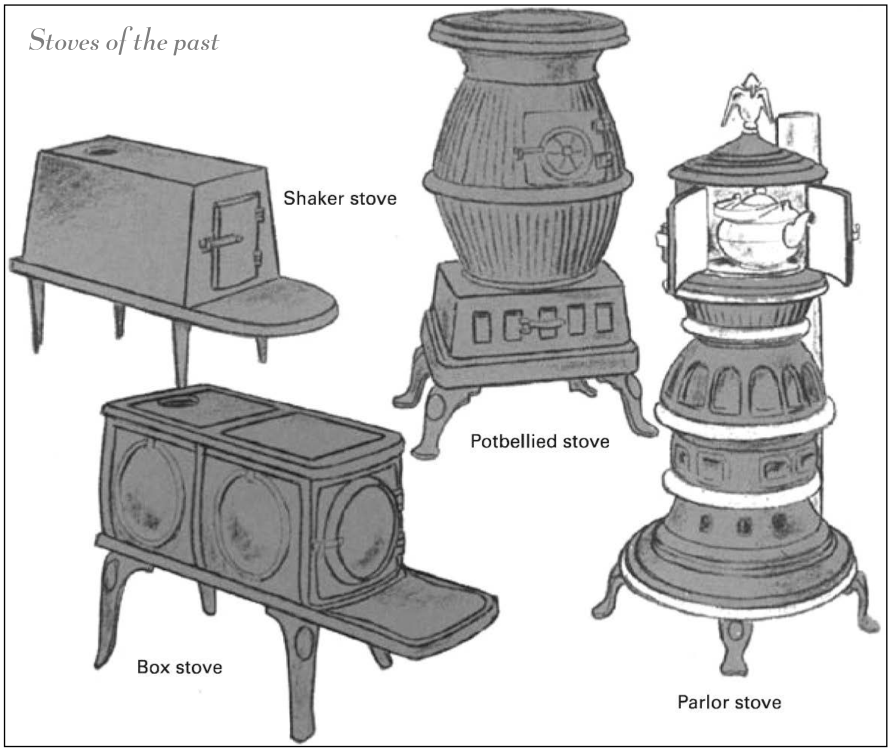
Woodshed can be made from scrap lumber. Protect stored wood from rain and snow, but allow enough air circulation inside to dry the wood. Store wood off the ground.

Wood-Burning Stoves: Plenty to Choose from Whether Old or New

Like the sun itself, a hearth fire or wood-burning stove radiates heat directly onto the human body. When you and your family cluster by the fireside on a frosty winter evening or gather near the cheery warmth of your stove, you will experience a satisfaction and comfort that modern central heating fails to equal. You will also be enjoying the only form of indoor heating that the human race has known for thousands of years.

Though they are charming and sometimes a bargain to operate, wood-burning devices require attention. Fuel must be replenished. Draft regulators and dampers have to be set, ashes must be removed, and the chimney must be cleaned out. Though drudgery for some, many people take pleasure in these chores, enjoying the direct hand they have in the control of their environment.

Stoves of the past



Stoves have been used to warm homes for centuries, but until recently, particularly in America, they took second place to fireplaces. In the 19th centrury, however, the development of techniques to produce cheap cast-iron plate helped iron stoves become the most popular home-heating devices. Hundreds of firms marketed stoves in a fantastic variety of shapes.

Iron stove design began with the box and the cylinder. A famous early version was invented by Franklin (see below). Despite the merits of his stove, it was soon supplanted by models that stood on legs and could be placed anywhere in the house rather than being tied to an existing fireplace or requiring special floor construction. At their peak iron stoves could boast of ashpits, built-in chambers for teakettles, secondary combustion chambers, and a lively baroque décor.

If you have never tried heating your home with wood, proceed gradually. For example, you might start with one stove, installed to heat one room, leaving the rest of the house to be heated by a more conventional system; in this way you can learn the virtues and idiosyncrasies of wood burning and be able to plan intelligently any expansion of its use. You may discover, for example, that wood burning might work well in conjunction with a solar energy installation, the former doing most of the job in midwinter, the latter handling the load in spring and autumn.

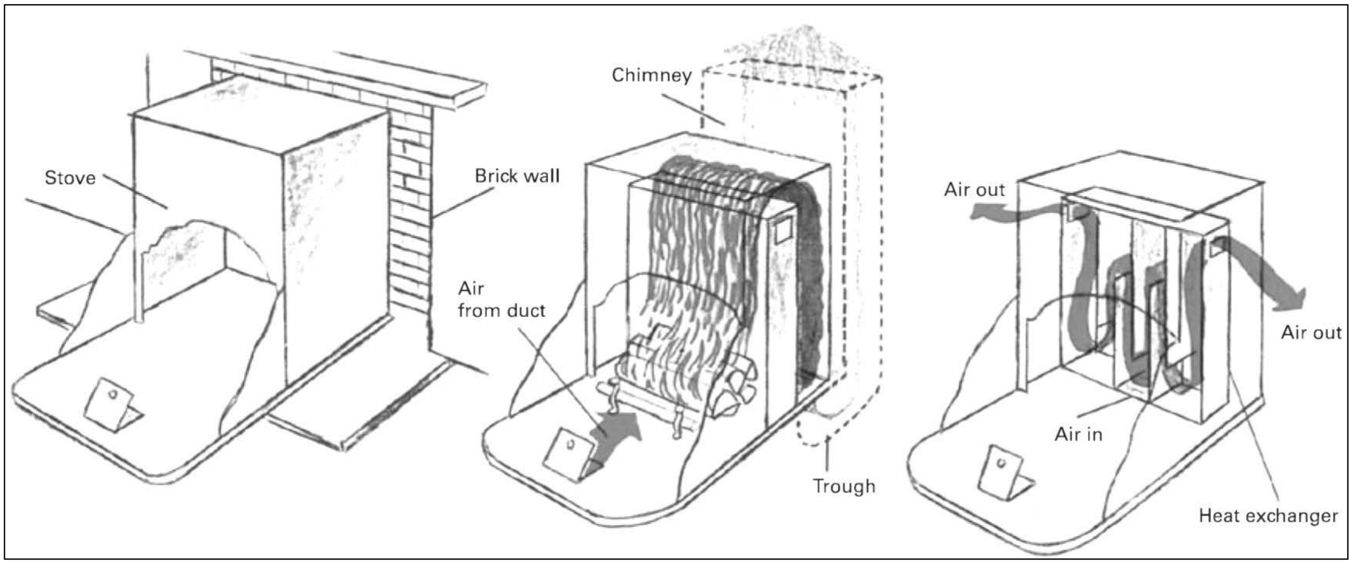
Making it easier for you is the wide array of wood-burning devices on the market today, most of good design, high efficiency, and excellent workmanship. With these at your disposal, you are likely to find the right stove for your situation whether you look for economy, aesthetic pleasure, or a combination of the two.

Modern Stoves

Recent developments in stoves have been mainly technological, an attempt to design a stove that will squeeze the last calorie of heat out of the wood being burned. Although there are many models on the market, no one stove can be singled out as generally superior to the rest. The best stove for you will depend on your personal taste, the purpose for which the stove is to be used, and on how the stove is installed and operated.

From the standpoint of efficiency, a good stove should not draw any more air than that needed for the wood and the gases given off by the wood to burn. Fireplaces, for example, for all their appeal and hominess, do not obey this rule. They gulp large amounts of unneeded air. In many homes, this air comes down the furnace and water heater chimney to create a potentially dangerous situation. Building codes or home insurance agents may require installation of a make-up or combustion air vent. To minimize this problem with stoves, many manufacturers make them airtight, meaning that the stoves are so well sealed and free of chinks that the air flow can be adjusted to the exact rate needed. You can even starve the fire of oxygen and make it go out. An incidental advantage of airtight stoves is

Ben Franklin's improved fireplace



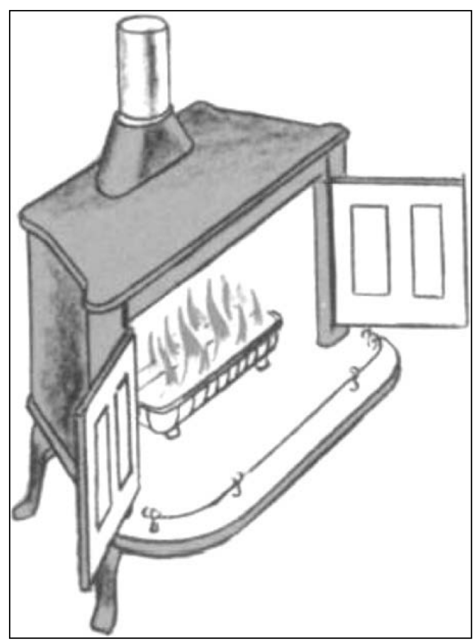
The Franklin stove of 1742 was designed expressly to improve on the notorious inefficiency of old-time fireplaces. It was an immediate success, gaining popularity during Franklin's lifetime and influencing stove design for years to come. Note, however, that the original Franklin should not be confused with what are now called Franklin stoves; the two types have little in common.

Fireplaces waste heat by sucking heated air from the room and sending it up the chimney. To circumvent this, Franklin blocked the chimney opening with a brick wall. To let smoke exit, he fitted a trough beneath the wall so that the smoke from his stove could exhaust under and up behind the wall. A damper inside the stove controlled the rate of exhaust. Fresh air was drawn from whatever space was under the floor (a cellar, for example) via a duct cut through the floor; the duct opened onto the fire.

To improve the stove's efficiency, a baffled heat exchanger was placed between the fire and the back of the stove. Air to the exchanger was channeled. The air in the heat exchanger absorbed heat from the fire and exhaust, passing out into the room via two ports, one on each side of the stove.

that they can be left untended for many hours, even overnight, while continuing to generate warmth at a fairly constant rate.

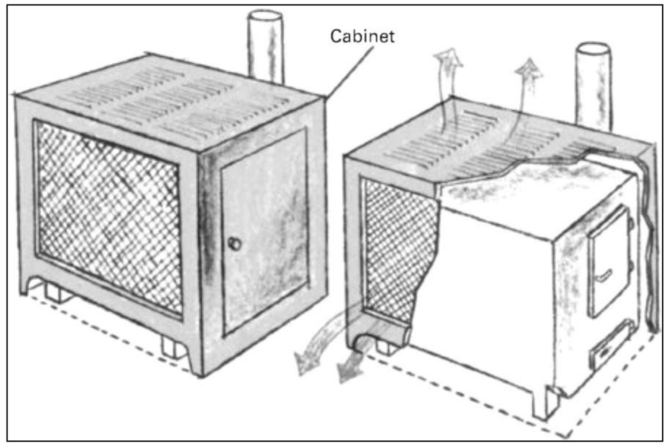
Another attribute of a good stove is that it transfers heat to the house rather than letting it go up the chimney. To accomplish this, a system of chambers or baffles is usually built into the stove. The hot air, smoke, and gases are channeled through the chambers or past the baffle walls. These, in turn, absorb the heat and radiate it into the room. There are a variety of stove modifications using this principle, some as simple as the single horizontal baffle plate design used in such European stoves as Lange, Jftul, Trolla, and Morsf; others with complex air-flow arrangements supported by secondary air inlets, as in the American-made Defiant, Tempwood, and Ashley stoves.



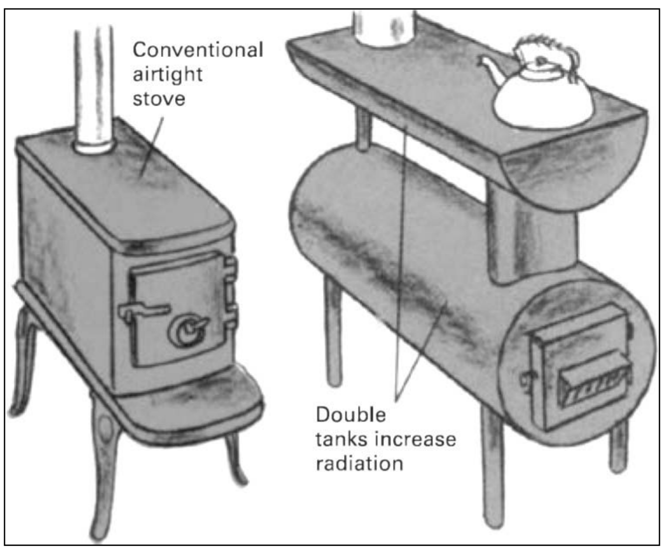
Franklin stoves as made today are only remote descendants of Ben Franklin's original design. The modern version amounts to a straightforward cast-iron stove, with doors in front that open to let you view the fire—a feature Franklin himself strove to keep. With doors closed the stove gains in efficiency but not up to the level that well-made airtight stoves attain.

As an added convenience, some stoves have a built-in thermostat; you set it for a particular temperature and the thermostat takes over, opening and closing the draft regulator (adjustable air inlet) to control the rate at which the fire burns. On stoves without a thermostat it is up to you to adjust the regulator to get the desired burn rate; you will learn by experience how to set it. To maintain a fire overnight, the regulator should be opened only a crack. Note, however, that slow burn rates can result in creosote buildup in the chimney.

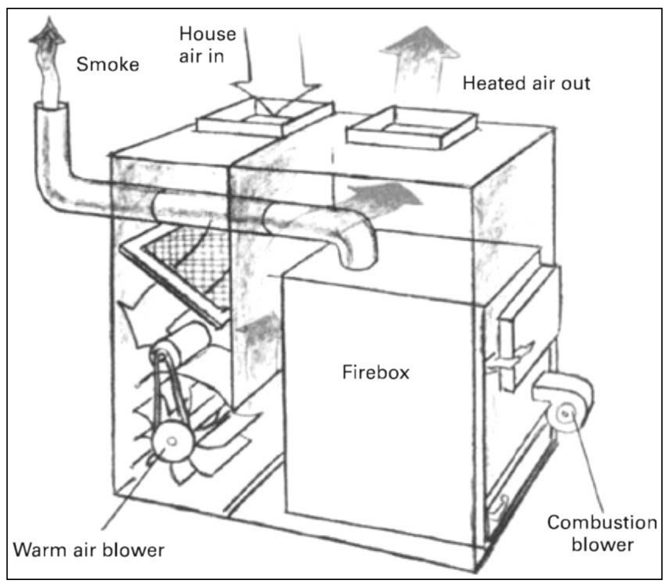
Some home heating units combine a wood-burning furnace with a conventional hot air system of the sort used with natural gas or oil burners. These have the advantage of heating the entire house with a single unite instead of with a number of stoves or fireplaces distributed in different rooms. Also, wood can be stored and dried in the basement, next to the



Circulator-type stoves, such as those made by Ashley and Rite-Way, are fabricated from steel plate and feature a cabinet (optional with some units) that surrounds the stove proper. Air between stove and cabinet heats up and is circulated out into room either naturally by convection or by a blower. A thermostatically controlled draft regulator is part of the design. Well-made units approach other airtight stoves in efficiency, but the warm air produced by the cabinet-enclosed models is generally not as pleasant as heat from radiant stoves.



Airtight stoves have top ranking for fuel savings, simple construction, ease of use, and long life. The design has been popular in Scandinavia for some time, and now American manufacturers, such as Fisher and Sunshine, make airtight units as well. One version, by Sevca, is built from a pair of empty propane tanks and features a separate smoke chamber above the fire chamber that extracts heat from the exhaust smoke and reradiates it into the room before it is lost up the chimney. The flat shelf shown offers a warming surface for the teakettle.



Wood-burning furnaces (see picture below) are essentially overgrown circulator stoves; their larger size is needed to accommodate the heating requirements of an entire house. They are normally installed in the cellar, just as an oil burner would be, and blow heated air through ducts to the rooms above.

furnace, minimizing handling and keeping the rest of the house free of wood chips. Countering these advantages, however, is the kind of heat provided;

most people find the radiant heat of a stove more comfortable than warm air from a register.

Selecting and Installing a Wood-Burning Stove

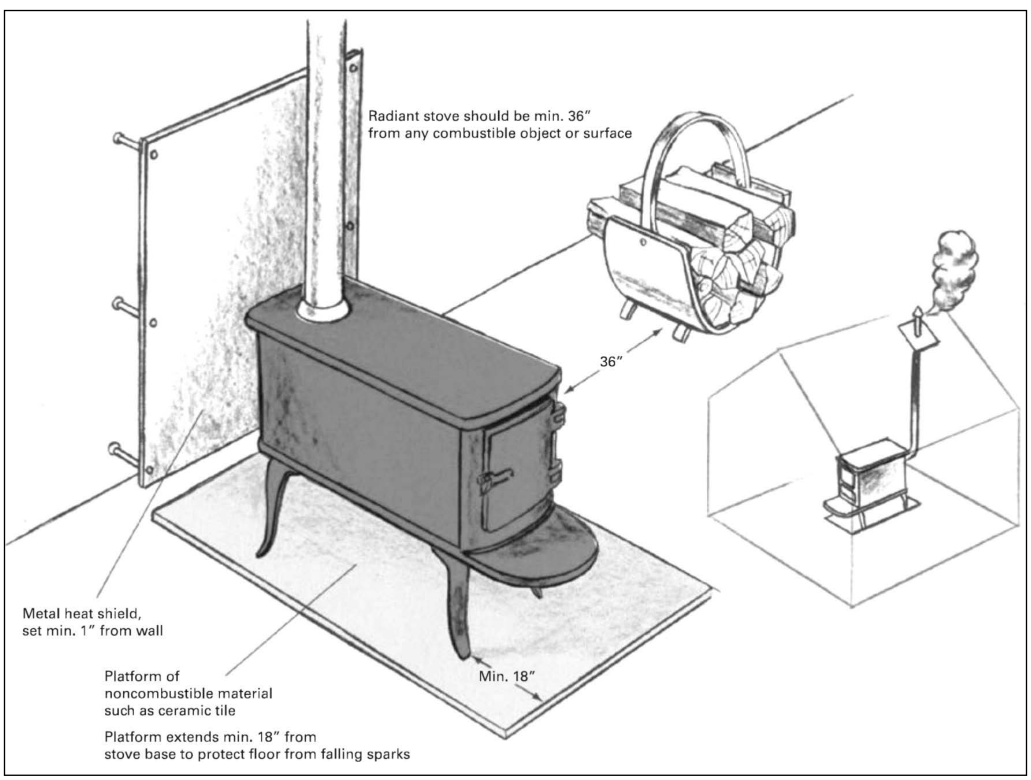
Choose a stove whose capacity matches the heating requirements of the space you intend to heat. A stove that is too small will have to be refueled frequently and still may not generate enough warmth. An overly large stove can be even worse, causing overheating on all but the coldest days, and more creosote build up from general use.

Manufacturers usually specify the heating characteristics of a stove in terms of the number of rooms or the number of cubic feet of space the stove can heat. In a few cases they give the heat output in BTUs per hour. An average-sized room contains about 1,500 cubic feet. When the temperature outside is at the freezing level, you should be able to heat such a room with a stove that puts out 15,000 BTUs per hour. Of course, there are many variables to consider. How well insulated and weatherproofed is your house? (The better your house retains heat, the smaller the stove you will need.) Is your home laid out ranch style or does it have a compact two-story design? (It is easier to heat a compact house than a sprawling single-level home.) What sort of wind velocities are typical in winter? (The more wind, the bigger the stove you will require.) Above all, you must consider the severity of the winter in your area. A stove that will function admirably in Maryland or Arkansas may work only marginally in New York, Kansas, and eastern Oregon and be totally inadequate in northern Maine, Minnesota, Montana, or Alaska.

Though a central location for the radiant heat unit is advisable, other considerations such as chimney location may take precedence. Bear in mind that you will frequently be transporting firewood into the house; the trail of dust, mud and wood chips that usually follows a trip from wood-pile to stove can become a nuisance. To shorten the trail, place the stove near the doorway through which the wood will be brought or install a through-the-wall woodbox.

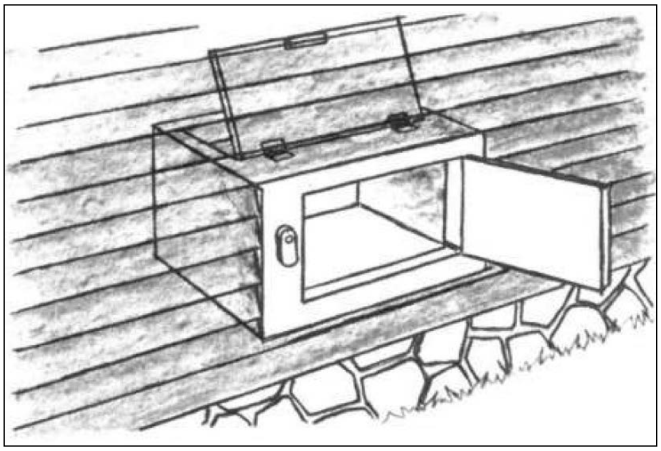
Buying a Used Stove

Not very long ago it was easy to find a discarded cast-iron parlor stove or cooking range.



Radiant stove will heat most effectively and evenly if is located toward the center of the house. Central placement of circulator-type stoves is less important; put them where they can take best advantage of natural air-flow patterns.

One style of woodbox



Through-the-wall woodbox conserves heat because you do not have to open house doors to fetch each load of wood. Keep interior of box dry to help prevent insect infestation and wood rot. Weatherstrip both doors.

Now, however, these have become treasured antiques, and unless you are lucky they will cost you as much as a new stove.

Besides being attractively designed, old stoves were made to last; however, many were built to burn coal rather than wood, so their fireboxes tended to be smaller. Wood can be used in a coal stove, but you must cut it into shorter pieces and load the stove more often.

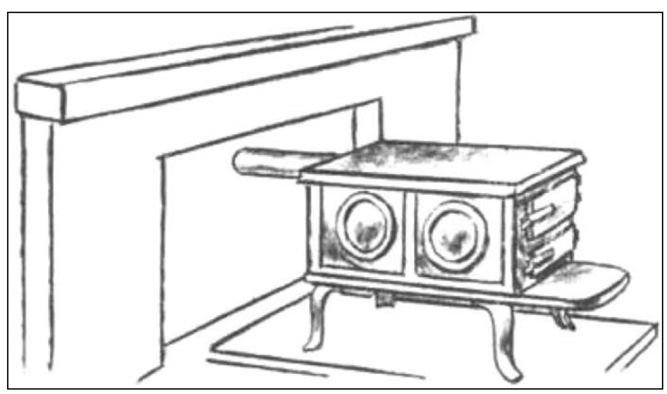
If you come across a stove you like, examine it carefully for cracks, particularly in the firebox. Cracks are responsible for inefficient operation and will cause the room to smoke up when the stove is started. Sometimes a cracked firebox can be fixed by welding or brazing, but this must be done by a specialist—repairing cast iron is a very tricky business. Cracks found in other parts of the stove, where the operating temperature does not rise as high, can be chinked with stove putty.

Before buying an old stove, be sure you will be able to replace essential parts, such as grates and doors, that happen to be warped, broken, or missing. There are a number of stove works around the country able to provide parts or cast new ones for you. Be wary of stoves that show signs of extensive rust. Surface rust can be removed with a wire brush followed by the use of stove black, but if vital inner parts are corroded, you may find it difficult or impossible to repair them.

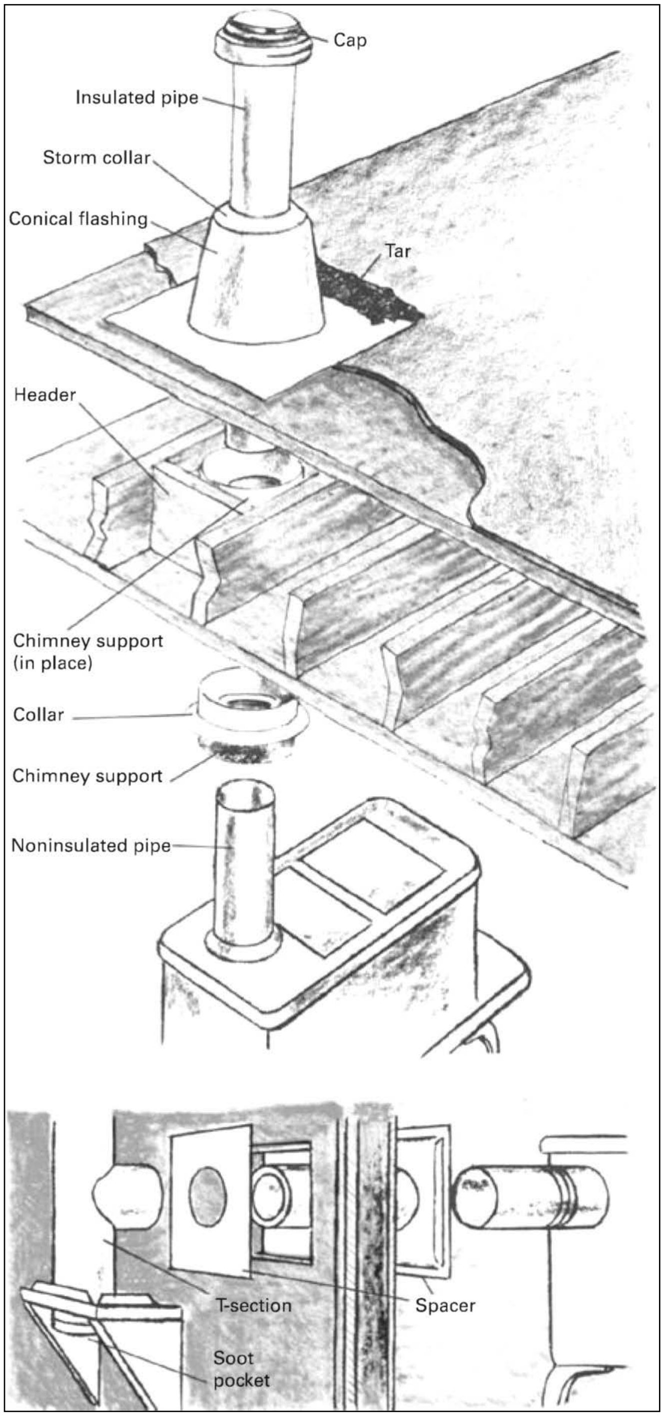
Chimney Installations

A properly designed and installed chimney will produce a strong, even draft through the stove without any backpuffing (smoke coming out of the stove). Backpuffing occurs when the chimney has the wrong capacity or too many bends in the way of the smoke path. The capacity of a chimney is determined by its height and inside diameter; the higher and wider the chimney, the more capacity it has. When the capacity is too small, the stove will smoke whenever you try to raise its heat output by opening the draft regulator beyond a certain point. When the capacity of the chimney is too large, smoking can also occur, since the rising smoke-saturated air loses too much heat to the chimney surface. As a result, the air rises more slowly, generating a back pressure whose effect is visible as backpuffing can also result from inadequate clearance at the chimney object within 10 horizontal feet of it.

Using a fireplace chimney



To connect a stove to an existing fireplace chimney, remove fireplace damper and frame. Install stainless steel liner in chimney and extend above the chimney. Seal with sheetmetal where liner exits damper throat. Fill between liner and masonry chimney with hi-temp insulation or cement slurry. Seal top of liner with sheetmetal and add proper cap. Connect the stove collar.



Special spacer made of noncombustible material must be used to support any stovepipe that passes through a frame wall. A useful addition is to install T-sections with soot pockets and cleanouts in place of ordinary 90° bends in stovepipe.

Usually, smoke problems arise only when you connect to an existing chimney. Typically, a masonry chimney may have too large a capacity; a metal chimney, too small a capacity. Do not connect to a chimney already used by another stove or fuel burner. When installing a new chimney, match the inside diameter of the chimney to the diameter of the stove's exhaust flue.

A sage installation is vital. You risk burning down your house if an uninsulated stovepipe touches or passes near a part of the house made of wood or other flammable material. Manufacturers of prefabricated chimneys give installation guidelines, but check building code requirements for your area also.

Installing A Prefab Chimney

1. Set stove in desired position, then use plumb bob to find center of hole that will be cut in ceiling for chimney. Ideally, chimney should pass through gap between roof beams. To locate beams, tap ceiling.
2. Draw a square on ceiling around center mark just large enough to accommodate chimney support (for example, 11 by 11 in. for 7-in.-diameter flue).
3. Cut square out of ceiling with compass saw.
4. Drill guide hole up through roof at one of four corners of square opening.
5. Working on top of roof, use guide hole to help draw and cut out a square hole centered on hole in ceiling below but 3 in. larger in each dimension (14 by 14 in. for the example here).
6. Saw through any beams that block 11 by 11 in. opening.
7. Cut headers to fit opening, then nail them in place between roof beams. Drive in nails at 45° angle.
8. Lift chimney support into hole in ceiling from below. Fasten support to adjacent beams and headers by hammering eightpenny nails through collar of support into beams and headers.
9. Lower insulated pipe section into chimney support from roof. (The section simply rests in support; conical flashing placed later will restrain section from toppling.)

10. Apply liberal amount of roofing tar to roof around 14 by 14 in. hole. Slip conical flashing down onto tarred area.

11. Add additional section of insulated pipe; then tighten band that locks sections together.
12. Put on storm collar and cap.
13. Nail rim of flashing to roof; then add more tar along flashing edges.

14. Seal gap between storm collar and pipe with caulking compound. (The purpose of the compound, and the tar around flashing edges, is to seal installation from inclement weather.)
15. Install noninsulated stovepipe by pushing it up from below into chimney support. Then attach stovepipe bottom to exhaust flue on stove.

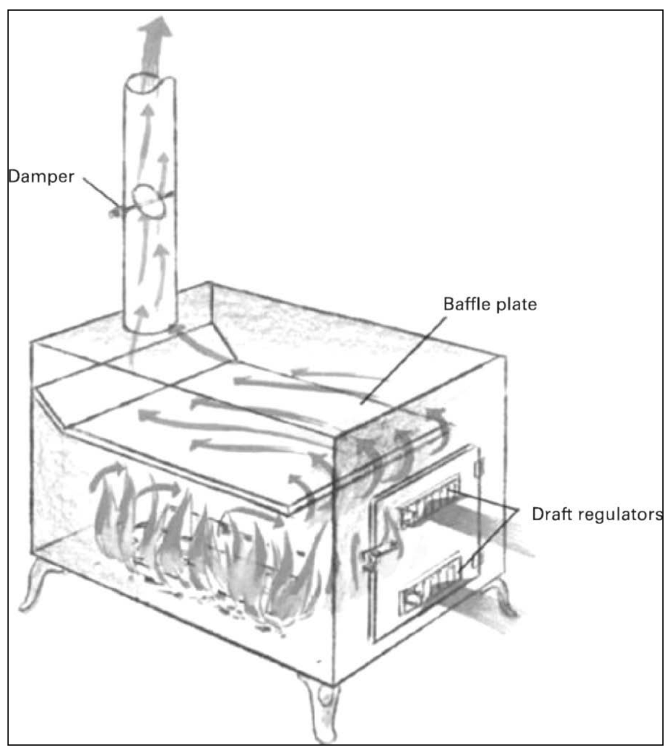
Starting and Operating a Wood-Burning Stove

To start up a fire in a wood stove, place a pile a kindling (thin slivers of quick-burning wood) over crumpled newspaper and top the pile with several light pieces of split wood. Open the draft regulator (and chimney damper if the stove has one), ignite the paper, and shut the stove door. After a few minutes, when the fire is going well, add larger and heavier pieces of wood—enough to fill almost the entire combustion chamber of the stove if you want a long burn. To avoid troublesome starting, use wood that is dry and dully seasoned.

As soon as the larger pieces of wood have caught fire, close the draft regulator two-thirds of the way or more. The further you close it, the slower the burn rate and the longer the fire will last. Remember, however, that a slow fire tends to increase creosote buildup (see facing page).

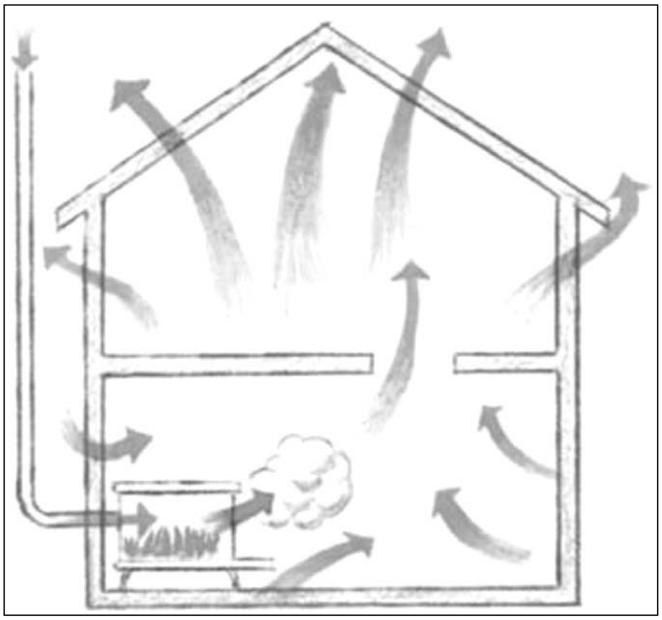
With a little trial and error in setting the stove's regulator, you will learn how to correct for external factors such as outside temperature, presence or absence of sunlight, and degree of wind chill. On very cold days, for example, you will find that the draft up the chimney is stronger than usual because the difference between inside and outside temperatures is greater. The result may be an excessively fast burn rate. To compensate, you should close the draft regulator or chimney damper a bit more than you would normally.

Stove controls



Draft regulators and chimney dampers let you control the flow of air into the stove and up through the chimney; this, in turn, lets you regulate how fast the fire burns. Sometimes both are needed, but on airtight stoves draft regulators are sufficient for this purpose and the chimney damper may be omitted.

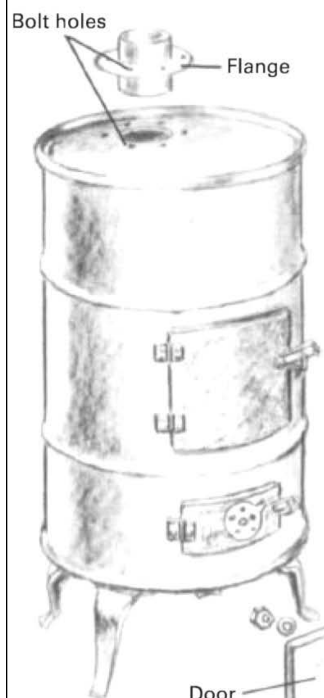
Draft reversal

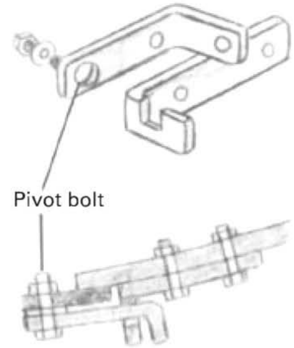


Warm stove air sometimes chooses a path through the house rather than up the chimney. Air then flows down chimney and into room. This is called draft reversal and is more common with exterior chimneys. To counteract the effect, open a window near stove. Also, before starting fire, ignite wad of paper in stovepipe. Once chimney is warm, air will go up it.

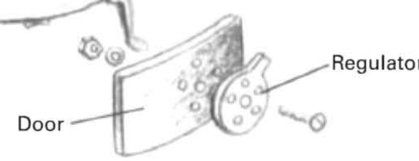
Making your own stove

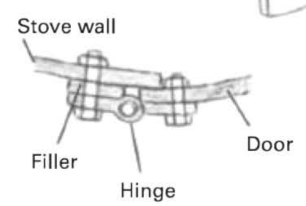
Small wood stove can be made from a 15-gal. Closed-head heavy gauge grease drum after cleaning drum of any residue of grease. Tolerances need not be precise. One weld and some furnace cement to hold stovepipe flange to stove top are needed. All other parts bolt on. Cut rectangular openings for fuel loading and ash removal; then cut doors from sheet metal to overlap the opening ½ in. all around.





Make door catches from 4-in. corner braces. Cut and notch with hacksaw; fit braces to curve of drum by filing and bending.





Cut draft regulators out of sheet metal; drill holes into them and through the doors in the pattern shown, then bolt in place. Door hinges should also be bolted on.

Kits for converting oil drums into stoves usually include legs, door assembly with draft regulator, and a 6-in. stovepipe flange. The picture shows a 55-gal. drum with parts bolted on. (For a longer stove life, a discarded water-heater tank might be substituted for the oil drum illustrated.)

Of course, if your stove has a thermostatically controlled regulator, these adjustments are made for you automatically.

Even with a well-designed chimney, a stove may occasionally backpuff. If this happens as you fire up the stove, try closing the draft regulator a bit. If backpuffing tends to occur when you add fuel, open up the regulator a minute or two before opening the stove door; increasing the draft will carry the smoke up the chimney.

Smoking can also be a sign of creosote buildup in the chimney, since this condition promotes chimney fires, it should be eliminated. Poor chimney design is another cause of smoking. Finally, tight house construction and/or kitchen and both exhaust fans can make a fireplace or non-airtight stove backpuff by restricting the air supply. Opening a nearby window a crack to increase air flow into the house will probably clear up the difficulty.

Safety

Anything that is flammable—curtains, clothing, paintings, furniture, wall hangings—can catch fire if it is repeatedly heated to 300°F or above. Since a stove will soon bring nearby objects to this temperature, it is vital to adhere to the standard set by the National Fire Protection Association by keeping flammable materials at least 3 feet away from any wood-burning device.

Chimney fires are another hazard. Creosote, a wood by-product, tends to accumulate on chimney walls and may be touched off by sparks or flames from the stove. A chimney fire generally has a crackling or roaring sound. As the fire's intensity increases, the stovepipe may vibrate violently and turn red hot. If the chimney is well built, and all metal chimney joints have at least three screws, the fire will likely die out without causing any damage. In some cases, however, it may become so hot that it ignites nearby wall lathing, wooden beams, or other structural members. In addition, chimney fires occasionally send clouds of sparks onto the roof, setting the roof aflame.

The first step to take in the event of a chimney fire is to stop the flow of air to the fire. This is easily done on an airtight stove by closing all draft regulators. With a fireplace, you should have a large metal cover available that can quickly be put over the fireplace opening. With a leaky stove, a sopping wet blanket thrown over it may serve to stop the flow of air through the leaks. Have a bucket of water ready to wet the blanket down, since the moisture may quickly steam of and leave a dry blanket to catch fire. As soon as you can, check the roof for sparks and wet it down with a hose if there is any sign of danger. If the chimney passes through upper floors of the house, inspect all areas adjacent to the chimney. You should certainly have several fire extinguishers handy in the event the fire starts to spread. Above all, if there is any hint that the fire is spreading beyond the confines of the chimney, call the fire department at once.

The best defense against a chimney fire is prevention. Clean your chimney regularly and operate your stove or fireplace so as to minimize creosote buildup. Details are given at right. Almost as important, you should make certain your chimney is in good running order. You will need to inspect it carefully to determine its condition. Do not assume that it is adequate simply because it has been in service for a number of years. Old stovepipes may not meet present-day requirements. If the chimney is made of brick, its flue may be cracked, the mortar may be partially disintegrated, or the chimney may have been built without a flue liner. If you have any doubts about the safety of a chimney, contact your local fire department; it can save you money and heartache.

The Creosote Problem

Creosote is substance deposited on chimney walls by smoke flowing up the chimney. Chemically, creosote is a mixture of unburned organic compounds. When hot, it appears as a dark, viscous liquid. When it cools, it forms a solid, tarry residue that may later turn to a black ash that seems to grow from the inner surface of the chimney in leaflike flakes. Creosote can burn, making it a fire hazard. It may also build up to such a point that it partially or completely blocks the air flow up the chimney, making the stove smoky and hard to light.

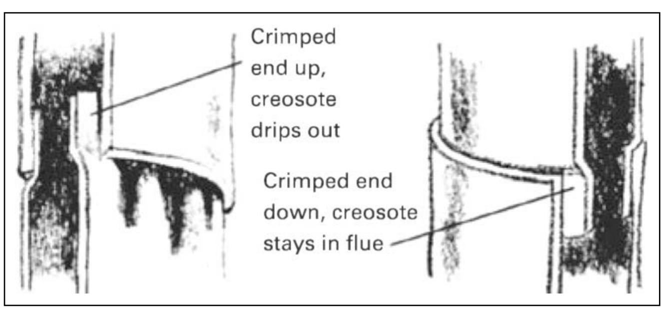
Contrary to what one might expect, the more efficient a stove is, the more apt it is to produce creosote. Leaky, inefficient stoves burn hot and fast, and the chimney walls become so hot that creosote does not have a chance to form on them.

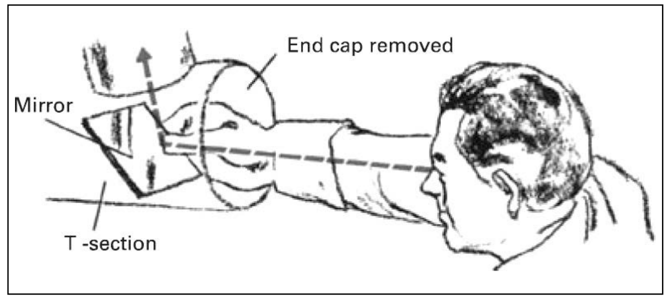
If your chimney becomes clogged frequently by creosote, you may be running the stove at too low a burn rate. A smoldering overnight fire sends a lot of creosote-forming smoke up the chimney.

To get an overnight burn with a minimum of creosote, run your stove hot, until the wood in it has been mostly reduced to charcoal, before closing down the draft regulator to its nighttime position. Of course, some heat will be wasted during the initial high burn period (unless the stove is adjacent to a large thermal mass, such as a heavy masonry wall, that absorbs heat and reradiates it back into the room overnight). A daytime approach, especially useful in the fall and spring when less heat is needed, is to make small, hot, quick-burning fires rather than cool, slowburning ones. You will have to refuel the fire often, but combustion will be more complete.

Hot creosote will drip down the chimney. Ideally, it will flow into the stove and be burned up. But if the stovepipe is a poorly joined metal one, the creosote may drip out of the joints and make a disagreeable mess. To discourage this, it is preferable to install the stovepipe and chimney sections with crimped ends inserted downward. This arrangement is typical of European chimneys but the opposite of traditional American practice.

If your chimney runs straight up, you can inspect for creosote buildup by holding a mirror inside the stove when the stove is cold. Hold the mirror at a 45° angle directly under the flue opening. You can estimate the amount of creosote by the amount of daylight you can see. If you have a metal chimney with turns, T-sections installed at appropriate locations will permit you to check most of the chimney.





A simpler but less reliable estimate can be made by tapping the stovepipe with a finger; the tap will produce a tinging sound if the pipe is clear but a duller, heavier sound if the pipe walls are laden with creosote.

Cleaning a chimney

The chimney on an airtight stove can become clogged in a short a time as two weeks if the stove is used carelessly. On the other hand, a stove used regularly and properly in a cold climate may need its chimney cleaned no more than once a year.

Cleaning a chimney is a messy job, and many prefer to hire a chimney sweep to do it. Some stove owners try to avoid the job by running a very hot fire once or twice a week to burn out accumulated creosote. The method is not reliable, however, and in addition such fires may eventually damage the chimney and break down its insulating properties. Chemical preparations are available that help disintegrate creosote when they are thrown on the fire. But first check with a stove or chimney dealer to make sure the preparation will not damage the chimney liner.

The best cleaning method is to lower a stiff chimney brush through the top opening. Work the brush up and down to knock soot and creosote down the stove pipe and into the firebox where it can be cleaned out. The stove should be cold. It also should be shut tight, otherwise clouds of soot may waft into the room. To better seal the doors, lap several pages of newsprint over the opening and close the doors onto the paper and latch them shut. (For the same reason, when cleaning a fireplace chimney, cover the fireplace opening as tightly as you can.) Never use tire chains in a burlap bag. This can easily break tile or cement lined chimneys and internal mortar joints. Old-timers sometimes tied a rock to the top of a small evergreen tree and lowered the tree upside down by rope from the top of the chimney.

Fireplaces: Warm, Charming . . . and Inefficient

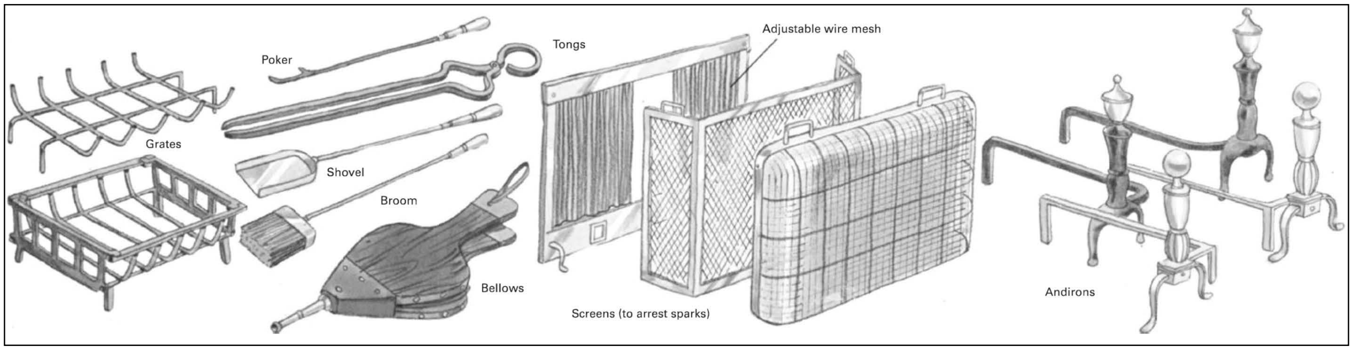
A fire glowing and crackling in a fireplace generates an aura that no other type of heating can equal. The aroma of burning wood, the play of light and shadow, the warmth from the flaming logs evoke a sense of peacefulness, security, and contentment. It is no wonder that wood-burning fireplaces are prized features of homes and apartments. At the same time, there is no denying that the heating efficiency of most fireplaces is low—less than 10 percent in many cases compared with upward of 60 percent for the best airtight stoves.

To start the fire, first pile kindling (thin pieces of dry wood that burn quickly) on balls of crumpled newspaper place between the andirons. Top the kindling with light pieces of split wood and two or more logs. Open the chimney damper and ignite the newspaper.
Caution: Never pour kerosene or other flammable liquid on the wood to help start the fire.

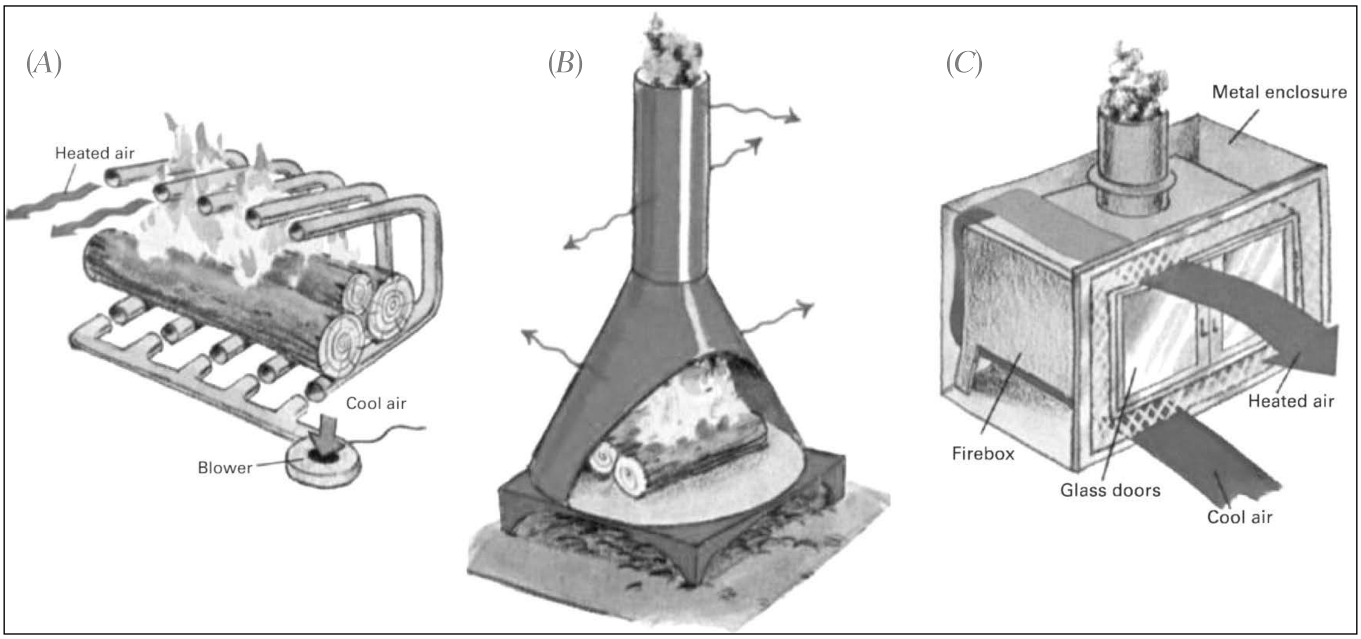
Much can be done, however, to improve the performance of even the oldest and most wasteful fireplace. Among the simpler steps is to make more effective use of the damper—a pivoted metal plate that can be adjusted to control air flow in the chimney. When the fire is burning, open the damper just enough to keep the fire from smoking. This will reduce the amount of heated room air lost up the chimney. It is also important to close the damper completely when the fireplace is not in use. This simple precaution, observed winter long, may reduce your overall heating costs significantly. The reason is that with the damper open enough warm air can be lost up the chimney to turn the fireplace into a heating liability rather than an asset. However, do not close the damper when the fire is still smoldering; otherwise you will wind up with a house full of smoke and noxious gases. To prevent heat loss up the chimney when the fire is low but not yet fully out, place a tight-fitting cover made of sheet metal over the fireplace opening. Few manufacturers make these covers, but it is easy enough to cut one out yourself.

Fireplace efficiency can also be boosted with the help of special equipment. One useful accessory is the tubular convection grate illustrated on the next page. Also described on the next page is a heat-saving fire-place that convects air around the firebox via ducts or enclosed spaces and then sends the heated air back into the room. Prefabricated units often incorporate this design. Modern masonry units, too, frequently use the same approach. To some degree, however, these improvements change the character of the fireplace, making it somewhat like a circulator-type stove and diluting the esthetic appeal that makes a fireplace attractive. Another effective device for raising fireplace efficiency is airtight glass doors fitted over the fireplace opening. These doors cut down on the amount of warm air lost up the chimney but also isolate the fireplace from the room; you can see the fire, but you lose intimacy with it.

Implements and accessories for the fireplace



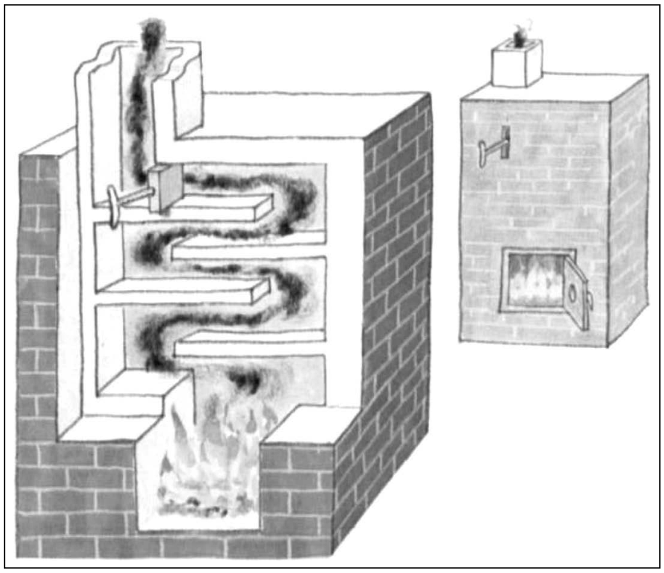
Equipment for improved efficiency



(A) Tubular convection grate, used in place of an ordinary grate or and-irons, serves as a ready-made heat exchanger for a fireplace. The fire heats the air inside the tubes, causing it to flow by convection out of the top openings. Efficiency is increased, since warm air goes into the room rather than up the chimney. A blower attached to the bottom openings of the tube will speed heat transfer.
(B) Freestanding fireplace is easier to install than a built-in unit. Like a metal stove, it radiates heat in all directions. However, without masonry to slow heat transfer, the fire must be tended more often than with a masonry unit.
(C) Prefabricated fireplace uses a special metal firebox so well insulated that the unit can be installed with "zero clearance," that is, directly next to wooden framing. Prefabricated fireplaces often come with airtight glass doors in front to reduce heat loss and a system of air ducts and spaces to circulate room air around the firebox and then out into the room again by convection. Like any wood-burning heater, performance is improved if the chimney is installed entirely inside the house.

Most people eventually develop their own techniques for building fires, yet there are nuances that are sometimes overlooked. When the logs are too close, not enough air will flow between them to support efficient burning; when they are too far apart, the logs will not absorb enough heat from adjacent logs to reach combustion temperature. Adjust the spacing for minimum smoke and maximum burn rate. A poker and tongs will come in handy for this chore.

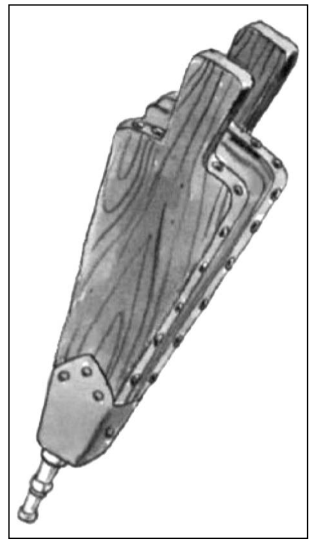
A common problem is a fireplace that backpuffs smoke into the room when the fire is started.



Masonry and ceramic stoves

Large masonry and ceramic stoves evolved over the years from continued attempts to improve fireplace efficiency. Originally developed in Europe, and later imported to the New World by the Pennsylvania Dutch and other early settlers, the stoves are vastly more efficient than the old-fashioned fireplace. (Their obvious advantages helped inspire Ben Franklin to design his famous fireplace stove.) Shown at left is a massive Russian-style brick stove featuring a serpentine arrangement of exhaust ducts to capture the heat before it can escape up the chimney. The stove is built entirely within the house. It is fired for a brief time with a very hot fire ad damped only after the wood has burned down to smokeless coals. The heat from the fire is absorbed by the masonry, which slowly reradiates into the room. From one firing enough heat can be stored in the masonry to warm a room for two days, and the heat given off remains remarkably even for that period. Since the fire burns hot, little creosote forms in the exhaust, making the stove one of the few wood-burning devices that can be left untended for long periods without collecting creosote.

Making your own bellows



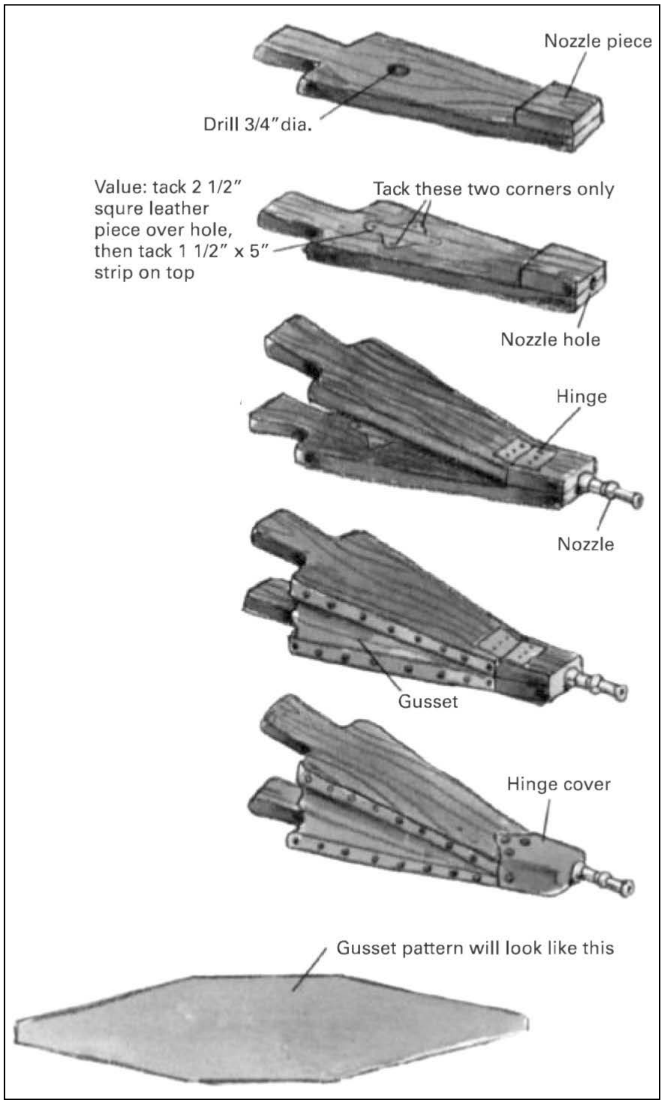
Basic materials for a good-looking bellows are a 3-ft. length of ½,-by 8-in. white pine and a few square feet of supple leather, such as split cowhide. For a nozzle, use ⅜-in. copper tubing or an old garden hose nozzle with its insides removed. When gluing, use casein or plastic resin, not white glue. Some ½-in. tacks and several dozen upholstery nails are also needed.

An effective remedy is to hold a wad of burning newspaper directly under the chimney flue before lighting the main fire. This prewarms the walls of the chimney, making it more apt to draw properly. If the problem persists, the house may be overly airtight. Open up a nearby window an inch or two until the fire is burning well. Check the furnace and water heater draft hoods to make sure replacement air is not also being pulled down their chimneys. If it is, contact your gas utility or state energy office for advice. (An inadequate chimney, poorly designed fireplace, or house exhaust fans may also be to blame.)

Waterpower

Streams and Rivers Provide Energy Free for the Taking

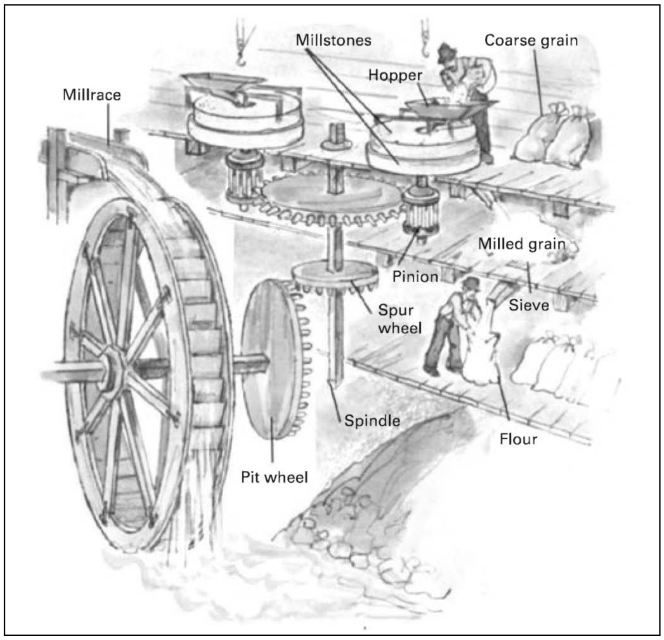
The use of waterwheels to free human beings from heavy labor is almost as ancient as the use of draft animals. The earliest applications of such wheels were to raise water from wells and to turn millstones to grind grain. Later, waterwheels were adapted to provide power for other processes to which a slow, ponderous, unceasing rotary motion was suited. In early America, textile factories and sawmills were generally built on riverbanks to take advantage of waterpower.



1. Cut bellows halves and nozzle piece from wood.
2. Cut valve parts from leather and tack over hole in lower bellows half.
3. Glue nozzle piece to lower bellows half.
4. After glue hardens, drill hole for nozzle; then glue nozzle into hole.
5. Cut hinge from leather and tack into place.
6. Prop bellows handles 4 in. apart. Tack cloth to edges where gusset is to be nailed; cut cloth along edges and remove it.
7. With cloth as pattern, cut gusset from leather. Starting from handles, nail gusset to bellows.
8. Make hinge cover pattern out of cloth; following pattern, cut cover from leather and then nail cover over hinge.

With the advent of steam power in the 19th century, the massive, wooden waterwheel became obsolete, and water did not again compete as a power source until the invention of the highspeed turbine for generating electricity. This development not only led to huge hydroelectric installations but also made small, private hydropower installations possible.

A personal hydroelectric power source has the potential to sustain every household energy need and provide an unexcelled level of independence. Having enough water flow is less a problem than one might imagine, particularly in hilly areas where hundreds of thousands of potential hydroelectric sites remain untapped. With a drop of 50 feet from water source to turbine, for example, a brook small enough for a child to jump across can provide enough power for a singlefamily dwelling. However, bear in mind that the smaller the installation, the higher will be the construction cost for each kilowatt generated. Scaled against the cost of power from a public utility, it may



Old-fashioned gristmills could grind 5 to 10 bushels of grain an hour. The miller poured the grain into a hopper from which it trickled down through the eye of the upper millstone onto a bed stone. As the ½-ton upper stone rumbled over the bed stone, it scraped off husks and pulverized the grain. The husks were then separated with a sieve, leaving flour.

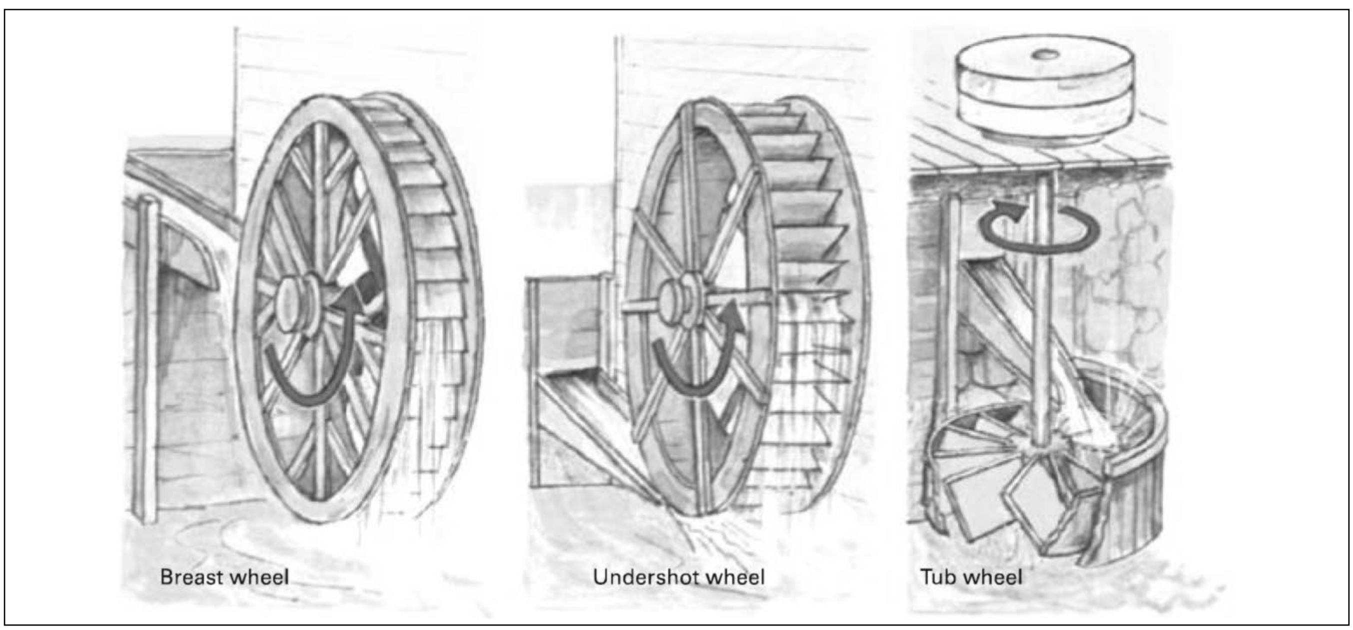
be 10 to 20 years before a small installation pays back its initial expense, though rising fuel costs may substantially shorten the payback period.

Modern Waterpower Systems

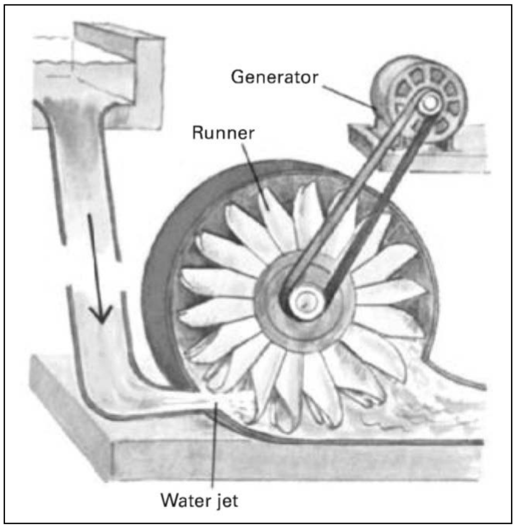
Waterpower achieves its greatest usefulness when it is converted into electricity. Lighting fixtures, heating systems, small appliances, cooking ranges, and machinery of all sorts are some of the common applications. The conversion is made possible by electrical generators that transform rotary motion into electric current.

Though not originally designed for the purpose, old-fashioned waterwheels can actually be used to run generators, but not without overcoming a major obstacle: electrical generators do not operate efficiently except at high speeds, on the order of 1,500 revolutions per minute. To reach these speeds, a large step-up in the waterwheel's rate of rotation is required, somewhere in the vicinity of 100 to 1.

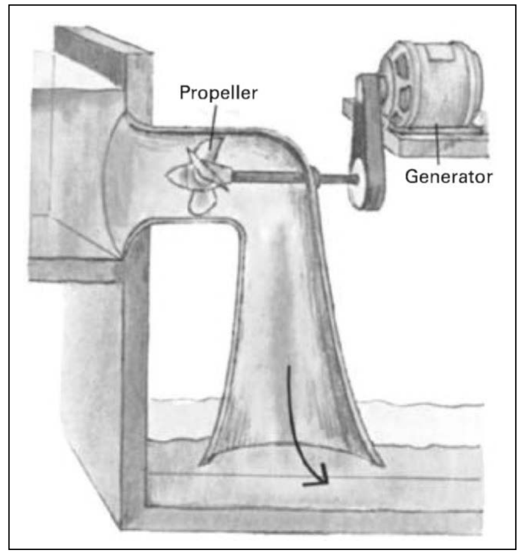
Traditional waterwheels



Individuality and variety marked the waterwheels of the past. Their diameters ranged from 3 ft. to 20 ft., and they incorporated every conceivable water-flow scheme. The most efficient type was the overshot wheel shown above, but if the water source was not high enough, a breast wheel or undershot wheel was employed. Of low efficiency, but simplest to build because it used no gears, was the tub wheel. A typical large wheel made 10 to 20 revolutions per minute; with wooden gearing this could be stepped up to 10 times the rate. A number of traditional waterwheels are still in operation in America, turning out the stone-ground meal so highly prized by home bakers.



Pelton turbines operate best with heads of 50 ft. or more. The high-velocity jet of water that results from such heads spins the bladed runner up to generator speed without the need of additional gearing. Pelton runners can be any size from 12-ft. diameters for megawatt installations down to 4-to 18-in. diameters for home installations. Very little flow is required to run a small Pelton turbine, in some cases no more than the water issuing from a modest spring. The need for a high head, however, restricts installations of hilly or mountainous locations. Also, springs tend to dry up during some parts of the year and freeze up during other parts, so care must be taken to select a water source that will provide year-round power. A recent improvement in impulse turbines is to orient the jet at an angle to the blades, as in Turgo turbines. These units are smaller and faster than Peltons.

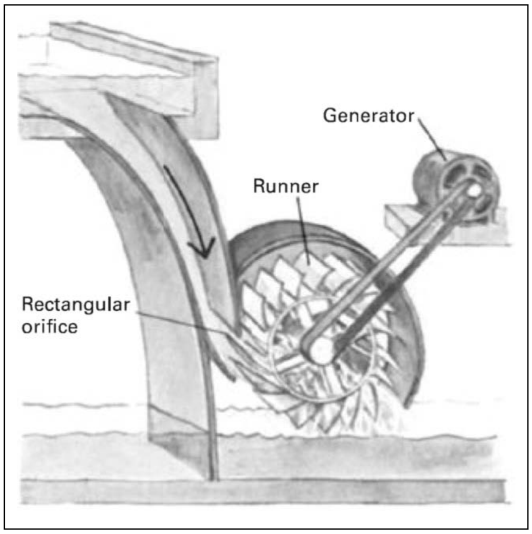


Propeller turbines are most effective at relatively low heads of from 3 ft. to 30 ft. The propeller is completely submerged and is impelled more by the dead weight of the water than by the water's velocity. In high-head installations, propeller turbines suffer wear from cavitation. In addition, they work well only over a narrow range of speeds, so care is required to match the size of the turbine to the available stream flow. For example, when flow drops to 50 percent of a propeller turbine's optimum, the power output will drop by about 75 percent, and when the flow drops to 30 percent, the output becomes nil. To overcome this limitation, some large hydroelectric installations use several turbines in tandem, shutting down one or more whenever the flow lessens. Others employ Kaplan turbines, which have automatically adjustable blades that compensate for flow changes.

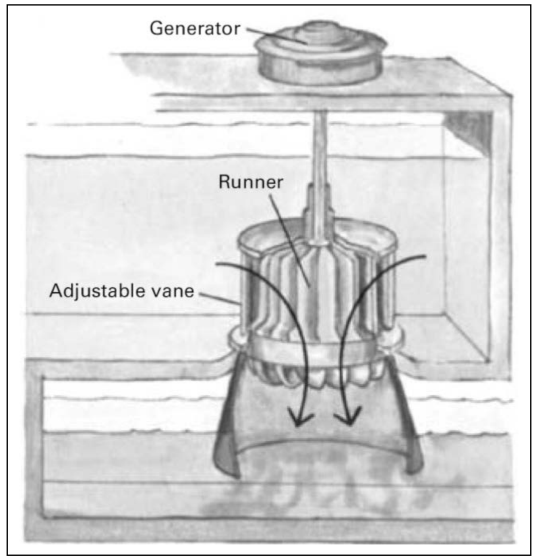
Wooden gears simply will not work—friction alone would destroy them. Instead, rugged, well-made gears or pulleys are required that are not only highly efficient but also capable of handling the huge forces present in the shaft of a waterwheel. Heavy-duty tractor transmissions have been adapted for the purpose and can provide several years of service. The design and construction of a system that will last 20 years or more calls for a high level of mechanical ingenuity plus persistence and luck in finding the appropriate used or abandoned equipment.

Gearing problems can be circumvented by using a turbine instead of a waterwheel. Turbines are devices that convert water flow directly into high-speed turning motion. Little in the way of supplementary gearing is needed to achieve generator speeds. In addition, turbines are much smaller than waterwheels of the same power output, hardly larger than the generators with which they are coupled. Turbines run with a high-pitched whine—not as shooting as the rumble and splash of the old mill wheel—and some are subject to cavitation (wear caused by air bubbles).

Before you buy a turbine, you should measure the characteristics of your stream, particularly its head, so you can match the turbine to them. ("Head" is the vertical drop the water makes from the point where it is diverted from the stream to the point a which it reaches the powergenerating equipment.) Pelton wheels, for example, perform best under high



Cross-flow turbines work well when the head is greater than 3 ft. Water from a rectangular orifice passes through a barrel-shaped runner in such a way that the water strikes the ring of blades on the runner two times. This turbine is a relative newcomer; it has not yet been built in megawatt sizes but shows a great deal of promise for use in small installations. Moreover, it is simple enough for a person with a home machine shop to make; yet it can match the performance of the other turbines shown on this page, whose fabrication requires a high level of technology. It works well over a wide range of water flow, is relatively free from problems caused by silt and trash, and is not affected by cavitation. To improve efficiency, the rectangular orifice can be partitioned and parts of it closed off during periods of low flow. Some step-up gearing may be needed for optimum generator speed.



Francis turbines can be used over a wide range of heads 4 ft. and more. As with a propeller turbine, the runner is immersed in the head water, which is guided onto the blades of the runner by a ring of adjustable vanes. The Francis turbine is highly efficient at its optimum flow but easily damaged by grit and cavitation. It is frequently used in large hydroelectric stations and is relatively expensive. As with propeller turbines and other interior-flooded turbines, a draft tube beneath the unit with its bottom rim immersed at all times in the tail water (the water flowing out of the power station) is a valuable flowing out of the power station) is a valuable adjunct: as water drops from the turbine runner down the draft tube, it sucks more water down with it, adding to the effective head of the system: This added head can be of substantial importance whenever the overall head of the remainder of the installation is small.

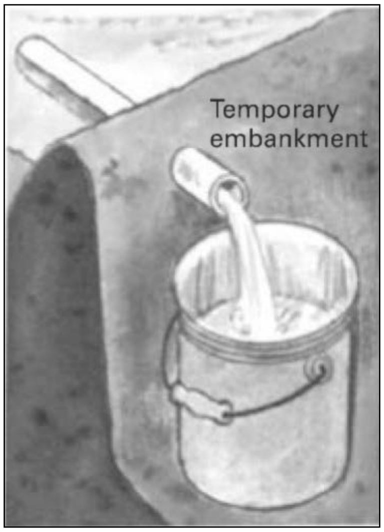
head conditions; propeller turbines, the reverse. "Flow"—the volume of water carried by the stream past a stationary point each second—is also a factor in turbine design.

Finding Out How Much Your Stream Can Do

To determine the amount of power available in a stream, it is necessary to measure the water flow and make calculations from these measurements. This is not a hard job, since a rough estimate is usually all that you will require. Generally, wide seasonal variations in flow put a limit on the degree of precision that makes sense when measuring a stream. Changes on the order of 100 to 1 in the volume of water carried by a stream are not uncommon from one part of the year to another. In the Southwest, large rivers as well as smaller streams often dry up completely for long periods of time.

The key information that your measurements should provide is whether or not a stream will yield enough kilowatts of electricity to make its development worthwhile. You will also want to get an idea of how large the equipment has to be to generate these kilowatts and what type of installation should be used.

When the stream is tiny

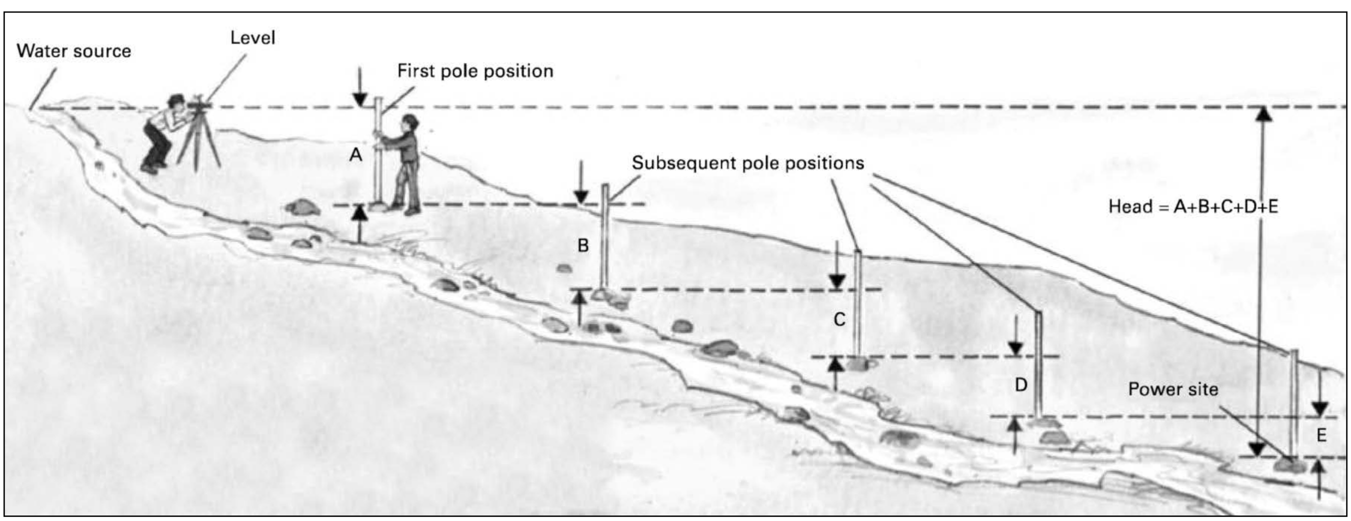


Flow from a spring can be measured by funneling it into a 5-gal. container and timing how long the container takes to fill. For example, if it takes 20 seconds, the flow is 5/20 gal. per second, or 0.035 cu. ft. per second (multiply by 0.14 to convert gallons to cubic feet). Flow, measured by a container, is the equivalent of the velocity times area, factors that are separately measured in larger streams. Water behind the embankment should not change elevation during the period of measurement.

A rough estimate, however, may fail to provide sufficient precise data to determine how the installation should be constructed or what specifications the turbine and generator should have. For greater precision professional surveying instruments may be needed; but before involving yourself at this level of complexity, consult the turbine supplier with whom you expect to do business. He should know the degree of accuracy required.

A stream should be measured several times during the year so that its overall potential can be estimated and the power-generating equipment tailored to the variations in flow. The measurements will have value even when the flow is so large that only a small fraction will satisfy your power needs. It is particularly important to measure a stream near its low point during the year. Also, potential flood level should be ascertained if equipment is to be installed near enough to the stream so that it could be destroyed by a flood. When a dam is to be constructed, knowledge of flood potential is crucial.

If you are not familiar with your stream's annual ups and downs just by living near it, contact the nearest US Geological Survey Water Resources Office (a branch of the Interior Department) for information on water runoff in your area. The information is free and likely to include rainfall and



Head is measured in steps The steps can follow a zigzag course downhill. At each step (except the last) the pole can be placed at any location that is convenient. Set the base of the pole on a stone, rock outcropping, or similar firm support and keep it vertical when marking it.

river flow data going back many years. If a stream is too small to have been directly measured by the office, a knowledge of local water runoff will help you from a profile of its behavior.

What You Must Measure

To find out how much power a stream can deliver, you must know three key measurements: the stream's head, its velocity, and its cross-sectional area.

Head refers to the vertical fall between the water source and turbine. In other words, it is the difference in elevation between the point where the water will be diverted from its natural streambed to the point where the water will be piped into the turbine.

Velocity refers to how fast the stream flows.

Cross-sectional area is a product of the width and depth of the stream.

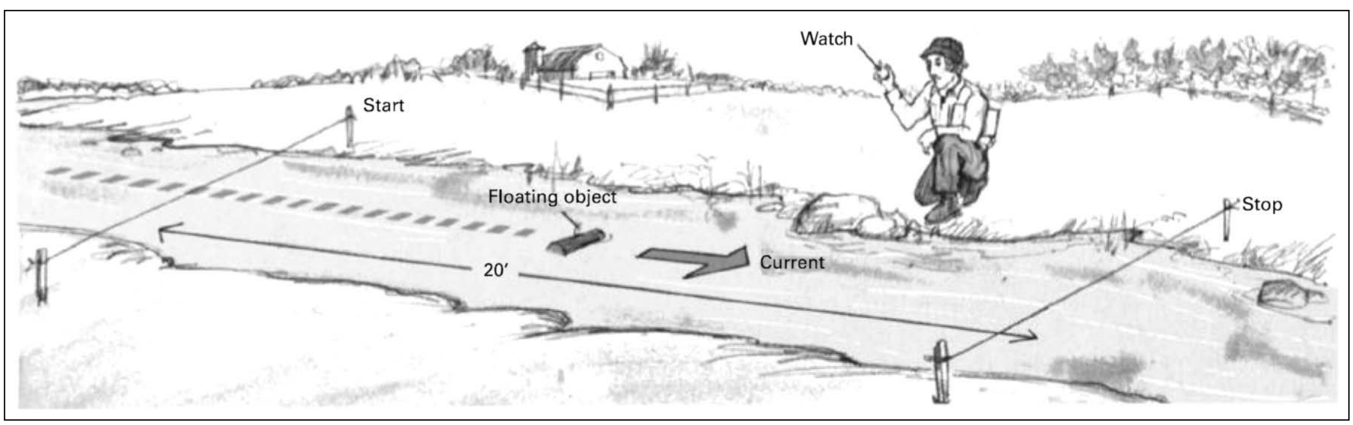
To make the measurements, follow the procedures outlined on this page and the next. Once the three quantities are determined, multiply them together to obtain a power product. The greater the product, the greater the power available.

Measuring head

Head is measured in step-by-step fashion proceeding downstream from the water source to the planned hydropower location. You will need an assistant to help you make the measurement plus the following equipment: a carpenter's level, a camera tripod or similar support, and 8-foot-long pole, and a tape measure.

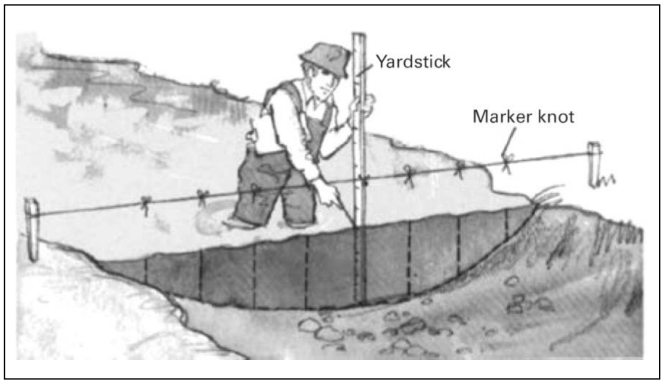
Set up the tripod near the water source and place the carpenter's level on the tripod's table. Adjust the table to the horizontal, then vary the tripod's height until the sight line along the level's upper surface is line up with the water source.

Measuring velocity



Estimate of velocity can be obtained clocking how rapidly floating objects move down the center of the strem. Select a portion of the stream that is reasonably straight and without obstructions, turbulence, or eddies. Tie strings across the stream at two locations spaced 20 ft. apart, with each at right angles to the direction of flow. Toss a cork, or other object that floats, into the center of the water upstream of the first string and time how many seconds it takes for the stream to carry the cork from one string to the other. Divide this amount into 20 ft., multiply the result by 0.7, and you will have the stream velocity in feet per second. (The factor of 0.7 is necessary to reflect the fact that portions of the stream flowing along the banks and near the bottom move more slowly than the surface of the stream where the measurement is made.) As an example, suppose the cork took 10 seconds to traverse the 20-ft. distance from string to string. Dividing 20 by 10 and multiplying by 0.7 gives a velocity of 1.4 ft. per second. For greater accuracy, repeat the measurement several times, then average the results.

Measuring area



Cross-sectional area of a stream must be measured at the same location at which you measured the stream velocity. Mark off one of the strings in equal intervals. Six to 12 intervals should be enough, depending on the size of the stream. Measure the depth of the stream at each of the marked points on the string, record each measurement, and calculate their average after all the measurements have been made by adding the figures together and dividing by the number of measurements. Multiply this result by the width of the stream, measured from bank to bank, and you will have the area.

As an example, suppose your stream measures 6 ft. across and you have marked your string at five points, each 1 ft. apart with depth measurements at each marker $\frac{1}{2}$, 1, 1 $\frac{1}{4}$, $\frac{3}{4}$, and $\frac{1}{2}$ ft. respectively. The measurements add up to 4ft.; 4ft. divided by five gives an average of $\frac{4}{5}$ ft. multiplied by six results in an area of 4.8 sq.ft.

Next, have your helper hold the pole vertically at a location downhill from the tripod so that you can sight from the other end of the level to the pole. Call out instructions as you sight toward the pole, and have your assistant make a chalk mark on the pole at the point where the sight line intersects it.

Now set up the tripod and level downhill from the pole at the location where the sight line, looking back uphill toward the pole, will intersect the pole at a point near its base. The assistant should now mark the new point of intersection, measure the distance between marks, and jot the measurement down. Once this is done, both chalk marks can be erased and the pole set up at a new location downhill, where the entire procedure is repeated. Once the power site is reached, add up the figures you have jotted down and you have the head.

What the Power Can Do

After measuring the head, velocity, and area, multiply together the numbers you have obtained and divide the result by 23. You will then have the usable steam power in kilowatts. Expressed as a formula, the calculation is:

$$\text{Power in kilowatts} = \frac{\text{Head in feet} \times \text{Velocity in ft./sec.} \times \text{Area in sq. ft.}}{23}$$

The divisor, 23, is in the formula to make the answer come out in Kilowatts and to reflect an overall system efficiency of 50 percent.

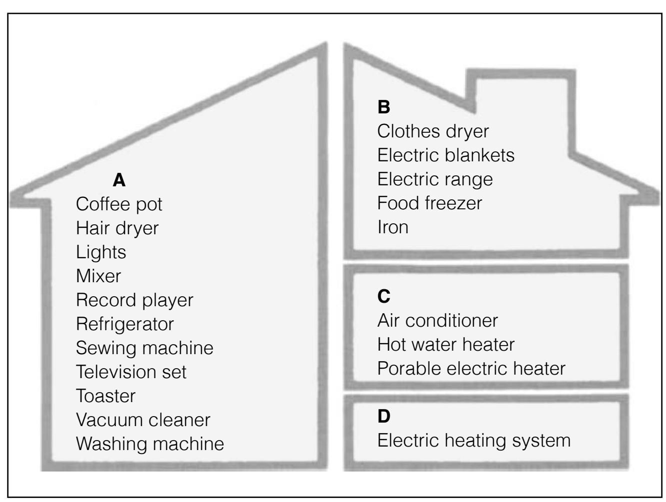
For example, for a head of 10 feet, a stream velocity of 1.4 feet per second, and a cross-sectional area of 4.8 square feet, the usable power output is:

$$\text{Power} = \frac{10 \times 1.4 \times 4.8}{23} = 2.92 \text{ kilowatts}$$

Power capability

The amount of kilowatt-hours per month that can run the appliances listed:

300 kilowatt-hours will run all those in A
700 kilowatt-hours will run all those in A and B
1,500 kilowatt-hours will run all those in A, B, and C
8,000 kilowatt-hours will run all those in A, B, C, and D



To find out how much electricity is available to you over a period of a month, multiply the figure you have obtained for power by 720—the number of hours in an average month. In the example above the 2.92 kilowatts (if this output is constant) would provide $2.92 \times 720 = 2{,}104$ kilowatt-hours per month.

The computation is similar if a container is used to measure flow (see facing page). Just take out velocity and area from the formula and substitute the flow measurements in their place.

Making the Calculations

Once you determine a stream's power, you can estimate its usefulness. One way to do this is to compare the kilowatt-hours stated on your electric bill with the stream power you have calculated; you will then have a quick estimate of the proportion of your needs the stream will be able to satisfy. For the comparison, use a bill with a monthly charge that is high for the year.

Another way to estimate what the stream can do is to use a capability chart like the one above. In an approximate way the chart indicates the number and type of appliances various power outputs can handle. It assumes that the use of these appliances will be fairly evenly distributed over each month and also assumes that a storage system, such as a bank of batteries, is used in the power system to take care of peak power demands.

One measurement of the stream is not likely to be enough to make a reliable estimate. Because stream flow varies, measure the stream's velocity and area at several times during the year (over the course of a number of years if possible) and use the lowest measured power to estimated usefulness.

Leading the Water to the Powerhouse

A small dam—one up to 4 feet high and 12 feet across—can often be built of locally available materials such as earth, stones, or logs. Such a dam can provide a dependable supply of water at an intake to a race (a canal for diverting water from a stream to a power station) or at a penstock (a pipe that serves as a race).

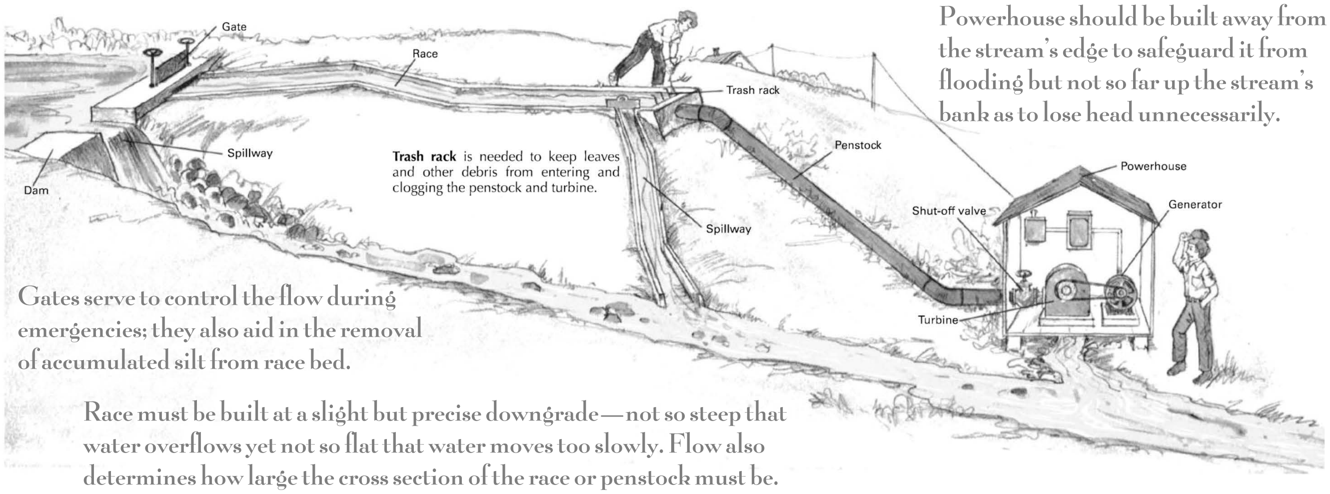
To moderate the effects of monthly and seasonal variations in stream flow, larger dams can be built. These will store excess water and release it during periods of low flow, providing more dependable power year round. Also, larger dams offer additional head (vertical drop from pond surface to turbine), a factor that can be critical in locations where the terrain is flat.

As the dam is made larger, however, its design becomes more and more complex and the number of potential problems increases. Particularly serious are cracks that may develop because of the varying stress and strain characteristics of the materials used in constructing the dam. In addition, rock formations under the dam may permit unexpectedly large amounts of groundwater seepage that threaten the dam's stability. As a result, dam builders must proceed with extreme caution. A failed dam can be awesomely destructive.

The best way to design against flooding is to obtain rain runoff data for the stream's watershed going back a substantial number of years. If such data are not available, the dam's construction must incorporate a large safety factor. Extra safety precautions must also be taken in earthquake-prone areas. If you are considering building a dam and have any doubts about the design of either the dam or its race, consult a professional engineer. In addition, you should check local regulations governing structures that affect stream flow. For dams above a certain size, a permit must be filed and limitations on construction observed. For further information, write to your state's water resources agency.

When building a dam and race, the area to be flooded plus a marginal strip around the area must first be cleared of trees and bushes. This is to prevent

A Low-head, high-flow power site



Penstock can be made of metal, concrete, or a plastic, such as PVC. Plastic can cave in and must be protected from sunlight but is least subject to wear and corrosion.

Powerhouse should be built away from the stream's edge to safeguard it from flooding but not so far up the stream's bank as to lose head unnecessarily.

Gates serve to control the flow during emergencies; they also aid in the removal of accumulated silt from race bed.

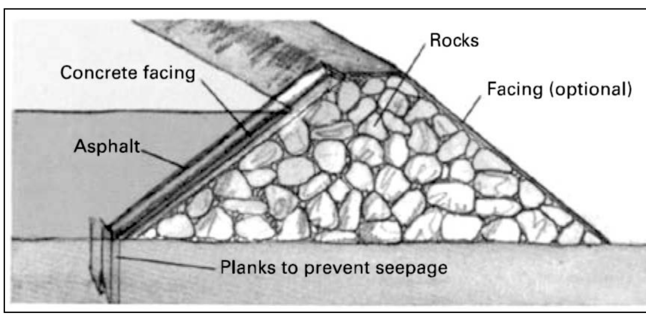
Race must be built at a slight but precise downgrade—not so steep that water overflows yet not so flat that water moves too slowly. Flow also determines how large the cross section of the race or penstock must be. To gain head, races sometimes extend a mile or more down a valley. Like dams, they can be made of a variety of materials. If a race is made of earth, make sure there is no danger that water will overflow during flood conditions. With masonry races money can be saved on cost of materials by using an extra-long penstock.

any undesirable tastes and odors that may later result from the decay of the plants. The foundation site of a dam itself should, at the very minimum, be cleared of all soil (earth containing organic matter). If a rock fill or concrete dam is to be built, the site should be dug down to bedrock, hard clay, or other stable formation.

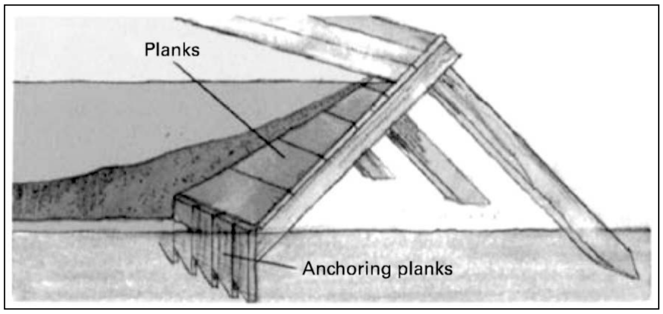
While construction is in progress, it will be necessary to divert the course of the stream. One way to do this is to dig a temporary channel around the construction site. Another method, useful for small streams, is to build a wooden flume that straddles the dam, carrying the water overhead while construction proceeds beneath. A third solution is a drainpipe installed under the dam works. By fitting the pipe with a valve, it can be made a permanent part of the structure for use in emergencies. How ever, such pipes may crack and silt up with the passage of years, so they should not be relied on as the only flood control device.

Types of Dams

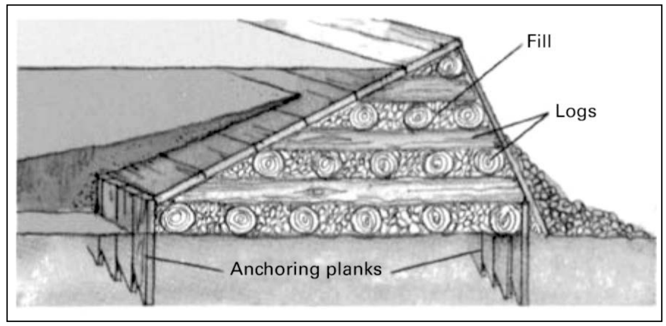
A dam impounds many tons of water. If its mass and strength are not sufficient, the weight of the water may be enough to topple the dam or slide it downstream. Also, water seepage under the dam can cause it to settle, crack, and eventually rupture. To protect against this, a variety of cores, barriers,



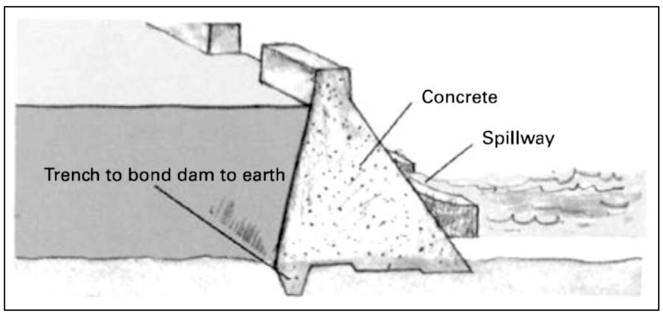
Rock-fill dam (and concrete dam as well) requires solid foundation of bedrock, compact sand, or gravel to prevent setting and rupture of waterlight facing. When constructing on bedrock, anchor dam with bolts and seal joint with concrete.



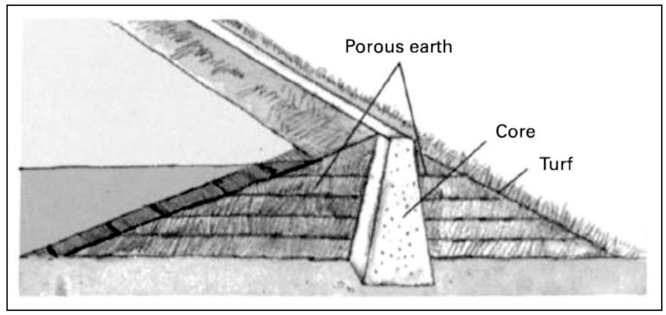
Frame dam is fabricated from planks that have been coated with such preservatives as creosote or pentachlorophenol to prevent rotting. To forestall seepage, face upstream side of dam with asphalt or a layer of fine silt or clay.



Log dam can be built of treated 6-in. logs, such as oak, with stone or gravel used as fill. Face the upstream side with seepage-proof planks. Wood dams do not last nearly as long as stone or earth dams and should not be more than 4ft. high.



Concrete dam is preferred whenever overflowing is possible, since a spillway can easily be incorporated. To prevent erosion under the spillway, pile rocks at the base or shape the base to deflect the down ward rush of water.



Earth dam is the oldest and most common type. For stability its slopes must be very gradual. To inhibit seepage, a core of impervious clay or concrete may be used.

Bill Delp, Hydroelectric Contractor

Harnessing Stream Power Rocky Mountain Style

Bill Delp of Sandpoint, Idaho, once worked for a large public utility and had his own electricity and refrigeration company. When he realized two of the house he was working on had streams on the property, he told the owners he could install hydroelectric power systems and save them money and trouble. Now he has his own water power business, one that has grown largely by word of mouth.

"I started out with cabins, and now we're installing equipment that's compatible with regular electric home too. But the main problem with hydroelectric power isn't installing it. Anybody with a crescent wrench, a screwdriver, and a little elbow grease can do that. The pitfalls come before you get to the installation stage. With hydroelectric systems in Idaho and Montana, you first have to get the legal rights to use the water. Even if the stream is on your own property you have to get what is called a 'nonconsumptive beneficial use permit' from the state. Then if you are going to have lines that cross anybody else's

(Continued)

Harnessing Stream Power Rocky Mountain Style *(Continued)*

property, you have to get a right-of-way. Once you get through the legal hassles and arrange the financing, the rest is easy.

"Maintenance isn't difficult. The waterlines are insulated in cold weather areas so you don't have to worry about freezing in winter. The major learning curve is realizing that you don't have unlimited power the way you would if you were hooked up to a big system. You're on your own, and if all the kids want hot showers and somebody is using the electric stove, you're headed for trouble. You have to make up an energy schedule so you can balance your use of power. Once you've done that, your major problems are solved.

"There's been tremendous interest in the hydroelectric power field. It's an immediately available technology on a large or small scale. It doesn't pollute, causes very little environmental disturbance, and it can be installed very quickly. Our only problem is figuring out how to handle the amount if growth."

and asphalt blankets are usually incorporated into the dam structure. Another hazard is the possibility of flood waters that may overflow a dam, eroding and disintegrating it as they pour downstream. To meet the danger, an overflow spillway should be built, either in the dam itself or as a separate pond-exit channel cut into the hillside to one side of the dam. On a site where the flood potential is great a spillway may be the dam's dominant feature.

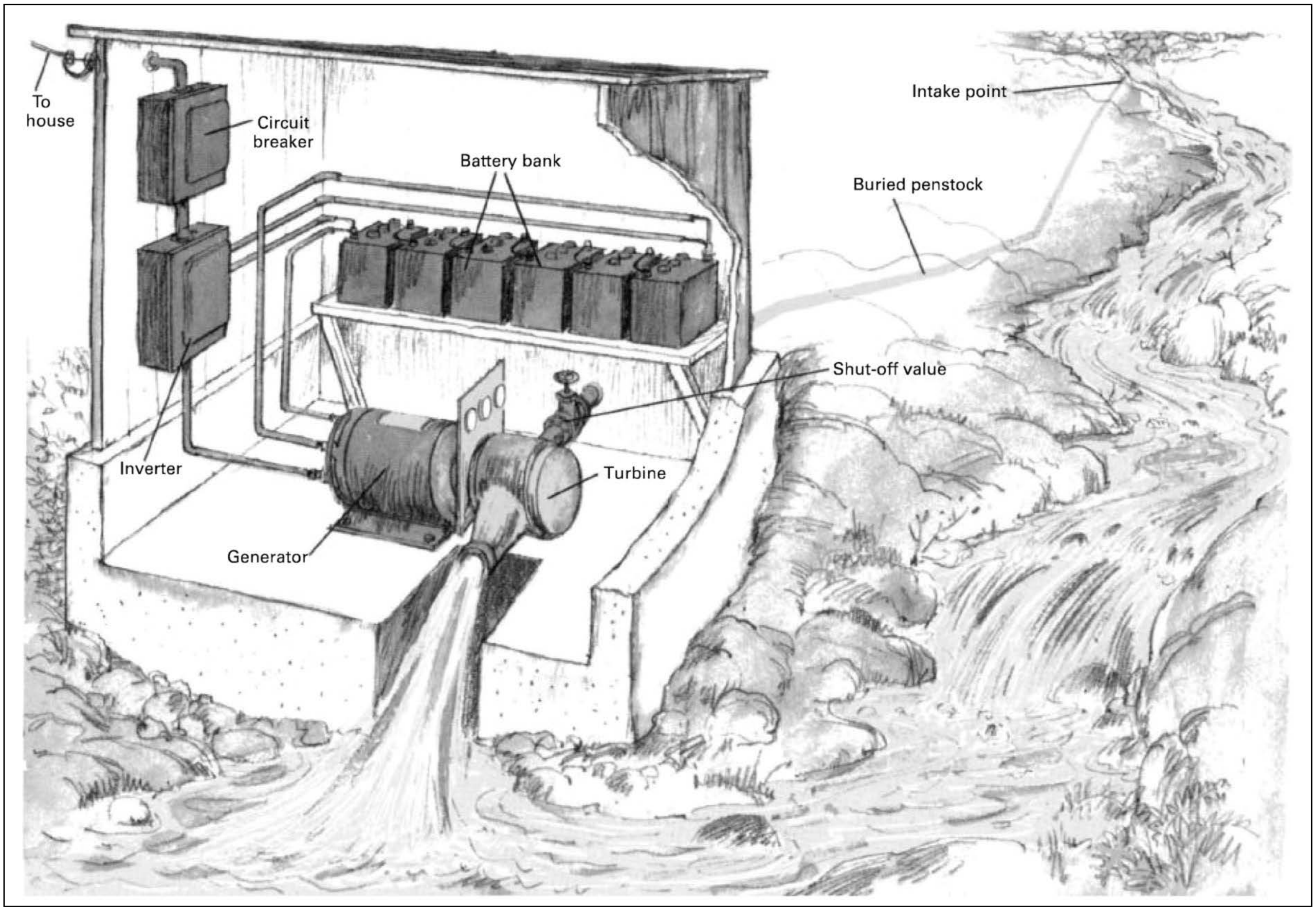
A Power System for Hilly Areas

A high head system relies on a long vertical drop rather than a large volume of water in order to generate power. The minimum head needed is 50 feet, but even at that minimum surprisingly little flow is required to develop usable wattages. For example, with a 50-foot head a flow of only 1 gallon of water (⅛ cubic foot) per second will yield an average power output of 300 watts.

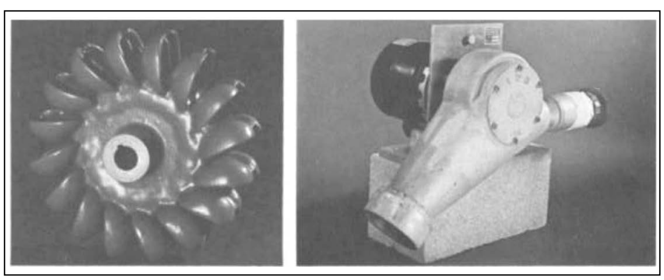
Energy storage is a key factor in many hydroelectric systems. In some, a pond or lake serves as the main storage element. In other systems, especially small ones like the one shown on this page, a bank of rechargeable batteries plays a similar role, helping the system to adapt to daily and seasonal variations in stream flow and power demand. Perhaps the most important function of the batteries is to store power during periods when little current is being drawn so that it can be tapped at times of peak usage. Demand is generally lightest after 10:00 p.m. and heaviest in the morning and between 6:00 and 8:00 p.m. in the evening.

The batteries in the system shown here will tolerate a power draw of up to 3 kilowatts. If peak demand exceeds this, or if the batteries become completely discharged, a circuit breaker discontinues service in order to protect them. A power outage will also occur if the waterline (penstock) becomes clogged. The inconvenience of an outage can be eased if there is an emergency backup system to switch on: either a small gasoline-powered generator or power from the local utility.

Clogging in the penstock is most likely to occur inside the turbine (the narrowest point along the line). To reach the nozzle and clean it, first close the



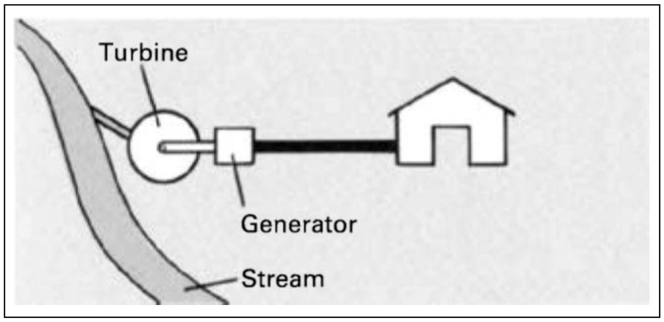
Powerhouse is built concrete foundation to minimize vibration. Batteries are a special type that can withstand repeated charging and discharging; they are not conventional auto batteries. An inverter converts the 32 volts DC (direct current) delivered by the generator and batteries to the 60-cycle 115 volts AC (alternating current) on which most appliances operate.



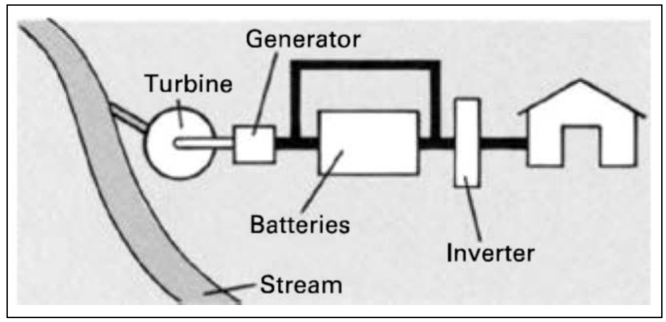
Pelton turbine uses a 4-in.-diameter runner (left with blades shaped in such way that water striking them is deflected to the sides, where it will not interfere with the incoming jet. An access plate on the turbine (right). can be unbolted to permit access to the epoxy-coated runner for inspection and cleaning.

Intake to penstock includes a trash filter to keep debris out of turbine. Filter should be checked periodically, especially in autumn when leaves are apt to collect at intake.

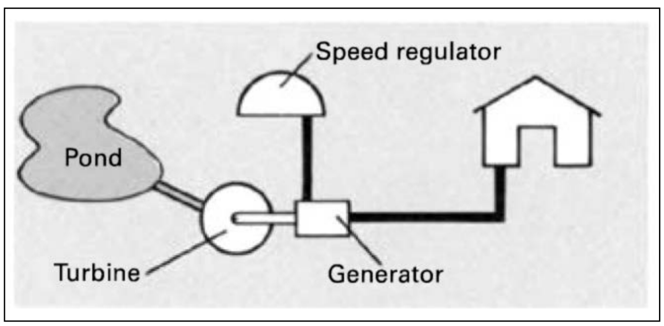
shutoff valve and open up the turbine. Unclogging a plugged line is particularly important in winter, since the stopped-up water may freeze in the penstock and burst it. In cold areas of the country the safest procedure is to bury the penstock below the frost line.



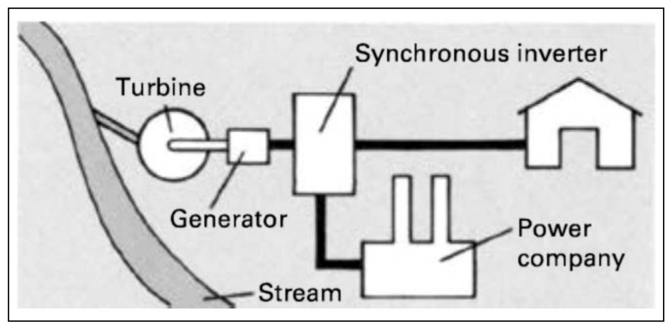
System without storage is the least costly to install but very limited in application. The output from the generator has a voltage that varies widely according to how much water is flowing in the stream and how many appliances happen to be switched on. Usually the only appliances that work well with such a system are ones with simple resistance elements for heating, such as hot water heaters and hot plates. The temperature of the heater's water may not be constant, but the arrangement is satisfactory if sudden demands on hot water are avoided.



Battery storage works well for small systems such as the one shown on the facing page. Since batteries store and deliver DC electricity, an inverter is required to convert to AC. An attractive feature of battery storage is that it acts in part like a regulator, automatically diverting power into the batteries when house power demand is low and releasing it when demand is high. But to accommodate periods when the batteries have become fully charged, the turbine must be sufficiently rugged to withstand the resulting no-load condition.



Ponds formed by damming a stream is the traditional means for storing energy and smoothing the effects of erratic stream flow. A speed regulator, such as the hydraulic model in the installation shown below, is needed to take care of varying electrical demands as appliances are switched on and off. Hydraulic regulators are expensive, however, sometimes costing more than everything else in the powerhouse. Regulators currently being developed to accomplish the same task electronically may become a cheaper alternative.



Local power utilities usually permit private citizens to sell their excess power to them. In this way the power company becomes a substitute for batteries or a storage pond. A device called a synchronous inverter automatically sends out the excess when the home system overproduces and draws power from the company when the home system underproduces. Power companies tend to pay less for your power than what they charge for their power. Even if they pay nothing, the arrangement still saves the cost of a regulator or batteries.

Storage batteries currently on the market can last as long as 15 years if a somewhat reduced charging capacity toward the end of the period is not critical for the howeowner. Eventually, however, they must be replaced. The cost will not be out of line for a small system, but for a large system, such as the one described on the facing page, the number of batteries required would make replacement too expensive. For such a system, a storage pond becomes the preferred alternative.

Hydroelectric power output (in watts)

	Flow Rate (in GPM)									
	5	**15**	**20**	**30**	**40**	**50**	**75**	**100**	**150**	**200**
Head (Vertical distance, in feet)										
5			5	8	10	15	20	30	40	
10		7	12	18	23	30	45	60	80	100
15	5	15	20	30	40	50	75	100	125	150
20	8	25	32	50	65	85	125	170	210	275
30	12	35	45	70	90	120	180	240	300	400
40	16	48	60	95	125	160	240	320	450	600
50	20	60	80	120	160	200	300	400	600	
75	30	90	120	180	240	300	450	600		
100	40	120	160	240	320	400	600			

Quick mini-hydro power table: Use this table to estimate approximately how much power in watts you might expect from your water source if you know the total head and the flow rate. For example, 20 feet of head at 30 GPM equals 50 watts of continuous power.

Power Storage, Regulators, and Inverters

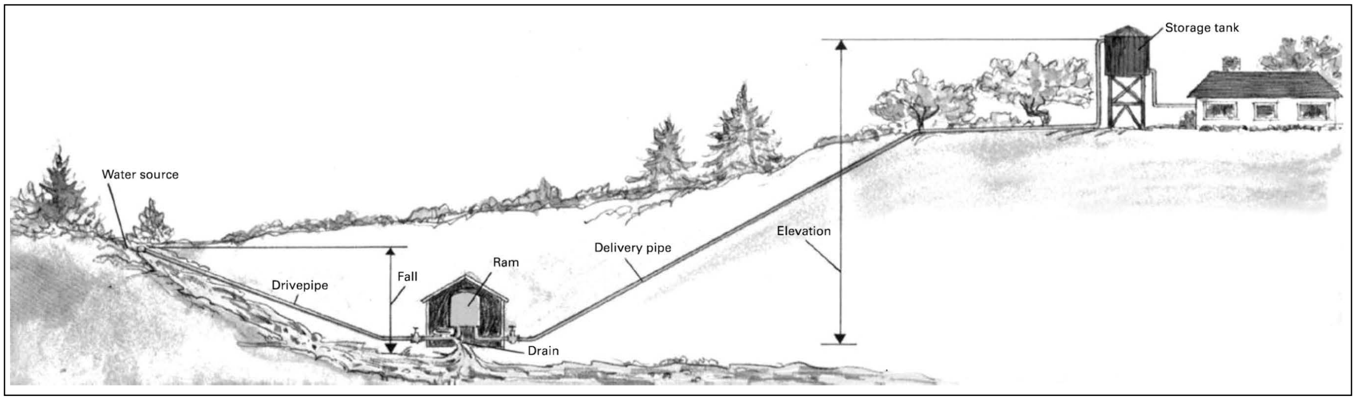
All but the simplest waterpower systems have some means of storing power to compensate for irregular stream flow and to hold power for periods of high user demand. It is also important to have some means of regulating the power output so that it matches the demand placed on the system. Power when it is generated has to be sent somewhere, whether to appliances, batteries, or the power company. If no loads of this type are present, or if most or all of them happen to be switched off, the generating equipment may freewheel up to a point where it eventually burns out its bearings and selfdestructs. The diagrams below show several methods to store and regulate power.

Where it is necessary to convert from DC to AC, an inverter is used. Inverters come in two forms. One is the rotary type, which consists of a combined motor and generator plus built-in controls for maintaining a constant 60-cycle 115-volt AC output. The inverter motor is run electrically by the 32-volt turbine generator. The other type of inverter is electronic. It is less bulky than the rotary type and roughly 30 percent more efficient (the rotary type is only 60 percent efficient). In addition, electronic inverters consume much less power than rotary inverters when all the appliances are turned off.

Something for Nothing: Water Pumping Itself

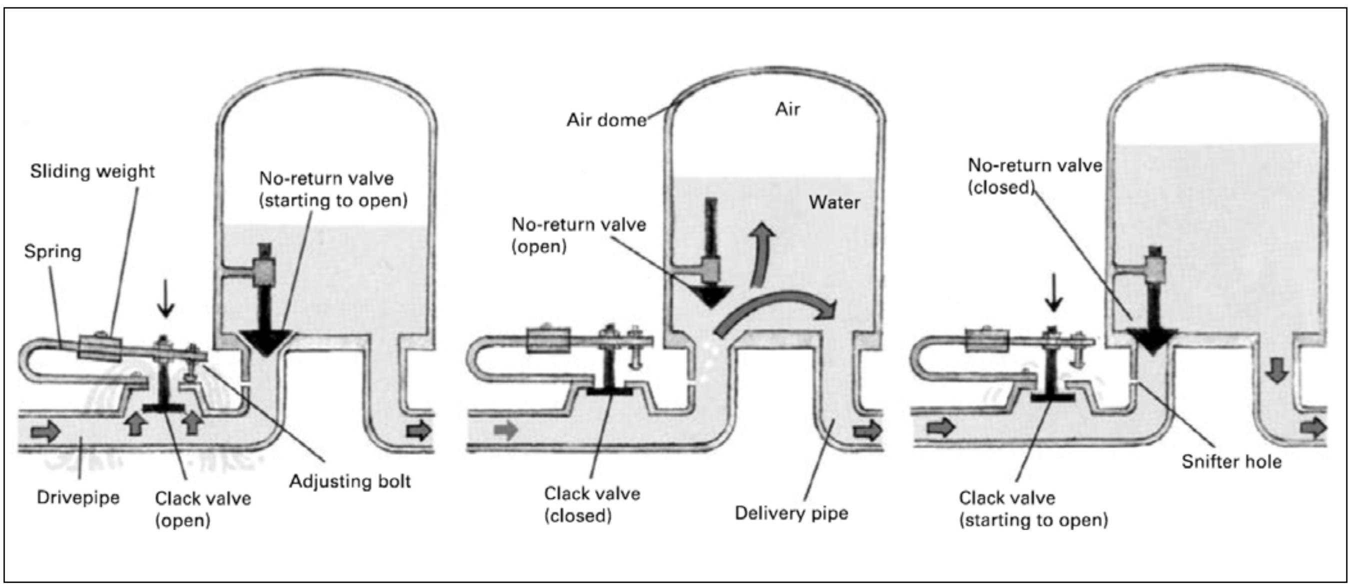
Hydraulic Rams

Although a stream or other water source may be considerably below the level of your house, it can be tapped for fresh water without relying on electrical motors, windmills, hand pumps, or buckets. The trick is to use the water to pump itself. The Amish system on the next page is one method. A more common approach is to use a hydraulic ram, a century-old invention that at first glance seems to give something for nothing.



Location of the arm should be selected so that the drive and delivery pipes slope upward a gradual angle. A rise of 1 ft. for every 2 ft. of horizontal distance is the maximum slope allowable. A rise of 1ft. for every 20 ft. of horizontal is the minimum. As a rule, the drivepipe diameter should be about twice that of the delivery pipe, and the cross-sectional area of both pipes should be large enough so that friction between the pipe walls and the moving water is negligible. For a similar reason, there should be as little bending in the pipes as possible. In northern areas bury the pipes below the frost line and house both the ram and water storage tank in well-insulated structures.

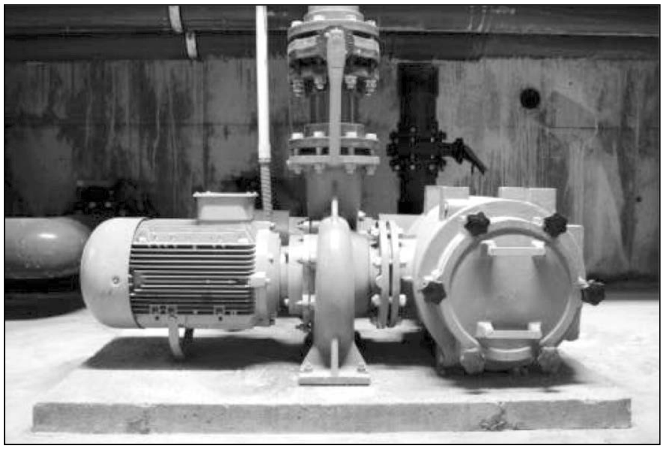
The ram-pumping cycle



1. The cycle begins with the no-return valve closed and the clack valve open. Water starts to flow down the drivepipe, out of the clack valve, and onto the floor of the ram enclosure from which it is drained off and returned to the stream. As the flow builds up momentum, pressure against the clack valve increases. Within a second or so the pressure rises to a point where it overcomes the force of the clack valve's weighted spring. The valve closes and the water stops pouring out of it.

2. With the clack valve closed the water in the drivepipe begins to push against the no-return valve, opening it. Water now flows into the air dome, compressing the air trapped inside while at the same time forcing water into and up the delivery pipe. After about a second, the air pressure inside the dome becomes great enough to exert a counterpressure that closes the no-return valve again. With both valves closed waterflow down the drivepipe momentarily stops.

3. With the no-return valve closed, pressure in the dome continues to drive the water in the delivery pipe upward toward the storage tank. At the same time the clack valve's spring opens the valve again because the pressure of the now stationary water in the drivepipe has fallen off. At this point, the conditions are the same as in Step 1 and the cycle repeats. Notes that the flow of water up the delivery pipe is continuous, largely because of the cushioning action of the air in the dome.



Commercially made rams can be purchased in a variety of sizes with drivepipes ranging from 1¼ in. to 8 in. in diameter. Or a person who has plumbing experience can actually build a ram at home. For plans write VITA publications, 1600 Wilson Blvd., Suite 1030, Arlington, Va. 22209, info@vita.org.

The heart of a hydraulic ram is a special pump, or ram, that uses the energy of a large mass of water dropping a short distance to raise a small amount of water far above its source level. A typical installation is illustrated at the top of the page. Ideally, for a fall of 10 feet and an elevation of 50 feet, 50 gallons per minute of water flowing down the drivepipe would be able to pump 10 gallons per minute into the storage tank, with the remaining 40 gallons being returned to the stream. In actual practice, however, rams operate at about 50 percent efficiency so that the water delivered would be half the ideal figure—5 gallons per minute in the example.

Rams pump at a cyclic rate of 20 to 150 times per minute. The ram shown at right has tow built-in rate adjustments: a sliding weight that regulates spring tension and a bolt that limits valve movements. Increasing tension and restricting valve motion speeds the rate and decreases the amount of water pumped. Such a control is useful when waterflow in the stream's drops off. If a ram's pumping capacity exceeds the stream's flow rate, intermittent and inefficient operation results.

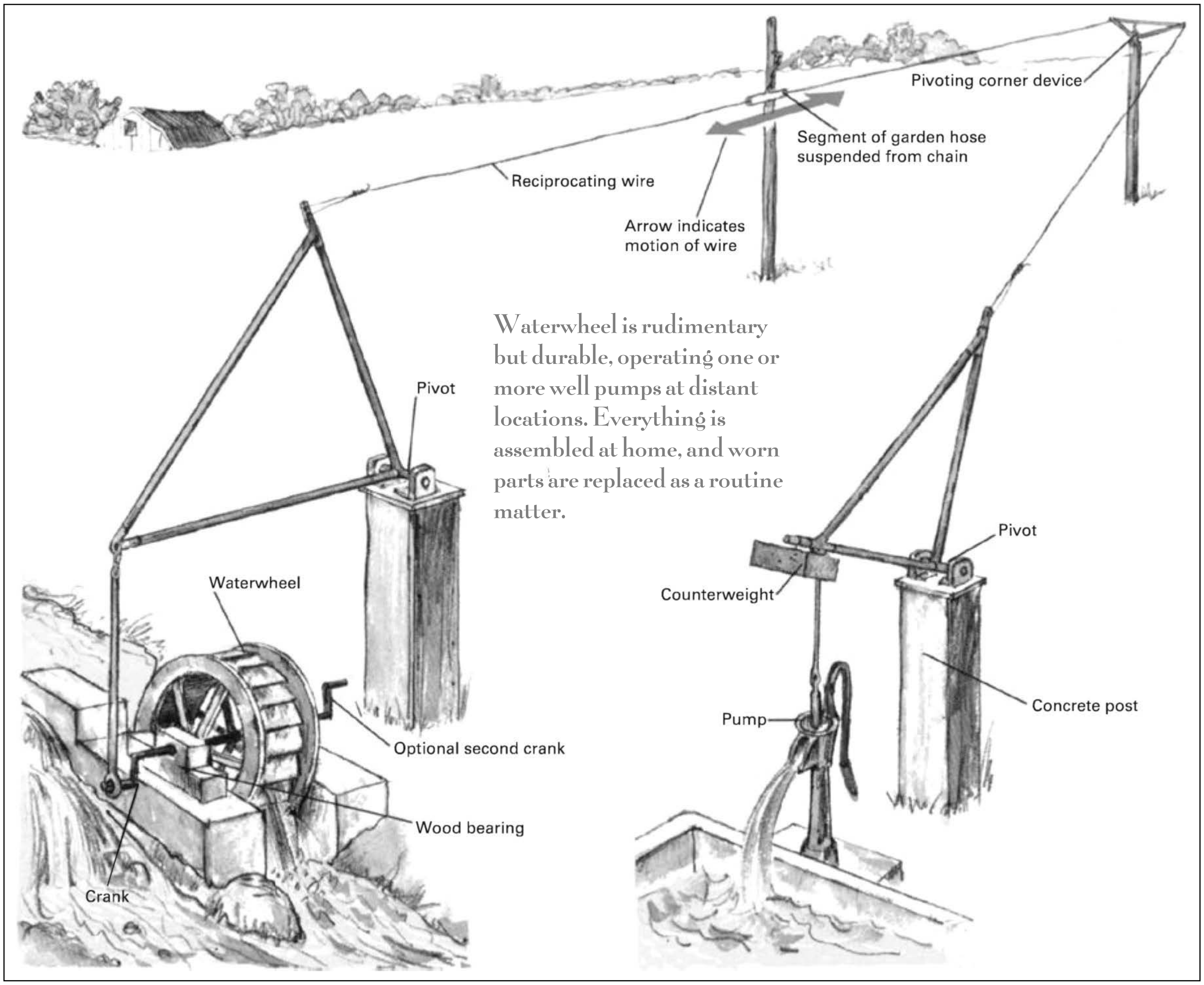
The Amish people of Pennsylvania have for many years been applying stream power to pump water from their wells. Their method is to use small waterwheels that turn at 10 to 20 revolutions per minute located on streams as much as ½ mile away from the well. power is transmitted between waterwheel and well by a wire, attached at one end to a crank on the wheel and at the other end to the pump handle. As the waterwheel turns, the crank translates its circular motion into reciprocating motion. The wire carries the movements to the pump.

Both undershot and breast wheels are used. The wheels are from 1 to 3 feet in diameter and are fabricated from steel sheet, with curved cups for blades. The length of the crank arm is critical; it must be just long enough to produce the back-and-forth motion needed by the pump, usually 4 to 6 inches. The crank is connected by a rod to a triangular frame that pivots at the top of a post. The frame is made of ¾-inch-diameter galvanized pipe welded or bolted together. A similar frame is used at the pump end of the system. A counterweight weighing about 100 pounds is attached to a corner of this frame.

The wire that connects the frames so that they move in tandem is smooth, galvanized 12-gauge fence wire. If the wire is very long, poles spaced 75 feet apart are used to support it. If the wire is to traverse a zigzag course around obstacles a device for negotiating the corners, such as the one illustrated, can be constructed.

The system can also be rigged to operate an additional water pump by attaching a second crank to the opposite end of the waterwheel shaft.

Waterwheel to pump water



Wind Power

Clean, Cheap Power from an Old Idea and a New Technology

Wind power has been used for hundreds of years to pump water and grind grain. Its use in milling grain was once so common, in fact, that all machines with blades turned by the wind became known as windmills, even though they were and are used for other purposes than milling. Traditional windmills of the type associated with Holland were ponderous and inefficient. As a result, wind power did not become popular in this country until mills with multiple metal blades were developed. Such mills performed admirably at pumping water from wells and proliferated rapidly after 1850, particularly across the Plains States. Millions of them were erected on farms and placed along railroad rights-of-way to supply water for the boilers of steam locomotives.

In the 1930s it became possible to buy a windmill that could generate electricity. This was a new development based on a mill using two or three propeller like blades turning at high speed. The best of these wind-electric systems were made by Marcellus Jacobs, whose product is

Traditional windmills with four arms in the Dutch style are rare in America. Such mills used cloth sails that were reefed when stormy weather threatened. The top of the mill was swiveled by hand to keep the arms facing into the wind.

still admired today. Many of these depression-era wind-powered generators, along with their water-pumping brethren, have fallen into disuse or been sold for scrap. But with the steady rise in the cost of electricity, wind generators may yet become a competitive alternative in areas of the country where the average yearly wind speed is high. However, it takes a very large wind plant to supply the entire power needs of a typical modern home, so unless the family is willing to budget its household electricity usage stringently, a wind plant can only act as a supplement or server as an emergency backup during utility blackouts.

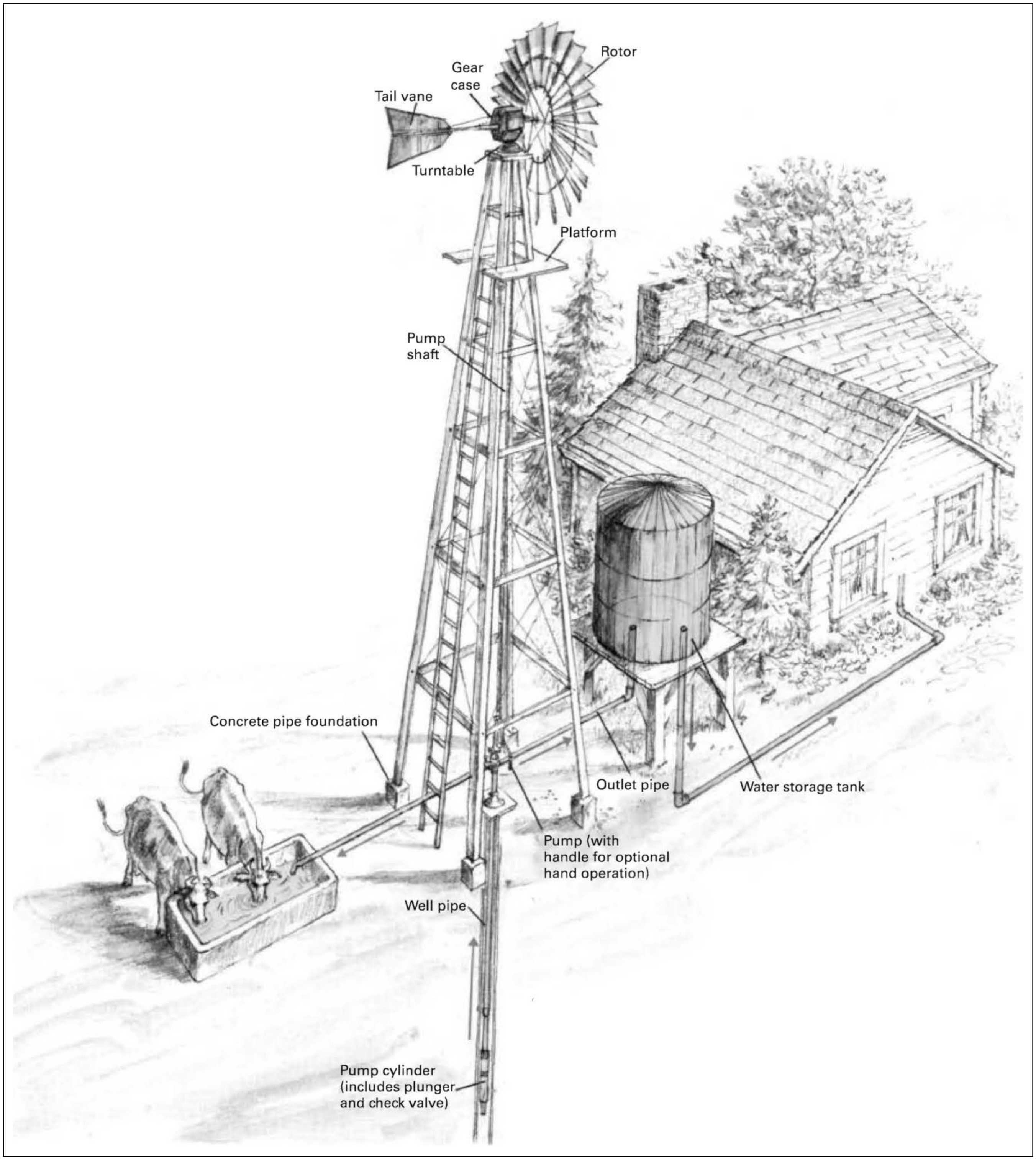
Modern Windmills

Turning speeds of greater than 1,500 revolutions per minute are necessary to generate electricity. To attain these speeds, propellers with only two or three blades must be used. Traditional multibladed windmills do not work because they operate well only at relatively low speeds. At higher rates of rotation the blades spin so fast that the air cannot pass between them, and as a result the whirling blades act like a solid disc.

High-speed wind generators are subject to stresses that can quickly destroy them if they are not carefully designed and built. Exhaustive testing of a variety of prototypes has led to several key discoveries. The most important was that the propeller blades should have an aerodynamic design similar (although not identical) to that of airplane propellers. In addition, it was found that the blades should be constructed from a durable lightweight material such as Sitka spruce or carbon fiber. Finally, engineers determined that either two or three blades will work well. Wind generators in both styles are being produces in sizes over 1000 kilowatts—electricity for more than 400 US homes.

High-speed windmills behave like gyroscopes. When the wind changes its direction and pushes at the tail vane to swing the mill around, the windmill balks and exerts a gyroscopic counterforce that can either break the blades or tear the entire propeller-generator unit off its base unless it is sturdily moored to the tower and cushioned at critical points by shock absorbers.

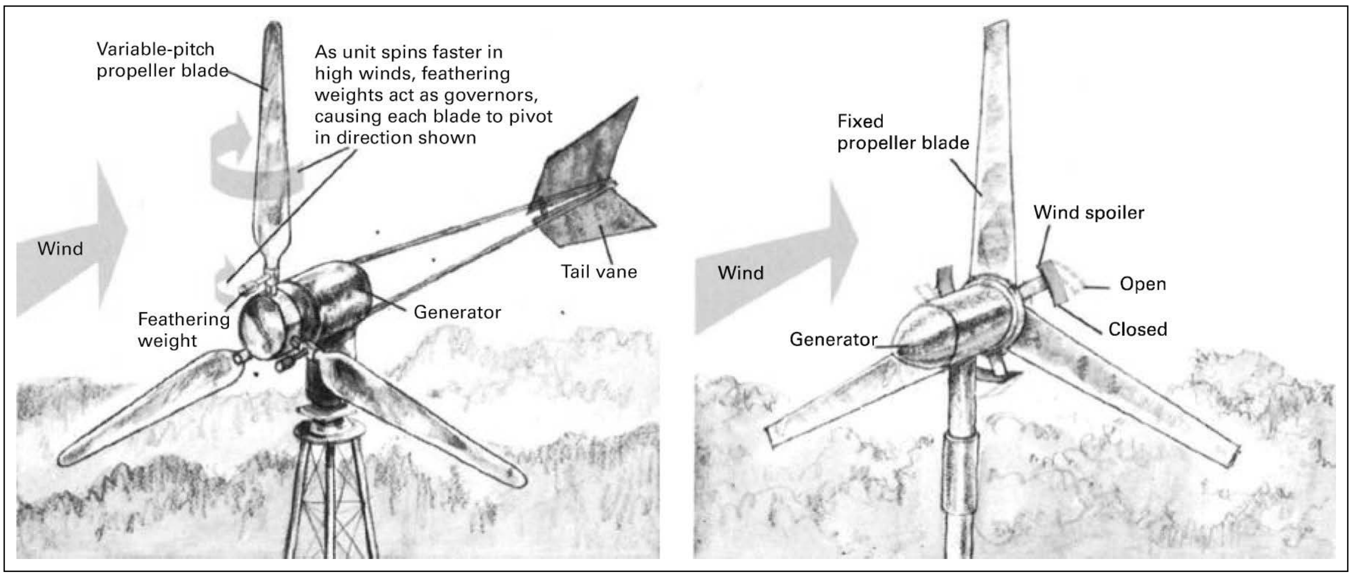
Windmills for residential installations that meet these requirements can be obtained from manufacturers in the United States, Europe, and Australia. The propeller diameters of the units (diameters of circles swept by the blade tips) range in size from 3 feet up to 30 feet, corresponding roughly to power outputs of 25 watts to 6,000 watts at a 25-mile-per-hour wind speed. Most of the plants are designed to run for 20 or more years with little or no attention. Lubrication is relatively permanent, parts are moisture-proof and noncorrosive, and some means is built into each unit to keep the windmill from running wild and destroying itself in extreme winds. Two such safety devices are illustrated below.



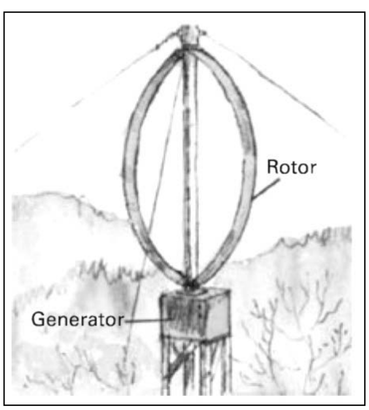
Water-pumping windmills, with rotor diameters ranging from 6 ft. to 16 ft., are still manufactured. Because of their many blades, only a gentle breeze is necessary to start and run them. Though they cannot take advantage of the large amounts of power in heavy winds (they do not spin fast enough), they are quite adequate for supplying the water needs for a small farm—500 to 5,000 gal. a day; depending on the size of the unit and depth of the well. Protection against extreme winds is provided in various ways: the tail vane automatically turns sideways to keep the rotor facing at right angles to the wind, brakes are automatically applied, or the mill may be automatically decoupled from the pump shaft. The only attention the windmill needs is replacement of the oil in the gear case once a year.

Wind-electric technology is no longer in its infancy, yet a variety of ways to tap the wind continue to be investigated. The Darrieus rotor shown at the right solves the problem of twisting stresses since it does not have to swivel its axis with each change in wind direction. A virtue of sailwing plants is that extreme winds are likely to do no more damage than rip the sails—a

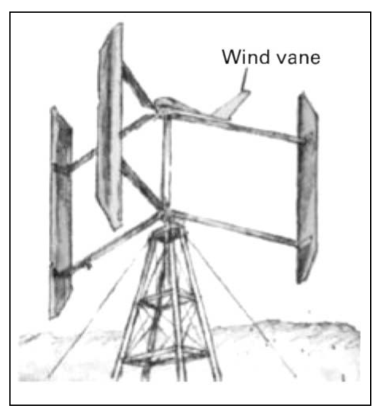
Wind-powered generators are manufactured in two configurations: with a tail vane and without one. Generators without a vane pivot on an off-center support point so that the force of the wind keeps them oriented toward the wind on the downwind side of the pivot. In heavy winds the generator shown with a vane has weights on each propeller shaft that turn outward like governor weights and "feather" the blades. (Feathered blades are edged into the wind; in this way they lose their propulsive power and keep the unit from overspeeding.) The wind spoilers shown on the downwind generator server the same purpose, but instead of feathering the blades, the spoilers spread centrifugally outward in rising winds to act as a brake.



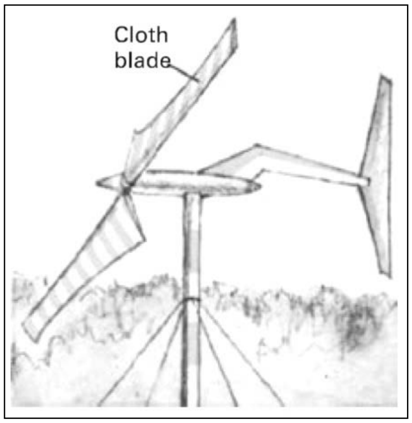
Experimental designs



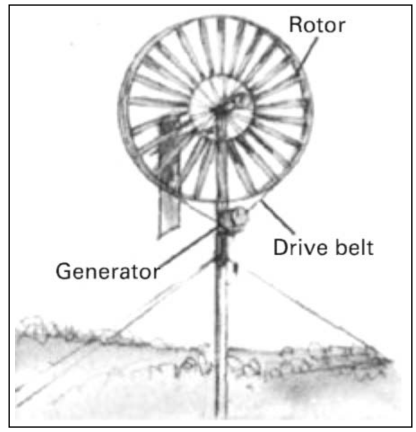
Darrieus rotor resembles a two-or three-bladed eggbeater. Because it spins on a vertical axis, it does not have to swivel into the wind to catch it every time the wind shifts direction. It does not start by itself, however, so a small motor is usually built on to get the unit going after each spell of no wind.



Variable-pitch blades on this type of Darrieus rotor give the unit a means to start by itself. A small wind vane on top of the rotor shaft makes starting possible by sensing any new direction from which the wind may be rising and altering the angle that the blades make with respect to the new direction.



Sailwing windmills use blades made of nylon. The cloth is kept taut by a framework of aluminum poles and takes on the airfoil profile of a sail on a sailboat whenever the wind blows. Since the cloth is flexible, the blades bend with the wind and so are less likely than solid blades to break.



Bicycle–wheel rotor is a modern cousin to the old multibladed windmills. The rotors weigh very little. To operate a generator, the rotor perimeter is employed as a drive wheel in a pulley system with a large step-up ratio. Fair amounts of power can be produced in this way in the low wind-speed range within which these mills are most effective.

considerably safer consequence than a broken propeller blade flying downwind. They are also easier to repair.

Measuring the Wind in Order to Reap It

Although the most accurate way to calculate the power potential of the wind in your area is to measure it yourself, a fair estimate can be obtained by using wind data accumulated by the government at over 270 locations around the country. It can be obtained by writing the National Climate Data Center, Federal Building, Asheville, North Carolina 28801; ask for data collected by the station nearest you. Also check with your local newspaper and television and radio stations—they frequently maintain files on wind and weather dating back many years. The most useful information you can get is the average wind speed for each month of the year as well as for the year as a whole. For most parts of the United States the average falls between 8 and 12 miles per hour. Localities that have an average wind speed of more than 12 miles per hour are definitely worth considering for a wind power installation; areas with an average below 8 miles per hour are marginal at best.

What the Wind's Power Can Do

After an optimum location has been selected, use the wind speed measured at that location and the monthly power output chart (p. 91) to determine the number of kilowatt-hours available if a wind-powered generator is installed. The output will depend, of course, on the wind-plant model planned for the site. The manufacturer will probably specify a power rating that is the maximum power the wind plant will deliver—usually it will be the power generated when the wind speed is 25 miles per hour. Use this rating in the chart.

Having determined the expected monthly output in kilowatt-hours, you can estimate what value it can have for you. One way to do this is to compare the kilowatt-hours on your electric bill with the expected output of the wind generator. This will tell you how much of your electric power needs the wind plant will satisfy. For the comparison, use a bill that is typical of the year.

Alternatively, use a power capability chart like the one at the right for the estimate. The chart indicates in an approximate way the number and type of appliances that various monthly power outputs can handle. It is expected that the use of these appliances will be fairly evenly distributed over each month and that batteries are used to store power and absorb peak power demands.

If you make your own wind speed measurements, you should obtain periodic readings at a number of locations around your property, particularly at higher elevations, to find the optimum site. One shortcut is to measure for a week or two only; if the ups and downs of the data over this period are similar to those reported by the nearest weather station, you can assume that the station's readings for the remaining 11 months will also be similar. For example, if your measurements consistently turn out to be 10 percent higher than the station's reported wind speeds, augment the remaining reported figures by 10 percent to achieve a year-round estimate.

Power capability

The amount of 90 kilowatt-hours per month that can run the appliances listed is:

150 kilowatt-hours will run all of those in A
300 kilowatt-hours will run all of those in A and B
700 kilowatt-hours will run all of those in A, B, and C

A	B	C
Blender	Iron	Food freezer
Mixer	Electric blankets	Clothes dryer
Heating pad	Lights	Electric range
Vaccum cleaner	Television set	
Toaster	Refrigerator	
Washing machine		
Coffee pot		
Record player		
Humidifier		

A variety of instruments are available for measuring wind speed. Some, costing only a few dollars, simply measure the speed at a given

Low cost system to measure wind speed uses anemometer wired to odometer. Cups of anemometer are spun by wind; odometer (black box at base of mast) counts each revolution of the anemometer. To measure wind, set odometer counter to zero and note the time. After several hours, read number tallied by odometer and recheck time. Divide odometer reading by 60 and by number of hours elapsed to obtain average wind speed in miles per hour. For example, if odometer tally is 1,500 after an interval; of 2 ½ hours, the tally is divided by 60 and then by 2 ½ gives an average wind speed of 10 miles per hour.

Average monthly power output

Output rating in watts	Blade diameter in feet	Kilowatt-hours at Various Wind Speeds				
		8 mph	10 mph	12 mph	14 mph	16 mph
100	3	5	8	11	13	15
250	4	12	18	24	29	32
500	5	24	35	46	55	62
1,000	7	45	65	86	100	120
2,000	11	80	120	160	200	240
4,000	15	150	230	310	390	460
6,000	18	230	350	470	590	710
8,000	21	300	450	600	750	900
10,000	24	370	550	730	910	1100

Chart shows the output you can expect for a variety of generator sizes and wind speeds. To use the chart, locate the wind speed column most closely matching the average in your area, and read down the column. Each entry shows the kilowatt-hours (kwh) per month that will be developed by a particular generator-blade combination. For instance, if the average wind speed at a potential site is about 12 miles per hour, a 100-watt wind generator will turn out 11 kwh (scarcely worthwhile), but a 2,000-watt generator will produce 160 kwh and a 10,000-watt generator, 730 kwh.

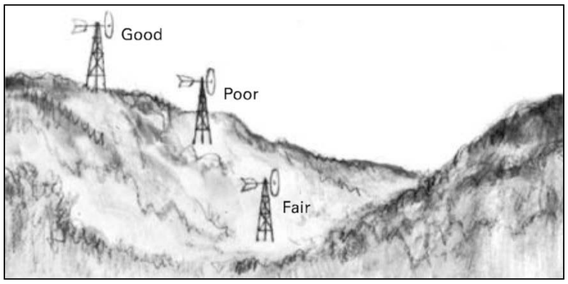
moment. To obtain a reliable average over a period of time with these devices requires that you make many observations, a chore that can quickly become tedious. At the other end of the spectrum are sophisticated instruments costing hundreds of dollars that automatically provide a complete printout of wind data over an extended period. The best choice for the individual homeowner may be a compromise, such as the semiautomatic anemometer-odometer arrangement shown at the right.

Selecting and Putting Up Towers

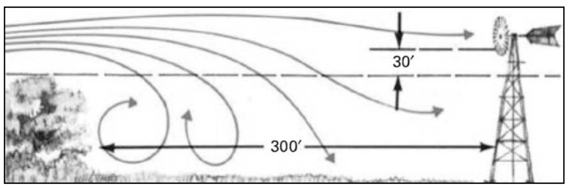
As towers rise in height, they also rise in cost, and eventually a point of diminishing returns is reached where added tower expense is not appreciably offset by added power output. Where to draw the line will depend on your power needs and the nature of the site. Factors to consider include average available wind speed, the type of tower used, and the cost of the windmill. For example, if a pole-type tower is to be erected, an array of at least five guy wires fanned out in different directions is preferable, an arrangement that requires more and more space as tower height increases.

It is easy to underestimate the twisting forces that a wind plant will exert in extreme winds, so it is best to use a commercial tower specifically engineered to support a windmill, especially for heights greater than 30 feet. The manufacturer will provide instructions concerning assembly and erection. You will need at least two helpers to put up the tower and install the windmill on it. The usual procedure is to prepare the foundation, assemble the tower on its side, and erect it by the gin-pole method (below). The mill is then installed part by part at the top. (Do not attach the generator unit before raising the tower; the added weight increases the tower's likelihood of falling down as it is being pulled up.) Towers can also be built vertically, section by section, but this is more hazardous. In general, erecting a

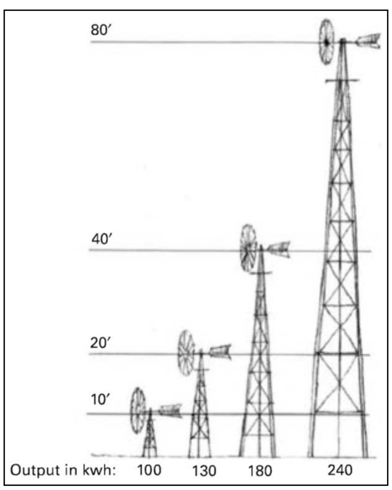
Preferred sites for windmills



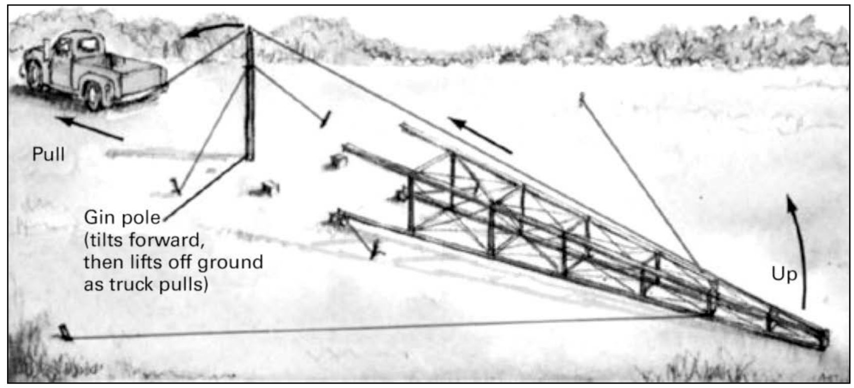
In hilly areas average wind speed can differ markedly according to location. As a guide when checking, hilltops are the best sites, hillsides are the poorest, while valley bottoms can do very well provided the direction of local prevailing winds is up and down the valley. But test each site to make sure.



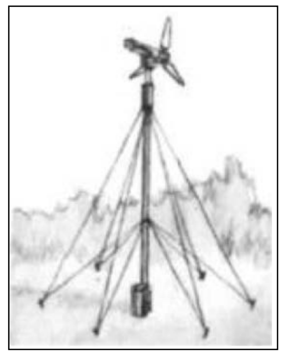
Nearby obstacles can be very detrimental to windmill power output. Even when a barrier is situated downwind from the mill it can produce enough turbulence in the area to interfere with the windmill's efficient performance. For best results, a windmill should be at least 30 ft. higher than any obstruction within a circle of a 300-ft. radius out from the windmill.



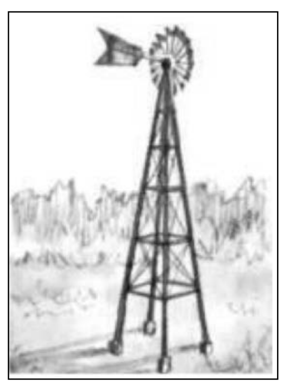
Height of windmill above the ground makes a substantial difference in power output, since wind speed in general increases with altitude. Also, windmills respond in exaggerated fashion to small changes in wind speed, their power output climbing 33 percent for each 10 percent increase in wind speed. The net effect is shown in the illustration. A wind plant that generates 100 kwh per month on a 10-ft. tower, for instance, will generate 240 kwh per month on an 80-ft. tower.



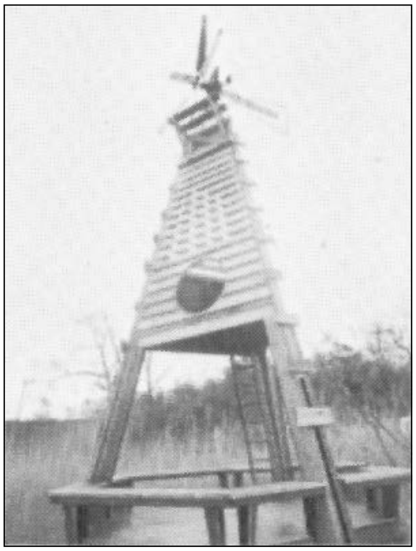
Gin-pole method for raising a tower depends for its success on carefully placed temporary guy wires that keep pole and tower from falling sideways during lifting. Wires at base of tower prevent it from sliding forward as vehicle pulls.



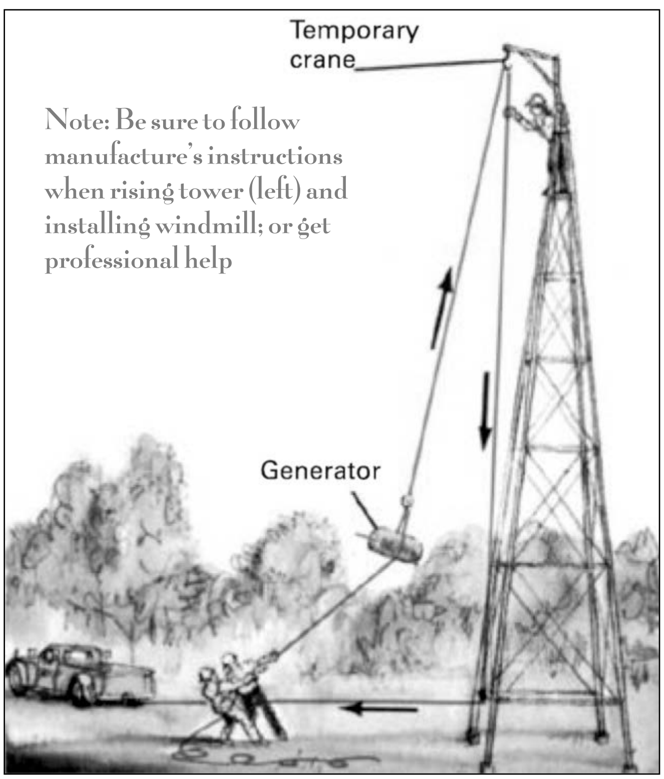
Pole-type tower must either be deeply anchored in concrete or supported by guy wires. Use a minimum of three guy-wire anchors (five are preferable). Set anchors at least one-half of tower height away from base of tower and use turnbuckles in the guy wires so that their tension can be adjusted. Some pole towers are hinged at the bottom to permit lowering for servicing and during gales.



Self-supporting tower does need additional bracing but most have an adequate foundation—usually concrete piers in which the tower's legs are embedded or to which they are bolted. Self-supporting towers are delivered in segments by the manufacturer and must be assembled on location. They are about twice as expensive as pole-type towers of equivalent height but require no guy wires.



Homemade towers up to 30 ft. high, such as the wooden structure shown here, can be built by experienced do-it-yourselfers. They can be quite attractive (this one includes a small picnic platform in the base) but are more apt to be blown down in high winds. If you plan on building one, consult a structural engineer and site the tower in an area where danger to life and property due to the tower falling will be negligible.



Temporary crane attached to top of tower is used to raise windmill parts—first the generator and then tail vane and blades. Man on ground guides each part with guy, helping it into place at tower top, where assistant installs it.

tower or climbing one to install equipment can be dangerous work. Never work alone and always wear strong boots, gloves, sturdy clothing, and a hard hat—tools or constructions debris falling from a structure can cause serious injury.

A Wind-Electric System for Household Needs

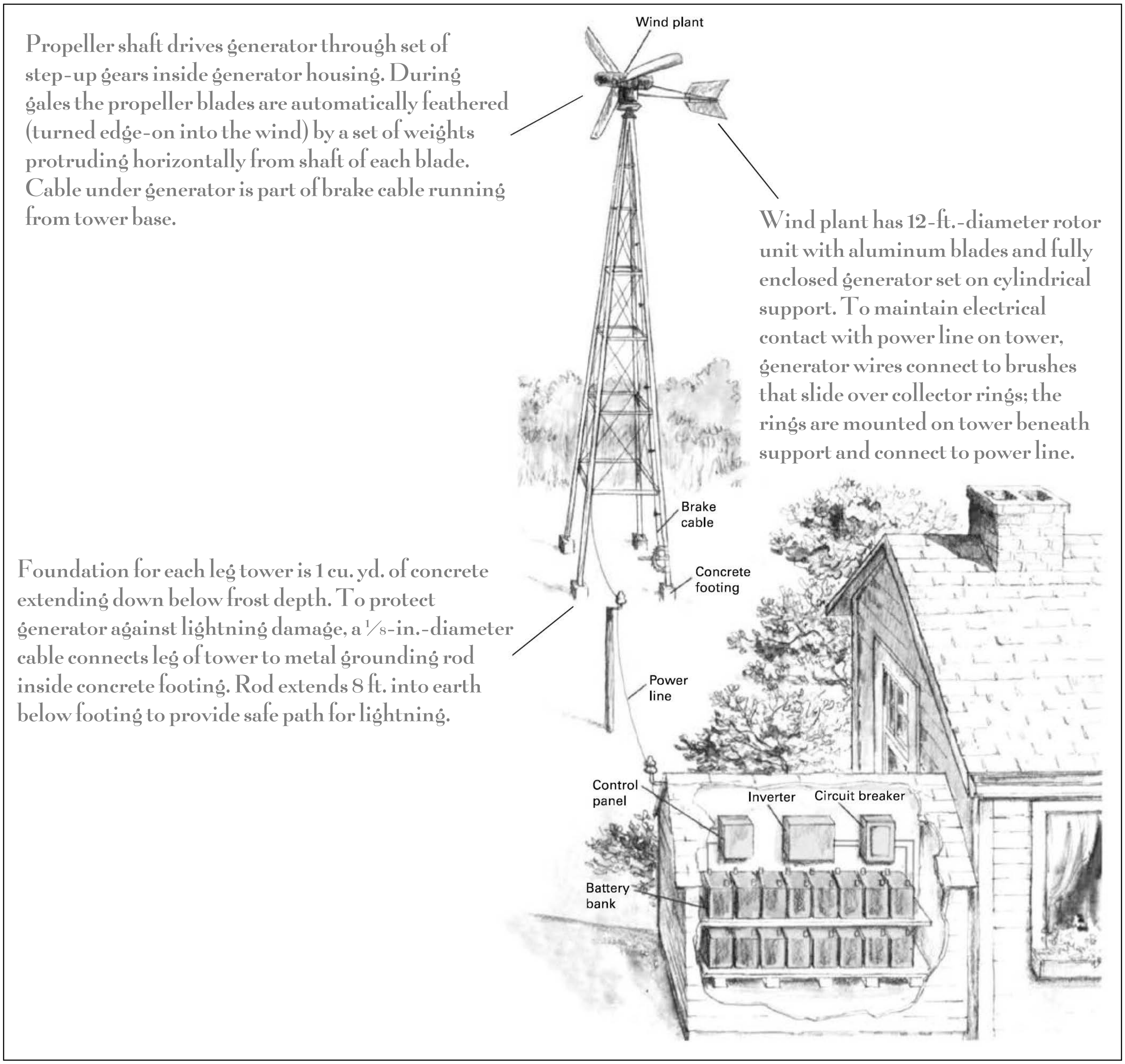
A system such as the one shown at right can supply a significant portion of the electrical needs of a one-family home. A bank of batteries installed in a well-ventilated shed (or basement of a house) stores excess power that the wind plant generates during low demand periods and releases during windless periods or times of peak demand. Operation is automatic. When the wind blows strongly and few appliances are on, or when the wind is down, the battery current reverses, sending just enough to the house system to make up the difference between windmill output and appliance demand.

Wind plants are generally rated according to their maximum output. The one illustrated here is rated at 2,000 watts, the rating corresponding to its power output when the wind is 25 miles per hour. Its actual output is considerably lower—in the 50- to 150-watt range for most places in the United States—since there are very few locations where wind speeds average 25 miles per hour.

The wind plant is built to stand up in winds of up to 120 miles per hour, but the propeller should be braked whenever winds above 80 miles per hour are anticipated. The brake, which is also useful for stopping the windmill for inspection and servicing, can be operated from the base of the windmill tower.

Electrical Equipment

The amount of electrical energy that can be stored by a wind-electric system depends on the capacity of its batteries. A typical home system will



Wind-electric system includes an AC generator. The current is converted from AC to DC inside the generator (batteries will only charge on DC) and is then carried by power line to control panel in shed. There it may be stored in batteries or reconverted to AC for household use by the inverter. Older systems made in the 1930s and 1940s used DC generators, but they have fallen out of favor because of the extra maintenance they require.

store enough to carry a family through two or three windless days after which some type of alternate backup supply must be switched on. If more batteries were used, more windless days could be handled, but batteries are expensive, and it is generally cheaper to use an occasional backup.

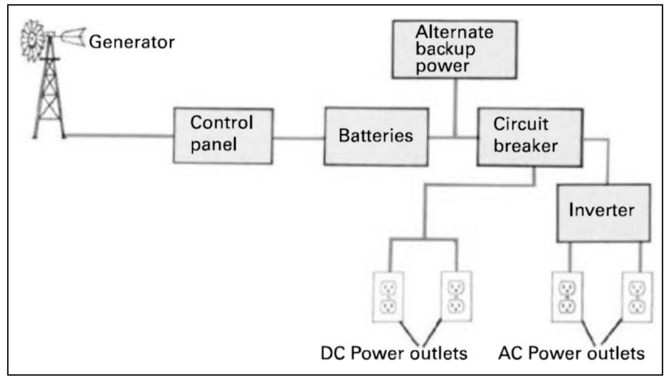
Batteries come in various storage ratings and are priced accordingly. Those shown below have a rating of 270 ampere-hours. This means, for example, if an appliance draws 10 amperes of current from such a battery, the battery will become discharged after 27 hours (10 amperes times 27 hours equals 270 ampere-hours). Appliances such as electric irons and toasters each draw about 10 amperes. This calculation can be extended to any amount of current drawn provided it is not excessive. (For instance, the batteries will not deliver 270 amperes for one hour; they are not built for it.)

Properly maintained and operated, a battery will last about 10 years. Water should be added periodically, usually every one to six months, the battery terminals should be kept clear of corrosion, and the batteries must not be permitted to become more than 90 percent discharged. Maintain the batteries at room temperature or above, since to ventilate the room in which the batteries are placed; they can emit hydrogen, a highly flammable and potentially explosive gas.

The public utility or a standby gasoline-fueled generator can be used for backup power. A standby unit requires an engine no larger than a snow thrower's, but it has a limited life span. A better backup option may be photovoltaic (PV) cells. PV cells convert sunlight to electricity and can allow greater daytime electric use.

Inverters are employed to convert DC to AC. The inverter used with the batteries illustrated below has a 2,000-watt capacity and automatically

Bank of 58 batteries produces 116 volts DC. Batteries are like those used in electric golf carts and can provide a steady output over long periods. Inverter is at far right on counter. Above it, on wall, are control panel and circuit breaker (partly hidden).



Typical wind-electric system has control panel to protect batteries from overcharging, and inverter to convert some of the DC output to AC, and a source of standby power. (Alternate systems, similar to some hydroelectric systems, can also be employed.)

State of charge or discharge is indicated by ball-shaped battery floats. When left ball drops to level shown, battery has become 30 percent discharged; when center ball drops, battery is 60 percent discharged; when right ball drops, battery is 90 percent discharged. Battery water level can also be seen through glass and checked. The water, which must be distilled water, should never be above high mark or below low mark. At top is a capped opening for replenishing water.

adjusts to changing loads. Such a device is quite expensive, almost as much as the wind plant shown on the facing page. If DC can be used in the house, a mixed system—one that delivers both AC and DC—is preferable; the inverter can then be smaller and less costly.

Neil Welliver, Painter and Wind Enthusiast

Independence from the Local Power Company

Neil Welliver, of Lincolnville, Maine, is an internationally renowned artist who often paints his giant landscapes under floodlights powered by the two wind plants on his isolated farm. The plants serve his other electrical needs as well and have saved him thousands of dollars in utility costs.

"I suppose I first got interested in wind power as a child when I got my first pinwheel. Later I read a little about electricity and wind plants but, really, I was a rank amateur. I put up my first wind plant myself with the help of a local electrician. I sure learned a lot about electricity in a hurry.

"There's no problem in generating enough power for all our household activities from the 2- and 6-kilowatt plants we have. We're conscious of what we're using, but I've never even had a light flicker. I have a backing generator, but we hardly ever need it except for August and September during the doldrums—you know, the period when the wind really dies down. In the winter the wind up here is very strong, and I get more power than the batteries can store.

"There's been an enormous interest in wind plants in the last several years. I was one of the first people in the country to install one and a New York paper did a story on me. People drove from as far away as Louisiana to see the wind plant without so much as a call beforehand.

"Despite the interest, I should say that wind plants are not for everybody. First of all, you have to climb a 50-ft. tower to grease the equipment. And to use a wind plant effectively, you really have to know how the whole thing operates, how to check the machinery and the batteries to see if everything is in good shape. Then, remember, a wind plant produces direct current. That's all right for light bulbs, but for most electronic equipment you have to use an inverter to change that direct current to alternating current.

"Nonetheless, I hope more people will get the information on wind plants. It's madness not to use the wind as power. Look, 90 percent of my electricity I get free. I like to think of myself as a consumer with my own electric company."

Growing Food

Growing Food in Small Spaces

BY MONTE BURCH

Creating lush gardens in small spaces is nothing new. Replicating the Hanging Gardens of Babylon might be a bit impractical, but regardless of how tiny a space you have for growing your own food, you can use a variety of methods to grow a bountiful crop. Green zones can flourish on rooftops, patios, decks, and even pint-sized apartment balconies by using containers, raised beds, and also the Babylon-style vertical or even hanging gardening methods.

Container Gardens

Container gardening offers many advantages. Containers can be used anywhere, but they're especially useful where space is a problem. You can place each container exactly where you want and rearrange them during the growing season for maximum effect. Pots and wooden boxes can be used to grow nearly anything, depending on the size of the containers; even dwarf fruit trees can be grown in containers.

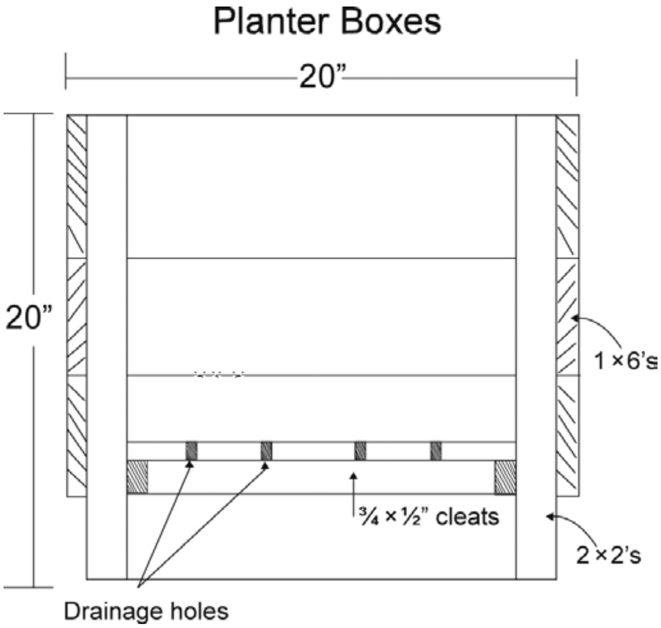
Almost anything imaginable has been used at one time or another for container gardening, from discarded bathtubs to halves of wooden whisky barrels. Large plastic buckets, with drainage holes cut in the bottom, can also serve as containers. Old recycled food coolers also make great, if somewhat ugly, containers.

The most popular containers are clay or plastic pots and wooden boxes. The latter can be purchased or built at home if you're handy with your hands. Do-it-yourselfers have the advantage of building precisely to size and shape the boxes they need.

Box containers can be placed on a deck, patio walkway or balcony, fastened to a window sill, or used as hanging planters on porches. Designs can be as simple or as elaborate as you like, and boxes can be crafted to suit your individual decorating or landscaping tastes. All containers must have

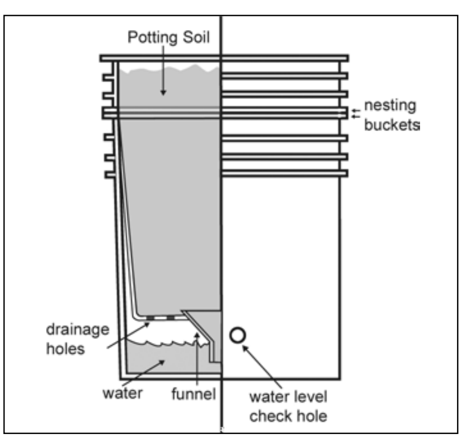
Container gardening is a great way of growing food on decks, patios, or even on an apartment balcony.

Containers for growing food can be any number of items, including purchased pots.

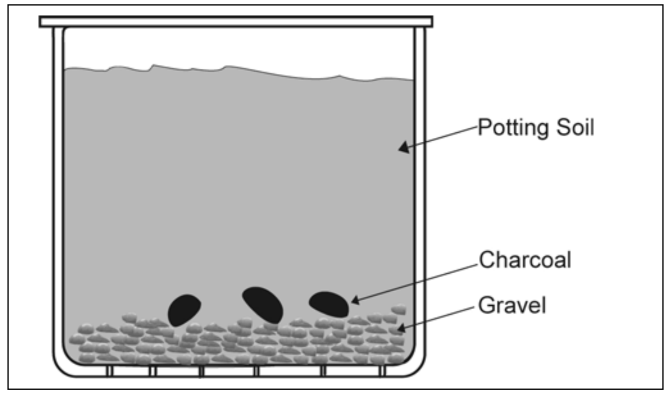


Even simple, do-it-yourself wooden boxes are effective for growing food.

drainage holes to prevent plants from drowning or rotting from too much water. You can even build your own “self watering” containers. If you intend to place boxes or containers on a wooden surface such as a deck, it’s a good idea to put shallow holding pans under them to catch excess water and prevent staining the deck. Another idea for large-sized containers on roofs, decks, and patios is to add wheels or make simple wooden dollies. This allows you to move the containers around for the best available light, or even indoors in the event of frost.



You can build self-watering containers using large 5-gallon buckets typically used for commercial storage.



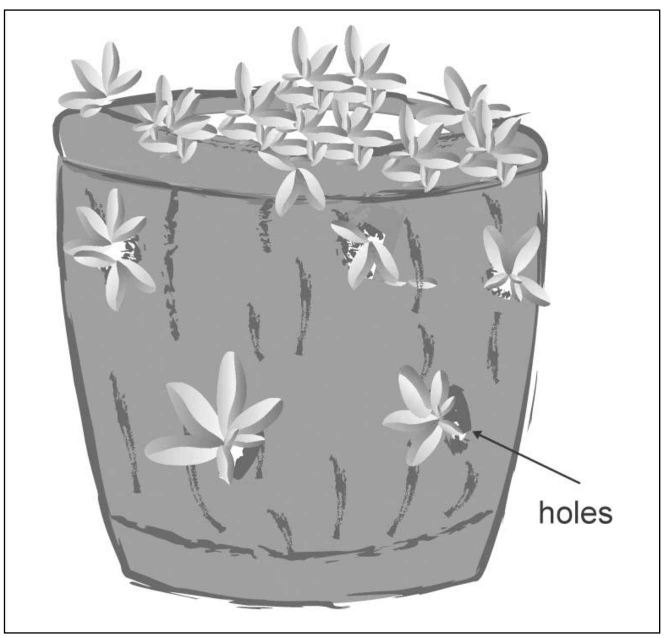
A soil mixture should be light and able to hold moisture and nutrients. Pebbles, gravel, or broken clay pot pieces can add to drainage.

Regardless of design, wooden plant boxes need to be constructed of wood, resistant to the ravages of weather, insects, and rot. Redwood and western cedar are two popular choices. Or use pressure-treated lumber for a long-lasting plant container. Whatever type of wood you use, make sure to also use exterior fasteners.

Another advantage of container gardening is that the soil used can be carefully prepared and matched to the specific need of the plants you want to grow. As a general rule, the soil mixture should be fairly light and able to hold moisture and nutrients. It should also be able to drain well. The first step is to place a layer of pebbles, gravel, or pieces of broken clay pots

Any number of foods can be grown in containers, including tomatoes in hanging baskets.

in the bottom of the container to aid in drainage. Some experts like to put a few pieces of charcoal in the bottom to help keep the soil "sweet." The boxes are then filled to within one-half inch or so of the top with soil. Use either purchased commercial potting soil mixes or make up your own using one part garden soil, one part compost or humus, and one part sand. Vermiculite or perlite can be substituted for sand to provide a lighter soil that will drain well, yet hold moisture. Another good recipe is six parts good, rich garden soil; one part peat moss; and two parts vermiculate or perlite. Some plants have specific alkaline or acid needs, and these can be met with soil additives. Your garden supplier or nursery should be able to help you with those. If you are gardening on a rooftop or balcony, consider using a growing medium without soil. It weighs about half as much as a soil mixture, which averages about twenty-five pounds per cubic foot. Planting mixtures without soil are available commercially, or you can make up your own. Use three parts peat moss and one part vermiculite or perlite. Add about a half pound of ground dolomitic limestone per each bushel to neutralize the acid in the peat moss.



Strawberries can be grown in the old fashioned strawberry jars, but can also be grown in a half-whiskey barrel planter with small holes cut around the sides.

All container-grown plants must be kept supplied with the proper nutrients according to the plants needs. This is especially important for mixtures without soil. Liquid fertilizers such Miracle-Gro and other commercial products, as well as fish emulsion or homemade manure tea, should be applied once a week. Plants in container also need to be kept well watered and during summertime heat, that often means once or twice a day, Regularly check the soil. If the top inch is dry, water until the water begins to drain out. Container-grown plants must have at least six hours of light daily. If you don't have a place with full sun, consider making reflectors to help direct sun to the plants.

Any number of vegetables can be grown in containers, with tomatoes, peppers, herbs, onions, and lettuce some of the most popular. The small hot peppers are especially popular because they also add decor. A number of plant varieties are also available especially for growing in small spaces, such as dwarf cucumbers and so forth.

Strawberries are popular planted in the old-fashioned strawberry barrel, and these days "strawberry kits" complete with containers are available. Some plants, such as some varieties of tomatoes and cucumbers, can even be planted in hanging baskets.

Raised Beds for Supersmall Gardens

Raised beds also provide a lot of gardening in small spaces, regardless whether you want to grow vegetables or herbs. In a way, raised beds are just big containers, and they have a number of advantages over traditional tilled-row gardening. Raised beds can be built and filled with an improved soil mixture in less time than it takes to develop a good in-ground plot. Raised beds also allow for intensive gardening, often called French intensive or square-foot gardening, raising more food in limited spaces. This means spacing plants much closer than

One of the best ways of growing in small spaces, even in larger garden areas, is in raised beds.

in traditional gardening methods. Experts suggest it takes five times as much space to grow food in conventional gardening.

With proper planting and care, you can produce over half a ton of vegetables in only a five-hundred-square-foot garden using these tactics. We have a number of raised beds in our garden. In fact, over half of our garden is made of raised beds, with mulched areas and walkways between. Built three feet wide, the beds allow you to reach to the center of the bed without walking on it or getting in it for planting, weeding, and harvesting. Without the compaction of walking on the soil, the raised beds provide a continuously loose, friable soil. Older gardeners, such as me, find the heights of raised beds easier to work on since we can sit on the edge or on a stool and not have to stoop or bend as with ground-level plots. Raised beds take less time to plant and maintain as well. First, you don't need to till. Merely dig up the bed in early spring with a shovel or trowel, which is easy because the soil hasn't become compacted. An even better method is to mulch the beds heavily in the fall.

Merely rake back the mulch in spring, uncover the loose soil, and plant. As the plants are growing close together, they also tend to shade out many of the weeds, cutting down on weeding. If raised with mulch, raised beds can almost eliminate weeding. And of course, harvesting and watering are also easier. With a little planning, you can direct water

We grow a great deal of our food in raised beds. The beds are easier to work with, the soil stays soft and workable because it is not compacted, and we can grow a lot more food in a smaller space.

Raised beds not only contain plants, but can also help keep out critters if covered with a wire mesh—which is great for those living in areas with an abundance of wildlife.

to specific beds or areas, cutting down on water and watering times.

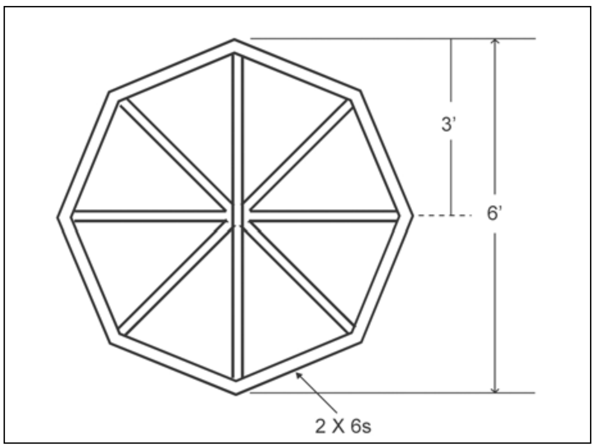
Raised beds can also be combined with frames holding netting to keep out birds and other pests, as well as covered with plastic for winter gardening. One idea I've used is creating a "cage" of welded wire used for reinforcing concrete. This comes in five-foot-wide rolls, perfect for making cages for my 3 × 5 foot beds. It keeps out the deer, and adding mesh wire to the bottom keeps out the smaller critters such as rabbits. Covering the cage with clear plastic creates a minigreenhouse for winter growing. There is one raised-bed intensive gardening problem you need to be aware of. If growing plants such as peppers in an intensive gardening method, they may cross-pollinate. Plant only one variety of each plant in each raised bed.

Raised beds are often combined with modern-day mulches such as black plastic or plastic screening mulch with microscopic holes that hold in moisture while holding down weeds for easy-care growing. This is a great way of growing strawberries that cuts down greatly on the weeding problem. Herbs do especially well in raised beds, and you can create an attractive herb garden by dividing the bed into sections for each variety of herbs.

Old-style raised-bed gardening consisted of mounding up the soil into long, raised, or rounded mounds with walkways between them.This is effective, but more intensive gardening can be done with contained beds. What makes a contained, raised bed is a border that holds the soil in place. My first beds were simply made of logs obtained by thinning the timber on our hillside farm. Concrete blocks, bricks, and rocks can all be used to build raised beds as can recycled railroad ties and landscaping timbers made of treated lumber specifically for use in creating raised-bed gardens.

Raised beds can be used with black plastic screening for weed-free growing of plants such as strawberries.

Containing the raised beds makes them easier to work with, increases their productivity, and keeps the soil in place.



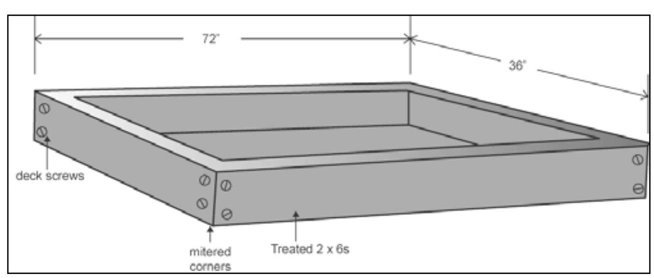
You can create a formal and attractive herb bed using wood to create a divided raised bed.

The easiest raised bed consists of simple raised mounds of soil with a walkway between the mounds.

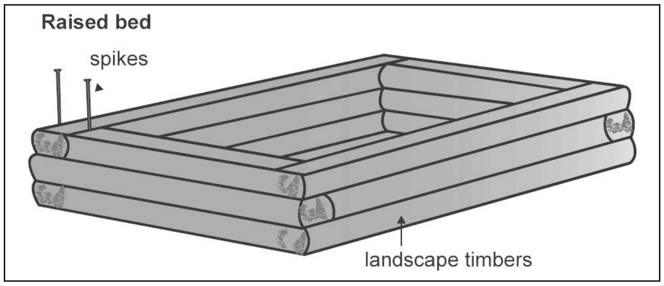
These are often simply laid in place or held to sloping hillsides with wooden stakes. Cedar, redwood, or treated 2 × 6s or 2 × 8s can be fastened together with deck screws to create a fast, sturdy, and economical raised bed. They're basically boxes without bottoms.

Locate the bed where it will catch the most sun, full sun if possible, and then mark off the area with stages and string. Use a shovel to dig out and remove all sod, grass, and weeds. The best beds have very deep soil bases. This is done by digging, if possible, down to at least eighteen to twenty-four inches. If you can't dig that deep, as in my area with rocks at about eight inches, simply build the beds higher.

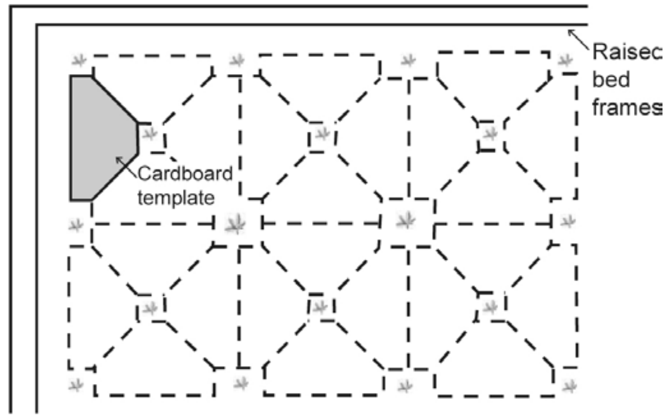
Some of my beds are twelve inches high for that reason. Build the sides of the bed using the materials you've selected and reinforce the corners with stakes driven into the ground and fastened to the logs, timbers, or planks.



Raised beds can be contained many ways, including simple treated 2x3x6 frames, Ours are three feet wide and vary in length from 5 to 12 feet.



Landscape timbers can also be used to create a raised bed.



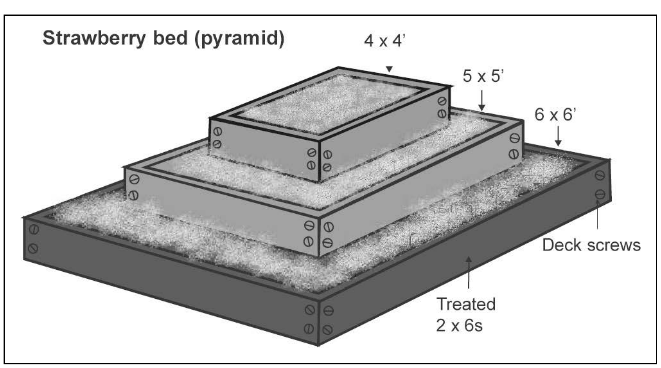
You can grow plants more intensively in raised beds with closer spacing. Rather than planted in rows, plants are spaced in an equidistant triangular fashion. A cardboard template, sized to match the spacing, helps space plants properly. This chart shows the spacing.

As with container gardening, soil that drains well and is rich in nutrients is the key to success. Both soil and nutrients should suit the plants you intend to grow. Because of the size and volume of a raised bed, you'll probably have to fill it with soil materials readily available in your area or obtainable at a reasonable cost. As a general rule, a mixture of good topsoil, compost, or well-rotted manure, peat, and sand is a good starting point. Once the bed has been filled, have a soil sample tested to determine pH level and to see if any additional nutrients are required.

Another important factor in intensive gardening is to use precise and close plant spacing. Seeds or transplants are normally spaced equidistance apart. This will increase yields. One trick to getting more produce from intensive gardening is to set or seed plants in a staggered fashion rather than in rows. Make up a cardboard template in a triangle shape and use this to determine proper seed or transplant placement. This shape better utilizes the available space. But don't plant too closely. As a normal rule, you can about halve the spacing for plants such as lettuce, broccoli, and cabbage. We also simply sow lettuce and spinach on bare ground in a raised bed, rather than in individual rows, and shovel more loose compost and well-rotted manure over the

Intensive growing spacing chart
(equidistant in inches)

Beans, Bush	6″
Beets	3″
Broccoli	15″
Cabbage	15″
Carrots	3″
Corn	12″
Cucumber	12″
Lettuce	6″
Melons	15″
Onions	5″
Peas	3″
Potatoes	10″
Radishes	1″
Spinach	3″
Squash	15″
Watermelon	12″



One great way of growing strawberries is in a raised pyramid bed.

Growing companion plants also helps save space. A tradition is planting beans, corn, and pumpkins next to one another.

seeds. The plants are then thinned as they sprout. We also interplant in raised beds, again adding to the intensive gardening tactic.

We often plant onions and lettuce together, lettuce or spinach, cabbage or broccoli. The lettuce is harvested first, but as the broccoli gets bigger, it shades the lettuce, extending the lettuce harvest as well. And the lettuce cuts down on the weeds until the broccoli gets started. Some food growers like to make a bed or two of the "big three"—corn, squash, and pole beans. The corn provides support for the pole beans, and the squash keeps down the weeds in the beans and corn. Another tactic we use is to keep the beds producing throughout the season with successive plantings—for instance, spring lettuce, followed by summer squash, followed by fall spinach. This is especially effective if you start seeds indoors, or in the summer on a porch or shady area, keeping plants ready to go into the beds at all times. Almost anything can be grown in raised beds in the intensive gardening method, even some plants you might not consider. You might even consider growing a fast-growing short or early corn in a raised bed. Space the seeds about six inches apart in all directions. Once the plants emerge, carefully weed and mulch heavily. Drive wooden stakes or steel posts in each corner of the bed and make a chicken wire cage around your mini corn patch. No pests, no fuss, and a bountiful supply of sweet corn from a very small space. A final trick to increasing yields is to keep produce regularly harvested. We pick tomatoes as soon as they begin to turn yellow or orange and allow them to ripen off the vine. They taste just as good as those left on the vine, and removing the tomatoes allows the plant to continue producing. The same tactic can be used with many other vegetables as well.

Vertical Gardening

Growing upward is a good choice when don't have room to grow outward. We also use vertical

Keep vegetables picked to help the plant continue producing. We pick tomatoes as soon as they begin to turn orange.

gardening techniques in our garden as well. In fact, some plants—such as cucumbers, peas, pole beans, and even tomatoes—not only take up less space but also actually do better when grown vertically on supports. Fruits or vegetables are less likely to be damaged because they're not lying on the ground, and larger crops can be grown because their flowers are more exposed and therefore more likely to be pollinated. Grapes and barriers, of course, all need to be supported by trellises or other means.

Fences are the simplest supports for some vertical gardening. For grapes or berries, fence posts should protrude six feet above ground level with no.9 wire stapled to them. A fence for cucumbers and other plants that put out heavy vines can consist of sturdy hog wire stapled in place to the posts. My favorite support for growing cucumbers is a "cattle" panel.

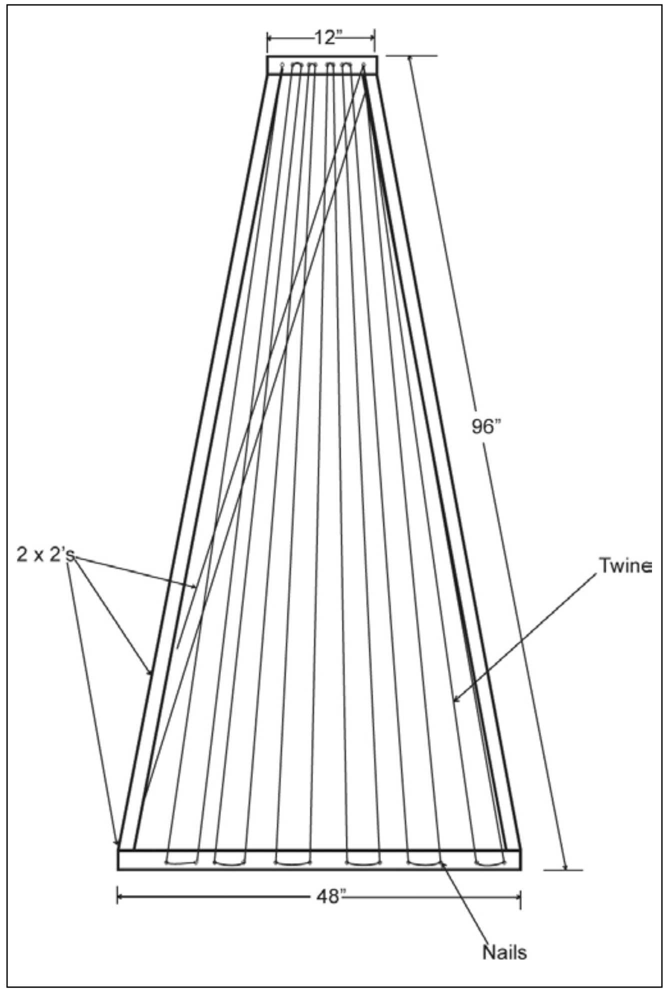
This is a heavy-duty galvanized, welded-wire panel available at farm supply stores. Sixteen feet long and five feet high, it is supported by three steel posts and will grow lots of cukes well off the ground, making them easy to care for and pick.

Tomatoes are a very common and popular vertical-gardening plant. Tests have shown tomatoes will produce a great deal more grown vertically rather than allowed to sprawl. The plants are traditionally tied to wooden stakes, but if you have a lot of plants, it can be a hassle keeping up with retying the fast-growing plants. The simplest method is to grow tomatoes in cages. These can be purchased, or you can make your own out of heavy wire. I made my first cages from hog wire,

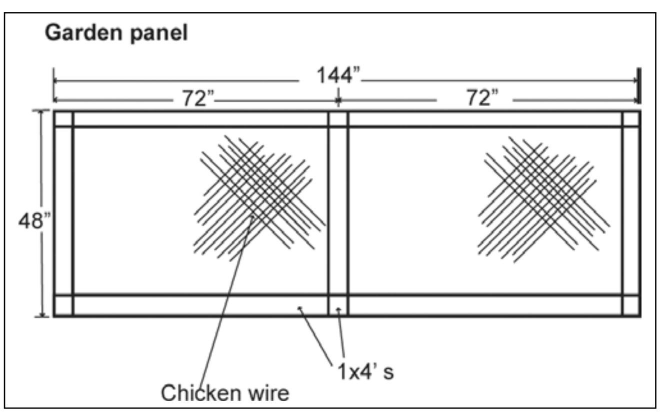
Growing vertically can also help produce a lot of food in small spaces.

A cattle-panel, held in place with steel posts, makes a great permanent vertical support for cucumbers and other "climbers."

Tomato cages are an extremely productive way of growing tomatoes vertically and are, in fact, the best way of growing the fruit.



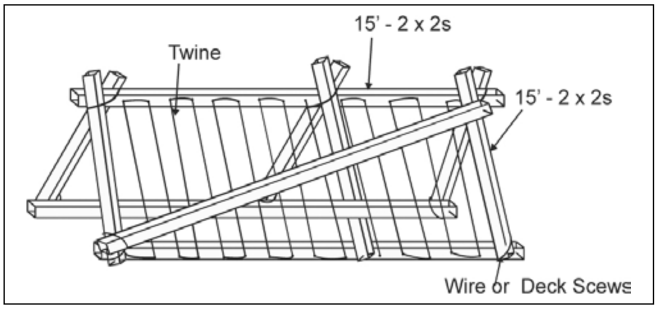
A simple, portable pole bean tower can be made from 2 × 2s and twine.



Peas and cucumbers can also be grown on garden panels made of 1x3x4s covered with chicken wire and supported by posts.

which creates a cage about four feet high. Then I discovered welded reinforcing wire normally used in concrete pours. This created a five-foot cage that is much stronger and supports even the most prolific plants. As I discovered, the higher the cage, the more tomatoes are produced. My tomatoes will eventually grow right over the tops of the five-foot cages and hang down, still producing. Each of the two-and-a-half-foot diameter cages hold two plants, and with the right conditions and varieties, I've harvested almost fifty pounds of tomatoes from each cage.

Our garden is on a hillside and can get pretty windy. Storms can blow the big cages over. I drive wooden stakes in beside the cages, spacing them about every

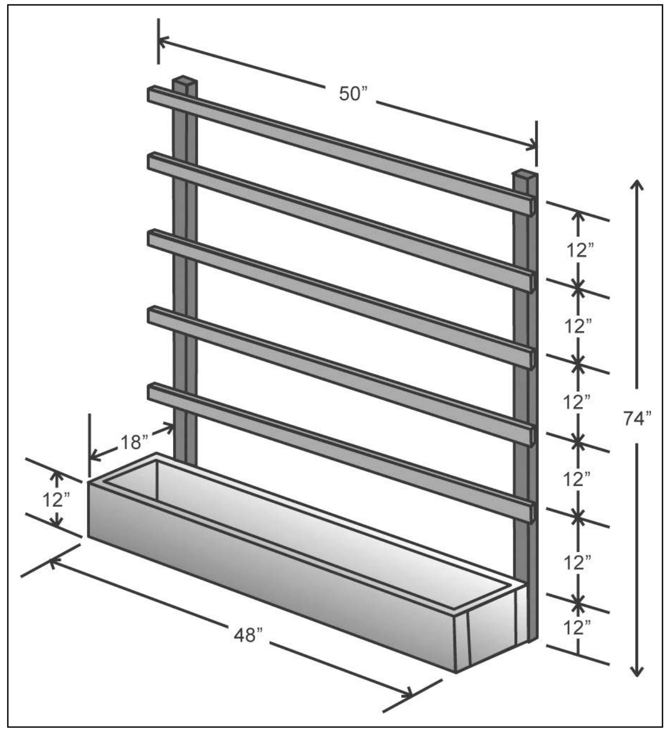


An A-frame support can also be made from 2x3x2s and set over a raised bed for intensively raising pole beans.

third cage. I then tie the cages together and to the stakes. So far, this has prevented the cages from blowing over even in severe wind storms.

Pole beans also need support. These can be purchased supports, or you can make you own. A teepee of 2 × 2 poles or, in my case, saplings from the timber is a simple and easy method of constructing a pole bean support. Another type of support is an A-frame of 2 × 2s. This can be bolted together and then taken down at the end of the season if desired. Combine the A-frame support with a raised bed and you can raise a lot of beans in a very small space.

Regardless of how tight your gardening space is, a little ingenuity and the right methods can help



You can even grow cucumbers and other plants vertically in containers with a simple box container and a trellis-like support.

make your world a little more green. More elaborate systems can be created if you're interested in decor as well as growing food. Don't let the thought of a big garden deter you from growing your own food. These gardening methods can be combined to grow a lot of food in a small space.

How Mini-Farming Works for You

BY BRETT L. MARKHAM

Many homeowners undertake the task of gardening or small-scale farming as a hobby to get fresh-grown produce and possibly save money over buying food at the supermarket. Unfortunately, the most common gardening methods end up being so expensive that even some enthusiastic garden authors state outright that gardening should be considered, at best, a break-even affair.[1]

Looking at the most common gardening methods, such authors are absolutely correct. Common gardening methods are considerably more expensive than they need to be because they were originally designed to benefit from the economies of scale of corporate agribusiness. When home gardeners try to use these methods on a smaller scale, it's a miracle if they break even over a several-year period, and it is more likely they will lose money.

The cost of tillers, watering equipment, large quantities of water, transplants, seeds, fertilizers and insecticides adds up pretty quickly. Balanced against the fact that most home gardeners grow only vegetables, and vegetables make up only less than 10% of the calories an average person consumes,[2] it quickly becomes apparent that even if the cost of a vegetable garden were zero, the amount of actual money saved in the food bill would be negligible. For example, if the total economic value of the vegetables collected from the garden in a single season amounted to about $350,[3] and the vegetables could be produced for free, the economic benefit would amount to only $7 per week when divided over the year.

The solution to this problem is to both cut costs and increase the value of the end product. This can be accomplished by growing your own seedlings from open-pollinated plant varieties so you can save the seeds and avoid the expense of buying both transplants and seeds, using intensive gardening techniques that use less land, conscientiously composting to reduce the need for fertilizers, and growing calorie-dense crops that will supply a higher proportion of the household's caloric intake.

Using this combination, the economic equation will balance in favour of the gardener instead of the garden supply store, and it becomes quite possible to supply all of a family's food except meat from a relatively small garden. According to the USDA, the average annual per capita expenditure on food was $2,964 in 2001, with food costs increasing at a rate of 27.7% over the previous 10 years.[4] Understanding that food is purchased with after-tax dollars, it becomes clear that home agriculture methods that take a significant chunk out of that figure can make the difference, for example, between a parent being able to stay at home with children and he or she having to work, or it could vastly improve the quality of life of a retiree on a fixed income.

The key to making a garden work to your economic benefit is to approach mini-farming as a business. No, it is not a business in the sense of incorporation and taxes unless some of its production is sold, but it *is* a business in that by reducing your food expenditures, it has the same net effect on finances as income from a small business.

Like any small business, it could earn money or lose money depending on how it is managed.

Grow Your Own Seedlings

Garden centers are flooded every spring with home gardeners picking out seedlings for lettuce, broccoli, cucumbers, tomatoes, and so on. For those who grow gardens strictly as a hobby, this works out well because it allows them to get off to a quick start with minimal investment of time and planning. But for the mini-farmer who approaches gardening as a small business, it's a bad idea.

In my own garden this year, I plan to grow 48 broccoli plants. Seedlings from the garden center would cost $18 if discounted and possibly over $30. Even the most expensive organic broccoli seeds on the market cost less than a dollar for 48 seeds. If transplants are grown at home, their effective cost drops from $18 to $30 down to $1. Adding the cost of soil and containers, the cost is still only about $2 for 48 broccoli seedlings.

Considering that a mini-farm would likely require transplants for dozens of crops ranging from onion sets to tomatoes and lettuce, it quickly becomes apparent that even if all seed is purchased, growing transplants at home saves hundreds of dollars a year.

These broccoli plants grown from seed saved lot of money in the long run.

Prefer Open-Pollinated Varieties

There are two basic types of seed/plant varieties available: hybrid and open-pollinated plant varieties produce seeds that duplicate the plants that produced them. Hybrid plant varieties produce seeds that are at best unreliable and sometimes sterile and therefore often unstable.

Although hybrid plants have the disadvantages of not producing good seed, they often have advantages that make them worthwhile, including aspects of "hybrid vigor." Hybrid vigor refers to a poorly understood phenomenon in plants where a cross between two different varieties of broccoli can yield far more vigorous and productive offspring than either parent. Depending on genetic factors, it also allows the creation of plants that incorporate some of the best qualities of both parents while deemphasizing undesirable traits. Using hybridization, then, seed companies are able to deliver varieties of plants that incorporate disease resistance into a particularly good tasting vegetable variety.

So why not just use hybrid seeds? Because there's no such thing as a free lunch. For plants that normally self-pollinate, such as peppers and tomatoes, there is no measurable increase in the vigor of hybrids. The hybrids are just a proprietary marketing avenue. So buying hybrids in those cases just raises costs, and since the tomato seeds can't be saved, the mini-farmer has to buy seeds again the next year. The cost of seeds for a family-sized mini-farm that produces most of a family's food for the year can easily approach $200, a considerable sum! Beyond that, seed collected and saved at home can not only reduce costs but be resold if properly licensed. (Here in New Hampshire, a license to sell seeds costs only $100 annually.)

Another reason to save seeds from open-pollinated plant varieties is if each year you save seed from the best performing plants, you will eventually create varieties with genetic characteristics that work best in your particular soil and climate. That's a degree of specialization that money can't buy.

Of course, there are cases where hybrid seeds and plants outperform open-pollinated varieties by the proverbial country mile. Corn is one such example. The solution? Use the hybrid seeds or, if you are so inclined, make your own! Hybridization of corn is quite easy. Carol Deppe's excellent book *Breed Your Own Vegetable Varieties* gives all of the details on how to create your own hybrids.

Hybrids seeds that manifest particular pest- or disease-resistant traits can also be a good choice when those pests or diseases cause ongoing problems. When using hybrid seeds eliminates the need for synthetic pesticides, they are a good choice.

Use Intensive Gardening Techniques

A number of intensive gardening methods have been well documented over the past century. What all of those have in common is growing plants much more closely spaced than traditional row methods. This closer spacing causes a significant decrease in the amount of land required to grow a given quantity of food, which in turn significantly reduces requirements for water, fertilizer, and mechanization. Because plants are grown close enough together to form a sort of "living mulch," the plants shade out weeds and retain moisture better, thus decreasing the amount of work required to raise the same amount of food.

Intensive gardening techniques make a big difference in the amount of space required to provide all of a person's food. Current agribusiness practices require 30,000 square feet per person or ¾ acre. Intensive gardening practices can reduce the amount of space required for the same nutritional content to 700 square feet,[5] plus another 700 square feet for crops grown specifically for person, so a family of three can be supplied in just 4,200 square feet. That's less than 1⁄10 of an acre. In many parts of the United States, land is extremely expensive, and lot sizes average a half acre or less. Using traditional farming practises, it isn't even possible to raise food for a single person in a half-acre lot, but using intensive gardening techniques allows only half of that lot—¼ acre—to provide nearly all the food for a family of four, generate thousands of dollars in income besides, allow raising small livestock plus leave space for home and recreation. Intensive gardening techniques are the key to self-sufficiency on a small lot.

Compost

By growing so many plants in such little space puts heavy demand on the soil in which they are grown, all intensive agriculture methodologies pay particular attention to maintaining the fertility of the soil.

The law of conservation of matter indicates that if a farmer grows a plant, that plant took nutrients from the soil to build itself. If the plant is then removed from the area, the nutrients in that plant are never returned to the soil, and the fertility of the soil is reduced. To make up for the loss of fertility, standard agribusiness practices apply commercial fertilizers from outside the farm.

The fertilizer costs money, of course. While there are other worthwhile reasons for avoiding the use of nonorganic fertilizers, including environmental damage, the biggest reason is a mini-farm with a properly managed soil fertility plan can drastically reduce the need to purchase fertilizer altogether, thereby reducing one of the biggest costs associated with farming and making the mini-farm more economically viable. In practice, a certain amount of fertilizer will always be required, especially at the beginning, but using organic fertilizers and creating compost can ultimately reduce fertilizer requirements to a bare minimum.

The practice of preserving soil fertility consists of growing crops specifically for compost value, growing crops to fix atmospheric nitrogen into the soil, and composting all crop residues possible (along with the specific compost crops) and practically anything else that isn't nailed down. (Chapter 5 covers composting in detail.)

A big part of soil fertility is the diversity of microbial life in the soil, along with the presence of earthworms and other beneficial insects. There are approximately 4,000 pounds of bacteria in an acre of fertile topsoil. These organisms work together with soil nutrients to produce vigorous growth and limit the damage done by disease-causing microorganisms known as "pathogens."

Grow Calorie-Dense Crops

As already noted, vegetables provide about only 10% of the average American's calories. Because of this, a standard vegetable garden may supply excellent produce and rich vitamin content, but the economic value of the vegetables won't significantly reduce your food bill over the course of a year. The solution to this problem is to grow crops that provide a higher proportion of caloric needs such as potatoes and onions.

Raise Meat at Home

Most Americans are accustomed to obtaining at least a portion of their protein from eggs and meat. Agribusiness meats are often produced using practices and substances (such as growth hormones and antibiotics) that worry a lot of people. Certainly, factory-farmed meat is very high in the least healthy fats compared to free-range, grass-fed animals or animals harvested through hunting.

The problem with meat, in an economic sense, is that the feeding for one calorie of meat generally requires anywhere from two to four calories of feed. This sounds, at first blush, like a very inefficient use of resources, but it isn't as bad as it seems. Most livestock, even small livestock like poultry, gets a substantial portion of its diet from foraging around. Poultry will eat all of the ticks, fleas, spiders, beetles, and grasshoppers that can be found plus dispose of the farmer's table scraps. If meat is raised on premises, then the mini-farmer just has to raise enough extra food to make up the difference between the feed needs and what was obtained through scraps and foraging.

Plant Some Fruit

There are a number of fruits that can be grown in most parts of the country: apples, grapes, blackberries, pears, and cherries to name a few. Newer dwarf fruit tree varieties often produce substantial amounts of fruit in only three years, and they take up comparatively little space. Grapes native to North America, such as the Concord grape, are hardy throughout the continental United States, and some varieties, like muscadine grapes, grow prolifically in the South and have recently been discovered to offer unique health benefits. Strawberries are easy to grow and attractive to youngsters. A number of new blackberry and raspberry varieties have been introduced, some without thorns, that are so productive you'll have more berried than you can imagine.

Fruits are nature's candy and can easily be preserved for apple sauce, apple butter, snacks, jellies, pie filling, and shortcake topping. Many fruits can also be stored whole for a few months using root cellaring. Fruits grown with minimal or no pesticide usage are expensive at the store, and growing your own will put even more money in the bank with minimal effort.

Grow Market Crops

Especially if you adopt organic growing methods, you can get top-wholesale-dollar for crops delivered to restaurants, organic food cooperatives, and so forth. If your property allows it, you can also set up a farm stand and sell homegrown produce at top retail dollar.

According to John Jeavon's 1986 research described in *The Complete 21-Bed Biointensive Mini-Farm*, a mini-farmer in the United States could expect to earn $2,079 in income from the space required to feed one person in addition to actually feeding the person. Assuming a family of three and correcting for USDA reported rises in the value of food, that amounts to $10,060 per year, using a six-month growing season.

Mel Bartholomew in his 1985 book *Ca$h from Square foot Gardening* estimated $5,000 per year income during a six-month growing season from a mere 1,500 square feet of properly managed garden. This equated to $8,064 in today's market. A mini-farm that sets aside only 2,100 square feet for market crops would gross an average of $11,289 per year.

It is worthwhile to notice that two very different authorities arrived at very closely the same numbers for expected income from general vegetable sales—about $5 per square foot.

Extend the Season

A lot of people don't realize that most of Europe, where greenhouses, cold frames, and other season extenders have been used for generations, lies north of most of the United States. Maine, for example, is at the same latitude as southern France. The reason for the difference in climate has to do with ocean currents, not latitude, and latitude is the biggest factor in determining the success of growing protected plants because it determines the amount of sunlight available. In essence, anything that can be done in southern France can be done throughout the continental United States.

The secret to making season extension economically feasible lies in working with nature rather than against it. Any attempt to build a super insulated and heated tropical environment suitable for growing bananas in Minnesota in January is going

to be prohibitively expensive. A simple unheated hoop house covered with plastic is fairly inexpensive and will work extremely well with crops selected for the climate.

Extending the season brings two big advantages. First, it lets you harvest fresh greens and seasonal fare throughout the year including heldover potatoes, carrots, and onions, thus keeping the family's food costs low. Second, it allows for earlier starts and later endings to the main growing season, netting more total food for the family and more food for market. It also provides a happy diversion from dreary winters when the mini-farmer can walk out to a hoop house for fresh salad greens in the middle of a snowstorm.

Understand Your Market

As a mini-farmer you may produce food for two markets: the family and the community. The family is the easiest market to understand because the preferences of the family can be easily discovered by looking in the fridge and cabinets. The community is a tougher nut to crack, and if you decide to market your excess crops, you will need to assess your community's needs.

Food is a commodity, meaning that the overwhelming majority of food is produced and sold in gargantuan quantities at tiny profit margins that are outside the reach of a mini-farmer. The proportion of crops that are grown for market cannot hope to compare with the wholesale costs of large commercial enterprises. Therefore the only way the mini-farmer can actually derive a profit is to sell at retail direct to the community or high-markup organics at wholesale. Direct agricultural products can work, as can value-added products such as pickles, salsas and gourmet vinegars.

Your products can appeal to the community in a number of ways, but the exact approaches that will work in a given case depend on the farmer's analysis of the needs of the community. You should keep careful records to make sure that the right crops are being grown.

The Economic Equation

According to the Federal Bureau of Labor Statistics, as of October 2005, the average nonfarm wage earner in the United States earns $557.54 per week or $28,990 per year for working 40.7 hours every week, or 2,116 hours a year. According to the Tax Foundation, the average employee works 84 out of 260 days a year just to pay taxes deducted from the paycheck, leaving the average employee $19,620.

According to the 2001 Kenosha County Commuter Study, conducted in Wisconsin before our most recent increases in fuel costs, the average employee spent $30 per week on gas just getting back and forth to work, or $1,500 per year, and spent $45 per week on lunches and coffee on the way to work, or $2,340 per year. Nationwide, the cost of child care for children under age 5 was estimated at $297 per month for children under age 5 and $224 per month for children aged 5 to 12. This estimate is from an Urban League study in 1997, so the expense has undoubtedly increased in the meantime. Assuming a school-age child though, the expenses of all this add up so that the average worker has only $13,092 remaining that can be used to pay the mortgage or rent, the electric bill, and so forth.

Though there can be other justifications for adopting mini-farming, including quality-of-life issues such as the ability to homeschool children, it makes economic sense for one spouse in a working couple to become a mini-farmer if the net economic impact of the mini-farm can replace the income from the job. Obviously, for doctors, lawyers, media moguls, and those in other highly paid careers, mini-farming may not be a good economic decision. But mini-farming can have a sufficient net economic impact that most occupations can be replaced if the other spouse

works in a standard occupation. Mini-farming is also sufficiently time efficient that it could be used to remove the need for a second job. It could also be done part-time in the evenings as a substitute for TV time.

The economics of mini-farming look like this. According to Census Bureau statistics from 2003, the average household size in the United States is 2.61 people. Let's round that up to 3 for ease of multiplication. According to statistics given earlier, accounting for the rise in food prices, the cost of feeding a family of 3 now amounts to $3,210 per person, or $9,630 per year. A mini-farm that supplied 85% of those needs would produce a yearly economic benefit of $8,185 per year—the same as a pretax income of $12,200, except it can't be taxed.

That would require 2,100 square feet of space, and 10 hours a week from April through September—a total of 240 hours. This works out to the equivalent of nearly %51 per hour.

If the farm also dedicated 2,100 square feet to market crops, you could also earn $10,060 during a standard growing season, plus spend an additional five hours a week from April through September. This works out to nearly $84 per hour.

When the cash income is added to the economic benefit of drastically slashing food bills, the minimum net economic benefit of $14,920 exceeds the net economic benefit of the average job by nearly $2,000 per year.

This assumes a lot of worst-case conditions. It assumes that the mini-farmer doesn't employ any sort of season extension, which would increase the value generated, and it assumes that the mini-farmer deducts none of the expenses from the income to reduce tax liability. In addition, once automatic irrigation is set up, the mini-farmer needs to work only three to four hours a day from April through November. Instead of working 2,116 hours per year to net $13,092 after taxes and commuting like the average wage earner, the mini-farmer has worked only 360 to 440 hours per year to net $14,920. At the end of the workday, the mini-farmer doesn't have to commute home—because home is where the farm is, and the workday has ended pretty early.

In this manner, the mini-farmer gains back more than 1,500 hours a year that can be used to improve quality of life in many ways, gains a much healthier diet, gets regular exercise, and gains a measure of independence from the normal employment system. It's impossible to attach a dollar value to that.

For families who want to have a parent stay at home with a child or who want to homeschool their children, mini-farming may make it possible—and make money in the process, by having whichever parent who earns the least money from regular employment go into mini-farming. For healthy people on a fixed income, it's a no-brainer.

Endnotes

1 Bird, C. O. (2001) *Cubed Foot Gardening*
2 Jeavons, J. (2002) *How to Grow More Vegetables*
3 Bartholomew, M. (2005) *Square Foot Gardening*
4 USDA (2001) *Agriculture Factbook 2001–2002*
5 Duhon, D., Gebhard, C. (1984) *One Circle*

Planning a Garden

A Plant's Basic Needs

Before you start a garden, it's helpful to understand what plants need in order to thrive. Some plants, like dandelions, are tolerant of a wide variety of conditions, while others, such as orchids, have very specific requirements in order to grow successfully. Before spending time, effort, and money attempting to grow a new plant in a garden, learn about the conditions that particular plant needs in order to grow properly.

Environmental factors play a key role in the proper growth of plant. Some of the essential factors that influence this natural process are as follows:

1. Length of Day

The amount of time between sunrise and sunset is the most critical factor in regulating vegetative growth, blooming, flower development, and the initiation of dormancy. Plants utilize increasing day length as a cue to promote their growth in spring, while decreasing day length in fall prompts them to prepare for the impending cold weather. Many plants require specific day length conditions in order to bloom and flower.

2. Light

Light is the energy source for all plants. Cloudy, rainy days or any shade cast by nearby plants and structures can significantly reduce the amount of light available to the plant. In addition, plants adapted to thrive in shady spaces cannot tolerate full sunlight. In general, plants will only be able to survive where adequate sunlight reaches them at levels they are able to tolerate.

3. Temperature

Plants grow best within an optimal range of temperatures. This temperature range may vary drastically depending on the plant species. Some plants thrive in environments where the temperature range is quite wide; others can only survive within a very narrow temperature variance. Plants can only survive where temperatures allow them to carry on life-sustaining chemical reactions.

4. Cold

Plants differ by species in their ability to survive cold temperatures. Temperatures below 60ºF injure some tropical plants. Conversely, arctic species can tolerate temperatures well below zero. The ability of a plant to withstand cold is a function of the degree of dormancy present in the plant and its general health. Exposure to wind, bright sunlight, or rapidly changing temperatures can also compromise a plant's tolerance to the cold.

5. Heat

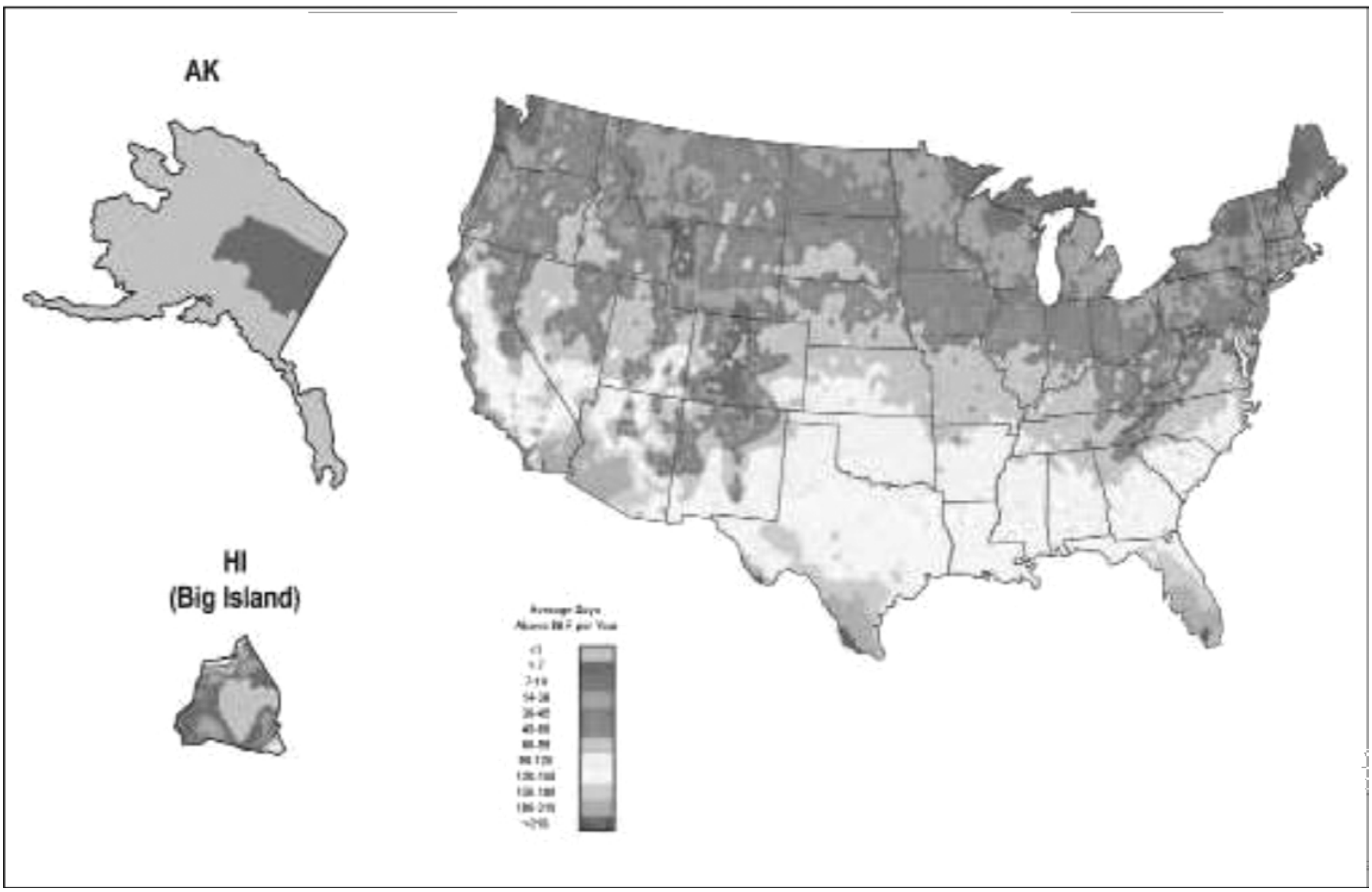
A plant's ability to tolerate heat also varies widely from species to species. Many plants that evolved to grow in arid, tropical regions are naturally very heat tolerant, while sub-arctic and alpine plants show very little tolerance for heat.

6. Water

Different types of plants have different water needs. Some plants can tolerate drought during the summer but need winter rains in order to flourish. Other plants need a consistent supply of moisture to grow well. Careful attention to a plant's need for supplemental water can help you to select plants that need a minimum of irrigation to perform well in your garden. If you have poorly drained, chronically wet soil, you can select lovely garden plants that naturally grow in bogs, marshlands, and other wet places.

7. Soil pH

A plant root's ability to take up certain nutrients depends on the pH—a measure of the acidity or alkalinity—of your soil. Most plants grow best in soils that have a pH between 6.0 and 7.0 Most ericaceous plants, such as azaleas and blueberries, need acidic soils with pH below 6.0 to grow well. Lime can be used to raise the soil's pH, and materials containing sulfates, such as aluminum sulfate and iron sufate, can be used to lower the pH. The solubility of many trace elements is controlled by pH, and plants can only use the soluble forms of these important micronutrients.



This map shows the average number of days each year that an area experiences temperatures over 86°F ("heat days"). Zone I has less than one heat day and zone 12 has more than 210 heat days. Most plants begin to suffer when it gets hotter than 86°F, though different plants have different levels of tolerance.

Plant and Gardening Glossary

Annual—a plant that completes its life cycle in one year or season.

Arboretum—a landscaped space where trees, shrubs, and herbaceous plants are cultivated for scientific study or educational purposes, and to foster appreciation of plants.

Axil—the area between a leaf and the stem from which the leaf arises.

Bract—a leaflike structure that grows below a flower or cluster of flowers and is often colorful. Colored bracts attract pollinators, and are often mistaken for petals. Poinsettia and flowering dogwood are examples of plants with prominent bracts.

Cold hardy—capable of withstanding cold weather conditions.

Conifers—plants that predate true flowering plants in evolution; conifers lack true flowers and produce separate male and female strobili, or cones. Some conifers, such as yews, have fruits enclosed in a fleshy seed covering.

Cultivar—a cultivated variety of a plant selected for a feature that distinguishes it from the species from which it was selected.

Deciduous—having leaves that fall off or are shed seasonally to withstand adverse weather conditions, such as cold or drought.

Herbaceous—having little or no woody tissue. Most plants grown as perennials or annuals are herbaceous.

Hybrid—a plant, or group of plants, that results from the interbreeding of two distinct cultivars, varieties, species, or genera.

Inflorescence—a floral axis that contains many individual flowers in a specific arrangement; also known as a flower cluster.

Native plant—a plant that lives or grows naturally in a particular region without direct or indirect human intervention.

Panicle—a pyramidal, loosely branched flower cluster; a panicle is a type of inflorescence.

Perennial—persisting for several years, usually dying back to a perennial crown during the winter and initiating new growth each spring.

Shrub—a low-growing, woody plant, usually less than 15 feet tall, that often has multiple stems and may have a suckering growth habit (the tendency to sprout from the root system).

Taxonomy—the study of the general principles of scientific classification, especially the orderly classification of plants and animals according to their presumed natural relationships.

Tree—a woody perennial plant having a single, usually elongated main stem, or trunk, with few or no branches on its lower part.

Wildflower—a herbaceous plant that is native to a given area and is representative of unselected forms of its species.

Woody plant—a plant with persistent woody parts that do not die back in adverse conditions. Most woody plants are trees or shrubs.

Choosing a Site for Your Garden

Choosing the best spot for your garden is the first step toward growing the vegetables, fruits, and herbs that you want. You do not need a large space to get started—in fact, often it's wise to start small so that you don't get overwhelmed. A normal garden that is about 25 square feet will provide

When planning out your garden, first sketch a diagram of what you want your garden to look like. What sorts of plants do you want to grow? Do you want a garden purely for growing vegetables or do you want to mix in some fruits, herbs, and wildflowers? Choosing the appropriate plants to grow next to each other will help your garden grow well and will provide you with ample produce throughout the growing season. If you live in the northern hemisphere, plant taller plants at the north end of your garden so that they won't block sunlight from reaching the smaller plants. If you live in the southern hemisphere, this is reversed.

enough produce for a family of four, and with a little ingenuity (utilizing pots, hanging gardens, trellises, etc.) you can grow more than that in an even smaller space.

Five Factors to Consider When Choosing a Garden Site

1. Sunlight

Sunlight is crucial for the growth of vegetables and other plants. For your garden to grow, your plants will need at least six hours of direct sunlight per day. In order to make sure your garden receives an ample amount of sunlight, don't select a garden site that will be in the shade of trees, shrubs, houses, or other structures. Certain vegetables, such as broccoli and spinach, grow just fine in shadier spots, so if your garden does receive some shade, make sure to plant those types of vegetables in the shadier areas. However, on the whole, if your garden does not receive at least six hours of intense sunlight per day, it will not grow as efficiently or successfully.

2. Proximity

Think about convenience as you plot out your garden space. If your garden is closer to your house and easy to reach, you will be more likely to tend it on a regular basis and to harvest the produce at its peak of ripeness. You'll find it a real boon to be able to run out to the garden in the middle of making dinner to pull up a head of lettuce or snip some fresh herbs.

3. Soil Quality

Your soil does not have to be perfect to grow a productive garden. However, it is best to have soil that is fertile, is full of organic material that provide nutrients to the plant roots, and is easy to dig and till. Loose, well-drained soil is ideal. If there is a section of your yard where water does not easily drain after a good, soaking rain, this is not the spot for your garden; the excess water can easily drown your plants. Furthermore, soils that are of a clay or sandy consistency are not as effective in growing plants. To make these types of soils more nutrient-rich and fertile, add in organic materials (such as compost or manure).

If your garden is not close to your house, you may want to construct a small potting shed in which to keep your tools.

4. Water Availability

Water is vital to keeping your garden green, healthy, and productive. A successful garden needs around 1 inch of water per week to thrive. Rain and irrigation systems are effective in maintaining this 1-inch-per-week quota. Situating your garden near a spigot or hose is ideal, allowing you to keeping the soil moist and your plants happy.

5. Elevation

Your garden should not be located in an area where air cannot circulate or where frost quickly forms. Placing your garden in a low-lying area, such as at the base of a slope, should be avoided. Lower areas do not warm as quickly in the spring, and will easily collect frost in the spring and fall. Your garden should, if at all possible, be on a slightly higher elevation. This will help protect your plants from frost and you'll be able to start your garden growing earlier in the spring and harvest well into the fall.

Tools of the Trade

Gardening tools don't need to be high-tech, but having the right ones on hand will make your life much easier. You'll need a spade or digging fork for digging holes for seeds or seedlings (or, if the soil is loose enough, you can just use your hands). Use a trowel, rake, or hoe to smooth over the garden surface. A measuring stick is helpful when spacing your plants or seeds (if you don't have a measuring stick, you can use a precut string to measure). If you are planting seedlings or established plants, you may need stakes and string to tie them up so they don't fall over in inclement weather or when they start producing fruit or vegetables. Finally, if you are interested in installing an irrigation system for your garden, you will need to buy the appropriate materials for this purpose.

Companion Planting

Plants have natural substances built into their structures that repel or attract certain insects and can have an effect on the growth rate and even

Here is a chart that lists various types of garden vegetables, herbs, and flowers and their respective companion and "enemy" plants.

Vegetables

Type	Companion Plant(s)	Avoid
Asparagus	Tomatoes, parsley, basil	Onion, garlic, potatoes
Beans	Eggplant	Tomatotes, onions, kale
Beets	Mint	Runner beans
Broccoli	Onions, garlic, leeks	Tomatoes, peppers, mustard
Cabbage	Onions, garlic, leeks	Tomatoes, peppers, beans
Carrots	Leeks, beans	Radish
Celery	Daisies, snapdragons	Corn, aster flower
Corn	Legumes, squash, cucumber	Tomatoes, celery
Cucumber	Radishes, beets, carrots	Tomatoes
Eggplant	Marigolds, mint	Runner beans
Leeks	Carrots	Legumes
Lettuce	Radish, carrots	Celery, cabbage, parsley
Melon	Pumpkin, squash	None
Peppers	Tomatoes	Beans, cabbage kale
Onion	Carrots	Peas, beans
Peas	Beans, corn	Onions, garlic
Potato	Horseradish	Tomatoes, cucumber
Tomatoes	Carrots, celery, parsley	Corn, peas, potatoes, kale

Herbs

Type	Companion Plant(s)	Avoid
Basil	Charmomile, anise	Sage
Chamomile	Basil, cabbage	Other herbs (it will become oily)
Cilantro	Beans, peas	None
Chives	Carrots	Peas, beans
Dill	Cabbage, cucumbers	Tomatoes, carrots
Fenned	Dill	Everything else
Garlic	Cucumbers, peas, lettuce	None
Oregano	Basil, peppers	None
Peppermint	Broccoli, cabbage	None
Rosemary	Sage, beans, carrots	None
Sage	Rosemary, beans	None
Summer savory	Onion, green beans	None

Flowers

Type	Companion Plant(s)	Avoid
Geraniums	Roses, tomatoes	None
Marigolds	Tomatoes, peppers, most plants	None
Petunia	Squash, asparagus	None
Sunflower	Corn, tomatoes	None
Tansy	Roses, cucumbers, squash	None

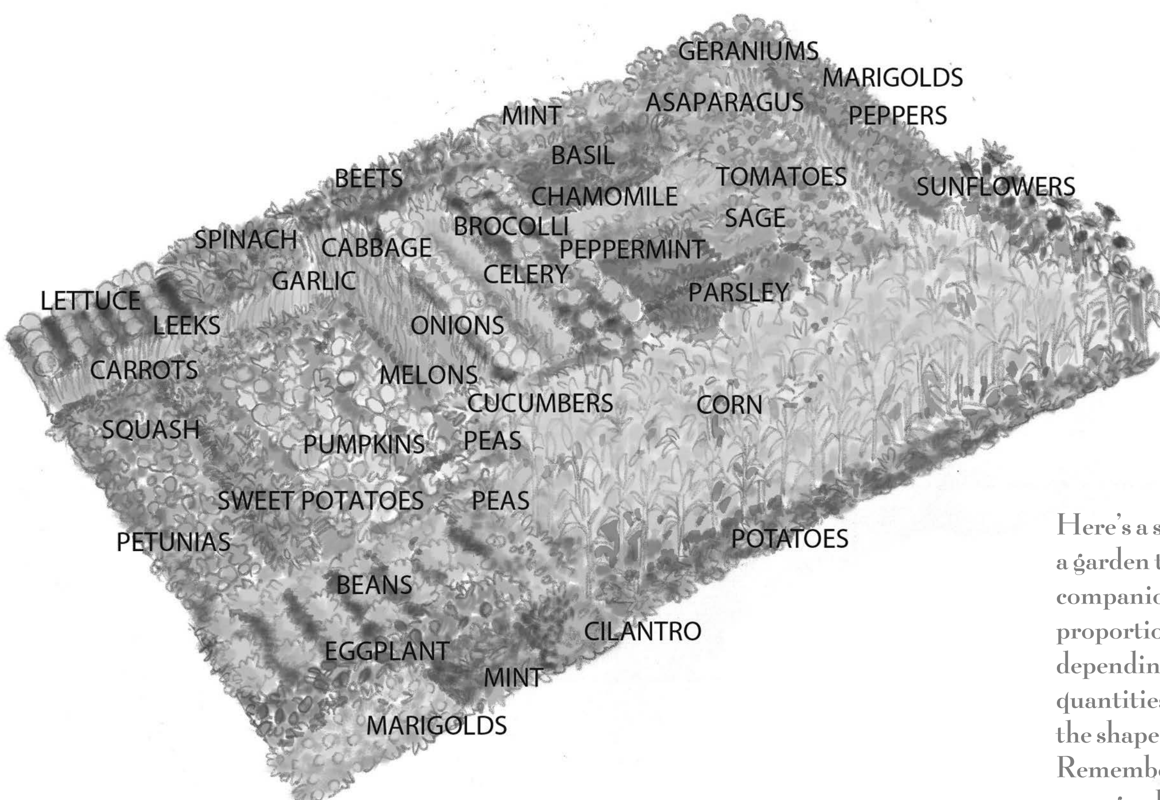
the flavor of the other plants around them. Thus, some plants aid each other's growth when planted in close proximity and others inhibit each other. Smart companion planting will help your garden remain healthy, beautiful, and in harmony, while deterring certain insect pests and other factors that could be potentially detrimental to your garden plants.

Shade-Loving Plants

Most plants thrive on several hours of direct sunlight every day, but certain plants actually prefer the shade. When buying seedlings from your local nursery or planting your own seeds, read the accompanying label or packet before planting to make sure your plants will thrive in a shadier environment.

Flowering plants that do well in partial and full shade include:

- Bee balm
- Bellflower
- Bleeding heart
- Cardinal flower
- Coleus
- Columbine
- Impatiens
- Leopardbane
- Lily of the valley
- Meadow rue
- Pansy
- Periwinkle



Here's a sample plan for a garden that utilizes companion planting. The proportions can be varied depending on your desired quantities of each crop and the shape of your garden plot. Remember to leave space in your garden to walk between rows of plants.

- Daylilies
- Dichondra
- Ferns
- Forget-me-not
- Globe daisy
- Golden bleeding heart
- Persian violet
- Primrose
- Rue anemone
- Snapdragon
- Sweet alyssum
- Thyme

Daylilies thrive in shady areas.

Vegetable plants that can grow in partial shade include:

- Arugula
- Beans
- Beets
- Broccoli
- Brussels sprouts
- Cauliflower
- Endive
- Kale
- Leaf lettuce
- Peas
- Radish
- Spinach
- Swiss chard

Planting and Tending Your Garden

Once you've chosen a spot for your garden (as well as the size you want to make your garden bed), and prepared the soil with compost or other fertilizer, it's time to start planting. Find seeds at your local garden center, browse through seed catalogs, and order seeds that will do well in your area. Alternatively, you can start with bedding plants (or seedlings) available at nurseries and garden centers.

Read the instructions on the back of the seed package or on the plastic tag in your plant pot. You may have to ask experts when to plant the seeds if this information is not stated on the back of the package. Some seeds (such as tomatoes) should be started indoors in small pots or seed trays before the last frost, and only transplanted outdoors when the weather warms up. For established plants or seedling, be sure to plant as directed on the plant tag or consult your local nursery about the best planting times.

Seedlings

If you live in a cooler region with a shorter growing period, you will want to start some of your plants indoors. To do this, obtain plug flats (trays separated into many small cups or "cells") or make your own small planters by poking holes in the bottoms of paper cups. Fill the cups two-thirds full with potting soil or composted soil. Bury the seed at the recommended depth, according to the instructions on the package. Tamp down the soil lightly and water. Keep the seedlings in a warm, well-lit place, such as the kitchen, to encourage germination.

Once the weather begins to warm up and you are fairly certain you won't be getting any more frosts (you can contact your local extension office to find out the "frost free" date for your area) you can begin to acclimate your seedling to the great outdoors. First place them in a partially shady spot outdoors that is protected from strong wind. After a coupled of days, move them into direct sunlight, and then finally transplant them to the garden.

Sprouting Seeds for Eating

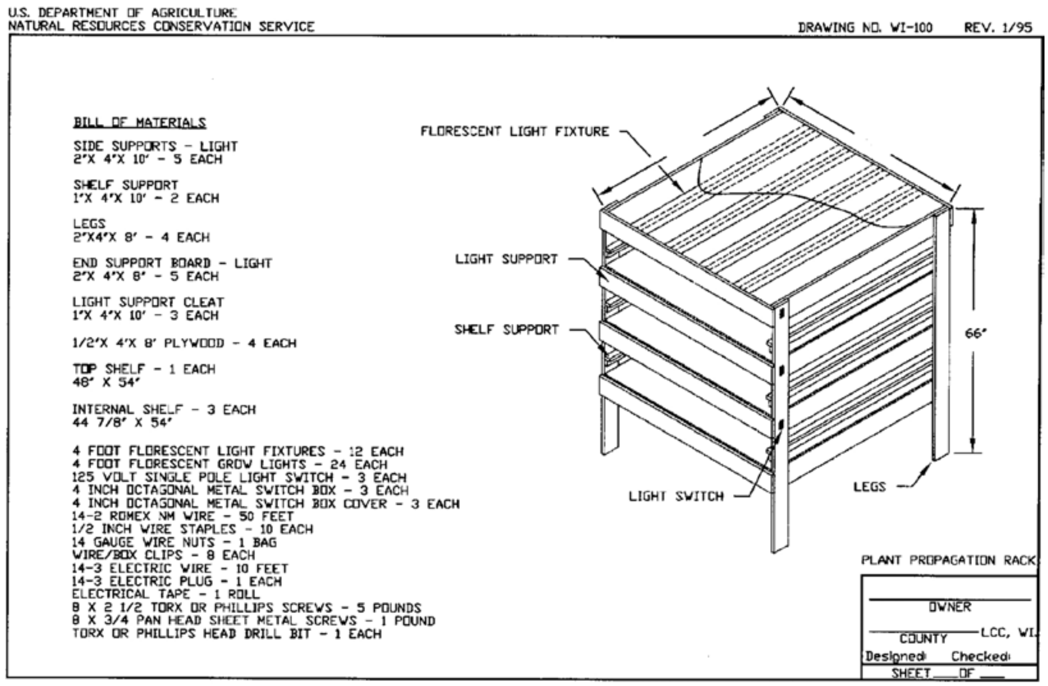
Seeds can be sprouted and eaten on sandwiches, salads, or stir-fries any time of the year. They are delicious and full of vitamins and proteins. Mung beans, soybeans, alfalfa, wheat, corn, barley, mustard, clover, chickpeas, radishes, and lentils all make good sprouts. Find seeds for sprouting from your local health food store or use dried peas, beans, or lentils from the grocery store. Never use seeds intended for planting unless you've harvested the seeds yourself—commercially available planting seeds are often treated with a poisonous chemical fungicide.

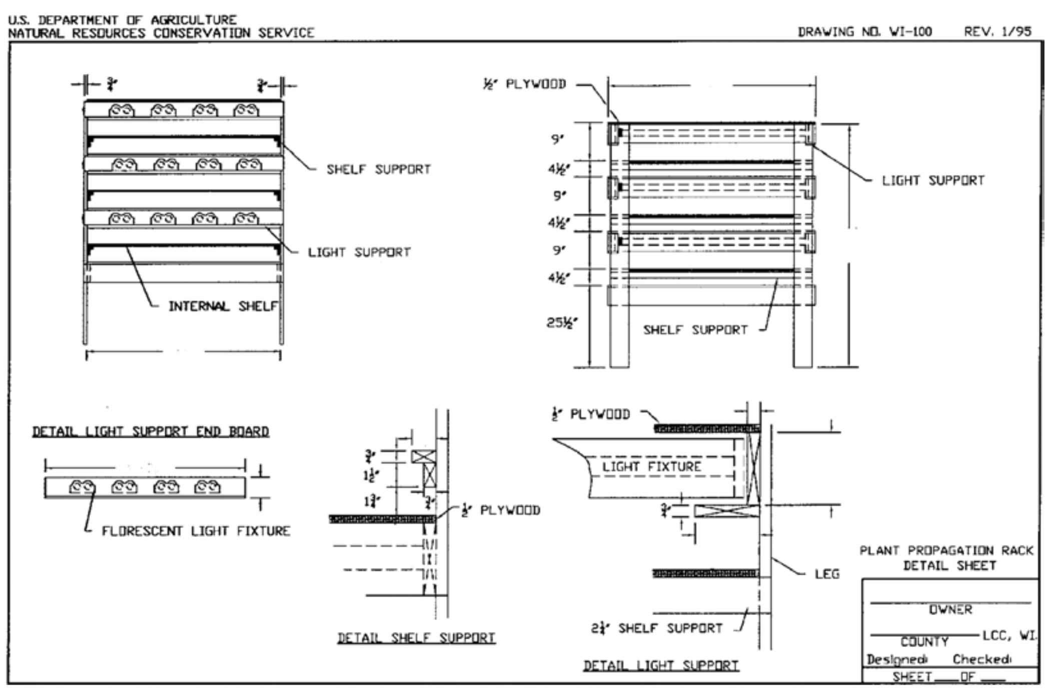
To grow sprouts, follow these steps:

1. Thoroughly rinse and strain the seeds.
2. Place in a glass jar, cover with cheesecloth secured with a rubber band, and soak overnight in cool water. You'll need about four times as much water as you have seeds.

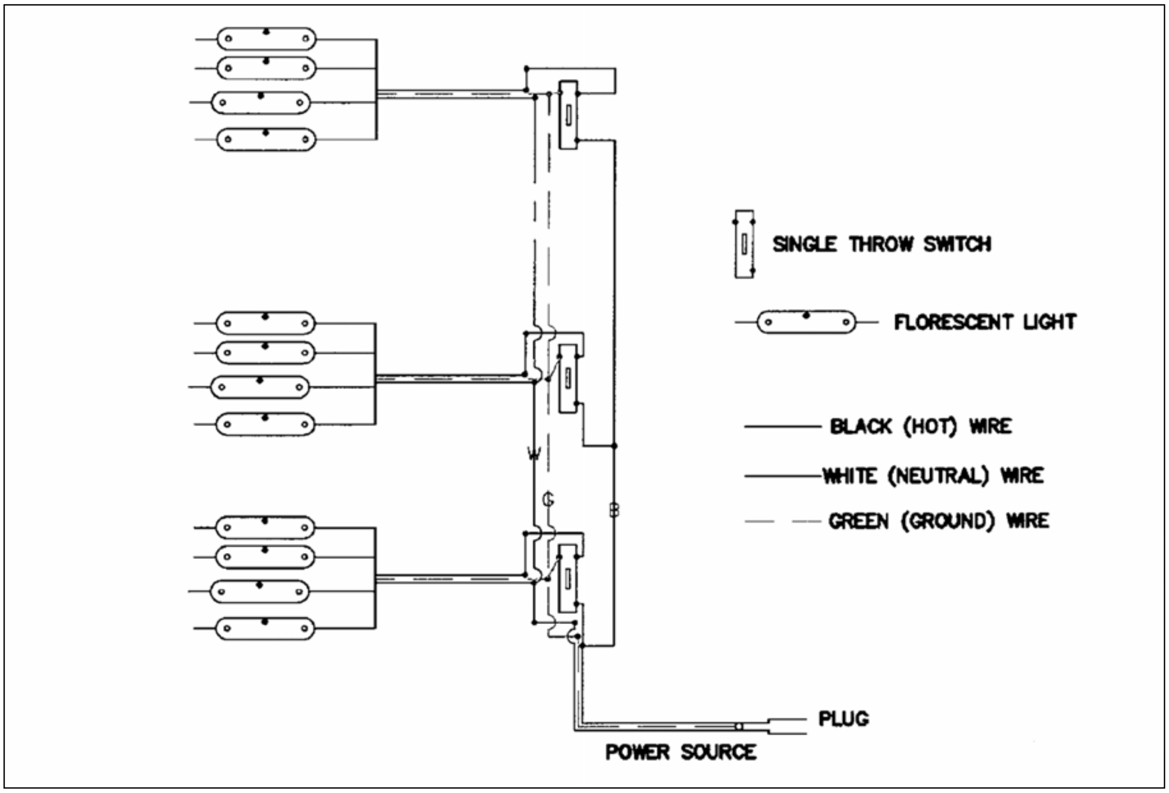
Germination temperatures of selected vegetable plants

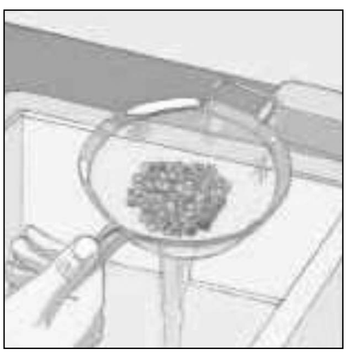
Broccoli 77°F	Eggplant 85°F	Onion 70°F	Summer Squash 80°F
Cabbage 86°F	Herbs 65°F	Pepper 85°F	Tomato 85°F
Cucumber 86°F	Melon 90°F	Pumpkin 85°F	Winter Squash 80°F

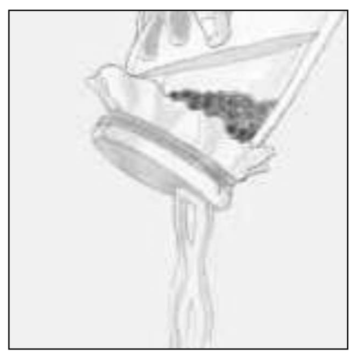




Follow the plans on this page to make your own propagation rack for starting seeds indoors. Though a propagation rack is not necessary, it will help to ensure your seedlings receive the light and warmth they need to stay strong and healthy.







3. Drain the seeds by turning the jar upside down and allowing the water to escape through the cheesecloth. Keep the seeds at 60 to 80ºF and rinse twice a day, draining them thoroughly after every rinse.

4. Once sprouts are 1 to 1 ½ inches long (generally after 3 to 5 days), they are ready to eat.

The Junior Homesteader

How do different treatments change how fast seeds sprout?

Experiment with sprouting seeds under different temperatures, or after being soaked for different times or in different liquids. Or, see how one kind of treatment affects different types of seeds. What makes seeds sprout the fastest? Do some look healthier than others? Write up a lab report to document your findings.

Watering Your Soil

After your seeds or seedlings are planted, the next step is to water your soil. Different soil types have different watering needs. You don't need to be a soil scientist to know how to water your soil properly. Here are some tips that can help to make your soil moist and primed for gardening:

1. Loosen the soil around plants so water and nutrients can be quickly absorbed.
2. Use a 1- to 2 - inch protective layer o mulch on the soil surface above the root area. Cultivating and mulching help reduce evaporation and soil erosion.
3. Water your plants at the appropriate time of day. Early morning or night is the best time for watering, as evaporation is less likely to occur at these times.
4. Do not water your plants when it is extremely windy outside. Wind will prevent the water from reaching the soil where you want it to go.

Types of Soil and Their Water Retention

Knowing the type of soil you are planting in will help you best understand how to properly water and grow your garden plants. Three common types of soil and their various abilities to absorb water are listed below:

Recommended plants to start as seedlings

CROP [s] small seed [l] large seed (planting cell size)	WEEKS BEFORE TRANSPLANTING	SEED PLANTING DEPTH (Inches)	TRANSPLANT SPACING	WITHIN ROW/ BETWEEN ROW
Broccoli [s]	(1)	4–6	¼–½	8–10” 18–24”
Cabbage [s]	(1)	4–6	¼–½	18–24” 30”
Cucumber [l]	(2)	4–5	½	2’ 5–6’
Eggplant [s]	(2)	8	¼	18” 18–24”
Herbs [s]	(1)	4	¼	4–6” 12–18”
Lettuce [s]	(2)	4–5	¼	12” 12”
Melon [l]	(3)	4–5	¼	2–3’ 6’
Onion [s]	(*)	8	¼	4” 12”
Pepper [s]	(2)	8	¼	12–18” 2–3’
Pumpkin [l]	(3)	2–4	1	5–6’ 5–6’
Summer Squash [l]	(3)	2–4	¾–1	18” 2–3’
Tomato [s]	(3)	8	¼	18”–24” 3’
Watermelon [l]	(3)	4–5	½–¾	3–4’ 3–4’
Winter Squash [l]	(3)	2–4	1	3–4’ 4–5’

1. Clay Soil

In order to make this type of soil more loamy, add organic materials, such as compost, peat moss, and well-rotted leaves, in the spring before growing and also in the fall after harvesting your vegetables and fruits. Adding these organic materials allows this type of soil to hold more nutrients for healthy plant growth. Till or spade to help loosen the soil.

Since clay soil absorbs water very slowly, water only as fast as the soil can absorb the water.

2. Sandy Soil

As with clay soil, adding organic materials in the spring and fall will help supplement the sandy soil and promote better plant growth and water absorption.

Left on its own (with no added organic matter) the water will run through sandy soil so quickly that plants won't be able to absorb it through their roots and will fail to grow and thrive.

3. Loam Soil

This is the best kind of soil for gardening. It's a combination of sand, silt, and clay. Loam soil is fertile, deep, easily crumbles, and contains organic matter. It will help promote the growth of quality fruits and vegetables, as well as flowers and other plants.

Loam absorbs water readily and stores it for plants to use. Water as frequently as the soil needs to maintain its moisture and promote plant growth.

Soil and Fertility

BY BRETT L. MARKHAM

In *Mini Farming: Self-Sufficiency on ¼ Acre,* I spend several chapters discussing soil and fertility in depth. The reason is because proper soil management and fertility practices are the foundation upon which everything else is built to make mini farming an economically viable enterprise rather than merely a hobby. Optimum soil leads to reduced problems with pests and disease, supports higher yields with greater density, creates more nutritious food, and allows you to spend less money and effort on getting more food.

In this chapter, I am going to summarize what you need to know, plus add a bit more information. This summary should be enough to get you started, though it doesn't substitute for the in-depth knowledge in *Mini Farming: Self-Sufficiency on ¼ Acre.*

Raised Beds

I recommend planting in raised beds for a number of important reasons. Raised beds that have been double-dug and enriched with finished compost retain water while properly draining so that oxygen levels in the soil are optimal, nutrients are bound in a living symbiotic matrix for release to plants as needed, and soil temperatures allow for early working. Furthermore, the close spacing of plants in a raised bed increases yields over use of row gardening while growing closely enough together to shade out weeds.

Beds are also useful for practicing crop rotation on a small scale. Every crop has slightly different requirements and places slightly different demands on the soil as well as enhancing it in different ways. Probably the single most dangerous thing that can be done, in terms of pests and disease, is growing the same crop in the same place year after year. By doing this, diseases and pests build up until they are ultimately beyond control. Rotating crops between beds substantially reduces pest and disease problems.

In general, beds should be placed near each other, but with enough space to walk between them. The space between the beds can be sod/grass, crushed stone, bark mulch, or practically anything else. Usually, sod/grass is not a problem, and that is what is between my beds. However, these can serve as a reservoir for diseases such as botrytis and a breeding ground for wireworms while providing easy access to slugs; so if disease problems are experienced or wireworms start doing serious damage, using (untreated) bark mulch or straw between the beds to suppress grasses may be wise. Also, if any grass isn't mowed regularly, it can grow over into a bed. The next thing you know, you'll be pulling grass out of your beds by the handful.

Composting

Composting is the key to preserving and enhancing the fertility of the soil. The law of conservation of matter says that matter cannot be created or destroyed. Without getting into the physics of matter/energy systems, in practical terms this means that the elements in a plant came from the soil, and unless those elements are put back into the soil, a mini farmer will find it necessary to purchase outside inputs such as fertilizer. Thus, if the foliage of a tomato plant has taken phosphorus from the soil and that plant is simply discarded, the phosphorus will need to be replenished from an outside source. But if, instead, that plant is composted, the phosphorus can then be returned to the soil via the compost and thereby reduce the need for an outside source of phosphorus.

Compost is a complex and literally living substance made form the aerobic decomposition of organic matter. Other than volatile elements such as nitrogen, all of the essential elements added to the pile as part of the composted materials are retained. But, in addition, the process of composting breaks down poisons, destroys both human and plant pathogens, generates a wide array of beneficial soil organisms that help plants get the most from the nutrients in the soil, and even produces antibiotics for combating diseases.

Composting, therefore, is absolutely crucial from an economic perspective because of the way it reduces the need for fertilizers; it also serves to passively prevent a whole host of pest and disease problems. The importance of composting cannot be overemphasized. You should be adding at least four cubic feet of finished compost to every 4 ft. x 8 ft. bed annually.

pH

The pH is a measure of how acidic or alkaline the soil is. It is important because plants generally have a certain range of pH preference for optimal growth and because the pH of the soil actively affects which microorganisms will thrive in the environment and how readily the nutrients contained in the soil can be used by plants. The pH is measured on a scale from 0 to 14. Zero (0) is highly acidic like battery acid; 14 is highly basic like lye; and 7 is neutral.

Many sources list a pH preference range for each plant, but these sources often differ in the details. For example, one source will list the preferred pH for tomatoes as 5.8 to 6.5, whereas another will list it as 6 to 7. The simple fact is that you don't need to be that detailed, as with only a very few exceptions, plants grown for food in gardens will grow well with a pH ranging from 6 to 7. True, a cucumber can grow at a pH as high as 8, but it will also grow at 6.5.

Because pH corrections can take months to show results and because the constant rotation of beds between crops makes it impractical to customize the pH of a bed to a given crop, it makes sense to test each bed individually, and correct the beds to a uniform pH of between 6 and 6.5. The exceptions are that the beds used for potatoes should have the pH lower than this, and the beds used for brassicas (such as cabbage and broccoli) should have extra lime added to the holes where the transplants are placed. These practices will be specifically covered in the chapters pertaining to those particular plants.

In most of the country, the soil pH is too low and needs to be raised to be within an optimal range. Correcting pH using lime can be problematic in that it takes several months to act. Though the gardening year should start in the fall along with any soil corrections so the lime has time to react with the soil, the reality of life is that the decision to start a garden is generally made in late winter or early spring. Thus, the farmer is stuck trying to correct pH within weeks of planting instead of months. However, with a bit of creativity and the use of alternate materials, both short- and long-term corrections can be made to the pH.

There are many liming materials available for this purpose but only four I would recommend: powdered lime, pelleted lime, dolomitic lime, and wood ashes. Others such as burnt and hydrated lime act more quickly, but are hazardous to handle and easy to overapply. If you choose to use these latter products, please follow package directions closely.

Pelleted lime is powdered lime that has been mixed with an innocuous water-soluble adhesive for ease of spreading. It acts no more or less quickly than the powdered product but costs more. Lime can take as long as a year to take full effect, but it will remain effective for as long as seven years.

Dolomitic lime contains magnesium in place of some of the calcium. In most soils in the U.S. (excepting clay soils in the Carolinas), using dolomitic lime for up to one quarter of the liming is beneficial to supply needed magnesium with calcium. It is used at the same rate as regular lime, takes as long to act, and lasts as long.

Wood ashes are a long-neglected soil amendment for pH correction. They contain a wide array of macronutrients such as potassium and calcium but also contain elements such as iron, boron, and copper. They act more quickly in correcting soil pH but do not last as long. Wood ashes are applied at twice the rate of lime for an equal pH correction but should not be applied at a rate exceeding five pounds per 100 square feet. So, in effect, wood ashes are always used in conjunction with lime rather than on their own.

The pH scale is a logarithmic value, similar to a decibel. As such, the amount of lime needed to raise the pH from 4 to 5 is greater than the amount of lime needed to raise the pH from 5 to 6. Furthermore, the effectiveness of lime is strongly influenced by the type of soil. So the following table reflects both of these factors. The numbers represent pounds of powdered limestone per 100 square feet. For wood ashes, double that number but never exceed five pounds per 100 square feet in a given year; so wood ashes can seldom be used exclusively as a pH modifier. Rather, they are best used when mixed with lime.

One further note about lime: A lot of sources say you shouldn't apply fertilizer at the same time as lime because the lime will react with the fertilizer and neutralize it. To some extent, this is true. However, lime stays active in the soil for as long as seven years, so the fertilizer will be affected anyway. As long as both are thoroughly incorporated into the soil, don't worry. In addition, these concerns largely pertain to inorganic fertilizers such as ammonium nitrate. When the fertilizers are organic and constituted of such compounds as blood meal or alfalfa meal, the adverse effect of the lime is considerably reduced.

Though excessively alkaline (e.g., a pH higher than 6.5) soils are rare in the United States, they exist in a few places such as the Black Belt prairie region of Alabama or can be accidentally created through excessive liming.

Correcting an excessively alkaline soil can be done using a variety of substances, including elemental sulfur (known as flowers of sulfur), ammonium sulfate, sulfur-coated urea, and ammonium nitrate. These latter methods are seen to be best practices in industrial agriculture, but they are excessively concentrated and can hurt the soil biology, so they aren't recommended for a mini farm aiming at sustainability.

Some authorities also recommend aluminum sulfate, but the levels of aluminum, if the pH ends up changing, can be taken up by the plant and can become toxic to both plants and animals. So I recommend either straight flowers of sulfur (if growing organically) or ammonium sulfate (if you don't mind synthetic fertilizers). In practice, the amount of ammonium sulfate required to lower soil pH a given amount is 6.9 times as much as sulfur, so you'll likely use sulfur for cost reasons.

Sulfur works by combining with water in the soil to create a weak acid. This acid reacts with alkalies in the soil to form water-soluble salts that are leached from the soil and carried away by rains.

Measured pH	Sandy	Sand/Loam	Loam	Clay and Clay/Loam
4	5.5	11	16	22
5	3	5.5	11	16
6	1.25	3	3	5.5
7	None	None	None	None

Pounds of lime required to adjust the pH of 100 square feet of bed space

Because it creates an acid directly, it is easy to overdo sulfur, so it should be measured and added carefully, and thoroughly incorporated into the soil. It takes about two months to reach full effectiveness, but results should start to manifest in as little as two weeks.

Ammonium sulfate works by virtue of the ammonium cation combining with atmospheric oxygen to create two nitrite anions (negatively charged ions), two molecules of water, and four hydrogen cations (positively charged ions). These hydrogen cations are the basis for acidity and they will then acidify the soil.

So, how do you measure your pH? You can use a soil testing kit or a pH meter. The cost of pH meters for home use has dropped considerably in recent years, with accurate units selling for as little as $13. Simply follow the directions that come with your individual meter for measuring each bed.

Macronutrients

Macronutrients are generally defined as being nitrogen, potassium, and phosphorus, as these are the elements that are required in greatest quantity by plants. To these, I also add calcium, magnesium sulfur, carbon, hydrogen, and oxygen. The latter three are supplied by water and the atmosphere so they won't be further considered here except to note that proper aeration of soils allows beneficial bacteria access to oxygen. Furthermore, avoid walking on beds to prevent the soil from being compacted. Raised beds in general, due to being hither than their surroundings, usually don't have a problem with becoming waterlogged, which helps keep water from forcing out the oxygen that these beneficial microorganisms need.

Most soils in the U.S. are acidic and require lime for optimum growing. Adding lime also adds sufficient calcium automatically. Furthermore, those few soils in the U.S. that are alkaline are usually made so by the high natural limestone content of the soil. So, in general, calcium levels should be fine.

The major problem you will see that involves calcium is blossom end rot. Blossom end rot is caused by uneven uptake of calcium, usually due to extreme variations in rainfall. Usually this can be avoided through properly thorough watering. There are also some effective commercial preparations on the market that contain a readily absorbed calcium salt called calcium chloride.

In general, if you are using dolomitic lime for at least a portion of your lime needs, your soil will not be deficient in magnesium. However, the soil chemistry of competing cations such as magnesium and potassium is complex, and a plant could end up deficient even though there is sufficient elemental magnesium in the soil. Magnesium can become unavailable if potassium is present in severe excess or if the organic matter that form that biological colloid that makes magnesium available to the plant is present in insufficient amounts.

A clear symptom of magnesium deficiency is often observable in seedlings that have been held

Measured pH	Sand	Loam	Clay
8.5	4.6	5.7	6.9
8	2.8	3.4	4.6
7.5	1.1	1.8	2.3
7	0.2	0.4	0.7

Pounds of sulfur needed to adjust the pH of 100 square feet of bed space.

too long in nutrient-poor starting mixes before being transplanted: interveinal chlorosis (the green turns yellowish between the veins) of older/lower leaves, often combined with curling leaf edges that have turned reddish brown or purple. If this symptom manifests, the deficiency can be corrected in the short term by adding Epsom salt (magnesium sulfate) at a rate of eight ounces per 100 square feet. This form of magnesium is easily absorbed by plants.

However, the deficiency should be addressed in the long term by adding sufficient levels of compost to the soil and by using dolomitic lime.

Sulfur is an important constituent of amino acids—the core building blocks of DNA and life itself. As such, the primary source of sulfur in the soil is organic matter. Soils rich in organic matter through composting hold onto sulfur so it can't be leached out, and convert it to the sulfate form needed by plants a little at a time as needed. However, even the most meticulous composting won't replenish all the sulfur lost because what we eat is seldom composted. So sulfur, in some form, should be added annually.

Elemental sulfur is not a good choice for this task unless it is already being used to alter the pH of the soil. In its elemental form, particularly in soils that aren't rich in organic matter, it isn't available to plants as a nutrient. Sulfur is best added in the form

Both the Rapitest and LaMotte testing kits will provide pH, nitrogen, phosphorus, and potassium levels as well as recommendations.

of either garden gypsum (calcium sulfate) or Epsom salt (magnesium sulfate). It can be added at the rate of five ounces per 100 square feet every year for either product.

Phosphorus is a constituent of the enzymes essential for energy production within cells. The primary source of phosphorus in soil is from plant and animal waste, in which it exists in an organic form not immediately accessible to plants. The phosphorus is converted as needed to an inorganic phosphate form that is usable by plants via microorganisms in the soil. This is, overall, the best method of maintaining soil levels of phosphorus because most of the phosphorus is held in reserve until needed and can't be leached out of the soil by rain.

The process of microorganisms converting phosphorus into a usable form is temperature dependent, and it is not at all unusual for spring transplants to suffer from deficiency because of this, even though there is adequate phosphorus in the soil. This is a condition that is better prevented than corrected and can be done by simply using a good liquid fish fertilizer at the time of transplant and every week thereafter until soil temperatures are consistently above 55 degrees.

You should also test your beds for phosphorus. Numerous test kits are available, and they all work fine when used according to the directions in the kit. If your soil is deficient, you should add phosphorus in the form of bonemeal in preference to rock phosphate. Bonemeal is broken down slowly in the soil, so you should test your soil and add it at least five weeks prior to planting. The amount you'll need to add depends on the results of your soil test; the instructions will be in the testing kit.

The reason why rock phosphate should be avoided is because it is high in radioactive substances that can be taken up by plants. In fact, one of the primary dangers of smoking is the radioactivity of the smoke, which is a result of tobacco being fertilized with rock phosphate. Tobacco is part of the same family of plants as peppers, eggplant, tomatoes, potatoes, and many other garden edibles. So if you don't want to be eating radioactive substances, rock phosphate is best avoided.

Potassium is abundant in most soils, though usually in forms not readily available to plants. These unavailable forms are converted by the microbial life in the soil into forms that plants can use as the plants require it. Though potassium is required for life, its deficiency is not as readily noted as other essential nutrients. Plants are smaller and less hardy than they would otherwise be, but this might not be evident unless compared side by side to the same plane grown in nondeficient soil. Therefore, use a test kit to determine if there is any deficiency.

Conscientious composting practices that return crop wastes to the soil are the primary source of potassium in a mini farm. This is, however, inadequate as the potassium removed in crops that are consumed or sold can't be returned in this fashion, so a certain amount of potassium will need to be supplied.

Nearly all plant materials contain usable levels of potassium, so occasionally supplementing your compost supply with an outside supply of compost will help maintain proper levels of potassium. Alfalfa meal, usually used as a source of nitrogen, also contains potassium. Wood ashes, discussed earlier as a way of lowering pH, also contain substantial amounts of potassium along with other trace minerals. Greensand, a mineral originally formed on the ocean floor, is also a source of potassium along with micronutrients. The same applies to kelp, seaweed, and fish meal. Depending on the results of soil testing, these materials can be used in any combination to supply potassium that is removed from the soil by crops.

Nitrogen is a primary constituent of amino acids and the DNA within plant cells. Though we live in an atmosphere that is roughly 78 percent nitrogen, this form of nitrogen is inert and not useful to plants. In nature, the nitrogen is converted into a usable form through a bacterial process known as nitrogen fixation that is usually done by rhizobium bacteria that live in symbiosis with the roots of legumes. This is why cover cropping is so important (as explained in *Mini Farming:Self-Sufficiency on ¼ acre*). A proper cycle of cover cropping and crop rotation can reduce the need and cost of outside sources of nitrogen.

Deficiencies in nitrogen show themselves quickly in the loss of green color, starting with the oldest or lowest leaves on the plant. Because the rate at which nitrogen in the soil can be made available to plants is affected by temperature, this deficiency is most often seen early in the season when soil temperatures are below 60 degrees. There may be enough nitrogen in the soil, but the bacteria can't keep up with the demand of the crops. It is better to prevent this problem than to correct it, and early plantings should be supplemented with a liquid fish fertilizer until well established and soil temperatures are sufficient to support natural nitrogen conversion.

Just as with most other nutrients, composting should be your first source of maintaining soil fertility. But because you can't compost crops that you eat or sell and because nitrogen losses in composting can be as high as 50 percent, you will need to add nitrogen as it is removed by crops. Good crop rotation with legumes and legume cover crops can help as well; sometimes this is enough. But often nitrogen needs to be added, and a soil test can tell you how much you need.

Sources of nitrogen include compost from an outside source, various fish, feather, alfalfa, cottonseed, blood and bonemeals, well-rotted manure from chickens and other animals, etc. I like using diverse sources in order to include as many other micronutrients as possible. Because we keep chickens, the chicken manure added to our compost pile dramatically reduces our overall need for outside sources of nitrogen, but to an extent this comes at the cost of feed for the chickens. In terms of dollar cost, however, this works in our favor as the eggs are more valuable than the feed, so the manure is free.

Micronutrients

A large array of minerals has been identified as being essential for human health, and more are being discovered all the time. So far, the following are known to be needed: potassium, chlorine, sodium, calcium, phosphorus, magnesium, zine, iron, manganese, copper, iodine, selenium, molybdenum, sulfur, cobalt nickel, chromium, fluorine, boron, and strontium.

These can only be acquired through the food we eat. We can get them through plants or through animals that have eaten plants. But, ultimately, they have to enter plants through the soil. Thus, deficient soils, even if the plants seem perfectly healthy, ultimately lead to problems with human health.

Because industrial farming doesn't have human health as its goal, farm management practices have led to a long-term decline in the mineral content of foods. A number of studies have shown that in just a 30-year period, the content of vitamins and minerals in foods have declined by anywhere from 6 percent to 81 percent.[1, 2]

There are a number of elements required by plants that are needed in small quantities, and are thus described as *micronutrients*. Overall, due to overfarming, these micronutrients are deficient in agricultural soils because they were never restored as they were depleted. Only a handful of plant micronutrients are officially recognized: boron, chlorine, copper, iron, manganese, molybdenum, and zinc. That is because severe deficiencies of these elements usually give clear adverse symptoms in plants.

However, as plants are the start of our food chain and humans require far more than just these seven minerals, soil deficiency in any mineral

Wood ashes, sea minerals, and borax are sources of micronutrients for your beds.

needed for human health should be avoided as its disappearance from plants means we don't get enough in our diet.

Composting to maintain the fertility of the soil and retain these elements is important. To a degree, as described in *Mini Farming*, these elements can also be added in small quantities to your beds. This is easy to do with elements such as calcium or iron that can be easily obtained, but more difficult with fluorine or strontium. And even if these elements are available, you may be missing something we haven't learned about yet.

The easiest way to make sure the soil has all of the trace elements needed is the periodic addition of ocean minerals. Over the ages, rain and erosion have moved a great many minerals that would ordinarily be on land in abundance into the sea. Overfarming without replenishment has exacerbated this problem. Though I am able to go to the seashore and collect kelp from the beach for my own compost, this is seldom practical for most people. What I recommend as a solution for the most robust and nutritionally complete plants possible is the periodic addition of a small quantity of ocean minerals.

In essence, sea water contains, in varying amounts, every known element save those made artificially in nuclear reactors. In 1976, Dr. Maynard Murray published a book titled *Sea Energy Agriculture* in which he highlighted the results of numerous studies he had made from the 1930s through the 1950s on the addition of ocean minerals to agricultural land. Though his book was published some time ago, I have discovered that in growing beds side by side, those treated with sea minerals do, in fact, produce obviously healthier plants.

The big problem with using ocean water directly is obvious: you can't grow plants in salt water because it kills them. In fact, one of the practices of ancient warfare was to sow your enemies' fields with salt so they wouldn't be fertile. Fortunately, only a small quantity is required, and when package directions are followed, not only is there no harm, but plants also become more healthy and more resistant to insects and diseases. It is also fortunate that on a mini farm, the amount of sea minerals required is tiny; so even a ten-pound bag of sea minerals from various sources will literally last for years. (I use five pounds annually.) There are a number of companies offering sea minerals such as GroPal, SeaAgri, Sea Minerals from Arkansas, and others. The key is that each offering is a bit different, so be sure to scale the package directions appropriately.

The one micronutrient that I don't believe sea minerals provide in sufficient quantity is boron. You'll see boron deficiency in hollow stems for broccoli and hollow or gray centers of potatoes. The amount of boron required is tiny and can be derived from borax. Use extreme caution because borax in higher concentrations is an effective herbicide that will leave your beds sterile for years if it is dumped on them indiscriminately. Sufficient borax can be added with one teaspoon dissolved in one gallon of water and used to lightly sprinkle over a single 4 ft. x 8 ft. bed before a regular watering. Once a year is plenty.

Conclusion

Healthy plants require healthy soil. Use of composting practices will help reduce the need for outside inputs plus provide optimum soil health for suppression of diseases. Raised beds allow for more aerated soil, higher levels of production, and the use of less fertilizer overall. Ideally, the process of amending beds for pH range and nutrient deficiencies will start in the fall or, at a bare minimum, start as soon as the soil can be worked in the spring. Cover cropping and crop rotation fill out the mix to create the most healthy soil possible, thus making whatever crops you grow more productive. I have only given basic information in this chapter, so for more in-depth knowledge of bed construction, double-digging, composting, and soil fertility practices such as biochar, please see *Mini Farming: Self-Sufficiency on ¼ Acre,* in which several chapters are devoted to covering these subjects in depth.

Endnotes

1 Bergner, Paul (1997), *Healing Power of Minerals, Special Nutrients, and Trace Elements* (The Healing Power)

2 Marie-Mayer, Anne (1997), "Historical Changes in the Mineral Content of Fruits and Vegetables," *British Food Journal*.

Seed Starting

BY BRETT L. MARKHAM

It is a good idea to learn to start seedlings for three reasons. The first reason is economic: Starting seedlings at home saves money. The second reason is variety: Starting seedlings at home vastly increases the range of crop choices because certain varieties may not be available at your local garden center. Finally, since seedlings grown at home were never in a commercial greenhouse, you'll have a known-good product that is unlikely to be harboring pests.

Starting seeds is simple: Place seeds in a fertile starting medium in a suitable container; provide water, heat, and light; and that's it. Many seeds—Such as grains and beets—are sowed directly in a garden bed, but others such as tomatoes, broccoli, and peppers, must be either started in advance or purchased as small plants ("seedlings") and then transplanted.

Timing

Seedlings need to be started indoors anywhere from 2 to 12 weeks before transplant time, depending on the particular crop. Transplant time is reckoned in weeks before or after the last predicted frost of the year for spring and summer crops and in weeks before the first predicted frost for fall and winter crops. The timing of transplanting is dictated by the hardiness of the particular crop. Broccoli is pretty hardy, so it is often planted 6 weeks before the last predicted frost, whereas cucumber is very tender, so it is planted 1 or 2 weeks after.

So the most important information that you will need for starting seeds is the date of the last frost for your geographic region. This can be found from the Cooperative Extension Service or from an Internet search in most cases. The National Climatic Data Center maintains Comprehensive tables on the Internet that give the statistical likelihoods of frost on a given date along with the probabilities of the number of frost-free days, broken down by state and city. Weather.com also provides data relevant to gardening.

Once you've determined the average date of your last spring frost, determine the date for starting seeds and transplanting seedlings into the garden by adding or subtracting a certain number of weeks from the date of the last frost, depending on the crop (see Table 15).

If my average last spring frost is June 1st, then I would start my tomato plants seven weeks before June 1st and set them out on that date. Cabbage would be started 13 weeks before June 1st and set out in the garden 5 weeks before June 1st. Eggplant would be started 8 weeks before June 1st and set out 2 weeks after June 1st.

Anything that can be planted in the garden before the last spring frost can also be grown as a fall crop. For fall cabbage, if my average date of the first fall frost is on September 6th, and my cabbage requires 65 days to mature according to the seed package, then I would transplant my cabbage seedlings on July 28th. This is computed by adding 25 days (from the table) to September 6th

Table 15: Spring and Fall Planting Guide

Crop	Start Spring and Summer Seedlings Relative to Last Spring Frost	Transplant Spring and Summer Seedlings Relative to Last Spring Frost	Start Fall Seedlings Relative to First Fall Frost	Transplant Fall Seedlings Relative to First Fall Frost
Broccoli	–12 weeks	–6 weeks	Transplant date –42 days	Frost date +32 days –days to maturity
Brussels sprouts	–12 weeks	–4 weeks		
Cabbage	–13 weeks	–5 weeks	Transplant date –56 days	Frost date +25 days –days to maturity
Cantaloupe	–2 weeks	+2 weeks	N/A	N/A
Cauliflower	–12 weeks	–4 weeks	Transplant date –56 days	Frost date +18 days –days to maturity
Celery	–13 weeks	–3weeks	Transplant date –70 days	Frost date +11 days –days to maturity
Collards	–12 weeks	–4 weeks	Transplant date –56 days	Frost date +18 days –days to maturity
Cucumber	–3 weeks	+1 week	N/A	N/A
Eggplant	–8 weeks	+2 weeks	N/A	N/A
Kale	–13 weeks	–5 weeks	Transplant date –56 days	Frost date +25 days –days to maturity
Lettuce	–8 weeks	–2 weeks	Transplant date –42 days	Frost date +4 days –days to maturity
Okra	–4 weeks	+2 weeks	N/A	N/A
Onions	–12 weeks	–6 weeks	Transplant date –42 days	Frost date +32 days –days to maturity
Peppers	–6 weeks	+2 weeks	N/A	N/A
Pumpkins	–2 weeks	+2 weeks	N/A	N/A
Squash (summer)	–2 weeks	+2 weeks	N/A	N/A
Squash (winter)	–2 weeks	+2 weeks	N/A	N/A
Tomatoes	–7 weeks	+0 weeks	N/A	N/A
Watermelon	–2 weeks	+2 weeks	N/A	N/A

then subtracting 65 days for the days to maturity (from the seed package). I can tell when to start my cabbage from seed by subtracting 56 days (from the table) from the transplant date. So I should start my cabbage seedlings for all on June 2.

Starting Medium

Gardening experts have many varied opinions on the best starting medium. To confuse matters, seed catalogs try to sell all kinds of starting mediums for that purpose, and the number of choices can be confusing.

Whatever is used as a seed-starting medium should be light and easy for delicate roots to penetrate, and it should hold water well and not be infected with diseases. It should have some nutrients but not too heavy a concentration of them. Commercial seed-starting mixes are sold for this purpose and work fine, as do peat pellets of various shapes and sizes. At the time of writing, commercial seed-starting mixes cost about $3 for enough to start 150 plants, and peat pellets cost about $5 per 100.

Compared to the cost of buying transplants from a garden center, the price of seed-starting mixes or peat pellets is negligible. But for a farmer growing hundreds or even thousands of transplants, it may be economical to make seed-starting mixes at home. Most seed-starting mixes consist mainly of finely milled peat moss and vermiculite. The Territorial Seed Company recommends a simple 50/50 mix of vermiculite and peat moss, but some authorities recommend adding compost to the mix because it can suppress diseases. Some farmers also add a little clean sand. If these latter two ingredients are added, they shouldn't constitute more than ⅓ of the soil volume in aggregate. Don't use garden soil, and don't use potting soil. It is extremely important that any compost used to make seed-starting mix be well finished so that it contains no disease organisms or weed seeds. (Garden soil can be used as an ingredient if it is first sifted through a ¼-inch mesh screen and then sterilized. Instructions for sterilizing are given later in this chapter. Potting soil can be used under the same conditions—if it is sifted then sterilized.)

A little compost or worm castings mixed into seed-starting mixes is fine and can be helpful in warding off diseases. But even organic fertilizer in too great a concentration will create an environment ideal for the growth of various fungi that will invade and harm the seedlings. An indoor seed-starting environment is not like the great outdoors. Wind movements, sunshine, and other elements that keep fungi at bay are greatly reduced in an indoor environment. As a result, the teaspoon of solid fertilizer that does so much good outdoors can be harmful to seedlings.

Another reason for keeping the nutrient content of seed-starting medium low is the lower nutrient concentrations cause more aggressive root growth. Improved root growth leads to a transplant that will suffer less shock when it is planted outdoors.

Here is my own recipe:

- Finely milled sphagnum peat moss, 4 quarts
- Medium vermiculite, 1 pint
- Well-finished compost passed through a ¼-inch screen made from hardware cloth, 1 pint
- Worm castings (available at any agricultural store), 1 pint

Again, the simple 50/50 mix of peat moss and vermiculite recommended by the Territorial Seed Company and most commercial seed-starting mixes work perfectly fine. Feel free to experiment!

Because the starting medium used for seeds is deliberately nutritionally poor and provided in insufficient quantity to meet a seedling's nutritional needs, it will become necessary to fertilize seedlings periodically once their first "true" leaves appear. The first two leaves that appear, called the cotyledons, contain a storehouse of nutrients that will keep the plant well supplied until the first true leaves emerge. (Plants can be divided into two categories—those with two cotyledons, called "dicots," and those with one cotyledon, called "monocots." The first true leaves look like the leaves that are distinctive for that plant.) Adding solid fertilizer to the cells of a seedling tray would be both harmful and impractical, so liquid fertilizer will need to be used.

Seedlings are delicate, and full-strength fertilizer is both unneeded and potentially harmful. A good organic kelp, fish, or start-up fertilizer diluted to half strength and applied every two weeks after the first true leaves appear should work fine.

Containers

Mini-framing is not a small hobby operation. The average mini-farmer will grow hundreds or perhaps thousands of seedlings. The best methods for starting seeds on this scale include cellular containers like those used by nurseries, peat pellets, and compressed soil blocks.

The use of undivided flats is advocated in the Grow Biointensive method. In this method, a rectangular wooden box of convenient size and about 2 inches deep is filled with starting medium, and seeds are planted at close intervals. The seeds are kept moist and warm, and once the cotyledons have appeared, the seedlings are carefully picked out and distance between seedlings. This process is repeated again when the growth of the plant makes it necessary, and the final time the plant is transplanted, complete with a block of soil, it goes straight into the garden. The most obvious benefit of this method is that it is inexpensive. The largest detriment is that it is extremely time-consuming. Grow Biointensive publications also state that this method produces a beneficial microclimate and stronger transplants, but may own experiments have shown no appreciable difference between seedlings grown this way and seedlings grown exclusively in soil blocks or peat pellets. Certainly, this technique works well, and in a situation where the farmer is rich in time but poor in cash, it is a very good option.

The commercial growers who make the small six-packs of transplants for the garden center use plastic multicelled containers. These containers cost money, of course, but also save on labor costs and are easily transplanted. These units have a hole in the bottom of every cell, fit into rectangular plastic boxed that provide for bottom watering, and can be picked up at most agricultural stores for around \$2 or \$3 for a tray and eight 6-pack containers. The price of these works out to about \$6 per 100 plants, which isn't expensive considering that the containers can be reused year to year as long as they are well washed between uses so they don't spread diseases. If you sell seedlings, as I do, you will want to take the cost of these containers (and labels) into account in setting your price. In practice, once acquired, the economics of using these is sound since the per-plant cost drops dramatically after the first year, and they save a lot of time compared to using undivided flats.

The disadvantage of multicelled containers is that each cell contains only two or three cubic inches of soil. This means that the soil can't hold enough nutrients to see the seedling through to transplanting time, so bottom watering with liquid fertilizer is required. Also, because of the small amount of space, roots grow to the sides of the cell and then wind around and around, contributing to transplant shock. Finally, because of the small soil volume, multicelled containers can't be left

Broccoli seedlings destined for market

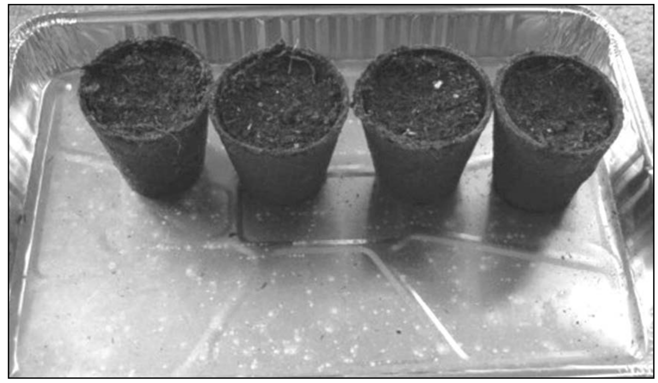
unattended for more than a couple of days because their water supply is depleted rapidly. Even with these disadvantages, they are the method of choice for producing seedlings for sale because of their convenience.

Peat pellets have a significant advantage over multicelled containers when it comes to transplant shock. Taking a transplant from a multicelled pack and putting it directly into garden soil can set the plant back for a few days as it acclimates to the new soil conditions. Peat pellets get around this problem because transplants are put into the garden without being disturbed, and roots can grow right through them into the soil. This allows for gradual acclimatization and virtually eliminates transplant shock.

Peat pellets cost about $5 per 100 and can be purchased at agricultural supply stores and occasionally at places like Walmart. They come as compressed dry wafers and are expanded by placing them in warm water. Once the pellets expands, the seeds are placed in the center and lightly covered, then the pellet is bottom watered as needed until time to plant in the garden. In the case of peat pellets, the seed-starting mix of a peat pellet is essentially devoid of nutrients altogether, making liquid fertilizer a must. If you use peat pellets, be sure to carefully slit and remove the webbing at transplanting time so it doesn't bind the roots.

Peat pots suffer from the same disadvantages that effect multicelled containers because of their small soil volume, plus they don't break down well, and they constrain root growth in many cases, so I don't recommend them. When I worked some compost into my beds last spring, I dug up perfectly intact peat pots that had been planted a year earlier.

Compressed soil blocks, while not aesthetically acceptable for commercial sale, are the best available choice for the farmer's own seedlings. That's because a compressed soil block contains 400% more soil volume than a peat pellet or multicelled container,



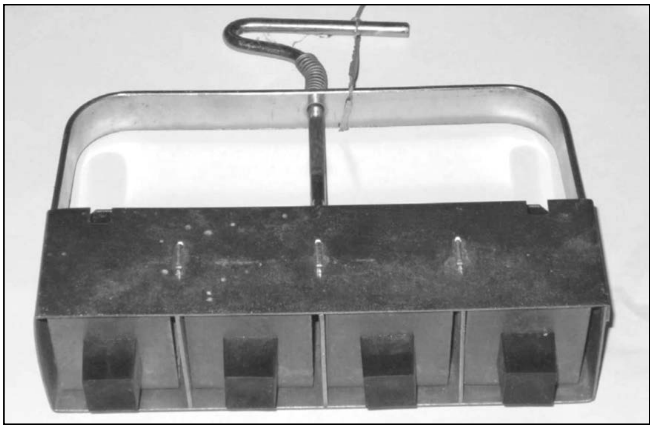
Peat pots often fail to break down quickly.

meaning it will contain more nutrients and moisture. Seedlings raised in compressed soil blocks using a properly constituted soil mix may require no liquid fertilizer at all. Because roots grow right up to the edge of the block instead of twisting around, and the block is made of soil so decomposition isn't an issue, transplant shock all but disappears. They are also the least expensive option when used in volume.

Compressed soil blocks are made with a device called a "soil blocker" into which a soil mix is poured, and the mix is then compressed.

A standard mix for the soil used in the blocker contains 30% fine peat moss, 30% good finished compost, 30% sterilized garden soil and 10% fine sand. A balanced organic fertilizer such as Cockadoodle DOO is added to the mix at the rate of ½ cup per four gallons of soil mix, and the pH is adjusted with lime if necessary to fall between 6.2 and 7.0. My own mix is 50% peat moss, 40% worm castings, and 10% coarse vermiculite with a bit of balanced fertilizer. (Garden soil can be sterilized by spreading it no more than 1 inch thick on a baking pan and baking in the oven at 200 degrees for 20 minutes. Don't use a good pan!) It is important that the ingredients used in a soil mix be sifted so large twigs don't interfere with the operation of the soil blocker.

Even though the devices for making soil blocks cost about $30 each, they are made of steel and will



A standard 2-inch soil blocker with rectangular inserts

last many years, so they will save many times their cost compared to muticelled containers. I bought mine from Peaceful Valley Farm Supply over the Internet.

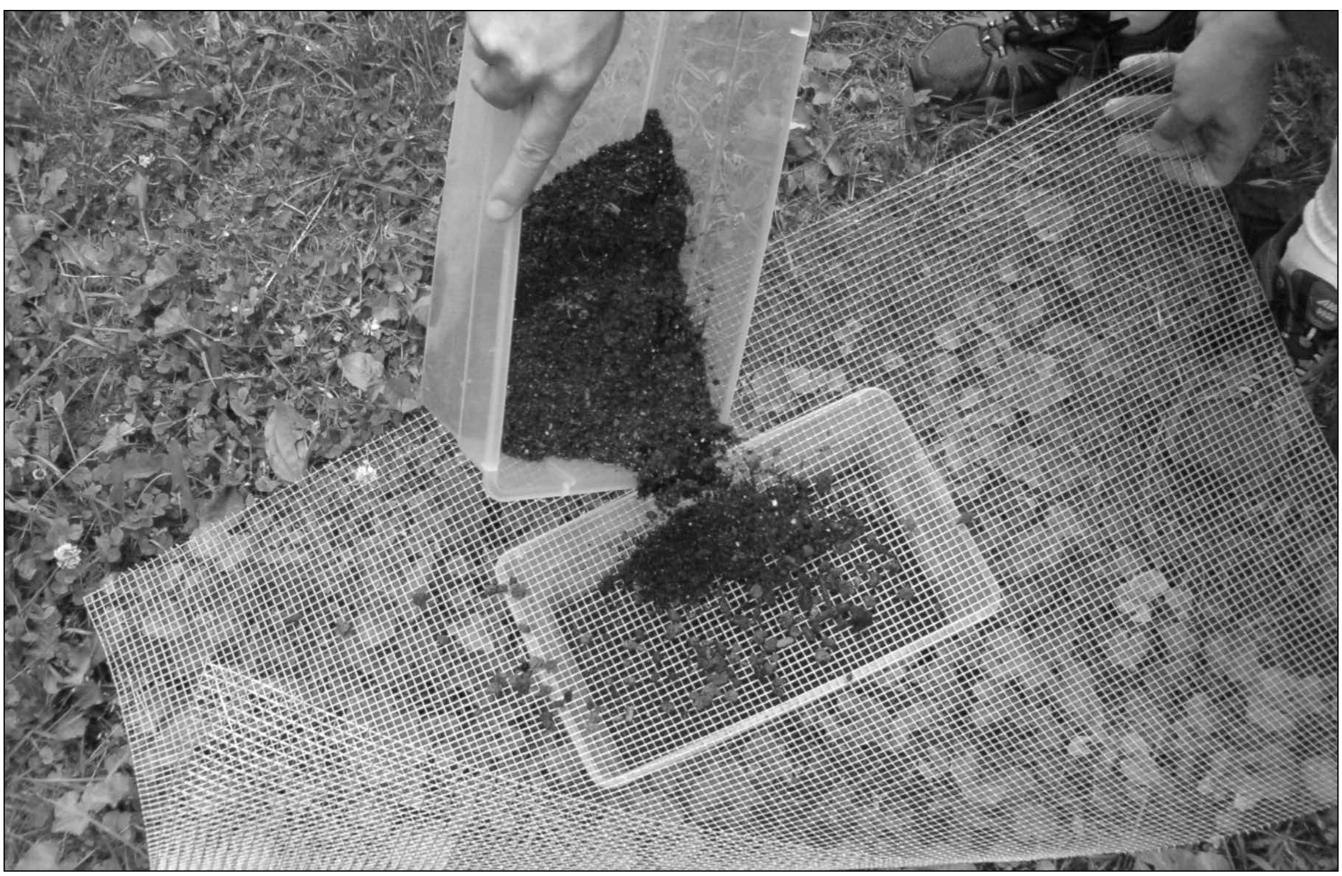
One particular technique for using soil blockers merits attention. An insert can be purchased for the 2-inch soil blocker that makes a ¾-inch cubic indentation in the block to accept ¾-inch soil blocks. This is a great idea because it allows germination to be accomplished in smaller soil blocks that are then transplanted into the larger ones. That way you aren't taking up a large soil block with seed that won't germinate.

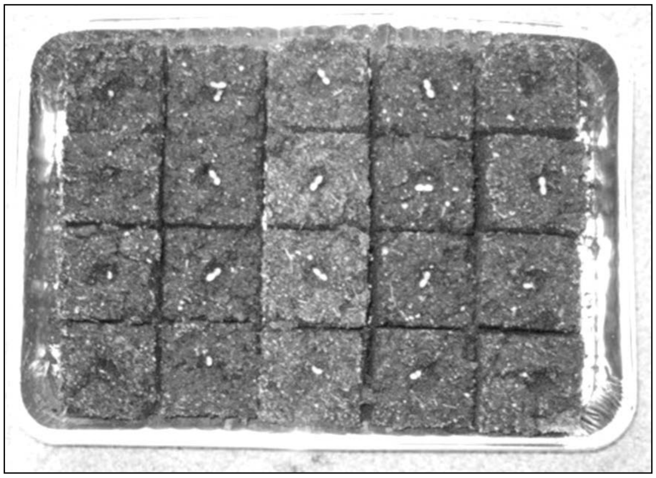
Light

Plants evolved with needs for light intensity that match the output of the sun, which provides light that is so intense that merely looking at it can permanently damage the eye. Naturally, seedlings grown inside also need an intense light source that can provide enough light without also making so much heat that plants get burned.

With the exception of certain flowers, most plants do not need light to germinate. In fact some plants, like those in the brassica family, may have

Use ¼-inch hardware cloth to screen out debris.





Soil blocks with sprouted lettuce seedlings

their germination inhibited by light. But once the first plant parts emerge above the ground, all plants need light to grow. In most of North America and Europe, there is not enough sunshine coming through even a south-facing window to adequately start seedlings during the winter months when most seeds starting takes place, so a source of artificial light is required. Selecting an artificial light source should be based on an understanding of the plants' requirements.

Plants require light of various wavelengths or colors for various purpose. Red wavelengths, for example, regulate dormancy, seed production and tuber formation, whereas blue wavelengths stimulate chlorophyll production and vegetative growth. Violet wavelengths affect plants' tendency to turn toward a light source. The best light sources for starting seedlings, then, should generate a wide spectrum of light wavelengths that encompass both the blue and the red ends of the spectrum.

There is a growing number of options for artificial lighting; unfortunately, most of these are quite expensive. Following is my particular approach that inexpensively meets the light needs for seedlings.

All sorts of special carts costing anywhere from $200 to $1,000 are sold for this purpose, but with a little ingenuity you can create a suitable contrivance, made like the one illustrated, at very low cost.

A homemade rack for seedlings works great and costs little.

This device is made from a simple wire rack sold in the hardware department of Walmart for $50. Three racks hold up to four large seed trays each, and two 48-inch shop light fluorescent light fixtures are hung over each rack using simple adjustable chains from the hardware store. This way, the lights can be independently raised and lowered to keep them the right distance above the plants as they grow. The six lights (or fewer if you don't need them all) are plugged into an electric outlet strip that is plugged into a timer. Each light hold two 40-watt 48-inch fluorescent tubes.

The fluorescent tubes need to be selected with the needs of plants in mind. Cool white fluorescents put out more blue light, and warm white fluorescents put out more red light. Combining the two in the same fixture gives a perfectly acceptable mix of wavelengths. It's what I use, and a good many farmers use it successfully. There are also special tubes for fluorescent light fixtures that are specifically designed for growing plants or duplicating the sun's wavelengths—and these work well too, but at a cost roughly six times higher than regular tubes and at a reduced light output. The thing to watch for with fluorescent lighting generally is light output, because plants need a lot of it. Go with the highest light output tubes that will fit in a 8-inch shop light fixture. Because the lights are used approximately five months out of the year, the tubes need to be replaced only every other year. Replace them even if they look and work fine, because after being used for two years, their measurable light output will have declined.

The intensity of light decreases in inverse proportion to the square of the distance from the source. In other words, the further away the lights are, the less light the plants will get. Fluorescent tubes need to be set up so that they are only an inch or two above the seedlings for them to get enough light. Because plants grow, either the height of the lights or the bottom of the plants needs to be adjustable.

Plants need a combination of both light and darkness to complete their metabolic processes, so too much of either can be a bad thing. Because even closely spaced florescent lights are an imperfect substitute for true sunshine, the lights should be put on an inexpensive timer so seedlings get 16 hours of light and 8 hours of darkness every day.

Don't forget: Once seeds sprout, shine the light on them!

Temperature

Many publications provide various tables with all sorts of data about the optimum temperatures for germination of different garden seeds. For starting seeds in the house, almost all seeds normally used to start garden seedlings will germinate just fine at ordinary room temperatures. The only time temperature could become an issue is if the area used for seed starting regularly falls below 60 degrees or goes above 80.

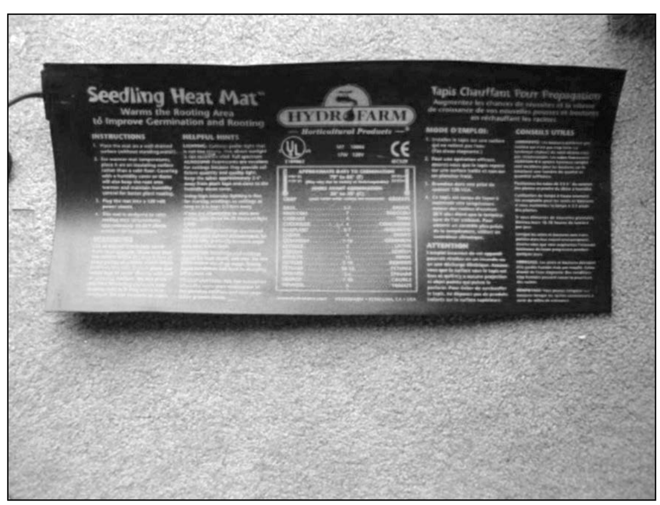
If seed-starting operations get banished to the basement or garage where temperatures are routinely below 60 degrees, germination could definitely become a problem. The easiest solution for this situation is to use a heat mat (available at any agricultural supply store) underneath your flats that will raise the soil temperature about 20 degrees higher that the surrounding air.

Water

Seedlings should be bottom watered by placing their containers (which contain holes in the bottom or absorb water directly) in water and allowing the starting medium to evenly water itself by pulling up whatever water is needed. Seedlings are delicate and their roots are shallows, so top watering can disrupt and uncover the vulnerable roots.

It is important that the starting medium be kept moist, but not soaking, for the entire germination period. Once the germination process has begun and before the seedling emerges, allowing the seed to dry out will kill it. Most containers used for seedlings are too small to retain an appreciable amount of water;

A heating mat is especially useful for peppers and tomatoes.



for this reason seedlings should stay uniformly damp (though not soggy) until transplanted.

Unfortunately, dampness can cause problems with mold growth. Often, such mold is harmless, but sometimes it isn't, and telling the difference before damage is done is difficult. If gray fuzz or similar molds appear on top of the seedling container, cut back the water a bit, and place the container in direct sunlight in a south-facing window for a few hours a day for two or three days. This should take care of such a problem.

Another cause of mold is the use of domes over top of seedling flats. These domes are advertised to create an environment "just like a green house." In reality, they create an environment extremely conducive to mold, even in moderately cool temperatures. No matter how clean and sterile the starting medium, anytime I have ever used a dome on top of a seed flat, mold has developed within two or three days. I recommend that you do not use domes.

Fertilizer

As mentioned earlier, once seedlings have their first set of true leaves, they should be bottom watered with a half-strength solution of organic liquid fertilizer once every two weeks in addition to regular watering. Since starting medium is nutritionally poor, some fertilizer will be a benefit to the seedlings, but anything too concentrated can hurt the delicate developing root system and cause problems with mold. The only exception to this is soil blocks, which can contain enough nutrients that liquid fertilizer isn't needed because of their greater soil volume.

Hardening Off

A week or two before he intended transplant date, you may wish to start the process of "hardening off" the transplants; that is, the process of gradually acclimating the plants to the outdoor environment.

This generally means bringing the seedlings outside and exposing them to sun an wind for an hour the first day, progressing to all day on the last day of the hardening-off period, which lasts about a week before transplanting. The process of hardening off serves to make the transplants more hardy.

In my experience, hardening off makes little difference with plants that are transplanted after the last frost, but it does have an effect on the hardiness of plants that are transplanted before the last frost. It should be done with all transplants anyway, because there is no way to know with absolute certainty if an unusual weather even will occur. I've seen no case in which hardening off transplants has been harmful and numerous cases in which it has helped so it is a good general policy for a mini-farm in which maximum yields are important.

Raised Beds

BY BRETT L. MARKHAM

Raised beds and properly constituted soil make mini-farming practical. Modern people in the industrialized world have a lot less spare time and a lot less available land their ancestors.

Raised beds offer so many advantages over row gardening that it is hard to imagine why everyone except big agribusiness cartels isn't using them. Especially in northern climates, raised beds can help gardeners lengthen their growing season because they can raise soil temperature by 8 to 13 degrees compared to ground soil temperatures.

By raising the level of the soil, farmers and gardeners can start their crops earlier because excess moisture drains easily so the cold spring rains won't overwhelm new crops. Raised beds are also easily fitted with attachments, such as cold frames.

A raised bed is essentially a bottomless and topless box laid on the ground and filled with soil. The boxes can be built from wood, plastic boards, cement, and other materials. Raised beds can be made from mounded earth, but surrounding them with a box structure limits erosion of the carefully prepared soil of the bed.

Raised beds extend the season and reduce problems related to excess water.

Material Choices

The frames of raised beds are in constant contact with damp earth and can be subject to rotting. Ordinary lumber will last two or three years before replacement is needed. This can be delayed by carefully painting all exposed surfaces of the frames with a water-based exterior latex paint and allowing them to dry thoroughly before putting them to use. Do not use oil-based paints or paints containing antimildew ingredients or else you'll poison the soil in your beds. Because of the weight of the soil, boards used should be at least 1.5 inches thick to avoid bowing, and opposite sides of long runs should be tied together every eight feet or so. The biggest benefits of lumber lie in its easy availability and easy workability.

Ordinary concrete blocks are inexpensive and easy to use. They are readily available, durable, and heavy enough to hold the soil in a raised bed without need for mortar. They can be picked up and moved around to relocate or expand beds, and they can be reused almost indefinitely. The only downside is their weight—45 pounds for each. That means that in spite of their compact size, only 22 at a time can be hauled in a pickup truck rated to haul


Raised beds can be made from a variety of materials. This one is made with cinder blocks and landscape timbers.

a half ton. Since each block is eighteen inches long, a pickup-sized load gives only 33 linear feet.

Boards made from recycled plastic used for decks and other outdoor structures have become more available in recent years and combine the assets of the easy handling of traditional lumber with the durability of concrete block. Several raised-bed kits are on the market that use plastic boards, and these may be a good idea if you plan on doing a small amount of gardening, but because of the expense of the kits, they don't make sense on the scale needed to feed a family. For a mini-farm, save expense by buying the plastic boards at the lumber store and cutting them to the right size yourself.

It is true that more modern pressure-treated lumber uses less toxic components than it used to, but the components are still toxic, and they can leach into the soil of the growing bed, so they are best avoided.

Many other materials can be used, ranging from landscaping timbers to poured concrete forms. Just let imagination, cost, durability, and the potential toxicity of anything you might use guide the decision. Keep in mind that using materials that leach poisons into the growing beds completely defeats the purpose of the home garden or mini-farm because consuming the products grown in those beds can be extremely hazardous. (The arsenic in pressure-treated wood, for example, is both directly toxic and highly carcinogenic.)

Shape and Orientation of Raised Beds

The most common and useful shape for raised beds is rectangular. Certain planters for flowers are circular, and this works fine as long as the diameter is not so great that the gardener has to step into the bed. Another common shape is a 4-foot square. This works well for casual vegetable-only gardening on a small scale, but at the scale of providing all the needs of a family, it becomes wasteful of space and material.

I recommend a rectangular shape because it makes maximum use of space and minimal material while making it easy to add standardized structures like hoop houses.

Any rectangular bed is going to be longer than it is wide. To give maximum sun to crops and avoid shading, ensure that the long sides face north and south. Any trellising for vining crops should be established along the north edge to get the advantage of sunshine without shading other crops.

Size of Raised Beds: Width

Everyone has an opinion on the proper size of raised beds. The Grow Biointensive method favors a width of 5 feet and a length of 20 feet to establish a "microclimate" for intensive agriculture. Square Foot enthusiasts advocate a maximum width of 4 feet, because it is easy to reach into a bed that is 4 feet wide from either side and get to whatever is in the middle. Many experienced organic farmers use even narrower raised beds.

The five-foot width advocated by Ecology Action requires, for many people, stepping into the bed onto a board intended to more widely distribute the weight and minimize damage to the soil structure. But stepping into the garden bed at all, even using a board, defeats the purpose of careful management of the soil structure by compacting the soil. The board would need to be set up so it can be laid across the sides of the bed structure and be rigid enough that it won't bend when someone is standing on it. (This would be impossible using the complete Grow Biointensive method since, in that method, the raised beds are only mounded soil without structural sides. My method uses structural sides instead.)

The 4-foot width is narrow enough that most people can reach into the garden from both sides since only a 2-foot reach is needed. This will not work, however, when trellised crops that grow food on both sides of the trellis are grown against one of the long sides of the bed. In that case, picking pole beans, for example, requires a 4-foot reach, which most people don't have. My wife and I did this with a 4-foot-wide bed one year, and watching my wife balance on one of the frame boards while reaching for the beans with one hand and holding on to me with the other was a sure sign that I would need to make some changes the following year!

For reasons of experience and convenience, then, I recommend that beds should be four feet wide if they aren't going to be used for tall vines like pole beans. They should be three to three and a half feet wide otherwise.

Sizes of Raised Beds: Length

We already know that beds needs to be rectangular for economic reasons and three to four feet wide for convenience—but how long can they be? Technically, they can be as long as the farmer wants, but there are some aspects of length worth considering.

One of the biggest causes of insect and disease problems is growing the same plants in the same space year after year. Bacterial, fungal, and viral diseases often have preferred host plants—and sometimes won't even grow in plants of an unrelated genus. Since these pathogens are competing against more beneficial microbes in compost-enriched soil, they can survive for only a limited period of time—usually three years or less—in soil that doesn't provide a suitable host.

Insect pests (some of which spread diseases) are quite similar. They have a particular appetite—a particular niche—such as cabbage. Such pests not only eat cabbage and infect it with diseases but also lay their eggs in the soil around the cabbage so that their offspring will emerge right next to their favorite food. One important way of foiling such pests is to make sure that when their offspring awaken in spring, they find plants that aren't appetizing.

Limiting the length of raised beds so that you have more room to create several of them makes it easy to practice crop rotation because the soil in one bed is isolated from the soil in the others. Making sure the same crop isn't grown in the same bed for three years solves a lot of problems in advance. In my own mini-farm, beds range in length from 8 to 24 feet.

Start at the Right Time and Grow Slowly

The time between when the soil can first be worked in the spring and when the early spring crops need to be planted is about three weeks. This is simply not enough time to create enough raised beds.

Ultimately, for total food self-sufficiency, you will need about 700 square feet per person. If you plan to raise market crops, you'll need even more. That will require a lot of beds. The number will depend on the length you choose.

Assuming the creation of beds that are 4 feet × 25 feet, that means you'll need at least seven beds per person or 21 beds for a family of three. Using 4 feet × 8 feet beds, that would be 22 beds per person or 66 for a family of three.
In practice, depending on dietary preferences, chosen crop varieties, climate, and other factors, a larger or smaller number of beds could actually be used.

Initial creation of raised beds takes a considerable amount of time and is very labor intensive, but once they've been created, they require very little work to maintain. Raised beds can be created in a number of ways, but even the most time-efficient methods will take a few hours per bed. If you have limited time, getting all the beds made in spring will be physically impossible.

Therefore the best time to embark upon mini-farming is *the summer or fall before* the first growing season. This way the beds can be prepared in a more leisurely fashion and then sowed with cover crops for overwintering. In the spring, you only have to cut the cover crops and put them into the compost pile, cultivate existing beds, and start planting. (Cover crops are explained in the next chapter.)

It may be best to start mini-farming slowly—say, by initially creating enough beds for just a single individual's food—and then keep adding beds as time and materials allow until the required number has been established. This is because of the trade-off between time and money. If the prospective farmer has the time to establish all of the required beds initially, that's great. But if time is lacking, the only way to shortcut the system is to pay for heavy equipment and truckloads of compost.

I don't want the fact that fall is the best time to get started to discourage you from starting in either the spring or summer if that is when you want to start. It is always better to start than to delay because even just a couple of raised beds can produce a lot of food. If you get started in the spring or summer, just keep in mind that you'll want to add new beds in the fall as well.

Creating the Beds

For reasons of economy and productivity, I recommend creating the beds initially by double-digging. Lay out the area to be dug using stakes and string, then once it is dug, surround that area with the material you have chosen to create the box for the bed. Because the process of double-digging will loosen the soil, the level of the dug area will be between four and six inches higher than the surrounding soil.

Double-digging has been a standard agricultural practice for soil improvement in various places around the world for untold generations, and it is what I recommend because it is the most effective for the money required. The idea behind double-digging is that plants send their roots deeply into the soil, and making sure there are nutrients and aerated soil two feet deep provides ideal growing conditions. Up where I live in New Hampshire, any attempt at digging, no matter how modest, can be difficult because of the large number of rocks encountered. Did you ever wonder where all those picturesque rock walls in New England came from? Yep—they came from farmers getting rocks out of their fields.

My grandfather never double-dug anything but his asparagus beds. But, then again, he had 96 acres of land, horse teams, plows, tractors, four sons, and three daughters, so he wasn't trying to squeeze every ounce of productivity out of every square foot like a modern mini-farmer either. Nevertheless, the asparagus grown in a double-dug bed was far superior to any other.

Although many plants, especially grasses, can send roots several feet deep, the majority of a plant's root system exists in the top six inches of the soil. That's why Mel Bartholomew's Square Foot gardening system, which uses only six inches of soil, works.

But in spite of the fact that six inches of perfectly prepared soil can be adequate, there can be no doubt that two *feet* of soil will necessarily hold a greater reservoir of nutrients and water.

As my father would say, with my apologies to our beloved cat, Patrick, in advance, "there's more our beloved cat, Patrick, in advance, "there's more than one way to skin a cat." Meaning, of course, that double-digging is not the only suitable way to prepare soil for mini-farming. There are actually three ways of digging the beds.

Digging Methods

The old-timers where I grew up never used the term *double-digging*. In the United States and Great Britain, that practice has been historically known as "bastard trenching" to differentiate it from full or "true" trenching. Most modern texts don't mention it, but there are actually three sorts of trenching that are useful under different circumstances. All three types of trenching are brutally hard work, particularly in areas with a lot of large rocks or with soils composed mainly of clay but they offer benefits worth the effort. These three types of trenching are *plain digging, bastard trenching*, and *trenching*.

Plain digging relies on using a garden spade to dig into and turn over the soil to the depth of a single spade. The area to be dug is laid out using string or other marking, and a garden spade is used to remove the soil one-spade wide and a single-spade deep across the width of the bed, and that soil is placed into a wheelbarrow. Then a couple of inches of compost is added to the bottom of the first trench, and the soil from the next parallel trench is added on top of the compost in the first trench. This process continues until the last trench is dug and compost added to the bottom, and then the soil saved from the first trench is added to the hole left by the last trench.

The only difference between plain digging and double-digging is that in the latter, after a trench is dug a single-spade deep and before the compost is added, a digging fork is worked into the soil at the bottom of the trench to lift and break up the soil. Finally, more compost is added on top and mixed with the top six inches of soil. I perform this last step after I've built the form around the dug area.

Both plain digging and double-digging can be useful for newly created beds can be especially useful for an area that is covered with grass as the spits of dirt (the dirt that makes up a spade-full is known as a "spit") can be turned grass-side down in the adjacent trench as they are dug. It is extremely useful in either case, where the land to be used for farming

The garden fork and digging spade are indispensable tools.

was previously weeds or lawn, to sift through the soil to remove wireworms and grubs as you go along. When I use either of these trenching methods, I not only put compost in the bottom of the trenches but also add some across the top of the finished bed and mix it in as well.

True or full trenching is serious work, but it is appropriate for regenerating soil in beds that have been previously double-dug or where the soil can be worked deeply without using a backhoe. A properly maintained bed should never need regeneration, but true trenching can be useful when dealing with land that was previously overframed using conventional methods since it exchanges the subsoil with top soil. In true trenching, the first trench is dug a single-spade deep and the soil from that set aside, and then the same trench is dug another spade deep and that soil is set aside as well, separately from the soil from the top of the trench. Then a digging fork is used to break up the soil in the bottom as deep as the tines will go, and compost is added.

When the second adjacent trench is dug, the spits from the top are added to the bottom of the first trench, then the spits from the bottom are added to the top of that. In this way, the topsoil is buried, and the subsoil is brought to the top. Continue in this way until the last trench is dug, at which time the top spits from the first trench are put into the bottom of the last trench, and then those spits are topped with those that remain.

Because true trenching exchanges the topsoil with the subsoil, and subsoil tends to have far less organic matter, generous amounts of aged compost should be added to the top layer, worked in thoroughly, and allowed to sit for a couple of weeks before putting the new bed to use.

In any of the three trenching methods, you will be using hand tools to move, literally, thousands of pounds of soil for each bed. This can be grueling work, and you should always use spades and digging forks that have been either bought or modified to accommodate your height. The correct height of a spade or fork (plus handle) can be judged by standing the tool vertically next to you, then seeing how high it reaches on your body. The top of the handle should fall somewhere between your elbow and the middle of your breastbone.

Digging forks and spades can be purchased with either straight or "D" handles. You should get the D-handled versions, as they will lessen the amount of required back twisting. When using the tools, keep you back straight, and avoid both twisting and jerky movements. Work at a comfortable pace, and take breaks when needed. This way you get an excellent and safe aerobic workout that improves your strength and flexibility while improving the soil.

What about "No-Dig" Beds?

In my experience, I have found nothing that competes, in terms of sheer productivity, with properly double-dug raised beds. However, this can be a lot of work, and folks without a lot of time or with physical disabilities might not want to undertake the effort. You can still get very good results, though, using a no-dig method that I've tested.

Save up old newspaper—just the black-and-white portions, not the glossy parts. In the fall, build your frame out of 2 × 4 lumber right on the ground. Lay down the newspaper several layers thick, and then fill the bed completely with finished compost. Don't skip the newspapers because their purpose is to smother the grass underneath. If the grass isn't smothered, and if your are using 2 × 4 lumber, you'll end up with a lot of grass growing in the bed.

When spring rolls around and the ground thaws, just use the digging fork to fluff it up a little; then plant, and you are done.

For no-dig beds it is particularly important to keep them planted with cover crops when fallow

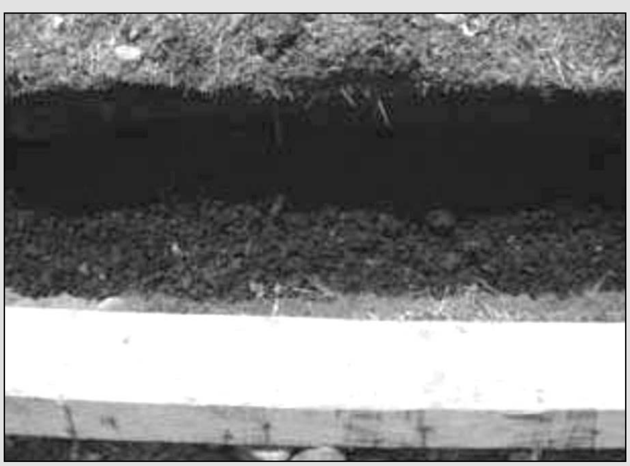
Illustrated Double-Dig

Every year I expand my mini-farm a little by adding a few raised beds. The beds in my farm vary in size depending on the materials I had available at the time of construction, but most of them are 3 ½ feet wide and 8 feet long. In the spring of 2006, I added a few beds and had my wife take pictures of the process so I could include them for your reference.

1. Mark off the area to be dug. In my case, I just laid out the boards where I would be digging. Notice a completed bed in the foreground and boards marking where the new bed will be in the background.

Boards are used to mark off the new bed. You could just as easily use string or chalk.

First row dug



2. Dig the first row across the width of the bed one-spade deep, and put the dirt from that row in a wheelbarrow.
3. Loosen the soil in the bottom of the trench with a digging fork.
4. Add compost to the bottom of the trench.
5. Dig the second trench parallel and adjacent to the first one.
6. Because, in this instance, I am digging an area that was covered with grass, I turn the spits from the second trench upside down in the first trench.
7. Work some additional compost into the top few inches of the finished bed.

Loosening the soil

Adding compost

(Continued)

Illustrated Double-Dig *(Continued)*

Digging the second trench. Beware the author's stylish footwear!

Working compost into the top few inches of the new bed

As you can see from the photo tutorial, preparing raised beds by double-digging is a pretty straightforward and very physical process. It is great exercise and loosens the soil to a depth of two feet, placing organic material throughout the entire depth. The yields from beds that I work like this are phenomenal!

Putting spits in the trench upside down

during the off-season because you are depending on the action of plant roots to mix the soil and keep it loose.

Because seeds don't always germinate well in compost, I'd recommend using the bed for transplanted crops for the first year, and then a good soil builder like beans the next year. In all other respects, you can treat this just like a regular raised bed. If fresh compost is added yearly, after three years the productivity will be the same as for a double-dug bed.

Trellising for Raised Beds: Flexible Trellising System

Trellises are necessary for certain crops and can be a valuable adjunct for others. Because raised beds don't provide much room for sprawling plants such as cucumbers or pole beans, adding a trellis makes growing these crops more practical and space efficient.

Many crops are more productive in vining versions than bush versions. This includes beans,

Electrical conduit makes a sturdy and versatile trellis.

peas, cucumbers, tomatoes, and more. Pole beans, for example, can yield almost twice as much product per square foot as bush beans. This means that a row of pole beans grown on a trellis along the north side of an 8-foot bed using only 8 square feet of space can produce nearly as many beans as 16 square feet of bush beans. This same calculation applies to other vegetables.

As mentioned earlier in the chapter, beds will ideally be located with the long sides facing north and south. Trellises should be established on the north side. If, for some reason, this orientation isn't convenient, the second-best choice is to have the long side upon which trellises will be established on the north west or, in the worst case, west side. Don't establish trellises on the south or east sides of a bed or they will shade crops during the times of day that are most sunny.

There are as many ways to erect trellises as there are farmers, and I've used many different methods over the years. In the past few years, my preferred method of trellising uses rebar, electrical conduit, and conduit fittings. Electrical conduit comes in lengths 10 feet long. By cutting it to strategic lengths and using appropriate fittings, you can vary its height and length. By fitting it over rebar driven into the ground, you can lift it off the rebar easily in the fall for storage, and moving it to a different bed is a snap.

Because lumber used to create the beds is eight feet long, the longest you need the conduit to be is eight feet. This is for the horizontal piece on top.

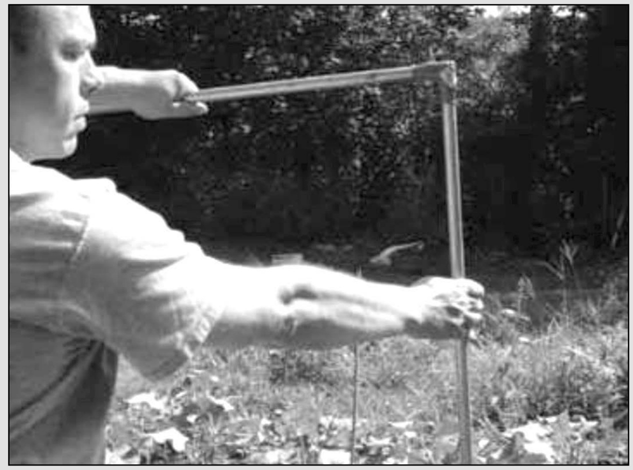
Complete Trellis Creation, Step-by-Step

Driving the rebar into the ground

Placing an upright over the rebar

1. Hammer 2-foot pieces of rebar into the ground at either end of the raised bed, leaving 6 inches protruding above the ground.

Attaching the horizontal to the bend



Deck screws drilled into the edge and protruding ³⁄₈ inch

2. Slip your vertical piece of conduit over the rebar. Repeat for the other side.
3. Attach a 90-degree elbow to each vertical piece of conduit, and then secure the horizontal conduit to the elbows.
4. Put deck screws into the side of the raised bed along the trellis every 6 to 12 inches. Leave them protruding about a quarter of an inch.

(Continued)

Complete Trellis Creation, Step-by-Step ***(Continued)***

Run string between the horizontal and the deck screws.

5. Run string between the horizontal bar on top and the deck screws in the side of the raised bed.
6. Now you have a completed trellis!

Completed trellis

Meanwhile, trellis heights can range all the way from two feet for peas to four feet for tomatoes to even six feet for pole beans. A trellis height of more than six feet isn't a good idea, as reaching the top would be tiring or—even worse if a stool is required—dangerous.

The easy way to get a flexible system is to buy 10-foot lengths of conduit six pieces at a time. Three are cut into an 8-foot and a 2-foot piece, two are cut into a 6-foot and a 4-foot piece, and the final length of conduit is cut into two 4-foot pieces and one 2-foot piece. When done, you have three 8-foot horizontals, two 6-foot verticals, four 4-foot verticals, and four 2-foot verticals. In addition to these, for every six pieces of conduit, you will need six 90-degree elbows, four screw couplings, and six pieces of 2-foot rebar. (You can find rebar already cut to length and bundled at Home Depot and similar stores.)

Once the rebar is hammered into the ground on either end of the beds, you can completely assemble or disassemble a trellis of any height from 2-foot to 8-foot in two-foot increments using only a screwdriver.

Fruit Trees and Vines

BY BRETT L. MARKHAM

Fruit trees and vines can provide an enormous amount of food compared to the effort invested. Many fruit and nut trees produce, literally, bushels of fruits or nuts, and some blackberry variants produce gallons of berries per vine. Unfortunately, even though berries may even produce in their first or second season, full-sized fruit and nut trees take several years to come into production and may produce nothing at all for the first few years. Dwarf trees will normally produce fruit within three years, but the volume of fruit they produce is lower.

To offset this problem, diversify! If possible, in the year preceding the start of your mini-farm, plant a small section with berry and perhaps some grape vines for the next year's harvest. Along with these, plant dwarf fruit trees and some full-sized nut trees. In this way, the harvest starts modestly with berries the first year and expands to include dwarf cherries the next year, dwarf apples the year after that, and so on. Within seven years, the farmer is producing enough fruit and nuts for the family plus some surplus.

Fruits are full of idiosyncrasies in terms of disease and pest problems, pruning requirements, suitable climate, and so on. This is particularly true of vinifera grapes, apples, peaches, and other popular fruits. I recommend reading as widely as possible about the fruits you plan to grow and selecting hardy varieties specific to your area, using a reputable nursery, and trying to purchase varieties that are resistant to expected diseases.

I recommend St. Lawrence Nurseries in Potsdam, New York, but there are other reputable nurseries as well. An invaluable Internet resource at the time of this writing is Garden Watchdog, at www.davesgarden.com. Garden Watchdog has a listing for almost every company in the gardening business and a list of feedback from customers along with ratings. Check out any mail-order nurseries with Garden Watchdog before ordering.

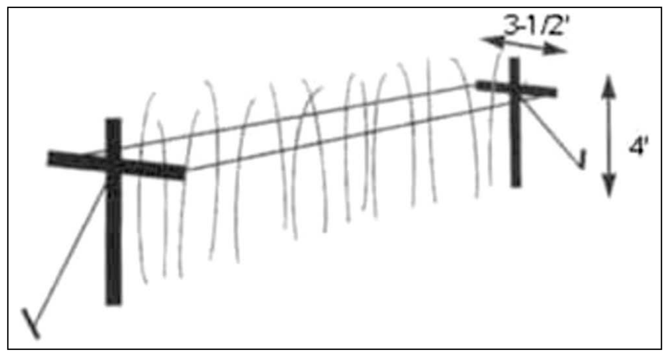
In addition to ordering high-quality trees that are likely to be less susceptible to problems, you should work proactively to keep pest problems minimal by making sure plants that attract beneficial insects are already established where the trees will be planted. Most notably, this means clover. Clover attracts insects that feast on the most tenacious pests of apple-family trees and fruits such as codling months, apple maggots, and plum curculios. The exact type of clover to be planted will vary with the condition of the soil, expected temperatures, and expected precipitation. A good resource for selecting the right variety of clover is a comprehensive organic gardening catalog like that from Peaceful Valley Farm supply.

Plant trees in the spring, and spray them for the first time in the fall with dormant oil that smothers and controls overwintering insects. The following spring spray the trees with a lighter horticultural oil in spring when the buds have swelled but not yet blossomed. Also spray them with either a lime sulfur or organic copper-based fungicide according to label directions every spring after their first year. Traps for common problem insects such as codling moths or apple maggots should be set out and maintained at a high enough density to trap out all of the males of the species.

Fruits and nuts often have specific pollination requirements that make it necessary to plant more than one tree. Sometimes the trees have to be of slightly different variants because trees of the same variety were propagated by grafting and are therefore genetically identical and self-sterile. A few nurseries sell trees propagated from seed rather than grafting, and these trees will pollinate each other without issue even if the same variety. Be sure to pay attention to catalog information and ask questions of the nursery staff to avoid later disappointment!

Pruning will be necessary to maximize the productive potential of the trees. There are many schools of thought on the subject of pruning, and numerous weighty tomes have been written, but the basics are easily described.

Raspberries are nutritious and easy to grow.



This sort of T-trellis is easily made and works well.

Blackberries and Raspberries

Cane fruits, like raspberries and blackberries, grow long and heavy enough that the tips of the canes touch the ground—where they then set a new root and grow more new canes. This isn't necessarily desirable, as it leads to an ever-expanding impenetrable thorny mess, so it is best to trellis the canes to prevent this. The easiest trellising for cane fruits is a four-foot-tall "T" at each end of the row of canes with galvanized wire run from each end of the T along the length of the row. The wire holds up the canes so they don't touch the ground, and new canes are trained to stay behind the wire. This makes the berries easy to pick as well.

Blackberries are pruned by distinguishing between *primocanes* and *floricanes*. Primocanes are canes in their first year that bear leaves but no flowers of fruit. Floricanes are those same canes in their second year, when they bear flowers and fruit. After a cane has fruited, it slowly dies, so fruiting canes should be cut out and removed once their fruiting season has passed. Primocanes should be *topped* during their first year of growth, meaning they should have their tops cut off just about 4 inches above the trellis. This will cause them to send out lateral shoots so that when they bear fruit the next year, they will bear more abundantly. The lateral shoots should be trimmed to 12 inches to 18 inches.

The same general technique applies to raspberries, with some minor changes. Yellow and red raspberries shouldn't be topped, and the laterals that form on purple and black raspberries should be trimmed to just 10 inches. Ever-bearing raspberry varieties fruit in the late summer of the primocane stage and then again in the early summer of the floricane stage. After the early summer fruiting, the floricanes should be removed. The easiest way to distinguish floricanes in ever-bearing raspberries is that the first-year fruit is one the top of the cane and the second-year fruit is at the bottom.

Grapes

Grapes can be divided into three general varieties: European, American, and muscadine. European grape varieties (*Vitis vinifera*) are vulnerable to a nasty pest called phylloxera, which is a tiny louse-like insect that causes all sorts of problems, especially in the eastern United States. Muscadine grapes, native to the southern United States, can be successfully grown only south of Maryland because of their climate requirements. Other American grape varieties are naturally resistant to phylloxera and can be grown practically anywhere in the continental United States. For varietal wine production, scion wood of European grape varieties is often grafted onto American variety root stocks to reduce their vulnerability to phylloxera.

Since grape vines are expensive and can last for decades, it is important to pick a grape variety appropriate for your local climate. Check a reputable vendor for your local climate. Check a reputable vendor for recommendations. All grape varieties can be used to produce jams, jellies, raisins, and wines for home use. Grapes do best in *moderately* fertile soil because soil as fertile as that in a vegetable garden will cause the leaves to grow so quickly and in such volume that the fruit will be shaded by the leaves, which will keep them damp and increase the likelihood of disease.

It is possible to start a grape vine in the fall, but odds of success are far greater if it is started in the spring because that gives the transplant more time to get established and store energy in its root system for overwintering.

Properly pruned grape vines yield good crops.

When you first bring home a grape vine, it will likely have numerous shoots coming out of the root system. Cut off all of the shoots but the strongest one, then cut that one back to only three or four buds. Plant the vine in well-drained soil in a locale with plenty of sun, and water thoroughly. Pretty soon new shoots will emerge at the buds, plus some more from the roots. Cut off the ones that emerge from the roots, and once the new shoots from the buds have grown to about 12 inches, select the best and strongest of these and cut off the others. The best shoot will be pretty much upright. Drive a strong stake into the ground close to the plant, and throughout the summer keep the shoot tied nice and straight to that stake.

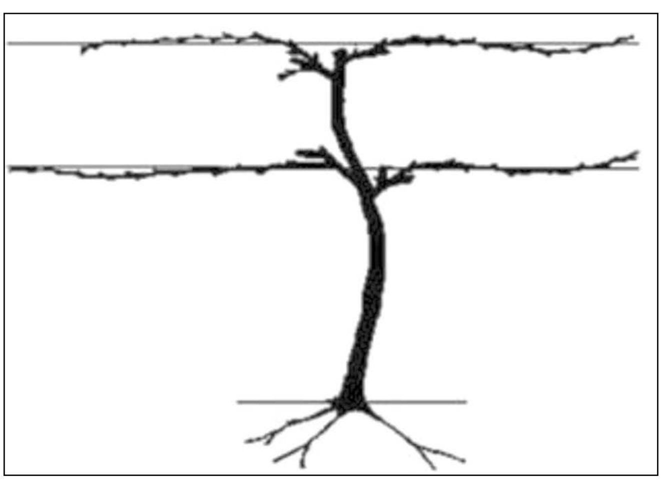
Meanwhile, set up your training and trellising system. There are many types, but about the easiest is the Kniffin system using two horizontal galvanized steel wires at three feet and six feet from the ground tied to two strong posts secured in the ground.

The first spring a year after planting, take the chosen shoot (which should have grown to a length somewhat taller than the bottom wire), and select the two strongest lateral shoots and tie those to the bottom wire while continuing to tie the growing trunk vertically to the stake.

Later in the season, once the growing trunk has grown to slightly below or slightly above the top wire, cut it off there and select the two strongest lateral shoots to tie to the top horizontal wires.

Occasionally, the chosen shoot that will serve as the trunk won't put out lateral shoots the first year. If that occurs—it's no big deal. Grape vines are vigorous and forgiving, so if a mistake is made in one year, it can always be corrected the next year. Just take the main shoot that serves as the trunk once it is slightly above the first wire, and tie it to one side of the wire and trim it back to three or four buds. These will form shoots. Select the two strongest of these—one of which will be run horizontally in the opposite direction on the wire, and the other of which will be run vertically up the stake and handled as detailed previously.

The Kniffin system is one of the easiest for training grapes.



Ongoing pruning will be important to maintain fruit production because grapes produce on the shoots that come from one-year-old wood. So any shoots that arise from wood that is more than one year old won't bear fruit. That means that the horizontal shoots selected the first year should be removed for the second year and new shoots from the trunk trained along the wires.

The foregoing is not the final word on grape pruning and training, as many other systems are available to those desiring more information—but this should be enough to get you started.

Grapes are prone to black rot and botrytis fungus, as well as birds and deer. Because of the rot and fungal problems, it is important to avoid sprinkler irrigation of grapes and practice good sanitation by consistently removing old fruit and leaves at the end of each season. A copper-based fungicide applied at bloom time is most effective against rot and fungus.

On a small scale, birds and deer can be foiled with netting; on a larger scale, some creativity (such as noisemakers and fencing) will be required. I grow my grapes far away from everything else, and the birds and deer haven't found them so far!

Strawberries

Very few fruits are as prolific and easy to grow in limited space as strawberries. Moreover, because of their delicate nature, they are expensive to ship long distances, so they sell well in season if you decide to market them. Beds are easy to establish and require minimal maintenance on the scale of a mini-farm.

Strawberries come in three basic types: spring-bearing, ever-bearing, and day-neutral. The spring-bearing variety produces a single crop; the ever-bearing variety produces crops in spring, summer, and fall; and the day-neutral strawberry produces fruit throughout the season. Spring-bearing varieties

Strawberries do extremely well in raised beds.

can be early season, middle season, or late season, meaning that through careful selection of more than one spring-bearing variety, it is possible to extend the length of harvest substantially. Consider the intended use of the strawberries—preservation or fresh eating—in selecting varieties for either a continuous small crop or one or more larger harvests.

Strawberry plants can be spread either through seeds or through plants and runners. The best bet in most cases is to buy strawberry plants of known characteristics and then let them spread by runners. Runners are a long stem that emerges from the crown of the strawberry plant and establishes a new crown and root system wherever it contacts suitable earth. Simply place the runners where they will fill in the gaps in your planting—no more than four strawberry plants per square foot.

Strawberries should be well fertilized with compost and any needed organic amendments and be mulched with straw or fallen leaves after the last frost. They occasionally fall prey to botyritis blight, a gray mold that can grow on the berries. To keep this controlled, keep the beds clear of debris, make sure strawberries are harvested when ripe or slightly underripe, and spray with an organic fixed-copper fungicide as needed.

Apples and Pears

Apples and pears are the quintessential home fruit trees and can be grown in almost any part of the United States. A wide selection of modern and heirloom varieties are available that are suitable for fresh eating, preservation, and pies.

Apples and pears offered in nurseries are usually produced by grafting the scion wood of the desired variety onto a more hardy compatible rootstock, such as that of flowering crab. The original rootstock can produce shoots below the graft (known as "suckers"), and these should be trimmed as soon as they are spotted.

Apples and pears should be pruned and trained when they are quite young or else they will become difficult to manage and produce inferior fruit. The objective of training the tree is provide optimal air circulation and sunlight while keeping the fruit

Pears are a bit easier than apples to keep pest free.

low enough to the ground so that it can be picked without a crane.

It is easiest for a mini-farmer is to select dwarf or semidwarf trees from the beginning. This will reduce pruning requirements and make maintenance easier and safer. Ideally, the tree will be pruned so that the shape is similar to a Christmas tree, which will allow maximum penetration of sunlight and easiest spraying while keeping the greatest bulk of the fruit closest to the ground.

A large number of articles on the specifics of pruning and training pomme fruits are available, but it isn't hard to master if a few rules are followed. (Apples, pears, and quinces are collectively referred to as *pomme fruits*. The word *pomme* comes from the French word for *apple*.)

When the young tree is first planted, tie it to a straight, eight-foot-long stake driven at least three feet into the soil for strength, cut off any limbs that are larger than 50% of the diameter of the trunk, and trim the trunk back to a height of three feet. Branches are strongest when they leave the trunk at an angle between 60 and 75 degrees, so when the branches are young, it is easy to bring them back to that angle by tying them with string or inserting small pieces of wood between the branch and the trunk. The branches on trees will tend to grow toward the sun, so that tendency will have to be countered the same way because you want the tree to grow straight and well balanced.

Subsequent pruning is best done in late winter or very early spring. The first spring after planting, remove any limbs closer to the ground than two feet and any limbs that are larger than 50% of the diameter of the trunk. If the tree has developed more than seven limbs, select the seven best distributed around the tree to be saved, and prune the rest. It is important when a limb is pruned that it be pruned back all the way to the trunk, otherwise it will sprout a bunch of vertically growing wood and create troubles. Once the pruning is done, limbs that need it should be tied or fitted with spacers to get the right angle to the trunk.

Beware of cutting off just the tips of the remaining limbs, because this can delay fruiting. Once the tree has been fruiting for a couple of years, such cuts can be used sparingly for shaping, but it is better to solve shading problems by removing entire limbs.

For all following years use the same rules by aiming for a well-balanced upright tree without excessive shading.

Stone Fruits

Stone fruits include cherries, apricots, peaches, plums, and nectarines. Because most stone fruits are native to warm climates and are thus susceptible to problems from winter injury or frost killing the flowers in the spring, it is important to carefully select varieties suitable for your area by consulting with a knowledgeable seller with a good reputation. No matter what cultivar is selected, it should be planted in an area protected from wind and with good sunshine and drainage. It is best to select a one-year-old tree five or six feet tall with good root growth.

Like apples and pears, stone fruits can be grated onto dwarfing rootstocks. Unfortunately, none of the dwarf varieties grow well north of Pennsylvania. The good news is that a number of hardy stone fruit varieties native to North America are available. The bush cherry (*Prunusbesseyi),* American wild plum (*Prunus americana*), and American beach plum (*Prunus maritima)* can be grown throughout the continental United States, and Indian blood peach (Prunus persica) can be grown south of Massachusetts. All of these are available in seed form from Bountiful Gardens (www.bountifulgardens.org) and are also available from a number of nurseries.

Nectarines are easy to grow and easy to can or freeze.

Almost all nursery stock is grafted rather than grown from seed for a number of reasons, but the effect of this is that if two trees of the same type and variety are selected, they may be genetically the same exact plant and thus incapable of pollinating each other, causing low fruit yields. More than one of any stone fruit should be selected to aid in pollination, and it is important to consult with knowledgeable nursery personnel about exactly what varieties need to be grown to ensure proper pollination. Space nectarines, peaches, plums, and apricots anywhere from 15 to 20 feet apart, and space cherries anywhere from 20 to 30 feet apart for best pollination and fruit yields.

Stone fruits should be planted in early spring by digging a hole big enough to accommodate the entire root system without bunching it up or looping it around and deep enough that the graft union is about two inches above the ground. Once the soil is filled back into the hole, the area should be watered thoroughly to help the soil settle around the roots. Stone fruits should be fertilized in early spring only (using a balanced organic fertilizer) and newer later in the summer. Fertilizing in late summer will cause vigorous growth that the root system hasn't grown enough to support so the tree could be harmed and have difficulty overwintering. By fertilizing in the early spring, the tree has a chance to grow in a balanced way across the entire growing season so it will overwinter properly.

A good fertilizer can be made by mixing together 1 pound of bone meal, ½ pound of dried blood, and 3 pounds of dried kelp or greensand. Apply ½ pound to the soil surface around the drip line of the tree (the "drip line" is the area on the ground just under the widest branches) by using a crowbar to make four to eight holes six inches deep in a circle around the plant and sprinkling some of the fertilizer in each hole. Use ½ pound the first year, then an additional half pound every year thereafter until, in the ninth and subsequent years, 5 pounds are being used each spring. Stone fruits prefer a pH of 6.0 to 6.5, and if a soil test shows amendment to be needed, that can be done in the spring as well. Keep in mind, however, that lime can take several months to work, so don't overlime and raise the pH above 6.5.

The following pruning directions are equally applicable to both dwarf and full-size trees. Because all stone fruits are susceptible to brown rot, they should be trained to an open center rather than a central leader (a single main trunk that reaches all the way to the top of the tree) like an apple tree. This will allow maximum light and air penetration to keep brown not problems under control.

When the tree is first planted, cut off any branches closer than 18 inches to the ground, and cut the central leader at 30 inches above the ground. This will force branches to grow out at 18 to 30 inches above the ground, which will yield branches at the right height when the tree is mature. Select three or four good branches that are growing evenly spaced around the trunk, and prune back the others all the way to the trunk, then prune back the central leader to just above the topmost selected branch. These selected branches will be the main *scaffolds* of the tree, referring to their structural importance. Stone fruit branches are strongest when they leave the trunk at an angle between 60 and 90 degrees, so now is the time to establish those angles and the direction of growth using a combination of ropes and wooden spacers inserted between the branch and the trunk.

Stone fruits should not be pruned in winter because of susceptibility to winter injury and because of a disease called cytospora canker. Rather, they should be pruned between the time they bloom and the first week after the flower petals have fallen.

The first pruning after planting should occur just after blooming in the early spring of the next year. At that time, any branches that are broken and diseased should be removed, and the main scaffolds should be cut back half their length to an outward facing bud. Any vertically growing shoots should likewise be removed, and spacers or ties for maintaining branch angles should be checked and adjusted as necessary.

The second pruning after planting will occur at the same time the next year. By this time, the main scaffold branches will be developing new branches on them. Select three or four sublimbs on each main scaffold to be preserved. These should be on opposite sides of the scaffolds, not growing straight up or bending down, and be at least 18 inches away from the main trunk. The main scaffold branches should then be cut back by ⅓ to an outward-facing bud, and all limbs but the selected sublimbs should be cut back to the branch or to the trunk as appropriate.

Subsequent pruning simply needs to maintain the open center by removing vertical limbs and limbs that grow inward toward the center. Limbs and sublimbs should be headed back to an outward-facing bud each year to make sure new fruiting wood is growing each year, and limbs should be pruned as needed to maintain the desired shape and size of tree and to avoid broken limbs.

Nut Trees

Compared to fruit trees, nut trees are easier to prune and care for. The only downside is that, except for filberts, they grow to be quite large and thus require as much as 50 feet between trees. Walnuts and, to a lesser extent, pecans and hickories produce a chemical called juglone in their root systems that inhibits the germination of other plants, so they shouldn't be planted close to a garden. A number of trees are unaffected by juglone, including cherries, oaks, pears, and most cone-bearing trees, among others. The only vegetables unaffected by juglone are onions, beans, carrots, corn, melons, and squash.

Most nut trees aren't self-fruitful and therefore must be planted in pairs. The same caveat applies to nuts as to fruits in that many nut trees are made by grafting and thus are genetic clones. For this reason, two different varieties of the same nut will need to be planted unless those trees were grown from seed, in which case two trees of the same variety will work fine.

Nut trees can be grown from seed as long as the requisite period of cold stratification is met to break dormancy. (Cold stratification means exposing the seed to a period of subfreezing temperature for a period of time. Many seeds for trees require this or they will never sprout.) If you plant the seed in the fall

Chestnuts, walnuts, and other nuts are highly nutritious.

Table 17: Nut Tree Planting Distance

Type of nut tree	Distance Between Trees
Black walnut, hickory, pecan, and hican	50 feet in all directions
English and Persian walnut	35 feet in all directions
Chestnut (Chinese, most American chestnuts succumbed to the chestnut blight)	40 feet in all direction
Filberts	15 feet in all directions

and protect it from rodents, it will sprout in the spring. Plant it about two feet deep and mulch with hay over the winter, then remove the mulch in early spring.

The tree should be transplanted into a hole big enough to handle the entire root system. About ⅔ of the soil should be carefully shoveled around the roots and then well watered and the remaining soil shoveled in and tamped down. The area around the tree should then be mulched to reduce competition with weeds and the trunk protected with a cirlcular hardware cloth protector to keep deer and other critters from eating the bark. (Hardware cloth is available at any hardware store at minimal cost.)

Because nut trees have a long taproot that grows slowly, they need to have about half of their top growth pruned back during transplanting, leaving several buds. This balances the upper and lower portion of the tree to enhance survivability. New vertical-growing shoots should emerge from the buds left behind, and when they are 8 to 12 inches long, the most vigorous should be selected as the tree's new central leader, and the remainder cut off even with the trunk.

From that point forward, you are mainly aiming for a balanced tree, so prune to keep the tree balanced. Conduct all pruning in late winter or very early spring, land remove all dead or damaged branches. At the same time, progressively shorten the lowest limbs a little each year until the tree is about 20 feet high, at which point all limbs lower than 6 feet should be removed flush with the trunk. This preserves the food-making ability of the lower limbs until it is no longer needed.

Growing distance/productivity for such large trees can be troublesome on a small lot, but there are ways to get around the problem. Table 17 gives the ultimate distance that the trees should be from each other when fully grown.

Keep in mind that nut trees produce nuts long before reaching full size and that nut wood is some of the most expensive, so selling it could net a nice bundle. If you wish to do so, plant the nut trees about 10 feet apart and then selectively harvest them for wood as their branches come close to touching. In the end, you have properly spaced highly productive nut trees and hopefully a wad of cash.

Disease and Pests

There's no such thing as a free lunch—or even free fruit! Fruit and nut trees are prone to numerous pest and disease problems. Thus, they require a regular schedule of sanitation and spraying to keep them healthy and productive, and they can pose a challenge to mini-farmers, particularly if they are committed to raising fruit without synthetic pesticides. This is more of a problem with fruits than with nuts, but it can be made manageable through advanced planning and a thorough understanding of the requirements. Pomme fruits such as apples and pears share common pests and disease, as do stone fruits such as cherries, plums, and peaches. No matter what fruits you grow or what diseases are prevalent, meticulous cleanup of debris around the trees and vigilant pruning of diseased tissues will provide the proverbial "ounce of prevention."

The difficulties of raising apples and pears explain the high concentrations of toxic contaminants in nonorganic varieties. Therefore you should carefully consider if some other fruit might be more suitable given the amount of time you will need to spend if you wish to produce organic apples and pears. According to the Agricultural Sciences department at Pennsylvania State University, as many as 6 to 10 pesticide applications might be required yearly to produce reasonably appealing apples, though as few as 2 or 3 applications are feasible with scab-resistant varieties. Spraying is simplified, and pomme fruits are more practical if dwarf varieties are selected.

Scab is a fungal disease of apples and pears. The spores mature over a four-to-six-week period of wet weather in the spring that corresponds with the wet weather required for the release of the spores. The spores take up residence on the leaves of the tree where they grow and produce more spores, starting a cycle of reinfection that infects the fruit as well, causing ugly, misshapen fruit. If all debris (apples/pears and leaves) is removed before the spores can be released, and a good antifungal agent (such as fixed copper or Bordeaux mix) is applied every 10 to 14 days starting in early spring and extending through early summer, scab infection can be controlled. A better solution, because antifungal agents can injure the tree, is to plant apple varieties that are naturally resistant to scab, such as Liberty. Carefully research the varieties you plan to grow.

There are a number of other apple or pear diseases, such as fire blight, that require comprehensive management programs to produce good fruit. Antibiotics are combined with pruning of diseased tissue for treatment of the blight once it becomes established.

The most prevalent pest of pomme fruits is the apple maggot, a little white worm. Luckily, the apple maggot is one of the few insects that can discern—and are attracted to—the color red. They can be effectively controlled by hanging red-painted balls coated with a sticky coating (such as Tangletrap). The balls should be hung just after flowering and remain through harvest, being renewed periodically to keep them sticky. Several are required for each tree.

The codling moth is another serious pest. This nondescript gray and brown moth lays eggs on the fruit. The first eggs hatch when the fruit is slightly less than one inch in diameter, and the small worm burrows into the fruit where it eats until it reaches full size then burrows back out, becomes a moth, and starts the cycle again. Codling moths are conventionally controlled by spraying carbaryl or permethrin at least once every 14 days following petal fall. These poisons can be avoided by aggressive organic measures including "trapping out" the male moths by using up to four pheromone traps per full-sized tree, encircling the tree trunks with flexible cardboard covered with a sticky coating to trap the larvae, and spraying frequently with the botanical insecticide ryania.

Stone fruits, like pomme fruits, require constant spraying to deal with a number of diseases and pests. Chief diseases include powdery mildew, leaf spot, peach leaf curl, crown gall, cytospora canker, black knot, and brown spot. Japanese beetles, fruit moths, aphids, borers, and spider mites round out the threats.

A regular spraying schedule is required for stone fruits. If raising the fruit organically, this includes fungicides such as Bordeaux mix, lime sulfur, and fixed copper and insect controls such as neem oil, horticultural oil, and organic insecticides used according to label directions. The spraying should start when buds swell in the spring and continue with the frequency specified on the product label until the fruit has been harvested. All dropped fruit and leaves should be raked up and removed from the area in the fall.

Black knot of the plum can't be controlled this way and instead requires that any sections of wood evidencing this distinctive infection be completely removed from the tree and destroyed by incineration.

Most nut trees never show signs of disease, and the regular spraying required for fruit trees is not needed in most cases. Major nut trees diseases include chestnut blight, pecan scab, walnut anthracnose, and walnut blight.

Chestnut blight was introduced into the United States before 1900 through the importation of various Asian chestnut species that carry the causative fungus but are resistant to it themselves. The American chestnut, native to Eastern North America, has no resistance to this fungus; within a generation this majestic tree, soaring up to 100 feet and measuring up to 10 feet across, was reduced to little more than a shrub that struggles a few years before succumbing to the threat. To put the impact of chestnut blight into perspective, it is estimated that in 1900, 25% of all the trees in the Appalachians were American chestnuts.

There are four ways of dealing with chestnut blight: prompt removal of infected branches, treatment of cankers in existing trees for five years with injections of a hypovirulent strain of the fungus, planting resistant Asian chestnut varieties, and planting American varieties that have incorporated disease-resistant genes through repetitive backcrossing and selection to maximize native DNA content while retaining resistance genes.

Mini-farmers interested in growing and preserving American chestnuts should seek guidance (and seeds!) from the American Chestnut Cooperators' Foundation (www.accf-online.org). Farmers interested in resistant Asian stocks can find suitable varieties at local nurseries.

Pecan scab, evidenced by sunken black spots on leaves, twigs, and nuts, is more of a problem in the southern than northern states. At the scale of a mini-farm, it is most easily controlled through meticulous sanitation—the raking and disposal of leaves and detritus through burning. Severe infestations require multiple fungicide sprays yearly.

Walnut anthracnose, a disease characterized by small dark spots on the leaves that can grow to merge together and defoliate entire trees in severe cases, affects black walnuts but not Persian varieties. Meticulous sanitation is normally all that is required on the scale of a mini-farm, but springtime fungicide spraying may be needed in severe cases.

Walnut blight is just the opposite in that it affects the Persian walnut varieties but not American black walnuts. Walnut blight looks like small, water-filled sunken spots on leaves, shoots, and/or nuts. The disease doesn't travel back into old wood, so the tree and crop can be saved by spraying fixed copper during flowering and fruit set.

Pest insects in nut trees can be controlled through keeping the area mowed and free of tall grasses that would harbor stinkbugs, meticulous sanitation to control shuckworms, and regular insecticide spraying to control hunkflies, weevils, and casebearers. For a handful of nut trees (unless the mini-farm is in close proximity to a large number of similar nut species), pests are unlikely to become a major problem, and it is likely that spraying will never be necessary.

Vegetable Gardens

If you want to start your own vegetable garden, just follow these simple steps and you'll be on your way to growing your own yummy vegetables—right in your own backyard!

How to Start a Vegetable Garden

1. Select a site for your garden and sketch a plan.
   - Vegetables grow best in well-drained, fertile soil (loamy soils are the best).
   - Some vegetables can cope with shady conditions, but most prefer a site with a good amount of sunshine—at least six hours a day of direct sunlight.
2. Remove all weeds in your selected spot and dispose of them. If you are using compost to supplement your garden soil, do not put the weeds on the compost heap, as they may germinate once again and cause more weed growth among your vegetable plants.
3. Prepare the soil by tilling it. This will break up large soil clumps and allow you to see and remove pesky weed roots. This would also be the appropriate time to add organic materials (such as compost) to the existing soil to help make it more fertile. The tools used for tilling will depend on the size of your garden. Some examples are:
   - Shovel and running turning fork—using these tools is hard work, requiring strong upper body strength.
   - Rotary tiller—this will help cut up weed roots and mix the soil.
4. After the soil has been tilled you are ready to begin planting. If you would like straight rows in your garden, a guide can be made from two wooden stakes and a bit of rope.

Label your garden rows as soon as you plant the seeds and seedlings so you'll remember what you planted where.

5. Vegetables can be grown from seeds or transplanted:
   - If your garden has problems with pests such as slugs, it's best to transplant older plants, as they are more likely to survive attacks from these organisms.
   - Transplanting works well for vegetables like tomatoes and onions, which usually need a head start to mature within a shorter growing season. These can be germinated indoors on seed trays on a windowsill before the growing season begins.
6. Follow these basic steps to grow vegetables from seeds:
   - Information on when and how deep to plant vegetable seeds is usually printed on seed packages or on various websites. You can also contact your local nursery or garden center to inquire after this information.
   - Measure the width of the seed to determine how deep it should be planted. Take the width and multiply by 2. That is how deep the seed should be placed in the hole. As a general rule, the larger the seed, the deeper it should be planted.
7. Water the plants and seeds well to insure a good start. Make sure they receive water at least every other day, especially if there is no rain in the forecast.

Things to Consider

- In the early days of a vegetable garden, all your plans are vulnerable to attack by insects and animals. It is best to plan multiples of the same plant in order to ensure that some survive. Placing netting and fences around your garden can help keep out certain animal pests. Coffee grains or slug traps filled with beer will also help protect your plants against insect pests.
- If sowing seed straight onto your bed, be sure to obtain a photograph of what your seedlings will look like so you don't mistake the growing plant for a weed.
- Weeding early on is very important to the overall success of your garden. Weeds steal water, nutrients, and light from your vegetables, which will stunt their growth and make it more difficult for them to thrive.

Harvesting Your Garden

It is essential, in order to get the best freshness, flavor, and nutritional benefits from your garden vegetables and fruits, to harvest them at the appropriate time. The vegetable's stage of maturity and the time of day at which it is harvested are essential for good-tasting and nutritious produce. Overripe vegetables and fruits will be stringy and coarse. When possible, harvest your vegetables during the cool part of the morning. If you are going to can and preserve your vegetables and fruits, do so as soon as possible. Or, if this process must be delayed, make sure to cool the vegetables in ice water or crushed ice and store them in the refrigerator. Here are some brief guidelines for harvesting various types of common garden produce:

- Asparagus—Harvest the spears when they are at least 6 to 8 inches tall by snapping or cutting them at ground level. A few spears may be harvested the second year after crowns are set out. A full harvest season will last four to six weeks during the third growing season.
- Beans, snap—Harvest before the seeds develop in the pod. Beans are ready to pick if they snap easily when bent in half.
- Beans, lima—Harvest when the pods first start to bulge with the enlarged seeds. Pods must still be green, not yellowish.
- Broccoli—Harvest the dark green, compact cluster, or head, while the buds are shut tight, before any yellow flowers appear. Smaller side shoots will develop later, providing a continuous harvest.
- Brussels sprouts—Harvest the lower sprouts (small heads) when they are about 1 to 1 ½ inches in diameter by twisting them off. Removing the lower leaves along the stem will help to hasten the plant's maturity.
- Cabbage—Harvest when the heads feel hard and solid.
- Cantaloupe—Harvest when the stem slips easily from the fruit with a gentle tug. Another indicator of ripeness is when the netting on the skin becomes rounded and the flesh between the netting turns from a green to a tan color.
- Carrots—Harvest when the roots are ¾ to 1 inch in diameter. The largest roots generally have darker tops.
- Cauliflower—When preparing to harvest, exclude sunlight when the curds (heads) are 1 to 2 inches in diameter by loosely tying the outer leaves together above the curd with a string or rubber band. This process is known as blanching. Harvest the curds when they are 4 to 6 inches in diameter

Handy Household Hints

Squashes should never be kept down cellar when it is possible to prevent it. Dampness injures them. If intense cold makes it necessary to put them there, bring them up as soon as possible, and keep them in some dry, warm place.

but still compact, white, and smooth. The head should be ready 10 to 15 days after tying the leaves.

- Collards—Harvest older, lower leaves when they reach a length of 8 to 12 inches. New leaves will grow as long as the central growing point remains, providing a continuous harvest. Whole plants may be harvested and cooked if desired.
- Corn, sweet—The silks begin to turn brown and dry out as the ears mature. Check a few ears for maturity by opening the top of the ear and pressing a few kernels with your thumbnail. If the exuded liquid is milky rather than clear, the ear is ready for harvesting. Cooking a few ears is also a good way to test for maturity.
- Cucumbers—Harvest when the fruits are 6 to 8 inches in length. Harvest when the color is deep green and before yellow color appears. Pick four to five times per week to encourage continuous production. Leaving mature cucumbers on the vine will stop the production of the entire plant.
- Eggplant—Harvest when the fruits are 4 to 5 inches in diameter and their color is a glossy, purplish black. The fruit is getting too ripe when the color starts to dull or become bronzed. Because the stem is woody, cut—do not pull—the fruit from the plant. A short stem should remain on each fruit.
- Kale—Harvest by twisting off the outer, older leaves when they reach a length of 8 to 10 inches are medium green in color. Heavy, dark green leaves are overripe and are likely to be tough and bitter. New leaves will grow, providing a continuous harvest.
- Lettuce—Harvest the older, outer leaves from leaf lettuce as soon as they are 4 to 6 inches long. Harvest heading types when the heads are moderately firm and before seed stalks form.
- Mustard—Harvest the leaves and leaf stems when they are 6 to 8 inches long; new leaves will provide a continuous harvest until they become too strong in flavor and tough in texture due to temperature extremes.
- Okra—Harvest young, tender pods when they are 2 to 3 inches long. Pick the okra at least every other day during the peak growing season. Overripe pods become woody and are tough to eat.
- Onions—Harvest when the tops fall over and begin to turn yellow. Dig up the onions and allow them to dry out in the open sun for a few days to toughen the skin. Then remove the dried soil by brushing the onions lightly. Cut the stem, leaving 2 to 3 inches attached, and store in a net-type bag in a cool, dry place.
- Peas—Harvest regular peas when the pods are well rounded; edible-pod varieties should be harvested when the seeds are fully developed but still fresh and bright green. Pods are getting too old when they lose their brightness and turn light or yellowish green.
- Peppers—Harvest sweet peppers with a sharp knife when the fruits are firm, crisp, and full size. Green peppers will turn red if left on the plant. Allow hot peppers to attain their bright red color and full flavor while attached to the vine; then cut them and hang them to dry.
- Potatoes (Irish)—Harvest the tubers when the plants begin to dry and die down. Store the tubers in a cool high-humidity location with good ventilation, such as the basement or crawl space of your house. Avoid exposing the tubers to light, as greening, which denotes the presence of dangerous alkaloids, will occur even with small amounts of light.
- Pumpkins—Harvest pumpkins and winter squash before the first frost. After the vines dry up, the fruit color darkness and the skin surface resists puncture from your thumbnail. Avoid bruising or scratching the fruit while handling it. Leave a 3- to 4-inch portion of the stem attached to the

fruit and store it in a cool, dry location with good ventilation.

- Radishes—Harvest when the roots are ½ to 1 ½ inches in diameter. The shoulders of radish roots often appear through the soil surface when they are mature. If left in the ground too long, the radishes will become tough and woody.
- Rutabagas—Harvest when the roots are about 3 inches in diameter. The roots may be stored in the ground and used as needed, if properly mulched.
- Spinach—Harvest by cutting all the leaves off at the base of the plant when they are 4 to 6 inches long. New leaves will grow, providing additional harvests.
- Squash, summer—Harvest when the fruit is soft, tender, and 6 to 8 inches long. The skin color often changes to a dark, glossy green or yellow, depending on the variety. Pick every two to three days to encourage continued production.
- Sweet potatoes—Harvest the roots when they are large enough for use before the first frost. Avoid bruising or scratching the potatoes during handling. Ideal storage conditions are at a temperature of 55 degrees Fahrenheit and a

relative humidity of 85 percent. The basement or crawl space of a house may suffice.

- Swiss chard—Harvest by breaking off the developed outer leaves 1 inch above the soil. New leaves will grow, providing a continuous harvest.
- Tomatoes—Harvest the fruits at the most appealing stage of ripeness, when they are bright red. The flavor is best at room temperature, but ripe fruit may be held in the refrigerator at 45 to 50 degrees Fahrenheit for 7 to 10 days.
- Turnips—Harvest the roots when they ate 2 to 3 inches in diameter but before heavy fall frosts occur. The tops may be used as salad greens when the leaves are 3 to 5 inches long.
- Watermelons—Harvest when the watermelon produces a dull thud rather than a sharp, metallic sound when thumped—this means the fruit is ripe. Other ripeness indicators are a deep yellow rather than a white color where the melon touches the ground, brown tendrils on the stem near the fruit, and a tough, slightly ridged feel to the skin surface.

Handy Household Hints

Onions should be kept very dry, and never carried into the cellar except in severe weather, when there is danger of their freezing. By no means leave them in the cellar after March; they will sprout and spoil.

Time and Yield

BY BRETT L. MARKHAM

Most of the United States, even the northern plains, has a growing season long enough to allow for multiple plantings of many crops. Moreover, well-orchestrated timing allows harvests to be timed either to allow a little at a time to be harvested for daily use or marketing—which is useful for crops like lettuce—or to allow multiple large harvests for the purpose of preservation and storage. Many crops are frost hardy, and second plantings will allow harvests to continue for as long as a month after the first fall frost, without using anything to extend the season. For example, two crops of broccoli or spinach can be raised in the same area as one crop, doubling production per unit area.

Succession Planting

This is a technique for maximizing productivity of garden space by having a new crop ready to plant as soon as an earlier crop is harvested. An example is planting a second crop of broccoli in the same space where a first crop of broccoli was harvested at midsummer. Another example is sowing spinach early and then planting beans where the spinach used to be as soon as the spinach is harvested.

Crops that work well for the early planting in a succession are anything from the cabbage family, spinach, peas, radishes, turnips, beets, and onions from sets. ("Sets" are the miniature onions for planting that you can buy in a mesh bag at the garden center. They aren't the same as supermarket onions.) The foregoing crops are usually harvested no later than the middle of July. Crops that can be planted in mid-July for a late summer or fall harvest include bush beans, lettuce, spinach, carrots, turnips, beets, parsnips, and anything in the cabbage family.

Timed Planting

Time planting means spreading out harvests by staggering the planting dates for a particular crop a few weeks rather than planting it all at once. The result is a steady supply of a particular crop for market or a continual harvest that can be frozen, eaten, or canned in small sessions.

The easiest way to do this is to take the total number of plants intended for a given crop and divide it by three. Sow the first third on the first sowing date for that crop, the second third a week later, and the final third two weeks later. This will given the same total harvest as planting the whole crop at once but will spread out the harvest over a two-week period.

The next aspect of timed planting is replanting. Take carrots, for example; if carrots were planted in four sessions, each two weeks apart, when the first planting is harvested, that area can be replanted with more carrots so the space never sits idle. By the time the final crop weeks away from yet another first harvest.

Interplanting crops creates synergies.

of space or sunlight, such as tomatoes, could have difficulty if planted in an established stand of corn. If planted before the corn has germinated, the tomatoes would shade the seedlings. On the other hand, white clover works well with most plants, as do beans.

Perhaps the most famous example of successful interplanting is the so-called Three Sisters of the Native Americans—corn, beans, and squash, which they grew together. In this case, the pole beans and squash vines used the corn stalks for support.

Succession planting and times planting both provide a little insurance so if serious weather hits early or late, there's still a harvest. All that you need to know to successfully use succession and/or timed planting is the days to maturity for the crop under consideration and its frost hardiness.

Interplanting

Interplanting is used in two ways, It is used to give green manures a head start on the winter and to maximize the amount of food that can be harvested from a given area. Carefully chosen, interplanted crops can save on fertilizer as well, as when a nitrogen producer such as beans or clover is interplanted with a nitrogen consumer such as tomatoes or corn.

There are some practical considerations to interplanting, and chief among them are overcrowding and shade. Plants that require a lot

Fall Gardening

Frost-hardy crops and biennials kept alive over the winter for seed production (called "overwintering") can be planted first in the spring, harvested in the summer, and then replanted for a second fall or early winter harvest. Late harvests can be achieved for many crops without going to the trouble of using season extension structures. Overwintering crops, so they can be used either as needed or for seed production, is more problematic. In the South or Pacific Northwest, it can be done outdoors. In the upper Midwest or Northeast, such plants have to be brought indoors for the winter or else protected with, at minimum, an unheated greenhouse or cold frame.

For purpose of fall gardening, crops can be divided into three categories: tender, semihardy, and hardy. Tender crops are damaged by a light frost. Semihardy crops will tolerate a light frost, and hardy crops will tolerate hard frosts.

The best bets for fall gardening are semihardy and hardy crops. Some hardy crops, like broccoli

Table 7: Crop Hardiness

Tender	Semihardy	Hardy
Beans	Beets	Broccoli
Corn	Carrot	Brussels sprouts
Cucumber	Caulitflower	Cabbage
Eggplant	Celery	Kale
Melon	Chard	Onion
Okra	Lettuce	Parsley
Pepper	Parsnip	Peas
Squash	Potato	Spinach
Sweet potato		Turnip
Tomato		

and spinach, often taste better when grown in the fall rather than in the spring. Semihardy crops should be timed for harvests within 28 days after the first frost, and hardy crops should be timed within 56 days after the first frost. For this, the time to harvest needs to be known. Each variety of a given crop has slightly different dates of maturity, and those dates are indicated in seed catalogs and on seed packets. Because growth is slower in the fall, 10 days should be added to the maturity date, so plant 10 days earlier for fall harvests.

Using Seedlings for a Head Start

Some crops, such as cucumbers, can be directly seeded in the garden or transplanted. Transplanting seedlings gives the plants a head start and can allow maximum production from the number of growing days in the season.

Winter squash, requiring 80 or more days to harvest, is a good candidate for transplanting seedlings, particularly in the northern half of the United States where there are often fewer than 90 frost-free days in a row in the growing season. Since squash shouldn't be direct seeded until 14 days after the last frost, leaving fewer than 80 remaining growing days, growing transplants instead will increase the amount of squash harvested without requiring the farmer to use season extension devices.

The same applies for crops in the fall garden. In the late season, broccoli can be direct seeded, but giving it a four-week head start by growing seedlings inside and then transplanting them will accelerate the harvest.

One place where I have used this technique to good effect is with a crop that most authors will tell you not to transplant: corn. Grown on the agribusiness scale, seed or sweet corn is usually coated with a fungicide to keep it from rotting in the ground. Seed corn is prone not just to rot but to being eaten by wire worms. In addition, it doesn't all germinate at the same time. On a very large scale, this all evens out. But on a small scale—say growing 48 plants in a 4-foot × 8-foot raised bed—it can be a problem. Transplanting seedlings is an ideal solution.

What I do is start 64 seedlings indoors about two weeks before the first frost-free date. It's important to not try any longer than two weeks because corn grows a taproot, and after than, transplant shock can be too great. After two weeks, some may not have germinated, and some will be taller than others. What I do is pick the 48 most uniform plants and transplant them into the bed. I keep the others handy for a week just in case cut worms or some similar pest strikes.

You can use this technique for most crops outside of root crops. By starting from seed indoors, you gain an advantage of anywhere from two to six weeks.

Example Timeline

The following table is part of the calendar for my own mini-farm in New Hampshire, so the exact dates may not work for you. Nevertheless, the examples given should be helpful.

Table 8: Example Activity Schedule

Date	Activity	Date	Activity
12/11/06	Start onion and leek seeds inside	05/06/06	Start cucumber, melon, and squash inside
02/18/06	Start broccoli, cabbage, and kale inside	05/07/06	Sow radish and salsify seeds outside
02/25/06	Start cauliflower inside	05/13/06	Sow ½ if carrots, beets, parsnips, and turnips; cut cover crops and add to compost pile
03/01/06	Start lettuce inside	05/27/06	Plant tomato and pepper transplants outside
04/01/06	Start tomatoes and pepper inside	05/28/06	Sow corn seed and second ½ of carrots, beets, parsnips, and turnips
04/15/06	Start marigold, nasturtium, pyrethrum, and dill seeds inside	06/03/06	Harvest radishes and plant cucumber, melon, and squash transplants where the radishes were
04/22/06	Transplant broccoli, cabbage, and kale outside	06/23/06	Harvest broccoli and kale and replant with new transplants for a second crop
04/23/06	Plant potatoes and peas outside, covered with hoop house	07/07/06	Harvest cauliflower and replant with new transplants for a second crop
04/29/06	Start new broccoli seedlings inside for second planting	07/20/06	Harvest potatoes and carrots, prepare potato area, and sow with carrots and spinach
05/06/06	Plant cauliflower transplants outside	07/24/06	Pull up pea plants and add to compost pile, sow area with lettuce

Composting

BY BRETT L. MARKHAM

In general, compost can be described as organic matter that has decayed to a point of biological stability, but such a generalized definition doesn't tell us much. The reason generalizations fail is because compost can be made from practically anything that was once alive, and it can be made using a vast array of methods. Every variation produces something different, so no two batches of compost are the same.

Compost can be made both aerobically (using oxygen) and anaerobically (without oxygen). It can be made at relatively high temperatures (thermophilically) or at moderate temperatures (mesophilically). You can even make it using earthworms as digesters. Though doing so is inefficient, it can be made entirely from a single starting ingredient, or from any mixture of ingredients. All of these approaches can be combined at various stages, and each has benefits that are balanced against shortcomings. The potential for confusion can seem insurmountable, which may be why anytime I go somewhere to speak, I get questions about composting.

The happy reality though, is that nature is on your side. It's really hard to mess up compost so badly that you get no compost at all. Nature loves compost and will turn anything that was once alive (or produced by something living) into compost all by itself. Biological materials will naturally degrade, and composting those materials is simply a way of accelerating or controlling the process. Though there are many ways of composting, each with its own trade-offs, nature will ultimately have its way and organic materials will rot with or without your help. The end product will be compost. So the most important thing you need to do when approaching composting is to not worry.

In the chapters ahead I'll take you through the nutrient cycle, explain the role of compost in soil microbiology and plant health, and delve into the various methods of composting. Even though I will stress a lot of points as being important, if you keep coming back to the fundamental concept that *organic materials will all eventually turn into compost with or without your help,* you'll realize that you can just dig right in and your end results will be a tremendous benefit no matter what.

Nearly all books that cover compost concentrate only on aerobic composting with a special emphasis on the thermophilic composting. But this is not, in my opinion, enough to make someone self-sufficient. For example, maybe you have noticed that you need compost for soil blocks when you are starting your onion seedlings in January, but your outdoor compost pile is going to be frozen until April so it won't do you any good. Or maybe you have a back or leg injury, and turning a two-ton thermophilic aerobic compost pile is simply not feasible.

Because nature is on your side, there are a lot of different ways to create compost, and all that is really necessary is an underlying understanding of the nature of the processes at work and an eye toward safety to adapt numerous methods to your situation.

I personally use many methods both indoors and outdoors, and this book will help you do the same.

Why Use Compost?

If you are looking at this book, you're probably already sold on the idea of composting. If you aren't already sold, then I am going to convince you.

Whether you garden using chemical fertilizers, pesticides and fungicides, or using organic methods, there is abundant and compelling scientific proof that compost will improve the fertility of your soil so that less fertilizer is needed. It will also reduce the incidence and severity of diseases that reduce your crop yield. The math is straightforward: using compost means your garden will be more cost-effective because you will have to spend less money on fertilizers, insecticides, and fungicides for a given harvest of any crop. That means *money.* A lot of money.

Compost induces resistance to a wide array of bacterial and fungal diseases. Induced resistance (as opposed to acquired immunity) is a form of epigenetics. That is, how a plant or animal expresses its genes is not controlled simply by the genes themselves, but also how various environmental factors affect that expression. Plants were not intended to be grown in sterile soil. Rather, they were intended to be grown in living soil. Compost creates and sustains a living soil, so when grown in the proper environment as nature intended, the gene expression of plants is optimized for their health.

This concept also applies to humans. Humans were never intended to be sedentary bumps on a log. Studies show that proper exercise literally turns certain genes on or off and thereby affects our vulnerability to a host of diseases to a substantial degree. So the fact that environmental factors such as the presence of compost can have a large effect on the well-being of plants is not at all surprising. When humans eat right and get their exercise, the aggregate cost of health care is reduced. When plants eat right, the cost of their health care is also reduced. Just as a human in optimal health is more productive, a plant grown in soil amended with compost has greater yields.

According to the Washington State University Cooperative Extension Service (along with dozens of other sources), compost helps soil retain fertilizers better, and also reduces or even eliminates the need for fertilizer altogether. Fertilizer, like fungicides, costs money. WSU also states that the beneficial microorganisms in compost can help protect crops from pests, thereby reducing the needs for pesticides. That's even more money.

So right there, if you garden and your intention in gardening is to save money over buying an equivalent product at the grocery store, the case for using compost is open and shut—done. If you aren't using compost, you are throwing money away.

Another reason to use compost is human health. Depending on which experts you ask, humans need anywhere from twenty-two to fifty elements in their diet for optimal health. I am not speaking of vitamins and other complex molecules, but rather basic chemical elements that we need in order to catalyze the synthesis of cellular enzymes or even as core constituents of structures such as bones. Though a person can survive and even thrive for a time with an ongoing deficiency in some of these elements, over time deficiency takes its toll, and some USDA researchers have come to believe that most cancer and as many as 50 percent of all deaths globally are caused directly or indirectly by insufficient intake of important trace elements.

Though this information has not been widely disseminated in an environment where other branches of the USDA continue to push nutritionally vapid commodities as "healthy", it is available for those who care to search. In fact, long before the USDA researchers came along, Dr. Maynard Murray conducted numerous experiments demonstrating dramatically reduced risks of cancer and many other chronic diseases in animals fed foods grown is such a way as to contain as many elements as possible.

Many find it puzzling that in an era where preventable causes of cancer and heart disease are in decline, many other forms of cancer and heart disease are increasing. But taken with the information above, it might not seem so surprising once we realize that the elemental content of agricultural soil has declined by 85 percent over the past 100 years and the nutritional content of commercially available foods has decline by anywhere from 30 percent to 81 percent over the past thirty years.

So the elements in the soil you use for growing food are important. The full complement of elements is certainly important for the well-being of your crops, and assists them in fending off pests and diseases through their own robust immune systems. But the elements in your soil are also important for the well-being of the people who eat those crops, including you.

Standard agricultural methods can be described as having mined all the nutritionally necessary minerals out of the soil. Those methods return a handful of elements in the form of fertilizer, but only thirteen elements are generally required to grow a good-looking and marketable food commodity in a competitive market that doesn't distinguish one tomato from another. All of the other elements needed for human health—elements that were abundantly present a century ago—are either absent or severely depleted.

Compost contains and preserves these micronutrients that are so important to human health. So if you grow a garden for your health, you really need to use compost; otherwise you are largely wasting your time.

Why Make Your Own Compost?

If you weren't already convinced of the value of adding compost to your garden soil, I hope I have convinced you. But the next question is: why should you make compost yourself rather than just buying it?

Cost-effectiveness in a home garden requires different methods than those employed in large commercial farms. Substantially enhanced nutrition and major cost savings can only be achieved in a home garden through the use of sustainable and organic methods, and the primary practice that enables these methods is *composting*.

If you have read *Mini Farming: Self-Sufficiency on ¼ Acre,* you know that I put a great deal of emphasis on compost. That emphasis is not misplaced, because composting is the primary method that will help to retain the elemental content of your soil in a biological matrix that will make it available to plants as needed, without being washed out of your soil.

Keep in mind that there is no such thing as a perfectly sustainable system because, if you eat the food you grow, part of that mineral content is retained in your body and some is discarded as waste. But even then, the mineral conservation achieved through composting substantially reduces the amount of minerals you will need to supply via outside sources.

Likewise, for a variety of reasons, few soils available to homeowners and renters already contain an optimum mineral content, and they will need to be supplemented with the required minerals. But once those minerals are in the soil, conscientious composting practices will help to retain them, so that fewer will need to be added in the future.

Fewer additives equates to less money being spent for the value of the produce you raise. So composting will allow you to raise more sturdy plants that provide superior nutrition for less money. If self-sufficiency or health are your objectives, composting is not optional—it's necessary.

Though you may need to buy bagged compost when you start gardening, bagged compost is extremely expensive. Though it varies from crop to crop, in general you may need to add anywhere from two to eight cubic feet of compost for every thirty-two square feet of garden. At the time of writing, bagged compost costs anywhere from $5 to $8 per cubic foot. It wouldn't take a very big garden for this to run into hundreds or even thousands of dollars. And what you get for all that money may not be what you expect.

When you buy bagged commercial compost, you have no idea what went into it. Though the regulations for USDA Certified Organic agriculture prohibit the use of sewage sludge on crops labeled as "USDA Organic," there is no such prohibition on the labeling of bagged compost, and many types of compost labeled as "organic" contain sewage sludge.

In theory, composting human waste is just fine, provided it is done in a fashion that eliminates pathogens. Even drug metabolites in human waste are often effectively destroyed or rendered biologically inert as part of the composting process. But sewage sludge is *not* a result of such a composting process, and large-scale waste treatments systems are not equipped to remove many harmful chemicals. Humans consume a vast array of chemicals in the form of medications, artificial colors, preservatives and so forth. The levels of drug metabolites in our waste stream are so high that pharmaceuticals such as Prozac have shown up in water supplies. Sewage sludge also contains more than merely human waste. Sludge contains the chemicals, hair dyes, heavy metals, paint, degreasers, detergents and motor oil people wash down their drains, drugs that are not detoxified by the sewage treatment process and more. An EPA survey of sludge samples conducted in 2009 found detectable levels of a dozen drugs, flame retardants and even endocrine disruptors.

So if you *do* wind up buying bagged compost, please pay attention to the fine print and ask about its contents.

As previously stated, bagged compost is pretty expensive. If when you start your garden you have to buy compost because you have made none of your own, it will be more cost-effective to have it delivered by the truckload if such an option exists for you. Compost delivered by truck is measured in yards. As a point of reference, a yard of compost is twenty-seven cubic feet. I have had compost delivered on a couple of occasions. In both cases the compost was not yet finished and couldn't be used until the next season. In one instance, the compost contained asphalt rocks and even hypodermic syringes. (Yikes!)

So remember, just as food you grow yourself is superior because it is grown with your own well-being as a priority, so is compost that you make yourself. *It is in your best interests to start making your own compost* because it is far less expensive and because you control its ingredients and how it is made.

Making your own compost is easy, and I have written this book to show you how.

Pest and Disease Control

BY BRETT L. MARKHAM

Pest and disease problems are an unavoidable fact of life for the mini-farmer. Sometimes, they are barely noticeable and cause no significant problems. But at other times they can cause major crop losses.

There are, unfortunately, hundreds of pests and diseases that affect vegetable crops. Going into the detail of identifying these is beyond the scope of this book, So instead I'll refer you to *The Organic Gardener's Handbook of Natural Insect and Disease Control,* published by Rodale and edited by Barbara Ellis and Fern Bradley. This 500-page book is loaded with color pictures and extensive explanation for every disease or pest you are likely to encounter, including specific details of organic methods for dealing with problems. What follows in this chapter is an overview that concentrates more on principles than details, along with my own unique passive-active-reactive pest management strategy developed specifically for the needs of mini-farms.

Since the old adage that "an ounce of prevention is worth a pound of cure" is true, mini-farming focuses automatically on passive prevention by giving plants what they need. Active prevention is used when experience or reliable data indicate that a particular pest or disease is likely to be a problem. Active reaction is employed when he value of likely crop damage will exceed the costs of active reaction methods.

Passive prevention is the application of good farming practices: well-composted and appropriately amended healthy soil, adequate sunshine, proper watering, crop rotation, and sufficient airflow. In essence, this simply means to give plants growing conditions that are as close to optimal as possible. This will make them healthier and thus less susceptible to diseases and less attractive to pests.

Active prevention uses active measures to prevent diseases or repel insect pest. Examples include applying repellent garlic or hot pepper sprays on plants to deter pests, installing physical barriers, putting out traps, or spraying the plants periodically with a fungus preventative. Sometimes, for certain types of pests, poisons that are usually used as a reactive measure may be required as active prevention.

Active reaction occurs when preventative measures fail and a problem already exists. Active reaction will often employ the same methods as active prevention, only with greater intensity, but it will also include, in most cases, the application of natural botanical or synthetic poisons or fungicides.

Pest management needs to be viewed holistically, as part of a bigger picture, to minimize crop damage while simultaneously protecting the long-range viability of the mini-farm. As part of this view, it is good to establish a threshold for what constitutes an acceptable level of damage before reactive, as opposed to preventative, measures need to be taken. This threshold is established economically, considering that the time, costs, and risks associated with active pest control measures will diminish the net grocery savings. So the thresold of acceptable damage for a given crop, in terms of percentage crop loss, is the level at which the value of the lost crop portion exceeds the cost of active control measures.

Passive Prevention

Passive prevention gives the biggest bang for both your time and money because the focus lies mainly in performing ordinary farming chores. Soil, water, sunshine, and crop rotations are the foundation of pest and disease control; all of these create an environment inhospitable to the persistence of pests and disease.

A healthy, living soil with plenty of nutrients allows for vigorous growth so that crops can outgrow problems. In addition, healthier plants are less attractive to pests and less susceptible to disease in most cases. Healthy soil plays host to various portions of the life cycles of many beneficial insect populations, along with beneficial microbes that compete with nasty pathogen for nutrients and generate antibiotics to eliminate them. It is no mistake that forests thrive independent of human intervention, and the more closely a farmer's garden approximates naturally optimal conditions for a crop, the less susceptible it will be to pest and disease problems.

Potato beetles are a common garden pest.

An important aspect of healthy soil, particularly with intensive agriculture, is compost. As discussed in the previous chapter, merely using compost in your soil can significantly reduce pest and disease problems.

Proper watering is another important aspect of disease control. Plant diseases spread most easily when plant tissues are wet; both excessive watering and overhead watering can increase the likelihood of disease problems. However, adequate moisture is also important because drought-stressed plants become more attractive to pests.

Crop rotation is impossible to over emphasize. Just like there are viruses and bacteria that affect some mammals but not others—such as feline leukemia—there are numerous plant diseases that affect one family of vegetables but not others. Since these microbes need a host hospitable to their reproduction to complete their life cycles, depriving them of the host they need through crop rotation is extremely effective at controlling many diseases. The same applies to insect pests, so the same crop should not be grown in the same bed two years in a row. Ideally, crop rotation will prevent crops of the same family from growing in the same bed any more often than once every three years.

Dill is a common attractant of beneficial insects.

Table 12: Preventative Plantings

Beneficial Insect	Controlled Pests	Plants to Provide
Parasitic wasps	Moth, beetle, and fly larvae and eggs, including caterpillars	Dill, yarrow, tansy, Queen Anne's lace, parsley
Hoverflies (syrphid flies)	Mealybugs, aphids	As above, plus marigold
Lacewings	Ahpids, mealybugs, other small insects	Dandelion, angelica, dill, yarrow
Ladybugs	Aphids	Dandelion, hairy vetch, buckwheat, marigold
Tachanid flies	Caterpillars, cabbage loopers, stink bugs, cabbage bugs, beetles	Parsley, tansy, pennyroyal, buckwheat

Specific plant variety selection is another important preventative. Notwithstanding the economic benefits of using open-pollinated seeds (described in the next chapter), some hybrids carry disease- and pest-resistance genes that can make them a better choice if certain diseases or pests become a repetitive problem. On my farm, for example, I now grow hybrid cucumbers that are resistant to bacterial wilt disease.

Finally, never discount the power of the sun. The same UV rays that make excessive sunshine a risk factor for skin cancer also scramble the genetic code in bacteria and viruses, rendering them incapable of infection. Sunshine sanitizes.

Attracting beneficial insects is also useful. Most beneficial insects feed on or invade pest species at some point in their life cycle, but they also require certain plants for their well-being. Providing insects a base of operations they can use to keep pest species controlled.

A small planting of early, intermediate season, and late-blooming beneficial insect attractors in each garden bed with help stack the deck in the farmer's favor. Ladybugs love to eat aphids; dandelion, marigold, and hairy vetch will attract Tachanid flies help keep cabbage worms and stink bugs in check; a planting of parsley or pennyroyal will give them a home. Beneficial insect attractors that bloom early include sweet alyssum, columbine, and creeping thyme. Intermediate bloomers include common yarrow, cilantro, edging lobelia, and mints. Late bloomers include dill, wild bergamot, and European goldenrod. An easy plan is to plant a few marigolds throughout the bed, a columbine plant, a bit of cilantro, and some dill.

You should familiarize yourself with the properties of beneficial plant attractors before planting them in your beds. Don't just run out and plant mint in the garden bed directly, for example, because it will take over the entire bed. Instead, plant mint in a pot and then bury the pot in the garden soil so that the upper edge sticks out of the soil ½ inch or so.

You may also want to choose some plants that you will already use in some other way—such as mint for tea, dill for pickling, and cilantro for salsa. That way you are making maximum use of limited space. There is nothing wrong with growing goldenrods just because they are pretty!

Another valuable addition to the garden and yard, once the seeds have sprouted and the plants are growing well, would be chickens or guineas. Both types of birds, but guineas particularly, wreak havoc on bugs, especially bugs like ticks that nobody wants around anyway. Such livestock can effectively keep many sorts of garden pests from reaching the critical mass of population necessary to be threatening to crops.

Active Prevention

Active prevention is often necessary when a particular pest of disease problem is a practical certainty. In such cases, the active prevention is tailored to the expected problem and can often encompass methods used for both passive prevention and intervention. For example, you may notice your garden is regularly infested with earwigs. Once the bugs are noticed inside a cauliflower plant, they've already done a lot of damage. A weekly spraying with pyrethrin (a natural insecticide) or hot pepper wax (a repellent) will increase the usable harvest significantly.

The materials and techniques most often used for active prevention include traps, immune boosters, compost extracts, imported beneficial insects, and application of repellents, fungicides, and pesticides. (The latter is particularly important with certain fruit trees.)

Lures and Traps

Many insect pests can be caught in traps. In commercial operations, traps are usually used to monitor pest populations to determine the optimal timing for the application of pesticides. In a mini-farm, because of the smaller land area involved, it is often practical to employ enough traps to completely eradicate a particular pest (or one of the sexes of that pest) in the garden without resorting to poisons. Examples of pests easily trapped are codling moths, Japanese beetles, and apple maggots. Traps can also be employed for cucumber beetles, white flies, and a number of other pests, but they tend to be less effective. The time when various insects emerge varies from area to area. Because the lures used in traps often have limited lifespan, the timing of their deployment can be important. This is something you'll learn from keeping notes, and within a couple of years you'll have no trouble with the timing of traps.

Immunity Boosters and Growth Enhancers

One immunity booster for plants on the market at the moment is marketed by Eden Bioscience in the form of harpin protein. Harpin protein, which is produced naturally by the bacterium that causes fire blight in apples and pears elicits a broad immune response from vegetables that makes them more resistant to a wide array of pests and diseases while enhancing their growth. Eden Bioscience uses this discovery in a product called Messsenger that is nontoxic and relatively inexpensive at my local agricultural supply store.

A company called Vitamin Institute sells a product called Superthrive that is advertised to improve the growth rate of plants and whose primary ingredient is thiamine. I have done some side-by-side testing, and the results have been ambiguous.

On the other hand, I have found a growth enhancer called Root Boost to live up to its advertising. It is not a fertilizer but rather an enhancer that is primarily based on kelp extract with the addition of humic acids. This product, when used as directed, really does enhance the soil and the plants that depend on it.

Compost Extract and Compost Tea

Compost extract is the most well-known and most widely studied homemade disease preventative. It is exactly what it sounds like: a shovel of properly aged compost in a water-permeable sack immersed in a bucket of water and steeped for 7 to 14 days.

As the chapter on composting pointed out, compost extract contains a cocktail of microbes and the chemicals that they produce. Compost extract contains a mix of beneficial bacteria and fungi that, when sprayed onto plants, eats the food substances that would otherwise be eaten by disease-causing organisms. As a result, the disease-causing organisms get starved out. A biweekly spray of compost extract is a good idea, and numerous studies attribute properties to the substance that are nothing short of miraculous. It can help prevent diseases such as black spot and powdery mildew. Best of all, it's free.

The next step up from compost extract is compost tea. Compost tea differs from an extract in that it is the result of an active attempt to increase the amount of fungi and bacteria in the solution through aeration. Still water (as used in compost extract) doesn't have much dissolved oxygen in it, and the beneficial microbes in compost require oxygen. So, actively aerating the water in which the compost in steeped will serve to boost populations of beneficial microbes from the compost. This can be done inexpensively by putting a fish tank aerator and air pump in the bottom of a container containing the water and compost. Some reasonably priced and favorably reviewed commercial options are also available through Keep It Simple, Inc. (www.simplicitea.com) or Alaska Giant (www.alaskagiant.com).

Importing Beneficial Insects and Nematodes

Imported beneficial insects have their greatest applicability in greenhouses because, being quite mobile, when applied outdoors they are prone to fly away. Even outside they can be useful though, particularly when applied to crops infested with their favorite pest species and also provided with their favorite plants. Table 12 (earlier in this chapter) lists which beneficial insects to use for what problem and what sorts of plants should be established in advance of their arrival so they will stay in the garden.

Beneficial nematodes are extremely small worms that wait underground for a chance to work their way into pest insects and kill them. Beneficial nematodes are harmless to plants and pollinators and shouldn't be confused with pest nematodes such as root knot nematodes. Once inside the host, the nematodes release their gut bacteria, *Xenorhabdus luminescens*, into the insect's interior, where the bacteria multiply and the nematodes feed on them.

Table 13: Beneficial Nematodes

Species	Pests Controlled	Notes
Steinernema spp	Webworms, cutworms, vine borers	Not effective against grubs
Heterorhabditis spp	White grubs, vine weevils, root weevils	

The pest species eventually dies from infection. There are two commonly used species of nematodes, listed in Table 13. Beneficial nematode products often contain both species to be as broadly useful as possible.

Beneficial nematodes require extreme care in their handling and are usually shipped by overnight courier in a refrigerated package. They are stored in the refrigerator until they are used. It is best to wait until ground temperatures are above 50 degrees, the ground is damp, and a light rain is falling. Then put the nematodes in a pump-style sprayer and apply them to the ground where you want them. The reason for this is that beneficial nematodes are very prone to dehydration, and the falling rain helps them get into the soil. If you live north of Maryland, you'll need to apply them yearly because they can't survive the winter. If you live in a more southerly clime, the nematodes will probably survive, so a second application may not be needed.

Pest Repellents

Organic repellent mixtures are not 100% effective, but they serve as a valuable part of an integrated strategy for pest management. One repellent mixture is simple hot pepper. Capsaicin, the active ingredient in hot peppers, repels onion, carrot, and cabbage maggots. Finely chop up a cup of hot peppers, and steep it for a day in a gallon of water to which a single drop of dish soap has been added. Another repellent mixture is garlic, manufactured the same way. One thing that I do, with great success, is make hot pepper and garlic mixtures in a coffee maker that has been set aside for agricultural use only. There are some commercial repellent preparations worth noting as well, including CropGuard and Hot Pepper Wax.

There is *some* evidence that certain plants can repel pest insects. According to numerous sources, for example, nasturtiums and radishes repel cucumber beetles. I have experimented extensively with this practice and found no difference in cucumber beetle populations between cucumber plants surrounded by radishes and intertwined with nasturtiums and cucumber plants grown on their own. On the other hand, I have found that onion family crops repel wire-worms, so I interplant leeks with my parsnips. A number of sites on the Internet list repellent plants, so I encourage you to experiment with the reputed properties of repellent plants and keep notes to see what works best for your granden.

Active Reaction

Even the most conscientious farming practices and most vigilant preventive measures will often fail to prevent pest and disease problems. Once these problems become apparent, reactive measures are in order.

Reactive measures will often include some of the same materials and methods as passive and active prevention. For example, many fungal infections can be eradicated by the timely application of compost tea, neem oil, or garlic oil. (Neem oil is an oil extracted from a tree in India.) Most often, though, reactive measures will involve the use of fungicides and/or natural or synthetic pesticides. Because these reactive measures use substances with greater potential to harm people or the environment, I don't recommend their application unless the farmer is certain that a likelihood exists that failure to apply them will result in an unacceptable level of crop loss.

Another tip to make active measures most effective is to take a cue from doctors treating HIV and tuberculosis: Never treat an insect or disease problem with only one active agent at a time. Using only one active agent increases the odds of survivors living to convey immunity to that agent in the next generation. When you mix two or more active agents, you increase the odds of success while decreasing the odds of creating resistant organisms. So, for example, I routinely apply pyrethrin and rotenone in tandem, neem oil mixed with a microbial insecticide, or garlic and hot pepper repellents mixed together.

When Disease Prevention Fails

Plant diseases fall into four broad categories: bacterial, viral, protozoan, and fungal. Usually, these are impossible to distinguish by the naked eye except through experience with their symptoms. (See also the Rodale book recommended earlier in this chapter.) All such diseases present the problem that once a plant is infected, it becomes a storehouse of infective particles that can be spread to other plants via insects wind or handling. The longer an affected plant remains in the garden, the greater the odds that it will infect other plants. Diseases caused by viruses, bacteria, and protozoans are seldom treatable, but sometimes you can save a plant by pruning out the affected portions. Many fungal diseases, though, are treatable through a combination of pruning and spraying.

When a plant infection of any sort is first noticed, you may be able to save the plant by applying compost tea and/or Messenger. These products can stimulate an immune response that helps the plant overcome the infection. Their usefulness in that regard varies depending on the plants and diseases involved, so try it and keep notes of the results. A number of spray fungicides can also be used. Common fungicides include copper sulfate, Bordeaux mix (a mixture of copper sulfate and lime), baking soda, garlic oil, and neem oil. Baking soda is mixed two tablespoons per gallon of water with one ounce of light horticultural oil added, and the others are mixed according to label directions.

Some less well-known antifungal agents can have surprising results. I had a problem with powdery mildew on my lawn last spring (we had an especially wet spring), and I eliminated the infection by spraying with a mix of neem oil and fixed copper.

If saving the plant is either unsuccessful or inadvisable, then the plant should be removed from the garden immediately. Removing an infectious plant can be problematic since it can be covered with microscopic spores that will spread all over the place if the plant is disturbed. The solution is to spray the plant with something that will hold any spores in place and inactivate as many as possible before attempting removal. A good spray for this is made of two tablespoons of castile soap, one tablespoon of copper sulfate, one tablespoon of lime, and one tablespoon of light horticultural oil all mixed together in a gallon of water. The soap and oil will make the plant sticky so that spores can't escape, while the copper sulfate and lime serve to actually kill many infectious organisms. Spray the plant thoroughly with this (though not until it is dripping), and then cut it out and remove it, being as careful as possible to avoid letting it touch any other plants.

When dealing with plant diseases, you should consider you hands and tools to be a mode of disease transmission. When handling known diseased plants, it makes sense to handle *only* the diseased plants before hand washing and also to immediately sterilize any tools used on the diseased plants with bleach. A suitable sanitizing solution is one tablespoon of bleach per quart of water.

Diseased plant materials can be thermophilically composted with minimal or no risk as long as proper retention times are observed. If the farmer uses mesophilic composting instead, then diseased plant debris should be burned or placed in the curbside trash. It is also very important not to grow the same family of plant in the same area the next year. If a variety of the plant that resists that disease can be found, it would be a good idea to switch to that variety for at least a year or two, if not permanently.

When Pest Prevention Fails

The best soil management and prevention mechanisms will not be 100% effective against insect pests. For example, naturally attracted beneficial insects exist in balance with pest insects. If the beneficial insects were to eat all of the pest species, then the beneficial insects would starve or move somewhere else, and the pest species would experience a resurgence in the absence of its natural enemies.

Reactive control measures include anything used in the preventive stages, along with importing beneficial insect populations, applying microbial insecticides, and using substances that actually kill insects directly, such as soaps, oils and natural or synthetic insecticides. Synthetic insecticides should be reserved as a last resort since they would reduce the healthfulness of the crop (as described later in this chapter) and would make it impossible for you to sell your produce as organic for several years if you wish to do so.

Both natural and artificial insecticides can also harm beneficial helpers, such as necessary pollinators and earthworms, and disrupt the life of the soil and thus harm fertility in the long run, so they are best employed only when absolutely necessary. Because natural insecticides don't last as long in the garden, they have less potential to do unintended damage.

Microbial Insecticides

Microbial insecticides are microbes (or toxins produced by microbes) that are deadly to pest insects but harmless to beneficial insects and humans. The have the advantage of being relatively benign but the disadvantage of being fairly species specific. For example, *Bacillus popilliae* is deadly to Japanese beetle larvae but harmless to other white grubs that infest lawns. They aren't contact poisons, and they must be eaten by the insect to be effective. Microbial insecticides have become increasingly popular, even among conventional farmers, and are readily available at agricultural stores.

Soap and Oils

Plain old soap (not detergent, but soap) kills a number of insects by dissolving a waxy coating that they need to breathe and preserve moisture. Specialized insecticidal soaps can be used, or else a pure castile soap (such as Dr. Bronner's), mixed two tablespoons per gallon of water. Insecticidal soap will effectively control aphids, white flies, scale, spider mites, and thrips. In needs to be reapplied fairly frequently—about weekly—to interrupt the life cycle of the target pest.

Light horticultural oils are highly refined mineral oils that contol the same insects as insecticidal soap by covering and smothering the pest and its eggs. Mix and apply according to label directions.

Both oils and soaps should be tested on a single plant first, then wait a day, because they can be toxic to certain plants. (Their degree of toxicity to plants varies with heat, sunshine, humidity, general plant health, and other factors. Most often, they won't cause a problem, but it never hurts to test first.)

Natural Insecticides

The fact that something is natural doesn't mean that it is harmless. Ebola, smallpox, and strychnine are all 100% natural, for example. Natural insecticides fall under the same category and thus require care in their use. Natural insecticides can be purchased, or they can be grown and made at home. From a cost standpoint, the latter approach is preferable, though certain natural insecticides aren't is preferable, though certain natural insecticides aren't practical for home manufacture.

Pyrethrin is a contact insecticide that controls most aphids, cabbage loopers, stinkbugs, codling moths, and white flies among other pests. It does not affect flea beetles, imported cabbage worms, or tarnished plant bugs.

To make your own pyrethrin, grow pyrethrum daisies (*Tanacetum cinerarifolium*) somewhere in the garden. Cut the flowers when they are in full bloom for the highest concentration of poison. And hang them upside down in a cool, dry, dark place to dry. Once they are dried, take a quart jar of the dried flowers and grind them up using an old food processor or blender that you pick up at a yard sale and that you will never use for food again. Mix it with one gallon of water and two drops of dish

Table 14: Common Microbial Insecticides

Microbe	Controlled	Notes
Bacillus thuringiensis var. *kurstaki*	The caterpillar stage of a wide variety of moths	Will not control codling moths
Bacillus thuringiensis var. *Israelensis*	Mosquito, black fly, fungus gnat	
Bacillus thuringiensis var. *San diego*	Colorado potato beetle	
Nosema locustae	Grasshoppers	Because of grasshopper mobility, may not work for small yards

liquid, and allow it to steep for three days, stirring every once in a while. When done, filter it through cheese cloth that you will throw away afterward, store in a tightly capped bottle in a cool dark place, and label it appropriately as a poison so nobody drinks it accidentally. You dilute this for use by mixing one quart of the poison with three quarts of water, shaking, and applying via a sprayer. (I cannot stress strongly enough that all bottles containing poisons of any sort be labeled appropriately. Not far from where I live, a child died tragically a couple of years ago because of an unlabeled container of insecticide.)

Other natural insecticides are widely available, including neem and rotenone. These can be purchased at most garden centers or via mail order and should be used with as much care and caution as synthetics, because they can be toxic to humans.

Synthetic Pesticides

While this book focuses on organic methods, synthetic pesticides available to home gardeners bear mentioning. Ideally, because of a combination of growing conditions, attraction of natural predators, and other factors, pests won't be a problem so no pesticides will be needed—synthetic or otherwise. But that's the ideal. Reality can be far different, especially when first beginning a mini-farm. Even the most carful planning won't completely eliminate pest problems.

As a mini-farmer, you are trying to put a lot of food on the table, and you are trying to put safe food on the table. Perhaps, like me, you are an organic purist. But what happens when the theory of being an organic purist runs into the reality of a pest problem that threatens an entire crop? In my case, since I sell my produce as organic at 200% higher rates than conventional produce, it is actually better for me to lose a crop entirely than use synthetic pesticides. But what if my operation were strictly oriented toward putting food on the table? In that case, *maybe* I would use them, albeit cautiously and as a last resort, because some research shows that the synthetic pesticides available at the hardware store can be just as safe as botanical insecticides—and more effective—when used properly.

Please note that I said "maybe," "cautiously," and "as a last resort" for a reason. First off, in a mini-farm established using the methods in this book, economically threatening insect problems should be rare, and insect problems that won't respond to natural remedies even more rare. In fact, I have had only *one* pest problem where synthetics would have possibly been the better short-term solution.

Second, the government agencies charged with ensuring the safety of foodstuffs, drugs, and insecticides have a poor track record. For example, an article in *USA Today* disclosed that in 55% of FDA meetings regarding drug approvals, over half of the participants had financial conflicts of interest serious enough to note. According to the same article, committees approving such things are actually required by law to include officials representing the industry in question. This is not exactly a recipe that would inspire confidence in most objective observers and perhaps explains the dozens of chemicals (including various insecticides and drugs) approved by government agencies and subsequently recalled after people have been harmed or killed.

Finally, studies indicate that synthetic pesticides make food less healthful by reducing the ability of plants to create antioxidants. This explains my caution regarding synthetic pesticides. If you are nice enough to buy my book, should I repay your kindness by giving you advice that could hurt you without totally disclosing the facts as I know them? Government agencies have a poor track record, and research in universities is often funded by self-interested parties. The extent to which this affects the results and conclusions of research is impossible to tell. So I am going to give you information on two synthetic insecticides, understanding that the research I have available says they are safe but that it could be discovered later that you shouldn't touch them with the proverbial 10-foot pole.

The use of natural insecticides like pyrethrin and rotenone is perfectly acceptable under the National Organic Program, but in practical terms these substances are every bit as toxic as commonly available synthetics while being less effective in many instances. The main difference is that the natural insecticides break down into nontoxic compounds very quickly under the influence of heat, sunshine, wind, and rain so they won't make it into your food supply if used properly, whereas the synthetics are specifically formulated to be more persistent.

Let's take pyrethrin as an example. Pyrethrin is a natural neurotoxin that insects quickly absorb through the skin. Once it is absorbed, the race is on between the insect's enzymes that detoxify the pyrethrin and the pyrethrin's toxic effects. Many insects, if they receive a sublethal dose, will pick themselves up and dust themselves off less than an hour after apparenly being killed! Synthetic pyrethrins approach this problem by mixing the product with a substance like piperonyl butoxide that delays the insect's ability to make the enzymes to detoxify the pyrethrin, thus lowering the threshold considerably for what would constitute a lethal dose. Moreover, semisynthetic pyrethrins, such as allethrin, are often more toxic to insects while being less toxic to mammals (such as humans) than their natural counterparts.

So a semisynthetic pyrethrin spray combined with piperonyl butoxide would require less poison to be used and be more effecive, and the type of pyrethrin being used would be less toxic to humans.

According to a metabolic study, neither natural nor synthetic pyrethrins accumulate in the body or show up in breast milk because they are quickly detoxified in the human body. Any allethrin consumed by a human is rapidly tranformed into something less toxic and eliminated. In addition, allethrin is broken down into nontoxic compounds through the action of air and sunlight within a few days, though not as quickly as natural pyrethrin.

The piperonyl butoxide used to increase the effectiveness of pyrethrins is a semisynthetic derivative of safrole—an oil found in the bark of sassafras trees. It works by inhibiting enzymes that detoxify the pyrethrins in the insect's body. Safrole is a know carcinogen, but the status of piperonly butoxide as a carcinogen is disputed. Unlike allethrin, piperonyl butoxide is stable in the environment and doesn't break down easily.

Given current information, the allethrin doesn't worry me much, but I am sufficiently uneasy about the persistence of piperonly butoxide in the environment that I wouldn't personally use it. Either way, synthetic pyrethrins and those containing piperonly butoxide should be used according to label directions and never be used on crops within a week of harvest; even then harvested crops should be well washed.

Carbaryl (also know as "Sevin") is another common synthetic insecticide used in home gardens. There is no clear evidence that carbaryl is carcinogenic or causes birth defects, and 85% of carbaryl is excreted by humans within 24 hours. Carbaryl has a half-life of 7 to 14 days in sandy loam soil, and the manufacturer (Graden Tech) states that it is not absorbed by the plant. Therefore, if used according to label directions, and produce is carefully washed, it should be safe. According to numerous studies, "Carbaryl breaks down readily and experience shows it readily decomposes on plants, in soil and water to less toxic byproducts. Accumulation in animal tissues and biomagnification of residues in food chains with carbaryl and its metabolites does not occur."

Certainly, the preponderance of science says that carbaryl is perfectly safe when used according to label directions. It definitely takes care of cucumber beetles much more effectively than my organic approaches. Nevertheless, common sense and the fact that it is a neurotoxin that takes a lot longer than most botanical insecticides to break down would dictate that it be used only as a last resort. All in all, if I were to use a synthetic insecticide, I would use carbaryl in preference to the others available. And, in fact, what is what I used before switching to organic gardening.

Animal Pests

So far, in this chapter, when discussing pests we've largely been talking about insects. But one ignores larger pests, such as raccoons, rabbits, and deer, at his or her farm's peril. For many years, my farm ran along just fine with only minor damage from moles who ate strawberries and ripped tomatoes, and raccoons who occasionally stole an ear of corn. But one year, my entire crop of beans, sweet potatoes, and Brussels sprouts was wiped out in just one night by a herd of hungry deer. And they kept coming back to nibble at the sad remains. Clearly, action was needed.

Moles can be bit of a nuisance in my garden. They are there, primarily, to eat grubs. If you get rid of the grubs by applying Milky Spore or beneficial nematodes, you will dramatically reduce the mole population, For faster relief, there are a number of castor oil products on the market that put castor oil into the dirt. When the moles dig, they get the castor oil on their fur, and they lick it off. This gives them diarrhea, and they move on within a couple of weeks. I've found this quite effective. A number of companies sell a battery-powered spike that generates noise that is supposed to deter moles. These may work for you, but I've found them ineffective.

Rabbits are only an occasional problem and don't usually do much damage on the farm. What I do is mix a hot pepper product with anything else I happen to be spraying and use it to wet the leaves. This serves as sufficient deterrent.

Deer are another matter entirely. I tried all the standard tricks. Bars of soap, hair Clippings, urinating around the property line, and similar homespun remedies did nothing. Spraying the plants with hot pepper wax was inadequate and only marginally effective. I have found only three things that really work. The first is quite expensive: an impenetrable physical barrier in the form of a fence eight-feet tall. The second is a product called Deer Scram, which is a deterrent scent that is sprinkled around the area to be protected. The third is the use of a baited electric fence.

A baited electric fence is a regular electric fence that has been baited with peanut butter wrapped in aluminum foil. Deer adore peanut butter, so they put their mouth right on the aluminum foil and get zapped. This works incredibly well and requires only a single strand of fencing about four feet off the ground where pets are safe. This same trick works for raccoons if you add another strand about 18 inches off the ground.

Products for deterring furry pests

Preserving the Harvest

Since the purpose of a mini-farm is to meet a substantial portion of your food needs, you should store your food so that it is available over the course of the year. The four methods of food preservation that I use and will be explaining in this chapter are canning, freezing, dehydrating, and root cellaring. These methods have all been practiced for decades in the United States and can be undertaken with confidence. Each method has its strengths and weaknesses, which is why they are all covered. Advanced techniques that I won't be explaining in this chapter include cheese making, wine making, and meat curing.

Canning

Perhaps the most intimidating form of food preservation for the uninitiated is canning. Stories are everywhere about people dying from botulism because of improperly canned foods, so some people conclude that canning is an art like making fugu (the poisonous Japanese blowfish) in that the slightest mishap will render canned foods unfit. Fortunately, these impressions are not accurate. Modern canning methods are the result of decades of research and can be followed by anybody with a sixth-grade education. (Yes, I knew somebody personally with a sixth-grade education who canned safely.) Those few cases of poorly canned goods resulting in botulism poisoning in the modern era stem from people who do not follow the most basic directions on how to can.

Current standards for home canning come from research by the USDA that is continually updated. Most of the standards haven't changed for decades, because the research methods are quite thorough. The USDA researchers deliberately introduce viable heat-resistant bacteria spores into foods in home canning jars and then use temperature sensors inside the jars as they are canned. After canning, the cans are kept at the precise temperature necessary for best bacterial growth for several months and then opened in a sterile environment and tested for presence of the bacteria or any other spoilage.

The USDA standards published around World War I allowed for up to 2% spoilage, but the standards published since that time require 0% spoilage. This means that foods canned at home using current USDA guidelines are completely safe. Actually, the times and temperatures provided by the USDA also contain a safety factor. This means that if experimenters achieved 0% spoilage at 237 degrees for 11 minutes, the standards specify 240 degrees for 15 minutes. Times and temperatures are always rounded *up,* never down.

There are two methods of canning: boiling water bath and steam pressure. The choice of method depends on the level of acidity of the food being canned. This is because the length of time that spoilage organisms will survive at a given temperature is longer in foods that are *less* acidic. So less acidic foods get canned using the steam pressure method that produces a temperature of 240 degrees; more acidic foods get canned in a boiling water bath that produces temperatures of 212 degrees. The length of time specified for canning is based on how long it takes the heat to fully penetrate a particular food in a particular-sized jar. The standards are written for half-pint, pint, and quart jars. If a mixture (such as stew) is being canned, then the canning time and temperature for the entire mixture is based on that of the ingredient that requires the most time. By using the correct method, container, and processing time, you can be assured of the safety of your canned food.

Home-Canning Jars

Jars for home canning are available at Walmart and many hardware and grocery stores, although their availability is seasonal. These jars are heavy walled and specifically designed to withstand the rigors of temperature, pressure, and vacuum created by home canning. Forget the old-style (though attractive) jars with rubber gaskets and wire closures since they are no longer recommended by the USDA. Today's standards specify two-piece caps that include a reusable metal ring called a "band" and a flat nonreusable lid that has a sealing compound around its outer edge. The bands can be used until they have warped or rusted, but the lids must be thrown away once they have been used and bought new.

Home canning jars are expensive—about $7/dozen at the time of writing. So figure a bit over $0.50 apiece. However, their durability easily justified their cost—home canning jars will last decades. By the time a jar has seen use for 20 seasons, its cost has dropped to $0.02. Once the jars and bands are purchased (new jars usually come with bands), you just need to buy new lids for each use—which are usually less than $0.10 each. There are a handful of brands of home-canning jars available, and on the basis of my own experience, I recommend Ball and Kerr, which are both manufactured in the United States by Jarden Corporation. I especially recommend Ball lids, because their underside is coated with a compound that keeps the food from coming into contact with the metal of the lid. This helps food stay fresher longer, and they cost the same as noncoated lids.

My stepmother often used glass jars from spaghetti sauce, mayonnaise, and similar products as long as the bands and lids fit and the rims were free from nicks of imperfections that would prevent a good seal. The good news is that she saved money. The bad news is that sometimes these jars would break and create a mess and lose the food. Most authorities counsel against using these one-trip glass jars because they aren't properly tempered, and their higher risk of breakage could cause injury and loss of valuable food. For these reasons, I recommend using jars specifically designed for home canning. If economy is a big consideration, then it is worthwhile to visit yard sales and flea markets where you can buy inexpensive, properly designed jars for home canning.

Foods and Canning Methods

As I mentioned earlier, the type of canning method required depends on how acidic the food is. Acidic foods (with a pH of less than 4.6) need only a water bath canning method while less acidic foods (with a pH greater than 4.6) require steam pressure canning. Unfortunately, the combination of time and temperature in a pressure canner can render some foods less nutritious and other foods unappetizing. Broccoli is a good example in that it requires such an extensive period of pressure canning to be safe that the results aren't worth eating. Broccoli is much better preserved through either freezing or pickling. The goal, then, is to use the method that preserves the maximum nutrition and palatability while maintaining a good margin of safety. So if I don't list a canning method for a vegetable (Table 19, page 198), it is because I have determined that it is better preserved using some other method.

An age-old method for canning foods that cannot be safely canned otherwise is to raise the acidity of the food by either fermenting it or adding vinegar. Sauerkraut is a great example because cabbage is not suitable for either canning or freezing in its fresh state, but if acidified through lactic acid fermentation (and thereby becoming sauerkraut), it can be canned in a boiling water bath while retaining its most important health benefits. (Technically, with great care, you can freeze grated cabbage, but your results may vary.) Pickles are made either by fermenting vegetables in a brine (which raises their acidity through the production of lactic acid) and/or adding vinegar. These methods create a sufficiently acidic product so that only a brief period in a water bath canner is required.

Boiling water bath canning is suitable for all fruits, jams, jellies, preserves, and pickles. Tomatoes are right at the margin of pH 4.6, so they can be safely canned in a boiling water bath if a known amount of citric acid (or commercial bottled lemon juice) is added. The correct amount is One tablespoon of lemon juice of ¼ teaspoon of citric acid per pint. Vinegar can be used instead, at the rate of two tablespoons per pint, but it can cause off-flavors. The only time I would recommend vinegar is in salsa. The acidity (or, rather, the *taste* of the acidity) can be offset by adding two tablespoons of sugar for every tablespoon of lemon juice, which won't interfere with the canning process. While few people choose to can figs (usually they are dehydrated instead), it is worth noting that they are right on the border line of acidity as well and should have lemon juice added in the same proportion as tomatoes if they are being canned. Everything else—vegetables, meats, seafood, and poultry—*must* be canned in a steam pressure canner.

Boiling-water canners are pretty much maintenance free. Just wash them like any other pot, and you are done. Pressure canners, on the other hand, require some minimal maintenance. The accuracy of the dial gauge on top of the canner should be checked annually by your Cooperative Extension Service. If it is inaccurate, send it to the manufacturer for recalibration. When the canner is not in use, store it with the lid turned upside down on top of the body. Never immerse the lid or dial gauge in water! Instead, clean them with a damp cloth and mild detergent if needed. Clean any vent holes with a pipe cleaner. The rubber seal should be removed and cleaned with a damp cloth after each use. Some manufacturers recommend that the gasket be given a light coat of vegetable oil, and some don't—so be certain to follow the manufacturer's directions. If you follow manufacturer's directions in using your pressure canner, it won't explode, as was sometimes the case years ago. Modern canners have a number of built-in safety features that our grandmothers' models lacked, and aside from deliberately defeating those safety mechanisms, an explosion is practically impossible.

Foods to be canned are packed into hot glass jars using either the fresh-pack or the hot-pack method. The methods are pretty much self-explanatory from their names: Fresh-packed foods are put into the jars fresh and then hot liquid, brine, or syrup is added, and hot-packed foods are put into jars after having been heated to boiling. In some cases, either method can be used. Once packed, the jar is filled with liquid (brine, broth, syrup; pickling juice, etc. depending on the recipe) up within ¼ to 1 inch from the top of the jar. This space is called headspace and is needed to accommodate the expansion of the food in the jar as it is heated and allow for a good vacuum seal.

Using a Boiling-Water Canner

Boiling water canners come with a wire rack that holds the jars so that they won't be sitting on the bottom of the canner or bumping into each other and breaking. Using a rack ensures that water of the same temperature surrounds the jars on all sides so that heating is even and therefore the best results are obtained.

Jars need to be sterilized for canning. My method is a little different from that in most books, but it works quite well, and I've never had a jar spoil.

1. Fill the canner halfway with the hottest water from the tap.
2. Put the jars you plan to use in the rack, without any lids.
3. Submerge the rack and jars in the canner, adding enough tap water to completely fill all the jars and stand 1 ½ inches above the tops of the jars.
4. Put on the lid and bring water to a vigorous boil, then adjust the heat to obtain a steady rolling boil.
5. Meanwhile, put a smaller pot on the stove without water, uncovered, but apply no heat. Put the lids (but not the bands) in this pot, making sure that the sealing compound is facing up.
6. Remove the jars from the canner one at a time using a jar lifter, and empty the boiling water in them into the smaller pot until it is nearly full and set them aside on a dish towel. (Once the smaller pot is full, empty the water in the remaining jars into the sink.) Keep the lids in the standing boiling water at this point—additional heating of the lids is not required.
7. Lift up the rack in the canner so that it is supported by the sides of the canner.
8. Put the product into the jars (a special canning funnel is helpful for this), allowing for proper headspace, get the lids out of the hot water in the smaller pot one at a time using tongs, and place them on the jars, then secure with a screw band tightened only finger-tight. (If you tighten it any more than that, the jar will break when you heat it in the canner.)
9. Put the filled jars in the wire rack, and submerge them in the water in the canner.
10. Turn up the heat on the burner a bit if needed to maintain a steady rolling boil. Start the timer once that boil has been achieved and put the lid on the canner.
11. Once the appropriate time has elapsed, remove the jars and place them on a dish towel at least 2 inches from each other on all sides and allow to sit undisturbed for at least 12 hours.
12. If additional product (more than one canner load) is being processed, pour the water back into the canner from the smaller pot, put clean jars in, and add any needed water to completely fill and submerge with 1 ½ inches of water on top of the jars, then repeat the process starting a Step 4.

Using a Pressure Canner

Each pressure canner is a little different, so read the manufacturer's directions and employ those in preference to mine if there is a contradiction. Pressure canners don't rely on completely submerging the jars. Instead, they rely on surrounding the jars with superheated steam at 240 degrees. They also come with a rack, but instead of being made of wire to hold jars securely in place like with a boiling water canner, it is a simple aluminum plate with holes in it. Put it in the canner so that the holes are facing up. When using a pressure canner. I don't sterilize the jars before use. Instead, I just make sure they are extremely clean, and I keep them in a large pot of near-boiling water at a simmer. You can also wash them in a dishwater and keep them hot with the dishwasher's heating element.

1. Put the rack in the canner and put three inches of very hot tap water into the bottom.
2. Put already-filled and lidded jars on the rack using a jar lifter, leaving some space between the jars.
3. Put the lid on the canner, but leave off the weighted gage, turn up the heat until steam starts

coming out of the port where you would put the weighted gage, and let the steam exhaust for 10 minutes.

4. Put the weighted gage on the port and keep the heat adjusted for a steady rocking motion of the gage. Start timing from when the steady rocking motion starts.
5. Once the time is up, turn off the heat and let the canner sit until the dial gage reads zero or when no steam escapes when the weighted gage is nudged. Wait an additional 2 minutes just to be sure.
6. Remove the cover and then remove the jars with a jar lifter and put them on a towel, leaving 2 inches between them on all sides.
7. Leave the jars undisturbed for 24 hours.

Fruits

Practically any fruit can be canned, and all except figs are sufficiently acidic that they can be canned without additives. (Figs require the addition of one teaspoon of lemon juice per pint.) Fruit should be in peak condition, free from obvious blemishes or rot, and well washed. To be sufficiently heated during the canning process, fruits that are larger than one inch should be cut up so that no single piece is larger than a one inch cube. Pits and stones of large-seeded fruit should be removed, and the fruit should be treated in an antioxidant solution, particularly once it has been cut to prevent discoloration. Antioxidant solutions can be bought commercially, or you can make your own by mixing ¾ cup of bottled lemon juice with a gallon of water.

Fruits are usually canned in sugar syrups because the sugar helps the fruit keep its color, shape, and flavor, although the sugar isn't strictly necessary to prevent bacterial spoilage. If you prefer, can the fruits by using plain water rather than a syrup. I don't recommend the use of artificial sweeteners in syrup because saccharine turns bitter from canning and aspartame loses its sweetness. (If you have ever bought a diet soda and though that it tasted a bit like dirt, that means that the product was stored in an area of high temperature and the artificial sweetener was damaged.) A "very light" syrup uses two tablespoons of sugar per cup of water, a "light" syrup uses four tablespoons per cup of water and a "medium" syrup uses seven tablespoons per cup of water.

To fresh-pack fruits, add them to the jars and then pour simmering syrup (or water) into the jar until it is filled up to within ¼ inch of the rim. Put the lids and screw bands on the jars finger-tight, and completely submerge in a boiling water canner for the specified time for that particular fruit. Then remove the jars from the canner and leave them to cool for at least 12 hours. Hot-packed fruits are handled pretty much the same except that the fruit is mixed with the syrup and brought to a light boil, and then fruit and syrup are added to the jar together.

Applesauce

Home-canned applesauce was a favorite of mine as a kid—I'd open up a couple of homemade biscuits on my plate, heap a generous quantity of applesauce on top, and dig in. Applesauce canned at home is simple, delicious, rich, and flavorful—nothing like the homogenized products available at the grocery store. Naturally, the same process used for applesauce can also be used for pears, quinces, and other fruits. Feed free to experiment!

Here is my recipe and procedure for semichunky applesauce.Yield: 22–26 pints.

Semichunky Applesauce

- 1 bushel of at least two types of apples, one type being rather sweet
- a bag of white and/or brown sugar (the actual amount added depends on your taste and the apples selected)

- cinnamon to taste
- allspice to taste
- nutmeg to taste
- lemon if desired

Procedure

- Wash ¾ of the apples and remove stems, cut up into 1-inch chunks, including the core and peels, and put into a very large pot with about 1-inch of water in the bottom. (You can buy a simple contraption for a few bucks that cores and cuts apples into segments in just one motion—I recommend it highly!) Dip in an antioxidant solution once cut.
- Cook until all of the chunks are soft throughout. Start off on high heat and then lower to medium-high.
- Run the cooked apples through a strainer to remove the skins and seeds and put them back in the pot. (You can do this hot if you are careful.) I use a Villaware V200 food strainer because I could get it for less than $50 and it came with the right screen for my two favorite foods—applesauce and spaghetti sauce. There are a number of strainers on the market—including the classic Squeezo stainer—that will also work fine.
- Peel and core the remaining apples, cut up into small chunks, and add them to the pot as well. (I have a "Back to Basics" Peel-Away apple peeler that peels, cores, and slices quickly in a single operation. It costs less than $20 at a cooking store.)
- Continue cooking on medium-high until the newly added chunks are soft.
- Add sugar, lemon, and spices to taste. You will probably need less than ¼ cup of sugar per pint if you used some sweet apples.
- Reduce heat to a simmer to keep the sauce hot while canning.
- Pour the sauce into freshly washed pint or quart canning jars, leaving ½ inch of headspace.
- Put on the lids and bands finger-tight.
- Completely submerge jars in boiling water in a boiling water canner for 15 minutes for pints or 20 minutes for quarts.
- Allow the jars to cool in a draft-free place for at least 12 hours before removing the bands, labeling, and storing in a cool dry place for up to two years.
- Enjoy!

Jellies

Jellies are made from fruit juice and sugar, and use heat and sugar for their preservation. The distinctive consistency of jelly comes from an interaction between the acids in the fruit, the pectin it contains, the sugar, and heat. Many fruits contain enough natural acid and pectin to make jelly without having to add anything but sugar. These include sour apples, crab apples, sour cane fruits, cranberries, gooseberries, grapes, and currants. Some fruits are slightly deficient in acid, pectin, or both and will require a small amount of added lemon juice, pectin, or both. These include ripe apples, ripe blackberries, wine grapes, cherries, and elderberries. Finally, some fruits simply won't make jelly without adding a significant quantity of lemon juice and/or pectin. These include strawberries, apricots, plums, pears, blueberries, and raspberries.

Because sugar plays an important role in the preservation of jellies, the amount called for in a recipe shouldn't be reduced. It also plays an important role in making the product gel, so using too little sugar can result in a syrup instead of a jelly.

The juice used to make jelly can be extracted in a number of ways. If you use a juice machine, use it only for fruits that would require added pectin anyway, such as berries, plums, and pears. This is because a juice machine won't properly extract the pectin from high-pectin fruits. The traditional way of extracting the juice is to clean and cut up the whole fruit (it is important to leave the peels on because pectin is concentrated near the peel) and put it in a flat-bottom pot on the stove with added water. For soft fruits, use just enough water to prevent scorching, but with hard fruits like pears you might need as much as a cup of water per pound of fruit. The fruit is cooked over medium heat until soft and then poured through a jelly bag. If you want a crystal-clear product (which I don't personally care about but many folks find aesthetically important), it is important not to squeeze the jelly bag but instead let the juice come through naturally and slowly. You should get about one cup of juice per pound of fruit. Jelly bags in various sizes can be purchased from cooking stores and over the Internet, If you use a juice machine, you should still strain the resulting juice through a jelly bag. If you can't find jelly bags, you can use a double-layer of cheesecloth lining a colander instead.

Once the juice has been extracted, it is combined with sugar and other ingredients (e.g., lemon juice and/or pectin depending on the recipe) and boiled on the stove until it reaches a temperature of 220 degrees as measured with a candy thermometer. The boiling point of pure water is 212 degrees, but that boiling point is raised when other substances such as sugar are added to the water. As water evaporates and the proportion of sugar in the water increases, the boiling point will slowly increase. If you live in the mountains, subtract 2 degrees for every 1,000 feet you live above sea level. So if you live at 3,000 feet, subtract 6 degrees—so boil the mixture only until it reaches 214 degrees. This is because the higher you are above sea level, the more easily water will evaporate because of lower air pressure.

Once the required temperature has been reached, fill sterilized jars with the hot mixture up to ¼ inch from the top, put the two-piece caps on the jars finger-tight, and process in a boiling water canner for five minutes for half-pint or pint size. There are all sorts of jelly recipes on the Internet, but here are two of my favorites.

Strawberry Rhubarb Jelly

- 3 pints of strawberries
- 1 ½ lbs of rhubarb stalks
- 6 cups of sugar
- ¾ cup of liquid pectin

Pulverize and then liquefy the strawberries and rhubarb in a blender. Using either a jelly bag or two layers of cheesecloth, gently squeeze out 3 ½ cups of juice and put it in a saucepan, mixing with the sugar, and then bring to a rolling boil. Add the pectin and allow to boil vigorously for *one minute only,* remove from heat, and immediately pour into hot sterile jars, leaving ¼ inch of headspace. Process five minutes in a boiling water canner. Yield: 5 half-pints.

Apple Jelly

- 5 lbs apples
- 5 whole cloves
- ½ tsp cinnamon
- 8 cups water
- 8 cups sugar

Wash the apples and cut them in quarters, and put them in a covered casserole pan with the eight cups of water and spices. Put in the oven at 225 degrees overnight. In the morning, strain through cheesecloth or a jelly bag and collect the liquid. Add it to the cooking pot one cup at a time, simultaneously adding one cup of sugar for every up of liquid. Heat to a rolling boil, stirring constantly, and check with a candy thermometer until it is boiling at 220 degrees. Immediately pour into hot sterilized pint or half-pint jars, tighten the lids finger-tight, and process for five minutes in a boiling water canner. Yield: 8 half-pints.

The same techniques covered in the recipes above can be used successfully with other fruits. For fruits high in natural pectin and acid, use the second recipe as a guide, and use the first recipe as a guide for fruits lacking pectin. For fruits that lack both pectin and acidity, use the first recipe as a guide but add 1 ½ tsp of lemon juice per cup of liquid. Jams are made the same way except the entire fruit is pulverized and used, rather than just the juice.

Brined Pickles and Kraut

Pickling preserves food by raising its level of acidity. It is used for foods that are not naturally acidic enough to be safely canned using a boiling water method. The two methods most widely used are lactic acid fermentation in brine, and infusing with vinegar.

Brine fermentation is most often used with cucumbers to make kosher-style dill pickles, but it is also used to make sauerkraut. Many other vegetables—like collard greens—can also be processed this way, but since I've never tried it myself, I can't guarantee the results will be tasty! There are three very important aspects of doing brine fermentation. First, keep everything clean. Second, use only plain salt with no additives whatsoever, or all sorts of cloudiness and discolorations will result. (Regular salt contains anticaking agents that will make the brine cloudy as well as iodine that will inhibit proper fermentation. Use canning salt!) Finally, pay close attention to the correct procedure, or your pickles will be soft and possibly even slimy.

Brine fermentation can take several weeks. It is also temperature sensitive and works best at temperatures ranging from 55 to 75 degrees. Before starting brined pickles, make sure you have both the time and the space to leave the containers undisturbed for a while. You should only use glass, nonchipped enamel, or food-grade plastic containers for fermentation. Under no circumstances should you consider using a metallic container because the product will become contaminated and possibly even poisonous. Don't use old-fashioned wooden barrels because sterilizing them is practically impossible. Start off with well-cleaned containers and well-washed produce.

Brined Dill Pickles

- 5 lbs of 3- to 4-inch pickling cucumbers
- 3 heaping Tbsp whole pickling spice
- 8 heads of fresh dill (⅓ of a bunch)
- ¾ cup white (distilled) vinegar
- ½ cup pickling salt
- 5 pints (10 cups) of clean pure water

The proportions of salt, vinegar, and water in this recipe are not approximations—measure them exactly! You can double or quadruple the recipe if you keep the proportions the same for a larger batch of pickles. Put half of the pickling spices and a light layer of dill in the bottom of a clean food-grade plastic pail or pickling crock. Put in the cucumbers. Mix the remaining dill and spices with the salt, vinegar, and water and pour over the cucumbers. If the amount of liquid isn't enough to come bout two inches above the cucumbers, make more liquid from water, salt, and vinegar according to the same proportions. Take a clean plate and place it on top of the cucumbers so they are held completely under the brine. The plate may need to be weighted down with a second plate. Cover the container loosely with plastic wrap covered with a clean towel held on with a couple of bungee cords tied together around the container like a big rubber band. Try to keep at room temperature—certainly no warmer than 72 degrees and no cooler than 60 degrees.

Uncover and check the pickles for scum once a day. Use a clean spoon to scoop off any scum, then put the towel back on. This should be the only time the pickles are uncovered. After three weeks, check the pickles by removing one from the container, cutting it lengthwise, and tasting it. If it is translucent and tastes like a good dill pickle, you are ready to can the pickles. If not, wait another week and try again.

Once the pickles are ready, remove them from the brine and pack into cleaned and cooled glass jars with a couple of heads of dill added to each jar. Take the brine, pour it into a large saucepan, and bring it to a boil, then pour it over the pickles in the jars, leaving ¼ inch headspace. If you run out of brine, make additional brine from 4 pints of water, ¼ cup of salt, and 2 cups of vinegar raised to boiling. (Again, proportions are exact rather than approximate—use measuring cups!)

Put the lids on finger-tight, and process 10 minutes for pints or 15 minutes for quarts in a boiling water canner. Yield: 10 pints.

Sauerkraut

- Cabbage
- Canning/pickling salt

Any sort of cabbage can be used for this recipe, but larger heads tend to be sweeter. Remove any damaged outer leaves, quarter the heads, and remove the hard cores, then weigh the cabbage on a kitchen scale. Weighing the cabbage is important because the weight determines the amount of salt to use—3 Tbsp of salt per 5 pounds of cabbage. Shred the cabbage into slices of about ⅛ inch thickness, and using clean hands thoroughly mix the cabbage with the salt. Put the mixture into a five-gallon food-grade plastic container a little at a time and use a clean potato masher to mash the mixture until enough) juice has been squeezed out of the cabbage that at least one or two inches of juice are above the cabbage by the time all the cabbage has been added.

Fill and seal a noncolored food-grade plastic bag with a mixture of 6 Tbsp salt and 1 gallon of water, and put this on the cabbage to weigh it down and keep it completely submerged, then cover the top of the container with plastic wrap. Keep the container at room temperature, and in four weeks, your sauerkraut will be ready. Just like with the brined pickles above, check daily for scum and remove any that you find. Once the kraut is ready, pour it in a large pot (or a portion of it at a time depending on the relative size of your pot) and heat while stirring to 190 degrees as indicated by a candy thermometer. Do *not* let it boil. Pack into clean canning jars and add brine to leave ¼ inch of headspace, and process in a boiling water canner for 15 minutes for pints or 20 minutes for quarts. Yield: depends on how much cabbage you use.

Quick Process Pickles

Quick process pickles rely on vinegar for their acidity rather than fermentation, so they are faster and easier to make. (And you needn't worry about scum!) the vinegar used to make pickles lends its own character to the pickles, so be cautious about using flavored vinegars such as red wine, cider, or balsamic vinegar unless specifically required in a recipe. When the type of vinegar isn't mentioned in a recipe, use white distilled vinegar. The preservation process relies on a certain specific amount of acid, so always use vinegar that is 5% acidity.

Bread and Butter Pickle

- 4 lbs cucumbers, washed but not peeled
- 3 thinly sliced medium onions
- ⅓ cup of canning salt
- 4 cups distilled vinegar
- 3 cups sugar
- 2 Tbsp mustard seed
- 1 Tbsp + 1 tsp celery seed
- 1 ½ tsp turmeric
- 2 tsp whole black pepper

Slice the cucumbers ¼ inch thick and the onions as thinly as practical. Combine all of the ingredients except the cucumbers and onions in a large sauce pot and bring to a simmer (not a boil!). Add the cucumber and onion slices, and bring to a very light boil before turning down the heat to low. Pack the slices into jars and then fill with pickling liquid to ¼ inch headspace, and put the lids on the jars finger-tight.

For the most crisp pickles, pasteurize by placing the jars in water deep enough to be at least 1 inch over the top of the jar lids that is kept at 180–185 degrees (check with a candy thermometer) for 30 minutes. Alternatively, you can process in boiling water for 10 minutes for either pints or quarts. Allow to sit six weeks before using for the development of full flavor. Yield: 4 pints.

Vegetables

Vegetables (other than tomatoes) are not acidic enough to be canned using the boiling water method. Instead, they must be processed in a pressure canner for a fairly long period of time. The process is essentially the same for all vegetables, the only difference being in the processing time. For larger vegetables, cut into pieces so that there is at least one dimension less than ½ inch thick, bring pieces to a boil in water (to which ½ tsp of salt per quart can optionally be added), pour hot into clean jars allowing the right amount of head space, put on the caps finger-tight, and process for the time specified in Table 19. You might consider using a little sliver (½-inch x 1-inch) of kombu kelp instead of salt. Kelp enhances the flavor of canned vegetables because of the natural glutamaic acid that it contains.

Generally, the pressure-canning methods employed with vegetables destroy a good portion of the vitamin C, so I recommend freezing instead. Regardless, the macronutrient and mineral values of vegetables remain intact after canning, so it is worthwhile if you don't have a freezer or reliable electric service.

Meat

Meat is usually better vacuum sealed and frozen, but where the electrical supply is unreliable or too expensive, canning meat is a viable alternative. Because canning times and temperatures for meats are significant, most vitamins that can be destroyed by heat, especially vitamin C, are destroyed in the process. On the other hand, both the protein and mineral value is unaffected, so as long as you have plenty of vegetables in your diet, canned meat isn't a problem.

While the USDA says that putting raw meat into jars and then processing it is safe, it is my opinion that the flavor suffers. So I recommend that all meats first be soaked for an hour in a brine made with 1 Tbsp salt to a gallon of water and then at least lightly browned in a little vegetable oil until rare and then packing into the jars. Once the meat is packed into the jars, the jars should be filled with boiling water, meat broth, or tomato juice to leave the amount of headspace described in Table 19. Most people prefer ½ tsp of salt added per pint, but this is optional. Put on the lids finger-tight, and process for the appropriate length of time. You can season meats before caning them, but avoid sage because the prolonged high temperatures can cause bitterness. Also, any meat broth you use *shouldn't contain flour, corn starch, or any other thickening agent* because, under pressure canning conditions, thickening agents congeal and make it impossible to get all of the air properly evacuated from the cans, and the risk of spoilage is increased.

Soups, Stews, and Other Mixtures

When canning anything that is a mixture of more than one ingredient, the time and headspace requirements from Table 19 that are the longest and largest for any of the ingredients apply. So if, for example, a mixture of carrots and peas were being canned, the processing time and headspace requirements for peas would be used since those are the greatest. The same warning about thickening agents regarding meats applies to stews as well.

Buffalo Stew

- 4 lbs buffalo stew meat cut into 1-inch cubes
- 12 medium red potatoes cut into ½ inch cubes
- 5 medium yellow onions, diced
- 2 lbs of carrots sliced ¼ inch thick
- 2 stalks celery
- 1 Tbsp cooking oil
- 1 tsp salt
- ½ tsp ground black pepper
- 1 tsp thyme
- 1 clove garlic
- 3 quarts water

Get the three quarts of water boiling in a large saucepan and brown the stew meat in oil in the bottom of another large saucepan. Add all of the spices and vegetables to the meat, stir thoroughly, cover, and allow to cook down for five minutes. Then pour in the three quarts of boiling water slowly and carefully, and bring everything to a boil. Put into jars leaving 1 inch of headspace, and process in a pressure canner for 75 minutes for pints or 90 minutes for quarts. Yield: 9 pints.

Freezing

Like canning, freezing has its pros and cons. In its favor is that it is easier and quicker to freeze vegetables and meats than it is to pressure can them, and the resulting product is usually closer to fresh in terms of quality. Some things, like broccoli, are just plain inedible when canned but perfectly fine when frozen. The downside is that when freezing an appreciable amount of food, a large freezer is required—which isn't cheap. Figure at least $500 for a new one at current market price. Also a consideration is the ongoing ever-increasing cost of electricity. And, if you are in an area prone to long electrical outages, you could lose the entire contents of your freezer if you don't maintain a backup power supply of some sort. So you'll have to weigh the advantages and disadvantages. We have a reliable electric supply and not a lot of spare time at my house, so we do a lot of freezing.

I used to freeze in regular freezer bags from the grocery store or wrap things in freezer paper. No more! Now, the only method I use, and the only method I recommend, is vacuum sealing. Vacuum sealing consistently yields a superior product that keeps up to five times longer, so it is what I'll describe.

Getting a Sealer

I got my first vacuum sealer at a Boy Scouts yard sale, complete with instructions and a bunch of bags, for $3. Evidently, people often purchase sealers thinking they will be handy and use them once or twice, and then they end up in the yard sale bin. It may not be practical to wait around for a sealer to show up at a yard sale while harvest season comes and goes—but it never hurts to look.

There is another big reason why these sealers end up in the yard sale bin: the price of bags. The name-brand bags at the store that carry the same name as the sealer you buy will cost over $0.50 each. You don't have to do a lot of math to see that spending that much on just the bag to store a product (like broccoli) that you could buy frozen at the store for $0.99 isn't a winning proposition. I'll give you some solutions to that problem in the next section.

There are two suitable sealers on the market in various configurations available at department stores—the Seal-a-Meal and the Food Saver. I've found both to be adequate, though you will find the FoodSaver a bit more expensive. I prefer the Seal-a-Meal since its design allows it to work better with a wide variety of bags. These are light-duty home-use units. They work fine for the amount of freezing that I do for the carbohydrates and vegetables for a family of three because we tend to freeze in relatively small batches of 10 or fewer packages at a time. Heavy-duty commercial units are available—but you should hold off on these until you see if the less expensive home-use units will meet your needs. Certainly they will work fine as you ramp up for the first couple of years.

Bags

As mentioned earlier, the name-brand bags for sealers are expensive—sometimes even more than $0.50 apiece. Luckily, you can get around this problem a number of ways. First, keep an eye out for the sealers and bags at yard sales. Second, use plastic rolls instead of premade bags because by cutting them to size for what you are freezing, you will use a lot less and save money. Finally, you can buy bags and rolls from brands other than those made by the manufacturer of your sealer. Two sources come to mind. First, a number of manufactures make less expensive bags and/or rolls including Black and Decker, FoodFresh Vacstrip, and Magic Vac. These usually cost less than half of what the other bags do. Second, check the Internet. There are eBay stores dedicated strictly to vacuum sealer that offer good deals and also websites dedicated entirely to getting good prices on bags, such as vaccum-sealer-bags.com. with these resources in hand, you will see the superior properties of vacuum sealing become financially viable.

The Freezing Process

Freezing is a six-part process that requires harvesting, blanching, cooling, drying, sealing, and freezing. First, since no form of food preservation can actually improve the quality of food, harvest as close to freezing time as possible, and thoroughly clean the produce. Hose it off with the garden hose

Weighing produce for consistent portions helps with menu planning.

outside first, then put it in a big bucket to soak that contains two tablespoons of salt per gallon of water to draw out any insects. Then cut it up as needed, rinse out the salt, and weigh it into portions using a kitchen scale. For vegetables, figure 4 ounces per person. So for a family of four, you'll want your bagged portions to be about 16 ounces, or 12ounces for a family of three.

Next comes blanching. Blanching serves to inhibit the enzymes that destroy the quality of food in storage. There are two common methods—placing the produce in boiling water for a period of time, or steaming it for a slightly longer period of time. Both methods work, but I recommend steaming because it preserves more of the vitamin content of the food. The blanching time varies depending on what is being frozen (see Table 18).

This steam blancher is just one of many steamers available.

Cooling down the produce in ice water after blanching.

When the allotted blanching time has passed, the produce should be dumped into a bucket of ice water so that it is cooled down immediately. (I slip a metal colander into the bucket first so that it holds the produce and makes it easy to retrieve.)

Leave the produce in the ice water for the same amount of time as it was being blanched, then take it out and put it between a couple of superclean, dry, and fluffy towels to pat dry. You have to do this when vacuum sealing otherwise the large water content gets in the way of making a good seal.

Once the produce has been dried, it is placed into bags and sealed. After the bags have been sealed, put them into the freezer in various locations so that they will freeze in various location so that they will freeze more quickly. Come back and rearrange them in 24 hours.

For some vegetables, particularly potatoes, and Jerusalem artichokes, discoloration can be a problem. This is easily solved by adding one tablespoon of citric acid or two tablespoon of lemon juice per gallon or water to the ice water being used to cool the vegetables after blanching.

Meats and fruits aren't handled the same way as vegetables. Usually, meats are frozen raw, though I find that they freeze better if firs soaked in a light brine (one tablespoon salt/gallon) to draw out any blood and then patted dry. The reason for drawing out the blood is so it doesn't interfere with vacuum sealing. Another way to accomplish the same thing (which I do with ground meats) is put the meat in a regular zipper bag and put it in the freezer overnight, then remove it from the zipper bag and immediately seal it in a vacuum bag—the frozen juices then won't interfere with sealing. With wild game such as squirrel or deer, I recommend soaking for an hour in a light brine, as that removes some of the "gaminess" from the meat.

Fruit is best frozen in a sugar syrup like used when canning. Once the sugar is dissolved in the water, you can add ¼ teaspoon of vitamin C or 2 teaspoons of lemon juice per pint of syrup to prevent

Table 18: Blanching Times

Produce	Water Blanch	Steam Blanch
Artichoke, globe	7–10 min	Not recommended
Artichoke, Jerusalem (chunks)	5 min	7 min
Asparagus spears	3 min	4 min
Beans, lima, butter, edamame	3 min	5 min
Beans, string	4 min	6 min
Beet roots, sliced ¼"	12 min	Not recommended
Broccoli	4 min	4 min
Brussels sprouts	4 min	6 min
Cabbage, shredded	2 min	3 min
Carrots	3 min	5 min
Corn (on the cob)	10 min	Not recommended
Corn (whole kernel)	5 min	7 min
Greens of all sorts	3 min	5 min
Parsnips, sliced	2 min	3 min
Peas, shelled of all sorts	2 min	3 min
Peppers	3 min	4 min
Potatoes, sliced/cubed	5 min	7 min
Turnips, diced	3 min	4 min

darkening. Slice or dice the fruit and put it in a can or freeze jar or suitable plastic container and then cover the fruit with syrup, leaving one inch of headspace to allow for expansion in the freezer.

Drying the produce with freshly cleaned towels before bagging

Sealing with a vacuum sealer preserves freshness longer.

Dehydrating

Drying food is one of the oldest methods of food preservation. By removing most of the moisture from foods, enzymatic action and microbial growth are retarded, and the food will keep for a long time. Food loses more nutritional value from drying than from freezing, and dehydrated foods will seldom reconstitute with water to look like appetizing fresh produce. But even at that, dehydrated products make a conveniently stored, tasty, and healthy addition to soups, stews, and sauces. When my daughter was little, I used to powder mixed dehydrated vegetables in a blender and stir that powder into her spaghetti sauce so she'd get a mix of vegetables without knowing it. She also loves dehydrated apple rings as a snack, and other dehydrated fruits make a great addition to oatmetal in the morning.

Just like vacuum sealers, dehydrators run the gamut from inexpensive units available at department stores costing less than $50 all the way to commercial-sized behemoths. I recommend starting with a small model that includes a fan and thermostat since that will be easy and trouble free. You can always switch to a more expensive commercial or even homemade unit later. (Dehydrators lend themselves easily to homemade solutions, and literally dozens of free designs—including solar designs—are available on the Internet just by doing a Web search that includes the terms "homemade" and "dehydrator.") You can use a dehydrator for fruits, vegetables, and meats, though the process for the three is somewhat different.

Vegetables destined for the dehydrator need to be cut in slices no more than ¼ inch thick and blanched just as though they were going to be frozen. This helps them dehydrate better and keep longer. Fruits should also be sliced no more than ¼ inch thick and then dipped in a solution containing one tablespoon lemon juice per quart of water before being put in the dehydrator. Fruit shouldn't be blanched. Every dehydrator is different in terms of its drying characteristics, so use the drying times and temperatures recommended in the literature that comes with your particular model.

Meats, especially ground meat and poultry, are problematic because dehydrating is not the same thing as cooking, and the temperature seldom gets high enough to ensure pathogen destruction. This becomes an issue because bacterial contamination of these meats is common, so failure to thoroughly cook them can result in serious illness or even death. There are some jerky mixes available at department stores that are specifically formulated to deal with potential contamination of ground meats through the use of nitrites. If you choose to use one of these mixes, follow the directions precisely! Outside of this exception, I don't recommend making jerky or dried meat from either ground meats or poultry. Other meats—like beef steak/roast, venison, buffalo, and so forth—are perfectly fine.

Most jerky recipes are for raw meat. In recent years, a number of universities have done studies and concluded that the practice can no longer be considered safe and that meat for jerky should be precooked in a boiling marinade. With the foregoing in mind, then, here is my general-purpose jerky recipe.

Brett's General-Purpose Jerky

- Start with prefrozen and partially thawed beef, buffalo, moose, venison, and so on. Trim away any visible fat and slice meat into uniform ¼ inch-thick slices across the grain.
- Create marinade in a saucepan by combining 2 ¼ cups of water, ¾ cup teriyaki soy sauce, ½ tsp of liquid smoke, and a dash of Tabasco sauce. Raise to a gentle rolling boil.

- Putting only a few strips of meat in at a time, boil a few strips in the marinade until uniformly gray then remove from the marinade with tongs and place on the drying rack of the dehydrator. Repeat this process until all of the meat strips have been used.
- Dry according to manufacturer's directions, or at a temperature of 140 to 150 degrees for six or more hours.
- Test to see if the jerky is done by taking a piece off the dehydrator, letting it cool to room temperature, then bending it. If it cracks but doesn't break, it is done.

Root Cellaring

Root cellaring is one of the best methods of preserving certain foods, including onions, cabbage, potatoes, carrots, parsnips, and apples, among others. The key to success at cold storage is establishing conditions conducive to long storage life, and these conditions include darkness, certain temperatures, and particular ranges of humidity.

Many things can be preserved via root cellaring for some small period of time ranging from days to a couple of weeks, while others can be preserved for times ranging from several weeks to several months. Invariably, food that can be stored only for a short time is better preserved via some other method. This includes all brassicas except late cabbage, asparagus, beans, sweet corn, cucumbers, summer squash, lettuce, tomatoes, eggplant, spinach, melons, and peas.

Other foods, though, can be preserved in a root cellar for extended periods assuming proper temperatures and humidity are maintained. Unfortunately, these aren't the same for all crops, but thankfully we don't have to be too fine-grained in our specification because, in general, crops that do well in a root cellar fall into broad categories.

Everything but onions and garlic will do well with humidity ranging from 85% to 95%. Onions and garlic require humidity ranging from 50% to 75%. All fruits store best at temperatures as close to 32 degrees F as possible, and almost all vegetables as well, except for late potatoes, which do best at 35 degrees F to 40 degrees F.

So, in general, cold storage requires an environment that is humid, dark, and close to 32 degrees F without going under. The real question becomes how to create and maintain such an environment in homes that were not designed with root cellars.

If you have a cellar of any sort, a portion of it can be turned into a root cellar simply be walling off a corner, insulating the walls thoroughly, providing some sturdy shelves up off the floor, and installing some ventilation that will allow cool air to enter near the floor (PVC pipe is good for this) and warm air to exit near the ceiling. You'll want a thermometer so you can keep an eye on the temperature and shut off or limit ventilation if it starts to sink too low. (This may or may not be a problem depending on where you live.) If humidity is insufficient, you can add a humidifier.

Most produce should be placed in open-weave baskets and kept up off the floor and shouldn't be piled deeply as the pressure from the weight of produce on the lower layers could cause premature rotting. Fruits should be stored only one layer deep and, if possible, individually wrapped in tissue and not touching other fruit. Carrots and parsnips should have the tops snapped off and then be buried in dampened clean sand in a box sitting on the floor.

If you don't have a basement, you could bury a drum in the ground or build an external root cellar. For more details on how to build root cellars, check out the book *Root Cellaring* by Mike and Nancy Bubel.

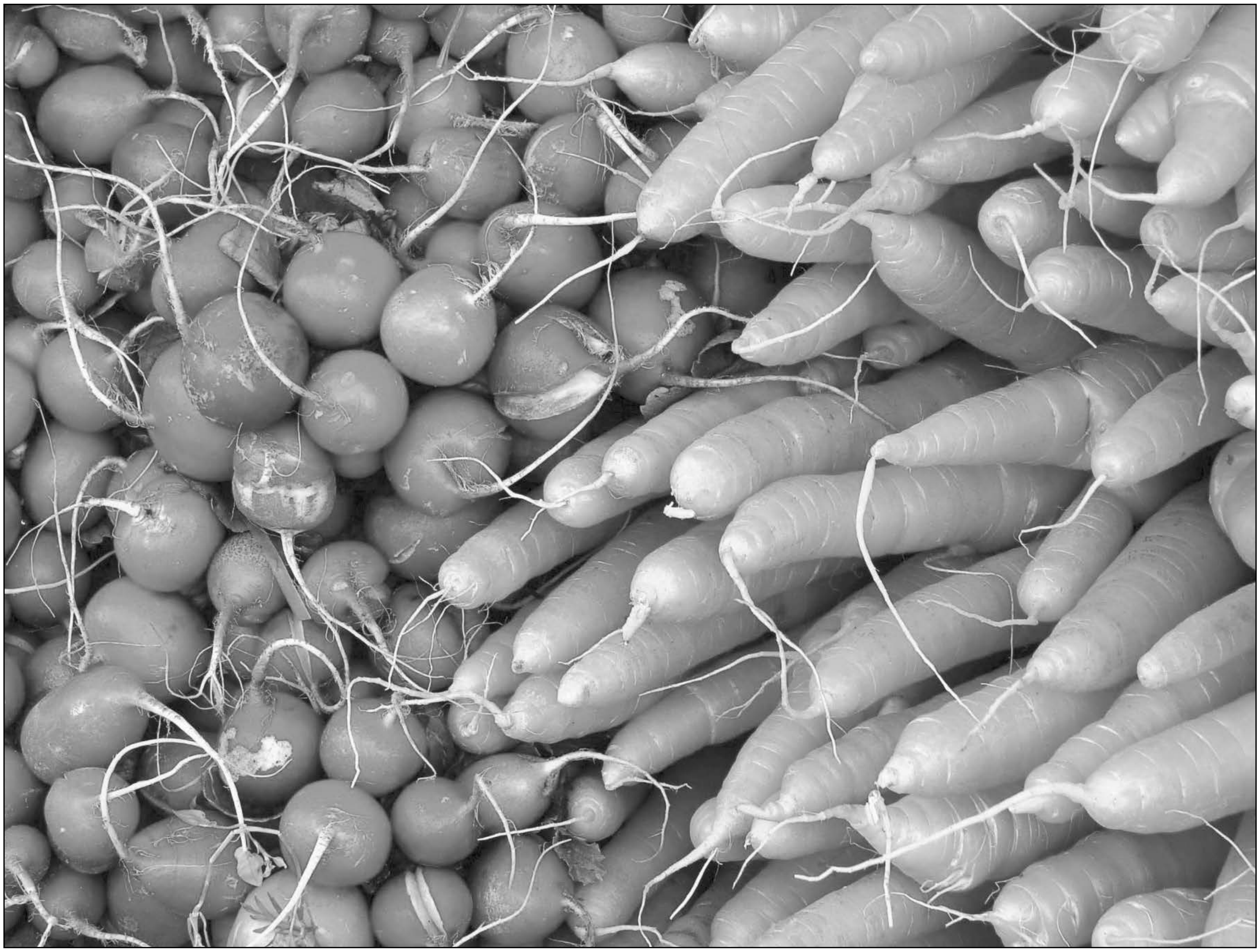


Table 19: Canning Times and Methods

Food	Packing Method	Headspace	Canning Method	Time for Pints	Time for Quarts
Apples (sliced)	Hot packed	½"	Boiling water	20 min	25 min
Applesauce	Hot packed	½"	Boiling water	15 min	20 min
Asparagus	Hot packed	1"	Pressure (10 lbs)	30 min	40 min
Beans (dry)	Hot packed	1"	Pressure (10 lbs)	75 min	90 min
Beans (shelled lima)	Hot packed	1"	Pressure (10 lbs)	40 min	50 min
Beans (snap)	Hot packed	1"	Pressure (10 lbs)	20 min	25 min
Beef, lamb, pork, venison, and bear (strips, cubes, ground, or chopped)	Hot packed	1"	Pressure (10 lbs)	75 min	90 min
Beets (sliced)	Hot packed	1"	Pressure (10 lbs)	30 min	35 min
Berries (all types)	Either	½"	Boiling water	10 min	15 min
Carrots (sliced)	Hot packed	1"	Pressure (10 lbs)	25 min	30 min
Cherries	Fresh packed	½"	Boiling water	20 min	25 min
Cherries	Hot packed	½"	Boiling water	10 min	15 min

Corn	Hot packed	1”	Pressure (10 lbs)	55 min	85 min
Fish	Fresh packed	1”	Pressure (10 lbs)	100 min	Don’t use quarts
Fruit purees	Hot packed	¼”	Boiling water	15 min`	20 min
Greens, spinach, chard, kale, collards	Hot packed	1”	Pressure (10 lbs)	70 min	90 min
Jams and jellies	Hot packed	¼”	Boiling water	5 min	Don’t use Quarts
Meat stock (any nonseafood meat with seasoning)	Hot packed	1”	Pressure (10 lbs)	20 min	25 min
Peaches, pears, plums, nectarines	Fresh packed	½”	Boiling water	25 min	30 min
Peaches, pears, plums, and nectarines	Hot packed	½”	Boiling water	20 min	25 min
Peas (shelled)	Hot packed	1”	Pressure (10 lbs)	40 min	40 min
Peppers (hot/sweet)	Hot packed	1”	Pressure (10 lbs)	35 min	Don’t use quarts
Pickles (fermented)	Fresh packed	½”	Boiling water	10 min	15 min
Pickles (quick process)	Hot or fresh	¼”	Boiling water	10 min	15 min
Potatoes (1/2” cubes)	Hot packed	1”	Pressure (10 lbs)	35 min	40 min
Poultry, rabbit, or squirrel with bones	Hot packed	1 1/2”	Pressure (10 lbs)	65 min	75 min
Poultry, rabbit, or squirrel without bones	Hot packed	1 1/2”	Pressure (10 lbs)	75 min	90 min
Pumpkins and squash	Hot packed	1”	Pressure (10 lbs)	55 min	90 min
Rhubarb	Hot packed	½”	Boiling water	10 min	10 min
Sweet potatoes (cubed)	Hot packed	1”	Pressure (10 lbs)	65 min	90 min
Tomatoes (acidified)	Fresh packed	¼”	Boiling water	40 min	50 min

Raising Animals

Chickens

BY LAURA CHILDS

No farm animal typifies the country-living experience better than a chicken. A few scattered hens lazily picking through the grass, a rooster strutting along the fence rail, or the whole lot scurrying to the child who calls them in for grain—their very presence on the landscape stirs the romanticism of simpler times.

Psychological effects aside, the rewards of keeping chickens are numerous. They'll bless your home with the finest quality, the tastiest, and the healthiest eggs and poultry you have ever consumed.

Since early domestication, this is the way chicken and eggs were meant to be enjoyed. Your taste buds will be challenged to be satisfied with the grocer's version ever again.

Knowing that the food at home is superior in all regards, you might find yourself turning up your nose at restaurant and take-out meals in the very near future.

Chickens are also an easy, inexpensive keep. Provided that you already have a small shed, you could be enjoying fresh eggs just a few days from now.

If I had but four sentences to describe the joy of keeping chickens they would be: "Cheap to purchase and to feed. Don't require much in way of housing. A few minutes per day to care for. Blessings unnumbered as reward." Where else can you get so much for so little?

Energy-Efficient Poultry

It takes:

Twenty pounds of feed to produce one pound of beef (20:1).

Two pounds of feed to produce one pound of chicken (2:1).

0.7 pounds of feed to produce 0.2 pounds of protein in an egg (3.5:1).

A Healthier Alternative for Your Family

Purchasing poultry and eggs at your local grocery store is a budget friendly way to feed your family. Compared to an unknown risk—that raising chickens at home might cost more—you may wonder if the added responsibility is worth all the bother. Setting economics and household budgets aside for later discussion, I assure you that raising your own eggs and poultry is definitely worth the bother. What you don't pay for today at the grocery store, you may be paying for in the future with your health.

Commercially raised poultry and eggs are reasonably priced due to the volume and efficiency of chicken factories in North America. With highly efficient systems and rigorous demands, these factories have mastered the art of maximum output with minimal waste of labor, space, and feed. Although it may be admirable on the surface (their efficiency facilitates lower grocery bill totals for families), you can't help but wonder, "At what real cost?"

- Less flavor and freshness
- More chemicals, residual antibiotics, and unnatural hormones in the end product
- Our consumption of animals that have led miserable lives

This is what we have been feeding, for the most part unaware, to ourselves and to our families, the effects and health risks of which are yet to be fully discovered and disclosed.

Until now.

In the last ten years, there have been no escaping monthly news reports across the continent, health articles around the world, and feature film documentaries on the implications of production-raised poultry. Large-scale poultry growers and egg factories are fined or shut down regularly for unsanitary, inhumane, and unethical practices. Many more continue to operate unnoticed. Neither blowing the whistle nor passing judgment on every packing house or poultry factory, are the following growing practices are both common and sickening.

- Meat birds are being fed hormones for fast growth. To deal with unsanitary conditions and stress-related sickness brought on from overcrowding, they are also fed a steady diet of antibiotic-laden feed.
- Laying hens are restricted to cages barely larger than their own bodies, in rooms where lights are left on for twenty-four hours a day, fed production-inducing and antibiotic-laden feed, and then culled the very day they stop laying.

Red sex-link hens, confined from the age of twenty weeks, spend their lives eating and producing eggs in harsh conditions.

These are possibly the only avenues a chicken factory has to feed a hungry, budget-conscious nation while still turning a profit. Yet our increasing awareness of these practices make inexpensive eggs and poultry seem less a bargain in the checkout line.

There is a better way.

Growing your own chickens and keeping laying hens buys you peace of mind. You know precisely the quality of the nourishment you are setting upon your dinner table, the humane manner in which that animal has been raised, and who you are supporting through purchase.

The Challenges of Chickens

Raising your own poultry is personally satisfying, but the journey from chick to table will have a few challenges along the way.

Although the positive aspects outweigh the negative, three common annoyances are dust, smell, and noise. The latter two are easily controlled. Dust, however, is inescapable.

Even a flock of ten chickens can create a considerable amount of dust through their litter and dander. This, plus the possibility of disease or virus transfer to other farm animals, is the main reason poultry need their own shelter.

A substantial portion of your coop chores will be based on dust removal. As long as the chickens are self-contained and healthy, it is your personal choice either to manage it regularly or to delegate the task to a larger, quarterly cleaning. As you've protected other farm animals from poultry dust, don't neglect yourself during coop cleaning. Wear a surgical mask, or even a kerchief over your nose and mouth, to avoid inhalation of the fine dust. Lung-health implications are now known to be cumulative.

The final two challenges, smell and noise, are often neighborly complaints. Sharing your farm-fresh eggs across the fence will go a long way to keeping the peace. If your coop is located on a shared property line, add a little extra litter to dramatically reduce coop odors, and avert potential noise complaints by opting out of keeping a rooster. A rooster's crow begins at the very first show of light, continues throughout the day, and can carry for a mile or more. Unless you are planning on breeding your laying hens and hatching out chicks, the rooster is nothing more than pretty plumage.

To keep all animals on your farm protected, chickens should have their own shelter.

Choosing a Breed to Raise

Knowing your objectives for raising chickens is the first step to selecting a breed that is right for you. While some breeds have been developed for maximum egg production, others excel at quick growth and efficient feed conversion. Chicken breeds are therefore classified as egg layers, meat birds, or dual-purpose. A final class, the exhibition breeds are beautiful and useful but are not considered top producers for home farms. For your time, space, and money, the first three classifications provide the highest return on investment.

The list of chicken breeds to choose from is extensive. On GoodByeCityLife.com, I maintain an ever-growing list of over one hundred known breeds, and I have only scratched the surface. All reputable hatcheries produce catalogs of the most popular breeds for your region, as well as a few fancy and hatchery-developed hybrids. Within each description you'll discover the hardiness, expected size, and production rates of each breed offered.

> **Chicken Fundamentals**
>
> Although a few breeds' needs vary in particularity, chickens all require three commonalities in care:
>
> - A commitment to a chore schedule that keeps their coop and equipment clean.
> - Access to fresh water and feed at all times.
> - Safety from disease, weather extremes, and predators.

Egg Layers

The egg-laying breeds have been developed to provide maximum egg output from the smallest feed intake. Although the hens of these breeds perform best in the controlled environments of large-scale farming, their small-farm use is popular with families looking only for a supply of fresh eggs. Supplementary heat and lighting ensures healthy hens provide a steady supply of eggs in regions where temperatures drop below 60 degrees Fahrenheit.

should you choose production over personality, the White Leghorn is considered a top layer in her class. These hens are high strung and seldom bond with their keepers, but their feed-to-egg ability is unmatched.

Hens in this class will lay six to seven eggs per week for two years. By their third year, output is decreased to 50 percent or less and the hens are considered spent. Hens are small and the meat can be tough but may be sufficient to flavor a small soup.

> **The Productive Life of a Laying Hen**
>
> A pullet (female chicken) will have eaten twenty-five pounds of feed before she begins laying at twenty to twenty-four weeks.
>
> At thirty weeks she will produce a standard-size egg almost daily.
>
> At seventy-five weeks of age she will go through a molting period (replacing old feathers with new) for approximately eight weeks. During the molt she may not produce at all.
>
> In her first laying year she will supply about twenty dozen eggs.
>
> In her second year her eggs will be larger but production will decrease to sixteen to eighteen dozen eggs per year. By the third year she is considered a spent hen and may only lay one egg every three to four days.

Meat Breeds

Very few North Americans raise a pure meat breed for the freezer, opting instead to raise a faster-growing cross. The most popular and easy-to-grow cross is that of a Cornish game (a true meat breed) with the Plymouth Rock (a dual-purpose breed) for its excellence in feed-to-meat conversion. A good cross will eat two pounds of feed for every pound of weight gained. By nine weeks of age the conversion ratio begins to deteriorate and the birds are ready to be butchered.

The drawback to growing these crosses is that they can neither be bred nor kept long-term. Each time you need to replenish your freezer's supply of poultry you'll be back at the hatchery placing another order.

The Barred Plymouth Rock, developed in America is a proficient dual-purpose layer that also grows to broiler size by twenty weeks of age.

Dual-Purpose Breeds

It is in this class you will find the breeds that fulfill the romanticism of country life. The dual-purpose breeds produce and grow at similar rates, have interesting personalities, and are easily trained. If your goal is to become self-sufficient, you could order a rooster to match your hens and eliminate the need to place future hatchery orders.

These breeds offer the most benefit to small farms. Early American settlers developed these breeds, producing weather-hardy hens and cockerels that grow to broiler size.

Although not as efficient at feed conversion as a meat breed cross, the dual-purpose cockerel finishes as a delicious three-pound meal for your dinner table by eighteen weeks. The hens, most of which you'll keep for two years, produce 75 to 80 percent of a dedicated egg-laying breed's volume.

The oldest and most popular breeds in this class are the Plymouth Rock, the Rhode Island Red, the Delaware, and the New Hampshire. Hatchery-specific hybrids and crosses are also popular in this class and are offered under a variety of names. As an example the common Red Sex Link or Red Star (or any other name the hatchery deemed marketable) is created by breeding a dual-purpose Rhode Island Red rooster to a laying-breed Leghorn hen. The resulting hens are hardier than the Leghorn and have a higher egg production than the pure Rhode Island Red. The resulting cockerels, however, have a slightly smaller finishing weight than a pure Rhode Island Red.

Chicken Instinct and Temperament

Chickens, an easy keep and simple in needs, have quirks and instinctual oddities all their own. They'll make you laugh, contemplate the human complexity of life, and frustrate you all at the same time with their actions and antics.

Whether you want to train your chickens to come running when you call, break bad habits, or understand and work within the scope of their quirks, you'll need to understand their instincts and motivations.

Social Order in Flocks

Chickens have a highly developed social order. Starting with the rooster or lead hen and organized down to the weakest chick, every flock member has its place.

Chickens raised together will have established the flock's social order by three weeks of age.

Social order is maintained through pecking. The top hen can peck everyone, and the second hen can peck everyone except for the top hen, all the way down the line until the very last hen. She is pecked by all but cannot peck back. If you watch closely you can note which of your hens are lowest in the chain.

Whenever you introduce a new hen to the flock, the social order is disturbed. The resulting aggression is worthy of concern. Existing flocks have been known to kill a new hen in their effort to "put her in her place." New hens need slow introductions into established flocks. A fence between them for a week or two helps make the transition smoother. As an extra precaution, introduce the new hen to the others one at a time, beginning with the lowest in the pecking order.

Cocks are always prone to a hearty scrap, even after they seem to have reached an understanding. If they have accepted their places and established their own flocks of hens and feed stations, the need to squabble is lessened. Some cocks are more aggressive than other and may never accept another male in their vicinity.

Cannibalism and Feather Picking

The worst pecking habit is cannibalism. In the brooding box and under bright heat lamps, chicks begin to feather out. Their brood mates, noticing the new small specks appearing, peck at each other. Pecking escalates, one weaker chick is picked on, and eventually the entire flock is in on the action.

These chickens are, for the most part, bored. With exercise and a red heat lamp (red minimizes the show of new feathers), you can prevent this altogether. Provide low perches at various heights for one- to four-week-old chicks to keep them occupied.

Feather picking is similar to cannibalism. Hens will pull on their own feathers as well as others in the flock. Although it can be prevented with a beak trim at sixteen to twenty weeks, it is more important to determine the cause. Improper feed, unbalanced nutrients in the feed, bright lights for too many hours, poor ventilation in the coop, overcrowding, boredom, and parasitic infestation are all known causes of feather picking.

Egg Eating

Laying hens, coming of age, commonly drop their first eggs on the floor on their way to the nesting box. The egg may crack or the other hens may peck at the egg. Chickens find eggs tasty and as soon as this happens, the egg-eating habit has begun—not even eggs laid in the nest will be safe.

Knowledge serves prevention. Watch coming-of-age layers and never leave an egg on the floor—even if it's soiled and your hands are full. If you have many hens laying their eggs on the floor, check the dimensions and accessibility of the nesting boxes you've provided.

Training Chickens to Come

Chickens, like most any other animals, can be trained through food reward. Scratch grain is easily accessible. My hens' favorite treats are cheese and cantaloupe. When you're training chickens to come, use a key word or sound to trigger a treat or you'll have them rushing to you at every sighting.

Training takes no time at all and could save a chicken's life if you need to get him back to the coop in a hurry. For a few consecutive days, while they're all going about their business, start calling them with your trigger word and drop a little scratch grain on clean, dry ground. A few will come over to investigate. Flock mentality will soon have them all around your feet. Keep using the trigger word and keep dropping grain for four to five minutes. That's all there is to it.

The Need to Brood

> **The Little Red Hen's Gosling**
>
> A few years ago my mother goose repeatedly, systematically, and daily, rolled one egg out of her nest. I kept putting it back. She kept rolling it out. I should have taken it as a sign of natural selection. Instead I tucked the goose egg under a laying hen already nesting on her own eggs. The goose egg took longer than the others beneath her, but my Rhode Island Red hen still hatched and mothered that gosling for months.

A hen's natural instinct is to lay a clutch of eggs, then sit on and hatch them. Yet, every day you enter the coop and remove her egg, effectively returning her to day one of the process. If she has a very strong desire to brood, she might sit on and defend any egg she finds in the nest.

Although noble and invaluable to the small flock owner desiring to increase flock size, the broody and protective trait isn't acceptable when eggs are required daily. The term "to break up a broody" and suggested practices to prevent broodiness (confinement, wire cages left in draft locations, denial of access to feed and water) are cruel and unnecessary. Broody hens have already gone off their food. Denying access completely will result in liver damage and other complications.

The best practice is to clip on a glove and keep removing the eggs from underneath her. In her own time she will stop trying to fight you for those eggs.

Quieting a Rooster's Crows

The domestic chicken has inherited and kept most of the traits of its wild ancestors. Roosters are a flock's only natural protection. Their crowing, carried on not just in the morning but throughout the entire day, is a territorial warning. You cannot retain instinct. Accommodations must be made. Although roosters are unnecessary if you don't plan on breeding your hens, many people enjoy their look, their desire to protect the flock, and their wake-up call. Melodious as it may be to you, your neighbors might not be as impressed at 4 A.M. on a Sunday morning.

Outwitting his instinctual nature is an option, but I would suggest that the following methods are neither easy nor entirely effective. Consider giving him away or, if he's young enough, dress him for your freezer.

Roosters know nothing of manners and a neighbor's need to sleep in on Saturdays.

Crowing is instinctual behavior. This is the rooster's means of protecting and maintaining his flock of hens—his very purpose in life. It can neither be untaught nor discouraged by any means. Surgery is possible, but expensive and inhumane.

To crow, a rooster must stand up tall and crane his neck upward. If you can prevent him from a full stretch, you might be able to quiet his earliest morning crows. This involves catching him every night and bedding him down in a cage that is too short for him to stretch. If you take this route every night while you look for a new home for him, be sure to release him as soon as you awake. It isn't fair to an animal to be awake, instinctively driven to crow, and immobilized.

A more humane short-term option might be to section off a dark corner of the coop and chase him in every night. Your goal is to trick him into believing it is still night until you release him in the morning. If he hears his hens stirring in the morning he may start crowing anyway. At the very least he will be stressed.

Designing Your Small Farm Strategy

After years of switching between various breeds—often raising two classes at a time—I have once again returned to keeping Barred Plymouth Rocks, a dual-purpose breed. My reasons for doing so are based on our family's needs, climate conditions, and available space (both in the coop and in the freezer). Your needs will vary from mine and, as your personal requirements change, overtime. To help you determine your best strategy from year to year, here are some of the top considerations before placing your hatchery order.

Meat Birds

- Grow meat birds to whatever size fits your family best. As an example, a family of four that doesn't enjoy leftovers might opt to grow their broilers to a three-pound dressed weight in seven weeks.
- Check your calendar before you order. If you will be butchering the chickens yourself you'll need a few days open for the task seven to nine weeks from the date day-old chicks arrive, or five to seven weeks from the date started chicks arrive. You don't want to overgrow any meat breed or cross when their conversion rates drop. You'll be losing money as well as potentially losing lives. Past the weight of seven to eight pounds (live weight) feed-to-muscle conversion becomes impractical. Personal experience has shown that almost all growth over nine pounds (live weight) is stored as fat that just ends up in the garbage bin anyway. Growing to obesity also wreaks havoc on your meat birds' overall health. Obese hybrids have an added sensitivity to heat and are prone to heart attacks.

Egg Layers

- Five or six laying hens at peak production will lay between two and three dozen eggs per week—an ample quantity for the average family of four. Add extra hens to your order and you'll always have an extra dozen to share with (or sell to) friends, family, and neighbors.
- Replace laying hens every two years. Productivity will be dramatically reduced by the third year. Even the hyper-productive Leghorn drops down to one egg every three days at this age.

Timing

- Plan on a spring start and you will move into the fall season with a freezer full of chicken meat and hardy hens laying in the coop.
- Starting with day-olds? You can raise meat birds and laying hens in one partitioned coop. By the time the layers need the space the meat birds will already be in the freezer.

- Dual-purpose cockerels take eighteen to twenty weeks to reach full size; hens take twenty-five to start laying.

Freezer Space

- If your family eats one chicken dinner per week you'll be raising over fifty meat birds throughout the year. Consider the option of raising two sets of twenty-five for fresher poultry throughout the year if your climate permits. Consider owning two smaller freezers and emptying out one halfway through the year to conserve energy.

Ordering

- Some hatcheries will let you specify your order to contain all male (cockerels) or a mix of both sexes. A little more expensive per chick, the males will grow faster and make better use of their food intake. If you grow only cockerels you will have yet one more reason to be committed to your finish date. Cornish-cross cocks—like any other breed—will squabble and crow at maturity. Ensure you get them to the freezer well before four months of age and you shouldn't have any problems with coop fights or crowing complaints.

Saving Money Raising Chickens

- All breeds will consume more food during cooler months.
- All breeds need supplementary heat if temperatures drop below 60 degrees Fahrenheit.
- Don't buy or keep a dual-purpose or laying-breed rooster if you don't plan on hatching chicks.
- A laying hen eats twenty-five pounds of grain before she'll lay her first egg. Consider buying started pullets or ready-to-lay hens.
- Running heat lamps, supplementary winter lighting, and coop heaters increases the cost of raising poultry. Minimize coop space for wintered chickens, add insulation, and keep the area draft-free to cut down costs.

The Chicken Coop and Yard

Although you will need to provide a shelter for your chickens, it merely needs to be adequate—adequate protection from extreme temperature and from predators, adequate space to eliminate stress-related illness from cramped living quarters, and adequate containment from your personal property and other farm animals' feed.

A shed or a corner of an existing barn will be sufficient. If you must build a coop, the simplest to build is a square building with:

- A slanted roof (rain should run away from the yard)
- Two doors, one for you and one for the chickens
- A ceiling tall enough that you can stand easily inside
- Enough space for the quantity of chickens you desire, plus room to add a few more along the way

Building a Stationary Chicken Coop?

Build it on a slight slope to prevent muddy yards during the rainy seasons.

Build it near a stand of trees, reducing the chilling effect of prevailing winds in the winter, but not so close that predators can jump from the trees to the yard.

If at all possible, have your coop wired for electricity. A heat lamp for new chicks, extra light during the winter for laying hens, or a small heater on the coldest nights of the year is a definite plus.

How Much Space?

Recommended space for a full-grown chicken is two to two and a half square feet—quite likely twice as much space as a chicken would receive in a poultry factory. Of the belief that a little more is a lot better, I allot four square feet each. This extra space means less concentration of odor, fewer fights among the flock, a lot less stress for the birds, and more places for you to put your feet when visiting the coop.

Based on my four-square-feet rule, twenty-five chickens of any breed can be housed in a ten-foot by ten-foot (one-hundred-square-foot) space. Add an outdoor run of another four hundred square feet (sixteen square feet each) and your chickens will have ample room to grow, explore, and exercise with few problems.

I apply the same principle when raising meat birds. Old-school farmers and hatcheries state that meat birds don't require as much room nor do they need an outside run. Their theory is that exercising the meat bird wastes feed energy that could be better utilized for building bulk. Although true—that a meat bird's sole purpose is to grow and therefore it does not need outdoor space—fresh air, sunshine, and space enhance their quality of life. When contemplating the blessings these birds give my family, a little extra feed and a little extra space just seems fair.

Variations of Coops

In the last ten years, one type of chicken housing has been growing in popularity in both urban and country yards. Dubbed the "chicken tractor," these movable coops are made to house four to six chickens comfortably. Tops are hinged to make egg collection, feeding, and water changes a snap. Coop mobility ensures no one area of the yard is compromised and chickens are less likely to develop internal parasitic infestations as a result.

A backyard chicken tractor. Note the handles (for moving) and ventilation holes above the roosting and nesting area on the "top" floor.

Litter

Spread litter on the floor of your coop and within nesting boxes to absorb smell and feces. Depending on your coop floor and the season, extra litter might also provide insulation. Begin a freshly cleaned coop with four inches of litter, adding an inch of fresh litter when the litter has lost its ability to absorb smell, becomes trampled down, or is noticeably soiled. Completely replace litter during every major cleaning.

Litter can be any soft and absorbent materials, such as straw, ground-up corncobs, wood chips and shavings, or shredded paper. Use whichever you can purchase inexpensively and is accessible nearby. Your local feed store might provide leads on sawmills that sell shavings or farmers who sell straw.

Temperature Control

The optimum temperature for chickens is between 45 and 80 degrees Fahrenheit. Extremes on either side may result in less-efficient conversion of feed. Temperature-related troubles include: fewer or smaller eggs, slower-growing meat birds, thin-shelled eggs, frostbitten combs and feet, onset of stress-related sickness, and death.

In cooler climates your coop should be completely free of drafts. Add a heat lamp or small heater over the roosting area when temperatures dip below 45 degrees Fahrenheit. Keep in mind that litter could be a fire hazard if kicked onto a floor-based heat source.

Be innovative in conserving electricity when wintering hens. In previous years I have moved laying hens to a smaller shed and have also been known to drop the ceiling on my large coop with securely stapled tarps and Styrofoam insulation above. In northern climates some people will move their hens to a south-facing front or back porch during winter months.

Chickens require shade, extra water, and cross-ventilation during summer. Sliding mesh vents, such as the ones shown in this photo, ensure that air moves freely inside.

When temperatures climb into the high 70s, air will need to move freely and regularly through the coop. wire-screened windows in the coop allow for cross breezes as do wire mesh gable ends or vents close to floor level (create sliders or board them over for winter).

Coop Cleanliness

Keeping your coop clean serves a dual purpose—your chickens remain healthy and odors are controlled. If you save coop-cleaning chores to once per week, other obligations will almost always take you away. On the other hand, regular maintenance in your twice-daily visits will result in a coop kept nearly as clean as the day your chickens arrived.

Daily chores include checking chickens' dishes, collecting eggs (if raising layers), and opening or closing yard access. Take just a few minutes, every now and then, to add new litter, sweep dust off rafters and walls, change nesting materials, or remove wet litter from the base of watering stations. You'll now have your weekends free to enjoy your chickens from the back porch with your feet up.

A few minutes here and there, a complete litter change every four to eight weeks (depending on odor), and a clean-and-disinfect session once to twice per year is all that is required to have happy chickens with a coop you'll be proud to show off.

Coop Equipment

Equipment to outfit your chicken coop is minimal. You'll need food and water containers and, if raising laying hens, perches and nesting boxes.

Roosters and hens are instinctively territorial, and feeding stations are within the dominion of territory. Although it may seem excessive, provide two watering and feeding stations per twenty-five chickens. The extra feeders and founts are a preventative measure that ensures every bird has access to food and water without stress. This measure of prevention turns to necessity should you introduce new birds to an existing flock or if you own more than one rooster in a large flock.

Founts

Chickens need access to water at all times and will consume one to two cups of water per day each.

Daily consumption varies per bird and across the seasons. A laying hen can drink twice as much as a meat bird of equal size.

During hot summer days your chickens can drink up to twice as much water as usual to keep their body temperature manageable. I like to add an extra fount in a shady spot of their yard to ensure they have quick and easy access to water at all times. In the winter an electric or solar powered de-icer saves you six trips to the coop to ensure your hens stay hydrated.

An inexpensive galvanized fount can last you many years. They are easy to handle, are quickly disinfected with a mild bleach solution, and should they ever crack, a quick bead of epoxy repairs them.

If you keep founts elevated you'll prevent waste from collecting in the trough area and rust from ruining the base.

I've never been fond of plastic as a long-term solution, but the small plastic founts are perfect when you need to quarantine a hen or when you are starting young chicks. Keep larger plastic founts out of direct sunlight and do not use if a chance of freezing exists. Plastic founts are prone to crack in extremes and may leach toxins into the water if not made of BPA-free plastic.

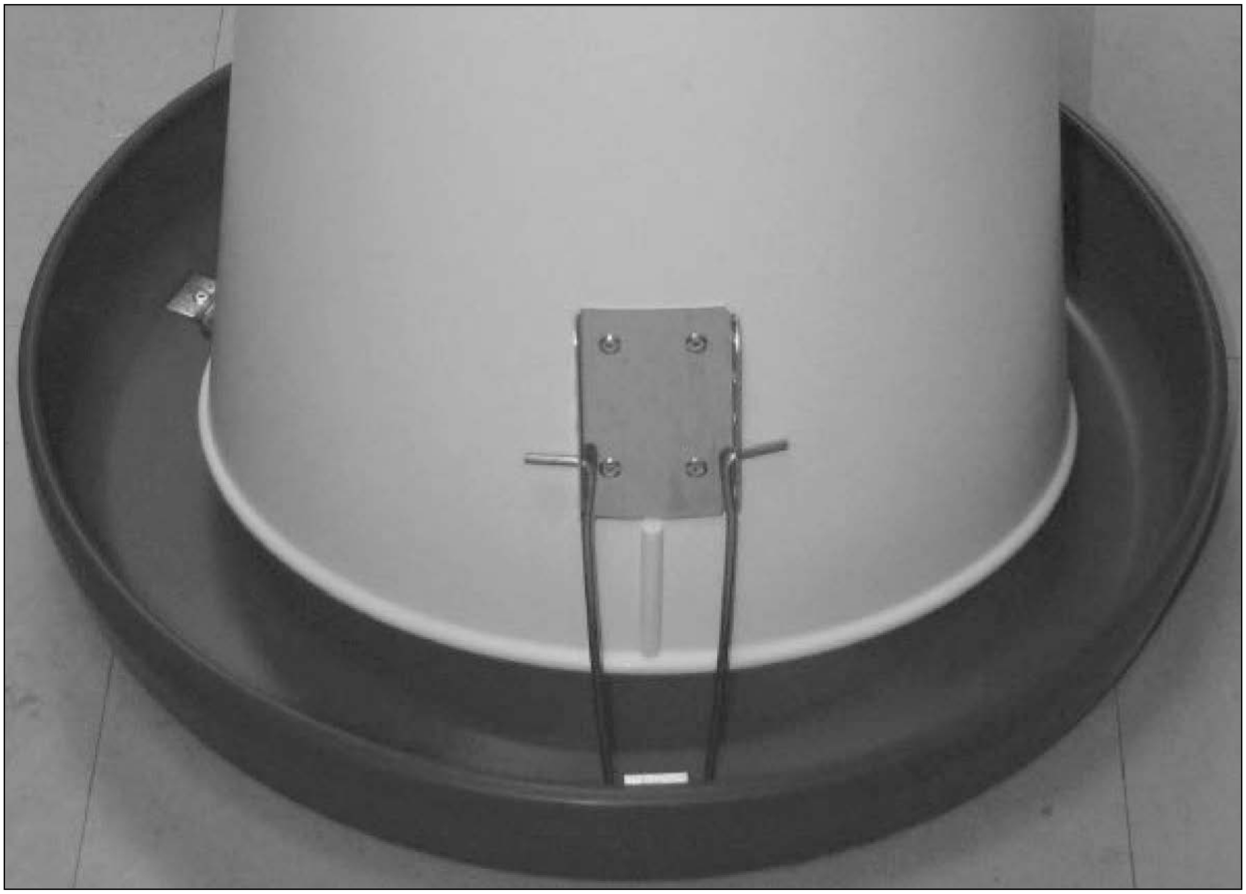
Dirty watering stations are a breeding ground for bacteria. Changing the water daily and sanitizing the fount weekly are as important as having an ample supply. Chickens are notorious for drinking with food in their mouths and kicking litter into the trough. Alleviate both problems by moving founts away from feeders and raising them off the floor to the chickens' chest level.

Galvanized watering founts are priced to fit your budget and can last for many years.

Feeders

As with water, chickens need to eat all day long to stay healthy and remain free of stress.

The rule of thumb is one five-gallon feeder for every twenty-five chickens plus one extra for every rooster in the coop. Even if you don't have two roosters, keep two feeders in operation to



The base of this feeder has a curved side and a rolled rim, lessening the amount of food wasted by chickens billing out their feed.

ensure chickens lower in the pecking order don't go hungry.

Chickens have no respect for household economics and are notorious for picking through feed for choice bits, dumping out and wasting a huge amount of feed. If you adjust the height of the feed basin to match their chest level and purchase a feeder with a rim that rolls inward, you can prevent the costly habit known as billing out. Hanging feeders allow you to make height adjustments as your chickens grow.

Another wasteful but preventable habit is when chickens roost upon the feeder top and soil the feed within. Hanging feeders deter them, but if they persist, add more roosting space in your coop and cut an upturned plastic bucket for a custom-fit cover.

Supplement Feeders

All chickens store and use grit in their gizzards to grind up food for digestion. Although chickens with outside access will obtain some grit naturally, they aren't likely to find all they need in a small yard. Ask your feed store if grit is included in your feed, and if not, add a small bag and a supplement feeder to your order.

Laying hens require calcium in their diets to form eggshells and keep their production cycles strong. Adequate calcium is already added to most laying ration. If your hens have access to a yard they'll also obtain calcium from eating hard-shelled insects. If you sense that your hens aren't receiving enough calcium in their diets, you can purchase it separately and provide it, free-choice, in a small feeder. As with granite grit, your chickens will not eat more than they need.

Special Considerations for Laying Hens

Perches

Instinctively, laying hens roost at night. If you don't provide a perch for them they will do their level best to rest (and mess on) their nesting boxes, food and water containers, feed sacks, ceiling rafters, or anything else they can reach. Furthermore, if perches aren't supplied, hens will fight for the best spot, feel overcrowded, and put themselves in danger (ascending and descending from ceiling rafters, for instance).

Perches should be made of one- to two-inch wood with slightly rounded edges. Allow twelve inches of roosting space per hen and keep perches a minimum of eighteen inches from the wall. Droppings are at their worst under roosting space. Elongated boot trays or a mechanic's plastic oil pan makes frequent cleanups a cinch.

Note: Meat birds might play and exercise on perches early in their lives, but you should discontinue access by the time they are five weeks of age because they become large and clumsy. If you decide to allow low perches for meat birds (six inches off the floor only), ensure they have at least two feet of space between wall and perch and eighteen to twenty inches of perch each.

Nesting Boxes

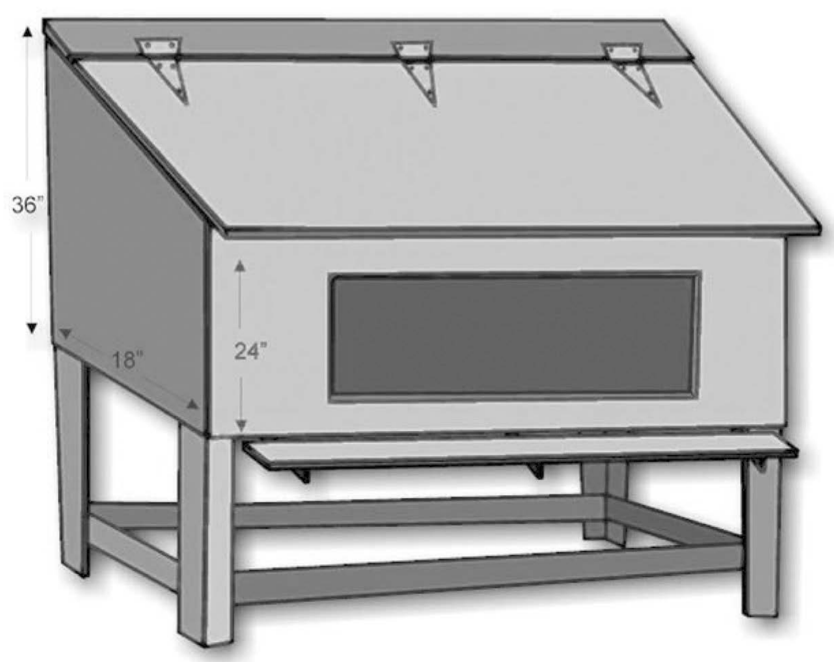
Instinctively a chicken knows to lay eggs in a nesting box. You don't need to teach her to do so; you simply need to provide an adequate box.

If you don't provide a nest, the hens will leave their eggs on the floor. Within minutes the eggs become soiled, cracked, pecked at, and potentially eaten by the others. A minor loss today becomes a serious loss in the future. Egg-eating quickly turns into a coop-wide bad habit that cannot be untaught.

There are a variety of nest styles to choose from. Hanging nests. Free-standing dark nests, and even sturdy wood crates raised just a few inches off the floor. Your hens won't be picky but they might have a favorite out of the ones you provide.

You can be creative with nests you make or provide; just be sure they allow for your easy access. A friend once built a partial wall of nests that was accessed by one large hinged door of round holes. She had the coolest coop for miles but collecting eggs in the top row of nests—where you couldn't easily see what you were collecting—wasn't fun. Sometimes what she'd pull out was just a round ball of poop. Ugh.

Over the years I've discovered a passion for the dark nest. Built of plywood and constructed in just a few hours, the dark nest can be used by multiple hens without squabbling or rivalry. Each hen requires only twelve inches of nest within so



The dark nest is a lumber-saving, age-old design that makes egg collection and cleaning easy.

you'll save on space and material if you need to build nesting boxes anyway. Include a perch on the front and your hens won't be apprehensive upon entering the dark nest.

Dimensions are not specific as the dark nest can be custom fit to your coop space. The slanted and hinged roof prevents hens from roosting above and allows easy access for egg collection. Rest the finished box on concrete blocks or build it with posts so it is two or more feet off the floor. Adjust the elevation to save your back, as you'll be stooping over every morning to collect eggs.

If you plan on building individual nesting boxes, here are some general guidelines.

- A size of fourteen inches square works for all sizes of laying hens.
- A lip on the front keeps eggs and nesting material safely inside.
- A height of two feet from the floor might be easiest for the hens, but not so easy on your back. Most hens will use nesting boxes three to four feet off the ground as long as they have the means and the space to ascend and descent without stress.
- A perch in front alleviates stress for hens wanting in and hens already settled inside.
- Three to four inches of litter or nesting material, changed regularly, keeps the area clean and odor free.

Lighting

Laying hens require thirteen to fourteen hours of light per day for optimum health and production. In North America this is only a problem during the shortest winter days.

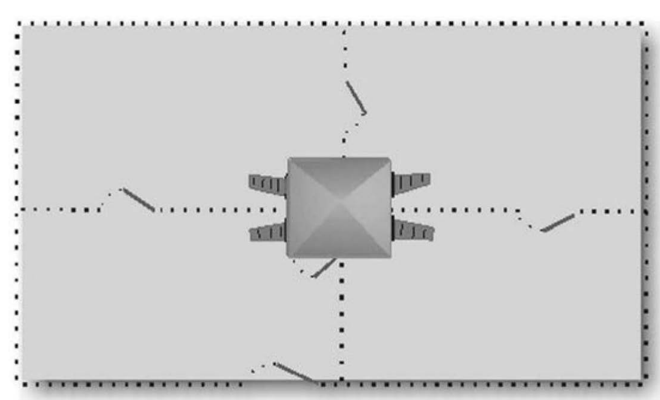
Although you may be tempted to move your hens to a covered and sunny porch during winter, allow me to remind you of the dust they can create in just a few days. You'll love your hens more if you leave them where they are, insulate and heat your coop, and add artificial light for the winter months. I've found the best results using one standard incandescent bulb and one full-spectrum grow light from the gardening section.

The Chicken Yard

Your chickens will be happiest and healthiest when given outdoor room to roam. They will roll in soil, forage for bugs, pull up roots, ingest sprouts, and enjoy the natural benefits of the sun. If you can provide them a safe place to enjoy acting like chickens and are thrilled to do so, you will be equally distressed to find that within a month's time their yard is a packed-dirt and barren wasteland.

Some say there is no way around it, that chickens will annihilate any yard you give them in short order. I say there is an alternative.

If you build a coop in the center of a divided chicken yard or build a large yard around your coop, you can rotate access to four quadrants while keeping each area viable. This is similar to the rotational-grazing method that manages larger livestock pastures. Concerning chickens, however, rotational grazing is much easier to implement. Four chicken doors within the coop allow you to dictate on a day-by-day basis which quadrant of the yard they will access.



Quad yard for chickens. More gates to build than a standard yard, but so much nicer for chickens that can't wander about freely.

The most trouble-free birds are those who have at least four times the fenced space out of doors that they have indoors.

My first 10-by 12-foot coop (120 square feet), which comfortably housed two dozen large laying hens, had a 3,000-square-foot yard sectioned into quarters (each quarter being 25 by 30 feet or 750 square feet). Considered overkill by old-school farming standards, this arrangement kept the hens happy and I felt satisfied in the way I provided for them.

Fencing

Chickens are absolutely incapable of defending themselves and every potential predator knows it. Foxes, hawks, wolves, weasels, and raccoons will jump at any opportunity to take one or more of your flock. The list of potential predators doesn't stop at wildlife. Mild-mannered family pets have also been known to annihilate an entire flock of chickens in less than an hour.

You may be one of the fortunate few who can free-range hens without a loss for years. It was once possible on my farm, too, but in the last five years, a large population of coyotes and foxes has moved in. Although I dislike fencing the chickens in, I appease the desire to let them roam free just a few times each year now.

A standard chicken yard fence is four feet high with posts spaced six to eight feet apart. Posts are buried two feet into the soil and, along with corner supports, are located within the perimeter of the fence. Wily and nimble predators can and will climb fence supports if they're left on the outsides of the corners.

Chicken wire is inexpensive and easy to handle, but the strongest fence is built of a medium-gauge yard and garden wire. With one-inch-square holes in the bottom quarter and larger holes on top, this fencing material can keep chicks as young as a month old on the inside and most predators out.

If weasels and raccoons are a nuisance in your area, consider attaching sturdy wire to the underside of the coop.

Perhaps the best defense against predators is to be mindful of the signs they leave from one night to the next. Should you notice a gnawed board, wire that has been pulled away from the post, or roofing material pulled off the coop, take immediate action. Many predators have been known to return night until they gain access. Never put off an issue of safety until tomorrow. Tomorrow may never come for your chickens.

Your family dog is also a great defense, but only as a deterrent. While some farmers might tie their dogs near the coop to sound an alarm, this strategy can have dire consequences for the dog should a pack of wolves or a lone cougar wander through.

If you have persistent problems with a particular animal, discuss the situation with other locals who keep chickens. Local wildlife authorities might also have solutions or insight into the problem.

In broad daylight and on open terrain, this bold fox takes a chicken's life and then stands in open space enjoying his lunch.

An Afternoon Out for the Girls

Should you decide to let your hens out a few times a year to wander in your gardens and enjoy a little extra space, you'll want to keep close watch. I only open the gate when I know I'll be spending the next few hours outside, and I ensure each one follows me into the yard, never leaving my line of sight. After the incident with a very bold coyote just three feet away, I also take my rifle.

I have yet to lose a hen doing so, but only because:

- We have cleared acreage. If a predator is stalking he'd be hard-pressed to sneak up on us.
- A hen will seldom roam from the safety of the flock or within a safe running distance of her coop. Should any of them leave the flock they most often end up at my feet.
- I spend a lot of time with my layers. If I need to get them back into their coop early I just call them in. (There's nothing magical to this—I simply conditioned them to the call of scratch grain—you can do it too!)

Where to Buy Chickens

Chicks can be purchased at country auctions, from a local farmer, by mail order, or direct from a reputable hatchery.

My best birds have consistently arrived from a hatchery. Although I've purchased some hens and a few roosters at auction and privately, too much is at stake to risk a chance on parasitic infestation and disease. An entire coop can get sick overnight and all will be lost for the sake of one small purchase.

In twelve years I have heard a hundred or more similar tales of woe from my readers on GoodByeCityLife.com. Here are just a few ways that purchasing chicks can go wrong.

You Can't Always Trust a Seller. One couple purchased three day-old pullets at a farmer's market. After raising and caring for the chicks for nearly four months, two of their pullets grew to be cockerels, but they seemed to be getting along with each other. Returning home from work one afternoon they discovered the smaller rooster lying nearly dead on the driveway and the larger one delivering some fierce final blows.

Mail-Order Chicks Arrive Dead. A young woman, living remotely and on a quest for self-sustained living, ordered thirty chicks by mail order. Arriving at the courier pickup location on time and excited, she found that the box was full of dead chicks.

Accounts from other readers have cited boxes of chicks that are travel-weary and stressed to the point of sickness.

Receiving chicks by mail order has lost the reliable reputation it once held. The best hatcheries will guarantee live delivery, but that merely equates to a credit of replacement chicks if yours arrive dead. Day-old chicks are shipped by plane (in the cargo bay), by regular postal trucks, or through courier services. Although a newly hatched chick is capable of surviving without food or water for twenty-four hours, it is not capable of thriving in impossible temperatures or managing the stress of being consistently jostled about. A delivery service is not concerned about stress, temperature, or whether live cargo arrives alive or not—they receive the same payment either way.

One New Hen Sickens Entire Flock. I've done this myself. At a livestock auction I met a knowledgeable and friendly seller with a hen I just had to have. I inspected her for lice, leg mites, and overall health, and she seemed perfectly sound. During quarantine the hen became listless and weak and eventually died. Had I released her into the general population I might have lost my entire flock.

The lesson here is no matter how experienced any of us think we might be about raising chickens, or how trustworthy we believe a seller to be, we can always be taken by surprise. Make your purchase from a recommended and local hatchery, no matter how small your order, and arrange to pick up your order personally and directly.

Your feed store might offer a service of pre-ordering and accepting delivery for annual chick orders. The hatchery delivers organized boxes to the feed store and the chicks inside are quickly inspected before you pick them up. This minimizes delivery stress, improper handling, and time in transit.

Ordering and Caring for Chickens

Chickens from commercial growers are sold as day-olds, started (two to four weeks old), and ready to lay. You can further specify whether you'd like cockerels, pullets, or straight-run chicks.

Straight-run orders are filled as the chicks hatch and are therefore cheaper. When raising meat birds, a straight-run order will give you wider variety in finished size. When ordering dual-purpose breeds as straight-run chicks, you'll have the best of both worlds—roosters to cull for the freezer and hens to keep for laying.

Day-Old Chicks

Day-old chicks cost about two-thirds less than started birds. They are often pulled dry from the incubator, vaccinated for Marek's disease, and popped into the box for delivery.

Once home, you will need a heat lamp to keep the chicks warm for a few weeks. One 250-watt infrared lamp will keep fifty to a hundred chicks warm, but keep two in case one should fail. A hanging heat lamp placed eighteen to twenty-four inches from the floor allows you to make adjustments from day to night and as chicks grow.

There are two ways to ensure the temperature is perfect for young chicks. The first is to take a temperature reading of 90 to 92 degrees Fahrenheit, two inches off the floor. The second is by observing the chicks' behavior. Chicks that are too cold will pile on top of each other under the lamp and chirp. If they are too warm they'll wander away from the lamp or lie down with wings spread and panting if they can't get far enough away. A sign of correct heating is when chicks are freely wandering within the perimeter of the lamp and occasionally returning to bask in some extra warmth. Feed and water dishes should rest just outside of the lamp's radius.

If chicks will be kept in an area where pets might enter, or that might be drafty, start your chicks in a solid-wall brooding box that is vented above. Brooding boxes can be as simple as a sturdy cardboard box or as elaborate as a fine mesh kennel protected on all sides. If chicks are going directly into a new coop where no other animal can get at them, you can skip the brooder—they are not likely to leave the immediate vicinity of the heat source or the safety of their brood mates.

Keep your chicks' area clean and dry with a constant supply of fresh water and feed. A base of newspaper with paper toweling on top is absorbent, can be easily changed, and will prevent slippery mishaps. Wood shavings or sawdust are not recommended as litter for young chicks. Chicks will ingest the shavings and end up with swollen, impacted crops that will eventually kill them.

Chicks will have to be taught how and where to drink. Dip a few chicks' beaks into lukewarm water from a small fount (provide one fount for every fifty chicks) and the others should catch on. Don't be shy about being overprotective and dipping every beak—I do it!

After the first week and every week thereafter, adjust the height of the fount to the chicks' chest

Meat birds from the hatchery, directly to you. Freshly hatched chicks are vaccinated, then packed into a box and shipped to the consumer. The chickens in the back of this box are huddling for warmth but are not stressed at the end of their journey.

level to keep kicked litter out of the basin. Make similar adjustments for feeders.

As your chicks grow they will spend less time under the lamp. Make adjustments for their age, the temperature of the room they're in, or by time of day. If I'm starting chicks in a cool spring I'll raise the heat lamp every week by an inch (thereby decreasing temperature by 5 degrees) and eventually turn the light off for daylight hours. They are fine as long as they aren't chirping loudly and huddling. By six weeks they should be acclimatized, but the exact time to remove it altogether is dependent on coop temperature (no lower then 65 degrees Fahrenheit). Close observation of their behavior without the lamp is the best cue.

Started Chicks and Ready-to-Lay Pullets

Started chicks are a nice option for the new farmer. Arriving between two and four weeks of age, vaccinated for Marek's and fed a medicated feed to kick-start immunity to coccidiosis, your chickens arrive young enough to bond with, but more established than a day-old.

A four-week-old chick is capable of dealing with low nightly temperatures of 75 degrees Fahrenheit. If seasonal temperatures in your region drop below 75 degrees, add a heat lamp (instruction above in the Day-Old Chicks section) until you're sure it is no longer required.

Ready-to-lay pullets (sold at sixteen to twenty weeks of age) may have just started laying eggs or will begin within the next few weeks. I like to call them "instant egg layers in a box"—just add coop, feed, and water.

It is common hatchery practice to leave the lights on for twelve hours a day when raising pullets, and to suggest that you increase their day's light by one extra hour over the course of a week, for the next four weeks—to a maximum of sixteen hours per day. I usually purchase hens in the summer months and let Mother Nature manage the light until winter arrives.

Saving Money on Your Chick Order

Chickens are sold by the hatcheries on a sliding scale. The larger number of birds you purchase, the lower price bird you'll pay. If you can double up your order with one or more friends you can save as much as $1 per chick.

If you're ordering laying hens, you can pay just a few dollars more per hen and get ready-to-lay pullets, which will save you the cost of twenty-five pounds of feed per hen and the need for heat lamps.

If your heart isn't set on a particular breed, check your hatchery for special deals on overruns and mixed lots. You can often save 50 percent per order through hatchery specials.

Caring for and Feeding Chickens

Commercial feeds are available to suit each changing need of your flock—starting, growing, maintenance, and finishing mixtures—in a choice of three consistencies: mash, crumbles, or pellets. For starting chicks I use crumbles for the first eight weeks, then switch over to pellets for the remainder. Mash has consistently been a dusty waster in my coop.

A few weeks before your hens are expected to begin laying (eighteen weeks for laying breeds, twenty-two weeks for dual-purpose breeds), start changing their feed over to a layer's pellet a little at a time at first until they are on straight laying ration.

If you've purchased straight-run, dual-purpose chicks, this twenty-two-week mark is also a good time to move out the cockerels. Grow them a little longer on grower ration or dress them for the freezer as your time permits.

The meat breeds can be switched over to grower ration by four weeks of age. You will not need to switch their feed again unless you choose to give them a finishing ration in the final weeks.

Another popular feed, but one to stay away from, is scratch grain. Deceptive in appearance, scratch grain looks like it might be the most natural feed for your chickens. Ounce per ounce it is also the cheapest. Scratch grain lacks in required protein and calcium for layers and is not suitable for fast-growing meat breed crosses. Use scratch grain as a treat or training aid only.

How Much Chicken Feed to Buy

Twenty-five two-week-old meat breed chicks eat at least twenty-five pounds of feed per week.

Twenty-five-four-week-old meat breed chicks eat at least fifty pounds of feed per week.

At eight weeks, twenty-five meat breed chicks will eat well over a hundred pounds of feed per week but will put this feed to its best use—conversion to bulk.

Twenty-five laying chicks (up to twenty weeks of age) will eat approximately twenty-five pounds of feed per week. (Obviously less in the beginning and more towards maturity.)

Twenty-five mature laying hens eat fifty pounds of feed per week.

Poor-quality feed with nutrient deficiencies creates internal imbalances. Dietary deficiency is the most common culprit for poor egg production or slow-growing meat birds.

Save on Feed Costs

Almost 60 percent of the cost of keeping chickens is spent on feed. Although your chickens will show you their own style of wasting feed, other factors within your control will assist you in raising chickens economically. Following are my top five tips for saving money on feed costs.

- In an effort to save money while raising your own food, the question comes to mind: "Why feed a rooster?"
- At the feed store, when given the choice between mash, pellets, or crumbles for birds over eight weeks old, choose pellets. Less feed will be wasted.
- Know how much feed you'll need for three weeks at a time and save gas running to the feed store every week. Keep feed bags dry and out of direct sun to protect against rot and staleness, respectively. Rodents such as chipmunks, mice, and rats can chew their way through the bottom of any feed bag or plastic tub and consume or contaminate the entire lot. Keep feed in the bag within a clean galvanized trash bin.
- Feed your chickens as much vegetable scrap from the kitchen and clippings from the garden as possible. The more you feed them from your farm and table, the less commercial feed you'll pay for. A few exceptions are potato peelings (which are not digestible) and pungent produce such as garlic and onions (which taint the taste of meat and eggs). Most other fruits and vegetables will surely be consumed and enjoyed by four flock. You can help put calcium back into a chicken's digestion by feeding empty eggshells to them. Just be sure to grind them up well past recognition before delegating them back to the coop.
- Plan on getting meat birds to the freezer before or as soon as possible after their ninth week. Their feed-to-meat conversion ratio begins to decline at this age.

Although stunning to behold and capable of sounding the trouble alarm when predators come around, unless you're planning on breeding hens you don't really need a rooster.

Maintain Good Health in Your Flock

Ninety percent of success in raising chickens can be found in these two words: obtain and maintain. When chickens arrive on your lad healthy, it doesn't take much to maintain that state. Clean living conditions, lack of stress, and an adequate supply of clean water are the top three preventative measures against sickness.

Vaccinations are another consideration to ensuring your chickens stay healthy. As some bacterial viruses and diseases are localized, ask a veterinarian in your area if any special vaccinations are required.

Prevent disease, virus, and infection being unknowingly introduced to your coop:

- Rodents and wild birds are notorious for spreading disease as they travel from coop to coop. Manage rodent population with traps or by ensuring they can't get at feed and grain. Without easy access to food, rodents won't stick around. Wild birds can be kept out of the chicken yard by adding aviary netting across the top of your yard fence.
- Some chickens are only carriers of a disease and show no signs of illness. Only purchase chickens to add to a flock from a hatchery and quarantine every new chicken for at least a week before introducing it to existing flocks.
- Just as introducing new chickens to a coop can cause the spread of a disease, so might the soles of your shoes carry in sickness if you've visited another coop. Before you head off to your own chores, clean and sanitize your shoes after spending time at another coop.

Catching illness before it becomes a deadly outbreak isn't easy. Your senses have to be fully present for each chicken in the coop, every time you enter the coop. Once familiar with your chickens, you'll pick up on changes that could be a signal of sickness. Loss of weight or lack of growth in a young bird, consistent drooping heads or hunched appearances, change in comb color or size, dripping noses or eyes, rattling chests, and changes in stool droppings are but a few signs of various illnesses.

Symptoms can be confusing. As an example, loose stools may be attributed to coccidiosis, and decreased laying or weight loss might be a sign of worm infestation, but coupled with other changes these symptoms might signal something worse.

If you notice illness in just one chicken, immediately quarantine it. If all your chickens appear sick, call a veterinarian for further instruction.

It is a fact of life and of raising chickens that not all diseases can be noted and cured in time. In most cases, by the time you notice that a chicken is sick, it is already too late. Even if you could cure the disease and nurse your hen back to health, she might remain a carrier and pass the disease on to others.

Parasitic Infestations

Of the two—internal and external—the most unnerving parasites are external. Unchecked lice and mites quickly turn into a coop infestation. They can arrive on your chickens, can live in your coop from one batch of chickens to the next, and if left untreated, can drag your chickens to death's door.

Lice and mites spread quickly from one bird to another. You'll only need to check one or two birds to know if you need to take immediate action. Visit the coop after dark with a friend and a flashlight. Don't startle sleeping chickens on the roost by waving the light in their faces, just calmly collect one off the roost and shine the flashlight to the base of the feathers by the head, vent, and under the wings.

Lice will leave signs of eggs that look like tiny rice grains. They will also leave scabs on your bird's skin where they've bitten and chewed.

Mites come in two forms—body mites and leg mites.

There will be no mistaking body mites under the flashlight's beam. They look like tiny red spiders crawling on your chicken's skin.

Raised scales on a chicken's legs are a sign of leg mites. Leg mites are discouraged, controlled, and smothered by coating perches and the legs of chickens with daily applications of vegetable oil or petroleum jelly for seven to ten days.

Body mites and lice require a thorough coop cleanout, poultry-safe insecticidal powder, and diligence to the directions on the label.

Coccidiosis

Coccidiosis is an intestinal disease that can weaken and kill untreated chicks. Most adult chickens have an immunity to the organism that causes it, but can still suffer from the disease. You will instantly recognize the spread of this illness by loose droppings throughout the coop. Medication can be readily purchased at any feed supply store.

Starter feed for chicks often contains Amprolium, a medication developed to control intestinal coccidia while allowing chickens time to build up a natural immunity. Ask at the feed store if Amprolium is present in your feed, and then make a personal decision about the value of pre-medicating poultry that is not sick.

Marek's Disease

Marek's disease is a cancer-causing viral infection. The disease is spread via feather dander and inhalation. Most hatcheries automatically vaccinate for Marek's within the first few hours of hatching.

The Joy of Eggs

Crack a farm-fresh egg into your frying pan and you'll find, a firm white with a deep-orange and substantial yolk. These eggs look and cook a little differently than the grocer's version. Yolks are darker, whites are firmer, and the air sac within is most certainly smaller. Higher density and less air space within the shell makes these eggs economical as well. Fewer farm-fresh eggs are required for large batch baking, and the whites create more volume when whipped.

As for the grocer's version of an egg, the time to market has some bearing on the lack of quality and taste, as most eggs are already a week old by the time they hit your shopping cart. However, a hen's diet and living conditions are the two main contributors affecting the taste and density of any egg—farm-fresh or commercial.

Years ago I was surprised to learn that farm-fresh eggs can be as dull as the commercial egg. For years my in-laws raised cooped-up Leghorns that were never allowed to forage on the land, never given garden or table scraps, and never enjoyed the wonders of direct sunlight. Take note: if you don't take the route of reproducing an egg factory in your own coop, you won't run the risk of having unspectacular eggs.

Give your layers a yard of sunshine, clean and spacious living conditions, fresh water at all times, and a varied diet. You'll be well rewarded for your efforts.

Freshness Tests

As eggs sit in storage (whether destined for the grocery store or awaiting use in your own refrigerator), they lose moisture through the shell. This evaporation creates an air bubble noticeable only when you hard boil the egg or hold it to a light source. If you're uncertain how old an egg is, check the bubble. Fresh eggs have virtually no hollow within the shell.

You can also float an egg to see if it is fresh. Fresh eggs sink in a bowl of water. An egg that stands upright is only a few days old. Older eggs float and aren't fit for consumption.

Cleaning and Storing Eggs

Freshly collected eggs have an invisible layer of protection upon them called a bloom. The bloom keeps moisture in and surrounding air out. If you scrub off the bloom before storage you compromise the egg's natural ability to stay fresh. A quick rinse in water slightly warmer than the egg maintains the integrity of bloom during storage.

Keep your eggs in the vegetables tray of your refrigerator—even if space is tight. Specialty shelves on the fridge door are not actually suitable for egg storage. Inconsistent temperatures and frequent jumbling about each time the door is opened will age eggs well before their time. Eggs gathered fresh and stored in a crisper easily stay fresh for a month.

There will be times when you have an abundance of eggs and no time to use them all. You can freeze them (out of the shell) for future baking with just a shake of the salt shaker per half dozen. I beat them in lots of four and six, as those are the quantities most often called for in the recipes. I use. Freeze them in small glass bowls with tight-fitting lids or BPA-free freezer bags.

A Closer Look at Farm-Raised Eggs

Let's clear this up once and for all: the color of an egg's shell does not determine nutritional quality.

The belief that a brown egg is higher in nutritional value than a white egg is a throwback from past generations. For the last thirty years, most laying hens raised commercially were white egg breeds. On the flip side, most layers raised on the farm were dual-purpose breeds, most of which lay brown eggs. Since we already know that farm-raised eggs are of higher nutritional value, you can see where the confusion began. Imagine the misconceptions that will arise once the Araucana and Ameraucana's eggs gain in popularity! These eggs have shells in various shades of blue green, and olive.

Yolk color suffers from similar misconceptions. It is not the freshness of the egg that has the greatest impact on yolk color, but the diet of the hen that laid it. Free-range and partial-range hens' eggs will have a dark golden to orange yolk. It is the adequate supply of fresh greens in the diet that creates the coveted hue. If your hens don't get out much or if you find your eggs to be dull in winter months, you

Did You Know?

You need to add two minutes to your cooking time when boiling farm-fresh eggs.
Soft-boiled store-bought eggs = Three minutes
Soft-boiled farm-fresh eggs = Five minutes
Hard-boiled store-bought eggs = Ten minutes
Hard-boiled farm-fresh eggs = Twelve minutes

How to Hard-Boil Fresh Eggs

Try this the next time you need to make a plate of devilled eggs for tomorrow's community dinner using the eggs you collected just this morning.

After hard-boiling fresh eggs from the barn, run cold tap water over the pot of eggs for one minute. Allow the eggs to rest in cold water for another four minutes. Break each shell by applying slight pressure while rolling the egg on the counter. Peel the eggs under water. The result? A perfectly peeled, fresh hard-boiled egg without the telling lack-of-freshness gap seen in aged eggs.

can supplement their lay ration with kitchens scraps of broccoli, green beans, and lettuce.

On occasion you might find colored spots within an egg. The spots within unfertilized eggs are completely natural and harmless, although not necessarily desirable. The cause is the tiny blood vessels within the hen during formation of the egg. It will not harm you to eat it or the egg it appeared in, but you might prefer to remove it before cooking. The common misconception is that is a sign of embryonic development. Most laying hens have never seen a rooster.

Butchering

The day will come when, either individually or as a lot, your chickens are ready for the butcher. You can take on the task yourself—farm wives and children have been doing it for centuries—as long as you don't intend to sell the chicken to others. Each chicken will take about twenty minutes to prepare for the freezer.

If you're pressed for time, have more than twenty chickens to butcher, or don't have the stomach for the task or volunteer assistants, there are other reasonably priced options for the backyard chicken farmer.

Poultry Processing Services

Scattered throughout North America, you'll find people charging just a few dollars a bird to come to your property and take your chickens from coop to freezer for you. They arrive at your door with a trailer full of equipment and supplies. Asking for nothing more than directions to the barn and the closest hookup for a hose, they set to work and a few hours later return with bags upon bags of perfectly plucked and dressed chickens.

If they don't mind you helping and you don't slow them down, spending a few hours with this group is an education in itself. You will quickly learn the most efficient and health-safe methods to move a chicken from coop to plastic bag.

Often run as a cash-only seasonal business, the service may not be as professional as you'd like. The owner may not be government-certified, so you will need to assess your comfort level with having this group handle food that will one day be on your dinner table. You are also unlikely to find these people in the yellow pages. Ask people in your area also raising chickens for referrals and contact numbers.

The alternative to the on-site butcher is a professional facility that specializes in homegrown poultry. You deliver live chickens to the facility, and then return the next day for pickup. Unlike the onsite option, you need to have enough chickens to make it worth two trips to the facility. These specialists are government-inspected and licensed, and are found in the yellow pages. If you can't locate one, ask for referrals from feed store staff.

Do It Yourself

If you've never butchered poultry, the best preparations is to spend a day with an experienced person. Offer to pay an old-timer or a farm wife in cash, or with a return of time, for a half day of work processing poultry for the freezer. No finer instruction exists than to learn hands-on with experience by your side.

The instructions below are not intended as a complete education in butchering chickens, but merely a guideline of the process.

The Day Before

Feed given twenty-four to thirty hours pervious will be found sitting in the chicken's crop, wasted. Time the chickens' last meal so that you are neither wasting feed nor adding unnecessary cleaning chores to the task.

Setting Up

This is an outside, messy task. Wear comfortable chore clothes. You'll need a work table, an axe, a large pot or bin of hot water, sharp knives, poultry shears, a small set of pliers, rubber gloves, garbage bags, easy access to running water, and if possible a screened tent or garden gazebo to work under. Flies and wasps will be exceptionally annoying.

Inside the house you'll need a sanitized sink or basing full of cold salted water. You'll also need to have large plastic freezer bags on hand.

If you're planning on butchering more than four chickens, having some company (even if just a radio playing) keeps monotony at bay.

Order of the Day

The order to be performed is:

- Catch and kill the chicken
- Allow it to bleed out
- Scald, pluck, and gut
- Soak to chill
- Bag for the fridge or freezer

If you've trained them, catching the first few chickens is easy. After three you'll have no choice but to corner each, one by one. Chickens sense that today is different than all other days. They are hungry, members of their flock are being carted out, a commotion can be heard outside, and the smell of trouble is in the air.

An Honorable Death

Knowing that you've *intentionally* raised to *eventually* kill can be unsettling the first time. It becomes less unnerving every year but it is never without emotion. Having a weak spot for animals by nature, I've somehow grown to adopt the farmer's creed: "If you raise it to eat it, you had better be man enough to kill it." In the end I count it honorable to perform this task myself whenever possible rather than have a stranger attend to it. I literally thank each chicken I carry to the chopping block. Whoever should perform the task, it should be carried out calmly and swiftly. Stress and suffering does nothing for the taste and texture of meat, nor does it honor the life that feeds you.

There must be fifty ways to kill a chicken. The workers at the slaughterhouse hang them by their feet on a moving rack, dip their heads into an electrified bath, and then slit their throats as they pass by. The traveling poultry trailer places chickens upside down in a killing cone, stretches their necks out, cuts their throats, and lets them bleed out from the cone. Small growers also use cones and pierce the chicken's brain through the back of the mouth with a sharp pick or knife.

Killing cones are popular tools of choice. They are inexpensive at the feed supply store, or you can make your own. A round plastic two-or three-gallon jug with the spout and the base cut off works fine.

Chickens can hang in the cone until they have fully bled out, containing the mess to one area.

It has been said that if you hold a chicken upside down for a minute it will go to sleep. This has never worked for me because I'm not one to stand the sound of a scared bird. Instead I remove each chicken from the coop and calm it. With one hand on both feet and the chicken's chest laid on the chopping block, I swing the axe. Immediately lifting and holding my chicken away from my body, I allow it to flap unrestricted for about a minute to bleed out. The belief is that flapping assists in pumping the blood out of the body.

Do be careful either to let wings flap without restriction or not at all. Knocks and bumps will bruise the meat of the bird.

A Quick Scald

Once bled out and with head fully removed, hold the chicken by the feet and dip into 148-degrees-Fahrenheit water repeatedly for forty-five to sixty seconds. Dipping is an art in itself—dip longer if water is not quite hot enough, shorter for water hotter than the recommended temperature. The outcome will be loosened feathers without burned skin underneath. Some chickens take a little longer, some a little less.

As soon as you remove the chicken from the water, lay it on the work tale and start plucking. Pull feathers, by the handful, in the directions they were growing. This only takes a few minutes per bird if you're working alone. Cut off the feet at the joint, then rinse off the chicken and your work surface with cold running water.

A Cleaning Out

Laying the chicken back onto the work surface, remove the tail and pointed oil gland at the base of the tail. Ensure that all the yellow substance inside the gland is removed. Using poultry shears or a boning knife, removed the neck and pull the crop and windpipe out from the cavity you've just created.

Splitting a young chicken up the back with poultry shears makes the remainder of the cleaning out process easy and educational for an inexperienced butcher. It affords the observation of the inner workings of a chicken before you ever decide to reach blindly inside to remove entrails.

Whether splitting or processing as a whole bird, take care not to pierce the green bile sac of the liver. It will taint and ruin any meat it touches.

To butcher a chicken whole, make a shallow, somewhat keyhole-shaped incision from the base of the rib cage nearly to the vent and then around the vent. You can reach gently inside, moving your gloved fingers to the spine, and literally scoop out entrails in one move. If your chicken is large and your hands small you may need to reach in again to fetch heart and lungs at the front of the chicken's body. You're nearly done!

If you keep and use organs, remove the green bile sack from the liver (be certain not to cut into it) and tubes from the heart. Similarly, split the gizzard in half to remove the tough yellow lining. Wash and place neck, liver, heart, and gizzard into cold salted water while you finish the chicken.

If you've split and then cleaned out a chicken, you can freeze half birds for the barbeque or cut each half into individual pieces for the deep fryer. To butcher into pieces, use a boning knife at each joint for wings, thighs, and legs. Separating back from breast meat will require a closer cut with a carving knife.

Rinse the chicken inside and out, then immerse in slightly salted chilled water. When the temperature of the chicken has reached current air temperature or cooler, drip and pat dry, bag, and refrigerate for two days to age and tenderize. If you don't have room in your refrigerator you can place the bags directly into the freezer with similar results.

Rotate your poultry two or three times a day for an even freeze.

Supplementary: Raising Turkeys

If you've ever eaten a homegrown turkey you'll never question a desire to feed one. So unlike the dry, almost sinewy, Christmas turkeys of the past, you'll swear it is an entirely different bird.

Personally—having eaten roast turkey dinner in more than thirty cooks' kitchens in forty years—I had never really enjoyed the meal. Until the day a farming friend served me the most delicious poultry I've ever tasted—a home-raised turkey.

A farm-raised turkey grows nearly as fast as a meat chicken and has similar feed-to-muscle conversion. They require no extra time (except in the first week) in chores and are easier to butcher, as feathers are fewer and the body cavity is larger. You can grown them to a family-appropriate size without worry of overgrowth and sparing among the male birds.

Growing white production breeds is the most common, as the finished bird has clean and bright skin with tender, short-fibered muscle. Large white hens are capable of reaching a fourteen-to sixteen-pound live weight in just four months. Toms will easily reach twenty-five to thirty pounds in five months. Dressed turkeys finish between 70 and 75 percent of their live weight.

Whether raising hens, toms, or a mix of both for three months, four square feet per bird is recommended. If growing on to five months, allow six or more. As always, my space recommendations are slightly higher than industry standards. Increasing these numbers to 30 percent more floor space plus a fenced, protected, outdoor yard adds quality of life and creates tastier meat.

If you are already raising meat chickens you'll find it isn't much extra trouble to raise a few turkeys as well in your first year. A full wall partition separating the two will be required as turkeys are prone to picking up viruses from intermingling with chickens. This may sound like too much extra effort, but it is worthy work. By the time next spring rolls around you may just find yourself raising turkeys exclusively—especially if friends have been fortunate enough to share a meal with you! Prepare yourself. Once friends or family members have tasted this exquisite bird—the home-raised turkey—they will be asking you to raise some for them as well.

This is not your average Christmas dinner! Home-raised turkey is considered an altogether different breed of poultry—unmatched in taste and tenderness.

From Turkey Chick to Your Table

Consider the one- to fourteen-day-old turkey chick to be lacking in a survival instinct and you'll have no trouble raising them. They can drown in a quarter inch of drinking water. They can slip and fall and not figure out how to get back up. As lacking as they may appear in the first few weeks, by the time they've reached a month of age, their antics are less life-threatening and far more entertaining.

During their stay with you they should always have easy access to fresh water and feed. They seldom make gluttons of themselves.

Day-old turkeys require perfection in their care. They are affected by chills and dampness, so their area must be 100 percent draft free and their water lukewarm. This is a chick that requires training on how to get a drink. Dip every beak, perhaps twice. To ensure they continue to find water, consider adding a few colorful marbles to their fount.

Turkey chicks aren't inquisitive by nature. They are, however, clumsy. Food needs to be easily available for the first three days and floor space should never be slippery. For the first three days cover their litter with an old sheet and sprinkle their feed on the surface. This ensures that they will not attempt to eat the litter and that they will be able to find their feed. Change the covering twice daily. By the fourth day all chicks know where the feeders are.

Turkeys will need a heat lamp providing temperatures of 95 to 105 degrees Fahrenheit for the first week. Turkey chicks will behave in the same manner as chickens—spending most of their time away from the light when temperature is adequate, huddling or stacking themselves on top of each other when they are cold. After the first week you can raise the lamp an inch or more to decrease floor temperature 5 degrees at a time. By five weeks of age they are capable of temperatures as low as 75 degrees, but if your nights are colder, keep the light on for another few weeks—if only through the night.

Turkey poults (sold at three weeks of age) are also available at most hatcheries. They'll cost twice as much or more, but are a bargain as they'll save you hours of heat lamp operation and have a lower mortality rate. Started poults arrive smart enough to find food and water.

Until they are eight weeks old, feed turkeys a commercial starter ration. I also purchase a vitamin powder to add to their water. Switch them to a grower ration until a few weeks before butchering, then switch them over to a finishing grain. You can slow down their growth if required by moving them to a finishing ration earlier and supplementing with oats, cracked corn, or turkey scratch grain.

More so than chickens, turkeys are susceptible to dampness, dirty litter, poor ventilation, chills, and overcrowding. If you're planning on raising turkeys, follow the guidelines in the earlier chapter on raising meat birds, paying special heed to preventing cannibalism. Slaughter and butchering practices also are the same as chickens.

Keeping Bees

BY JOANNA RYDE

Apiculture, or beekeeping, is the art of bees with the aim of producing and harvesting the honey surplus and its other by-products. It is an ancient technique going back thousands of years.

Getting Started

You may have been considering the idea of keeping bees for a long time, encouraged by childhood memories of watching beekeepers tending to their hives, or perhaps it is a recent interest encouraged by a local beekeeper with the tempting offer of a hive to get you started. Whatever your level of interest, it is important to do a little homework before bringing home your first hive.

The best way to learn about bees is to read as much as you can and to talk to experienced beekeepers on how they manage their hives. In the beginning, you will probably read and be given some conflicting advice that, when you are starting out with your bees, can be a little bewildering. Nothing beats the confidence gained from experience, however, and after your first year or two so much will suddenly fall into place.

Warning

It may sound obvious, but if you know you have an allergy to bee stings it is unwise to proceed. However careful you are, there will be the odd time you get stung during a hive inspection. If any family member or friend suffers from anaphylaxis (an extreme allergic reaction), they should carry an epinephrine pen with them at all times while in the vicinity of an apiary.

Join Your Local Beekeeper's Association

There are some things to consider and plan for that will ensure a smooth and encouraging start to beekeeping. Finding a mentor, especially in the early days of beekeeping, is invaluable. You will pick up lots of useful tips and have someone to call on in moments of confusion or doubt. An easy way to meet other like-minded people and to learn from experienced local beekeepers is to go along to your local beekeepers' association. Members come from all walks of life but have a common enthusiasm for beekeeping and a willingness to pass on their knowledge. Many are amateurs with one or two hives, but others will have many more colonies in their apiary. Regular meetings are held with expert speakers coming from around the country to give talks and demonstrations.

Some associations run courses during the winter months with weekly meetings for those interested in learning more about keeping bees. It is an invaluable and entertaining way to find out whether this unique pursuit is for you. Driven on by others' enthusiasm can be a delightful way to learn about a new and fascinating subject. By spring, the meetings are held at local apiaries where the newly acquired theory is put into practice. This is an exciting moment: for many this will be the first time they have donned a bee suit and looked inside an open hive. For some, this first encounter, at such close quarters, can be overwhelming, but for most it soon subsides with the realization that they are well protected in their suit. At this point, the enthusiasm to get involved in the practical tasks rapidly takes over.

Get Partnered with a Mentor

With the theory and practical learning behind them, many budding beekeepers will go on that same spring to start with their first hive or two. Others will continue to complete a full season of beekeeping under guidance, either by continuing to visit the association's apiary or a fellow beekeeper's colonies, to help with the regular hive inspections.

If you choose to get on with setting up your own beehive, finding someone willing to guide you when it comes to some of the practical hive manipulations is a great way to learn and an enjoyable and sociable one, too. Having a mentor to call in moments of uncertainty will make for a happier start to beekeeping.

The Best Time to Start Keeping Bees

Spring is probably the easiest and most satisfying time to set up your hive. By starting at this time of year, you will give yourself time to settle into a routine with your bees, making your regular inspections with the bonus of watching the gradual build-up of comb and honey. If the next few months are managed well and you are lucky with the weather you will, by the end of the summer, be able to harvest your first crop of honey. If you complete a beekeeping course during the winter months, starting in spring is ideal if you want to keep up the momentum, enjoy the summer getting to know your bees, and be rewarded with the huge pleasure of eating your own honey—all within a few months of starting!

The bees, dormant through the winter months, become more active with the warmer spring weather. The colony starts to grow and the spring flowers, which start to bloom in March and continue through to May, together with trees, provide ample nectar and pollen. It is about this time that a prime swarm will take place. If swarm is discovered, a local beekeeper is often called to collect it. The caught swarm (a nucleus) is then available to be transferred to an unoccupied hive. If you make yourself known to local association beekeepers, it will probably not be too long before you are offered a nucleus of bees to start your hive.

In spring, bees are also readily available from beekeepers who are looking to reduce the number of hives in their apiary. If you are lucky you can be instantly set up by receiving a hive from a reputable beekeeper with an already established, disease-free colony of bees. For those who have not had much practice handling a busy hive and would be happier with a gentle introduction, starting with a nucleus of bees is preferable. This way you are really starting at the beginning. With fewer bees to manage on inspection, it will be easier to observe and understand how the hive works, watching the colony grow with the fresh new comb.

A Place to Keep Your Equipment

Where to keep your beekeeping equipment is something to be carefully considered. You may start with very little: your bee suit, a smoker, and a hive tool. Within your first season, however, you are likely to gather more bits and pieces than first anticipated. Bulkier equipment such as spare supers and frames, which you will need to add to your hive as the honey flow speeds up (see Setting up your hive,p.38) will take up space, and as your apiary and your experience grows you may want to acquire your own wax and honey extractors. As well as a place to store your equipment, you also need to think about where you can perform your honey and wax extraction.

Consider Your Neighbors

Most beginners do not have any choice in where they will keep their bees other than at home in the garden. If you have a larger than average garden you will probably have no problem placing your hive so that your neighbors never know it is there. With smaller gardens there is a little more to consider where neighbors are concerned. The last thing you want is for your bees to cause a nuisance and prevent the neighbors from enjoying their garden. Another potential annoyance is bees "spotting" clothing that is out on the line to dry, resulting in little yellow spots. In addition, if you or your neighbours have a pond, you will notice, some time in early spring, that the water's edge will be visited by large numbers of bees collecting water. They do this in order to break down and eat the old supplies of last year's honey stores. For some pond owners this can be fascinating, but for others it becomes troublesome. Put your neighbors' minds at rest by encouraging them to join you in one of your hive inspections. Get them involved by introducing them to some of the amazing facts about the honeybee and how vital their role is in the pollination of plants and crops. The promise of a pot of honey, or two, will certainly help.

Positioning Your Hive

A little planning before deciding where to place your hive will save time and needless stress later on. Keep in mind what matters foremost: the safety of your family and neighbors.

Ideally, a hive should be positioned facing southeast. This is to ensure that the rising sun beams onto the doorway of the hive encouraging the bees to make an early start to the day's foraging. Do not worry if this is not possible, however, as it will not make too much difference to your build-up of honey. It is worth noting though that to encourage a healthy colony, it is preferable to locate the bees in a sheltered area with a sunny spot away from persistent winds and drafts.

If there is no water nearby, ensure you keep a dish of water topped up by the hive. Including some stones and mossy sticks perched at the sides will help the bees to get to the water without falling in and drowning.

If you can nestle your hive between some bushes and tall hedges (not actually touching it—you want to keep the hive airy and dry with enough space for you to attend to it easily), away from the house it will attract less attention. The hive must be set on level ground which is easily achieved by bedding it in a flagstone. Adding some tall planting or screening ten feet or so in front of the hive is an excellent way to divert the bees' flight path upward, thus keeping them above both head height and neighboring gardens. It will also offer some welcome shade for the hives in the height of the summer. With all of these factors considered, you will be on the way to a successful season's beekeeping.

If you come to the conclusion that your garden is not suitable or big enough to keep your bees without it becoming troublesome, then there are alternatives to consider. Some people successfully, even in cities, keep their bees on the roof if they have an area that is stable and flat. Find out from other beekeepers where they keep their bees and you may find that they will be able to offer a space near their hives. Local associations often have an apiary and are in a good position to help you in locating a site.

Starting with One Hive, or Two

You could consider starting with two fully set-up hives or begin with one and have the other ready to take on a nucleus (swarm) of bees. By starting with just one hive, you are likely to feel a little more in control as you relax into managing the hive inspections and, equally important, you will have time to assess whether you are happy with the location you have chosen for your bees.

Getting a New Hive Ready

If you could see a cutaway view of your hive you would see how it mimics the natural shape of the nest in the wild with the brood, pollen, and honey set in a specific pattern, albeit in a controlled environment.

Your wooden hive, with its detachable sections, echoes the tiers found in a natural hive, but in a way that allows you to easily check the health of the brood, control swarms, and monitor your honey stores.

Working up from the bottom, a standard modified national hive consists of:

1. At ground level a stand provides a firm base for the hive, elevating it to a comfortable height for inspections while also providing ventilation and security from unwanted intruders.
2. Next is the floor section which incorporates the base of the hive, the entrance, and sometimes a landing board. In its most basic form, the floor is a solid timber base onto which can be added a tray and screen used to collect the hive debris, which you can pull out to make checks for varroa mites. A more recent innovation is the open-meshed floor. Unlike the traditional wooden floor, the base is made entirely off fine mesh that the bees can move around on while allowing improved ventilation and debris including mites to fall through to the ground below. Some of these open-meshed floors also include a thin white panel which you can slide under the mesh to inspect the debris more closely for signs of disease.
3. The brood box sits on the floor section, and this is the nest where the queen lives and lays eggs and the workers rear the brood. To allow for easy inspection and to give the bees a head start, the brood box contains brood frames. These are thin wooden frames that each hold a sheet of foundation wax upon which the bees will build the comb to hold the brood, some pollen, and honey.
4. A queen excluder is placed over the brood box to keep the queen from entering the honey stores. Without the queen excluder, the queen's natural instinct is to move up through the center of the hive to lay brood. The excluder is a screen with gaps that allow worker bees to pass but are too small for the queen to squeeze through.
5. The super, shallower than the brood box, is placed over the queen excluder. It is filled with frames, fitted with the wax foundation, which is where the bees will begin to draw the comb ready for filling with honey. As the season progresses, the honey flow becomes stronger and additional supers can be added for the bees to expand into.
6. The crown board is the covering placed on the top super. It has one or two elongated slots in it to allow for feeders to be placed over them during the winter months. The slots are also used for attaching the porter bee escape used for clearing the bees before harvesting.
7. The roof is the lid of the hive. The deep sides slip over the top of the super making it waterproof and acts as a safeguard against predators while

maintaining gentle ventilation. The top is usually covered with a sheet of metal for extra protection from the elements.

Introducing a Nucleus of Bees

A nucleus of bees may be purchased from a reputable supplier or beekeeper. Although buying a nucleus can be an expensive way to start, it offers an easy and gentle introduction to beekeeping. The advantage over a swarm is that the hive will be smaller in numbers making inspections easy and enjoyable to carry out as you start. Your colony of bees will strengthen through the season, along with your confidence and skill in handling them.

A good nucleus, whether bought or inherited, should have at least three frames covered in bees with a good amount of healthy brood and stores, with the all important vigorous young queen.

On receipt of your nucleus, the bees should be hived as soon as possible, but before making the transfer, there are a few things for you to prepare ahead of time. Depending on how many frames your nucleus arrives on, the brood box will need to be fitted with enough frames to complete the "nest." To help the bees progress quickly with the comb building, be ready with a feeder filled with syrup (4 cups of sugar; 2 ½ cups of water). With your hive in position and ready for action, place the box holding the nucleus by the hive and allow the bees to fly from the box. This enables them to cool off and quench their thirst for a couple of hours before you prepare to transfer them early in the evening.

When the bees have resettled, have your smoker ready to gie a few cool puffs across the top of the nucleus box to subdue the bees, then gently transfer the frames one by one to the brood box. Place them in the gap you have prepared in the center of the brood nest, making sure they are set down in the same order as they arrived. Cover the brood box with a crown board and position the feeder accordingly. Put a super frame around this and cover with the roof.

The feeder will need a regular check every few days to see if the syrup needs topping off. After a week, the bees will have settled and it will be time to make that first inspection and observe the exciting development of the brood nest. For the beginner, this is the perfect way to experience an open hive and to gain a good understanding of the bees inside.

Introducing a nucleus of bees into your hive by early May will stand you in good stead for achieving a strong colony by the end of the summer, and if lucky, a surplus crop of honey as your reward—all in your first season.

If you are unable to get started until later in the season, at the latest July, the bees will probably have just enough time to build up some stores for themselves to winter through, although they are likely to need more feeding through the winter than a more established hive. Timing is everything. If you want a strong colony and the thrill of harvesting your first honey by the end of the summer, you need to be sure that your nucleus of bees will arrive on time. A delay of just a few weeks can make all the difference to the rate at which your bees strengthen in numbers.

Inspecting Your Hive

Every time you inspect your bees, take time to prepare. Allowing yourself enough time is important because an unhurried and unflustered inspection will make a difference to the temperament of your hive. Check that your bee suit is fastened securely, however brief you think your visit will be. You must also ensure there are no gaps for the bees to crawl inside your veil, your boots, or your gloves. A few sensible precautions, which will become instinctive, will reduce the chance of being stung. A good smoker is an important tool; use it every time you tend to the hive. When a bee senses smoke, it instinctively plunges its head into the honey cells to gorge itself as it fears the hive is under threat. Light puffs of smoke will instantly clear bees and the control it brings will help your confidence. You will also need a hive tool to assist in levering and scraping off sections of the hive which will be sticky with propolis. It is also useful for pinching out unwanted cells from the frames.

Removing the Roof and the Crown Board

With the smoker lit and filled with enough fuel (cardboard or sacking) to last the session and the hive tool to help you break open the hive, you are ready to lift the roof off the hive and place it to one side. Underneath, covering the top super, is the crown board. This will be sealed to the super with propolis, the gluey substance that the bees secrete to close any gap they find in the hive. Gently ease the crown board with your hive tool. The gentler you are when handling the hive, the less agitated the bees will become. If you avoid abrupt movements and take care not to knock the hive, the bees should remain calm, making the rest of your inspection easier to complete.

Inspecting the Supers

With the crown board removed, you will have exposed the top super (the sections where the bees build their honey stores) which will, depending on the time of the year, be a mix of new foundation, newly drawn comb, comb filled with honey but not capped, and honey ready to harvest. Always check there are enough stores for the bees particularly when checking early or late in the season. In the height of the season, make sure there is enough room in the supers for the bees to keep busy building and filling new comb. A congested hive will be an unhappy and frustrated one and will be likely to swarm. If it looks like the bees will need more room, adding a new super will keep them content and busy.

Inspecting the Brood

You now need to inspect the brood, located at the base of the hive where the queen lives and lays her eggs. The brood nest is the most important part of any hive and each frame needs to be thoroughly checked. To inspect the brood, the excluder is carefully removed by gently releasing it from the brood box using the hive tool. The queen excluder will be sealed with propolis. Once loosened, carefully lift it off and check the underside for the queen before leaning it to one side of the hive. You do not want the queen to accidentally drop out of the hive, as the bees will quickly swarm to find her. The likelihood of this happening is small, however, as the queen is shy and as soon as the brood box is exposed, she will run from the light and often a cluster of worker bees will gather round to hide and protect her. A gentle puff from the smoker at the door of the hive will push the bees up from the base; this will give you a better chance of glimpsing the queen as you work your way through checking the frames. Inspecting the brood is important for a number of reasons.

After checking the brood frames make sure they are replaced carefully in the position they were found. They will build a distinct pattern to the brood nest running throughout the frames and if changed, by shuffling them around, it will upset the bees.

Your checklist should include:

1. Is there evidence that the queen is laying?
2. Search thoroughly for queen cups and cells.
3. Assess condition of brood and uniformity of brood pattern.
4. Look for signs of disease in the brood and any deformities in the bees.

Time to Harvest

Achieving a good crop of honey is reliant on managing a number of factors, but the weather is the one thing we have no control over. No matter the variety of flowers available for the bees to forage, and the care taken with your hives, it is the unreliability of the climate that can govern so much. The wrong mix of weather, unfavorable temperatures, and humidity at critical moments in the season can badly affect the nectar yield. If there is little nectar for the bees to extract, the honey flow will be feeble and your harvest may be smaller than anticipated. But if you can maintain a strong colony, are lucky with good spells of sunny weather coinciding with the flowering of local plants, providing the bees with a good honey flow, you will be on track towards reaping your well-deserved reward.

The harvest is usually carried out at the end of the season, although it is possible to remove the honey when a super is full. Some postpone the harvest until late August to ensure the honey is fully ripened and is of a good consistency. Check that the honey you are removing is completely capped, because the bees will only cap the honey once it has reached the correct density. In this state the honey will survive for a long time without fermenting. If you are impatient and take unripe honey before it has been capped, it will be very thin and watery, prone to fermentation, and therefore no good for storing.

If you only have a hive or two to harvest, begin the process by placing a clearance board with a porter bee escape in position under the supers you wish to harvest from. The porter bee escape will do its job of acting as a one-way door, allowing the bees down into the hive but blocking their entry back up again into the super. Left with this in place for at least twenty-four hours, the supers should clear, enabling you to take the honey with very few bees to contend with.

On a small scale, it is possible to harvest your honey without the use of a clearing board and porter bee escape. A frame of honey can successfully be cleared by gentle strokes with a soft brush to tease the bees away.

When you have taken the honey safely away from the hives and are inside with doors and windows shut to keep out any interested bees, you can start the extraction or comb cutting.

Goats

A goat, it has been said, is "like a three-year-old in a goat suit."

If you've ever thought you might like to try your hand at running a day care for preschoolers, you'll love looking after a few goats. They are both sweetness and shenanigans, loving and annoying, obedient and troublemakers–all within minutes of each other. They can double you over with laughter as easily as they make you cry out in absolute frustration.

With all the raw emotions that a goat or two can bring out in their keepers, they still count as the most versatile of all farm animals. With the right conditions one goat could supply your family with milk, low-fat meat, and an income throughout the year.

Milk from a backyard dairy goat can be used for household consumption and to make luxurious soaps. Although laws that allow the sale of milk are stringent, you could easily sell the soap as a high-end beauty product through multiple venues.

When compared to cow milk, goat milk is higher in phosphorous, riboflavin, niacin, calcium, and vitamins A and B_1 and is lower in cholesterol. Right off the udder, goat milk is loaded with antibodies and has a much lower bacterial count than cow milk. Based on these and other benefits, goat milk is often recommended by doctors to safely treat physical conditions including eczema, vomiting (dyspepsia), and insomnia in infants, pregnant women, and children.

Goat milk is decidedly richer in flavour than cow milk if you are used to 1 or 2 percent milk from the grocer's shelves. As you'll see in the breed section (following) some goats produce milk that is up to 6 percent butterfat.

Although the milk may be high in fat, the meat from a goat is not. Found most for sale within Spanish, Greek, and Jewish communities, chevon is growing in popularity across the United States and Canada. Chevon is the meat from young, but mature, goat. Cabrito or Chevrette is the term for meat from a milk-fed kid. The less tender meat from an older goat is called chivo or mutton (a term commonly used for older sheep meat).

Goats will give you much more than milk and meat though. You might be able to sell the hair from your goats or use them to control overgrowth on your land. A goat or two can make short work of returning a neglected homestead to its former beauty.

Measured by all these benefits, goats are a surprisingly inexpensive purchase and are also cheap to keep.

A final blessing of keeping goats is the fiber many of the breeds produce, known as cashmere. Cashmere is still the lightest weight, warmest, and most completely non-irritating fiber known to man. This down-like hair grows under the primary hairs of goats raised in cold climates where extra warmth is required. In most cases a cashmere-producing goat will only create a quarter to a third of a pound per year.

Dispelling Myths about Goats

Goats Are Smelly. Does smell like pasture, fresh air, and hay. It is the buck that carries the offensive odor that gives goats a bad name. Bucks have two major scent glands located slightly behind and between the horn area. The odor is strongest during breeding season.

Goats Are Mean. As a rule, goats are not mean. When raised with understanding and care they develop an eagerness to please their owners. Goats can be trained to come to their name, pull a cart or field tiller, and be led peacefully by a rope. If you've met a mean goat, you've either been in the presence of an uncaring owner or somehow the goat felt threatened and displayed aggression in an attempt to protect itself.

A Goat Will Eat Everything in Sight. Goats are inquisitive animals that explore their world orally. Few goats will swallow objects that don't taste good. Proper fencing is a top priority when raising goats to ensure they don't "explore" your prized roses or climb onto your pickup truck to see what's inside.

Choosing the Right Breed for Your Needs

Pure goat breeds are separated into three main groups for farm use—milk, meat, and fiber. A milk or fiber goat can be raised for meat. A meat or milk goat can produce salable fiber. Fiber and meat goats can be milked. Even though all goats are triple-blessed, not one breed is versatile or exceptional enough to be classified as such.

Around the world more than two hundred breeds of goat exist. Eighty of these are registered for agricultural use. The breed you choose will depend on your family's needs, your ultimate goal, and regional availability.

Approximately 60 percent of goats currently in North America are mixed breeds (termed "grades" or "scrubs"). These animals are unregistered but they still have use and purpose to a small farm. A grade goat might be a risky proposition to raise for milk, but they are perfectly acceptable animals for meat.

Meat, Milk, and Fiber Yields for Goats

Yields to be expected from registered classes are:

- Dairy—Average doe supplies nine hundred quarts per year.
- Meat—The average buck kid provides twenty-five to forty pounds of meat. Boer goats produce nearly twice as much.
- Fiber—Adult Angoras supply ten to fifteen pounds of mohair per year. Adult cashmere-producing goats might supply a third of a pound per year.
- All—Supply approximately one pound of garden-enhancing manure per day.

Dairy Goat Breeds

Of the six most common dairy goats, the Swiss breeds (Alpine, Oberhasli, Saanen, and Toggenburg) are the hardiest for colder climates. The remaining two (LaMancha and Nubian) are genetically equipped to handle extremely warm and dry climates but may be kept in the North with proper care and consideration.

Nubian—Easily recognized by long droopy ears and wide nostrils. Nubians are the most energetic class and produce milk high in butterfat.

LaMancha—These goats originated in the United States and have very small ears, if ears are at all noticeable. LaManchas are the calmest breed and also produce milk high in butterfat.

Saanen—The largest of the milk goats. Saanens are usually white, with a narrow face

The Saanen is one of the top producing milk breeds.

Meat Goat Breeds

Although any breed of goat (including the scrub) can be used for meat, this classification is specific to the few breeds that grow the quickest and add more lean muscle fiber than other classifications of goats.

The Spanish and Myotonic goats have been raised for centuries by North American farmers to provide a reliable meat source for their families. Both breeds grow to decent proportions and are well-muscled animals. Spanish bucks grow to an average of 175 pounds and their partners to 100 pounds. Myotonic bucks can weigh up to 140 pounds and the does approximately 75 pounds at maturity.

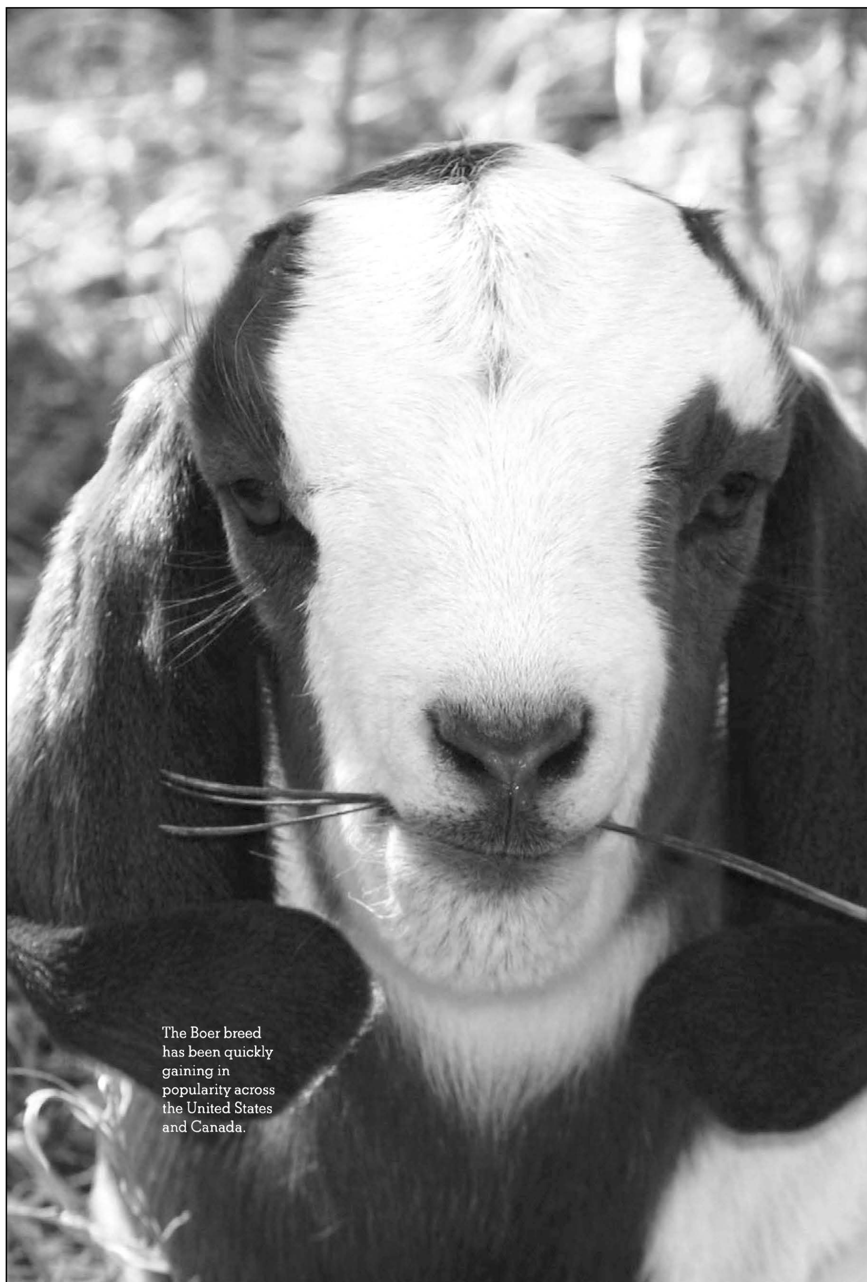
and nose. Saanens are one of the top two milk producers. Notes: A colored Saanen is called a Sable. Although a Sable is the product of two Saanens with a present recessive gene,

Sables are slowly becoming recognized as a separate breed in North America.

Alpines—(French, Swiss, British, and Rock) Alpines come in a variety of colors, the most common of which is the French White Neck Alpine. These goats match the Saanens in milk production.

Toggenburg—Toggenburgs are the oldest registered breed. Usually brown (from creamy to dark brown) and showing white stripes or patches above each cheekbone, on the ears, inside the legs, and/or on the rump.

Oberhasli—You can easily see the genetic cousins of goats (deer) in the Oberhasli. These goats are small, like the Toggenburgs, and are easily distinguished by their thin faces and coasts of russet brown, often with black markings.



The Boer breed has been quickly gaining in popularity across the United States and Canada.

The Myotonic goat is also known as the Tennessee Fainting goat. This goat was introduced into America by a Nova Scotian (Canadian) breeder. The animal's success as well as its shortcoming is the result of a genetic disorder causing it to react to fright with muscle spasms. The goat, when startled, will stiffen his legs, lose his balance in the process, and fall to the ground. The repeated stiffening gives the goat muscular thighs—enough so to be classified as a meat goat. Unfortunately this condition also renders the animal helpless in the pasture until the myotonia dissipates.

In the last century a new breed has entered North American soils. This breed, the Boer, hails from South Africa, where it was developed for size, speed of growth, meat quality, and uniformity of coat color. The Boer is statuesque in comparison to the native North American goats. A mature buck can tip the scales at more than 300 pounds, a doe at 220 pounds.

With a history and development similar to the Boer's, another new breed of meat goat is being introduced to the world from New Zealand. The Kiko goat is the product of a government-funded initiative that began in the 1970s to crossbreed wild with domestic goats to produce a faster-growing meat breed. Within just a few generations and mirror variations during development, the Kiko was established as a breed. Kikos are now proven to have the highest occurrence of kidding twins, a fast and reliable growth rate, and a hardiness to disease and harsh weather.

Fiber Goats

Goats produce two distinct fibers—mohair and cashmere. While mohair is only produced by the Angora goat, cashmere can be found on more than sixty of the world's goat breeds. (In North America we most often find cashmere on northern-raised Spanish and Myotonic breeds.)

Finding a top-producing cashmere goat is difficult in North America, not to mention an expensive acquisition for the small herder. Goats in the top of their class for producing cashmere often net a few thousands dollars upon sale and yet may only produce a quarter to a third of a pound of fiber per year.

Angoras, on the other hand, are a pure and registered breed. These silky-haired goats generate eight to twelve pounds of mohair annually. A wether (castrated male) produces slightly more than a doe.

The Angora is certainly in a class of its own, but the care is similar to that of other goat breeds. If you are only planning on keeping a few and hope to sell the fiber twice a year, find a local breeder or Angora goat group to collaborate with. Not only will they share invaluable breeding, feeding, and coat care tips, they will also assist you in finding a buyer for your yield.

Miniature Breeds

Miniatures are currently popular on farms with limited space for both meat and milk production. The miniatures also make great pets and are easy enough for most children to handle. These goats are one-third to two-thirds the size of an average milk goat and therefore require much less space and food.

Nigerian Dwarf—At seventeen to twenty inches tall, this miniature dairy goat is capable of producing one quart of milk per day (ample or a small family) and requires. Mature does average thirty to fifty pounds. Bucks and weathers average thirty-five to sixty pounds.

African Pygmy—These well-natured dual-purpose goats are often displayed at petting zoos. They stand eighteen to twenty-four inches tall, but their stocky build weighs them in at between thirty-five and seventy pounds. Their milk is higher in butterfat than any other goat (approximately

6 percent), and their muscular nature makes them a viable meat breed as well.

Although there are only two recognized miniatures, a few crossbreeds are gaining in popularity. The Pygora (a cross between an Angora and a Pygmy) produces a lesser-grade mohair but will also produce the fine down a Pygmy provides, and will finish a little larger for freezer meat.

Another dual-purpose crossbreed is the Kinder (a cross between a Pygmy and a Nubian). This breed has been gaining in popularity since first introduction in 1986. Kinders have been recorded to produce three to six kids annually, and some have been rated as top performing milkers.

Designing Your Small Farm Strategy

As goats are herd animals, it is best to have more than one. They are not meant to be the only one of their kind on a farm, but they will bond and make friends with any other four-legged farm animal with which you house them. At any rate, if one is a charming addition to your farm, two will be twice the fun.

There are many options to consider when designing a small-farm strategy to suit your needs. A few scenarios follow.

- Raise dairy goats with the added benefit of meat once per year: Purchase two bred or breeding dairy does. Breed them every year, four to six months apart from each other, to keep the milk flowing. Increase your herd by keeping the doelings or fill your freezer by growing the buckling on supplemented pasture for four to six months. If you don't intend to increase your herd and your original does are of good stock, you can sell the young dairy does to other farms.
- Raise goats for meat and a little milk: Purchase two bred does of any breed (or have them bred) and continue to breed for the next few years. Keep or grow doelings and grow the buckling for a few months.
- Raise goats for meat only: Purchase two wethers. Boer or Boer-cross wethers will yield the most meat in the shortest possible time.
- Raise goats for fiber with no interest in breeding or a milk supply: Purchase and keep wethers long-term. Wethers yield a higher fiber count, are cheaper to purchase, and grow larger than a doe.
- Raise Angora goats for income or for meat: Purchase two bred does, raise the offspring on supplemented pasture for meat, have some milk for personal use, and during shearing season make a little extra income.

Raising Kids for Meat

One of the most popular small farm strategies involves breeding milk does to keep them in production and raising the kids for just a few months to supply meat for the freezer. Others purchase weaned kids to raise for meat and are done with chores by winter solstice.

Whichever strategy you employ, your goal is to raise the largest possible kid, in the shortest period of time, at the lowest possible cost. The least expensive goat meat to raise is the six- to eight-week-old milk-fed kid weighing about thirty-five pounds. Since this kid will only net fifteen to twenty pounds of freezer meat, grow him on for a larger yield. By twelve weeks of age the average goat will weigh fifty pounds and will have only cost you a few dollars in grain. Put that same kid on pasture (with normal supplemental feeding), and by the time he's reached seven to eight months, he should weigh in at eighty pounds.

Just by adding an extra five months of pasture grazing and a few pounds of grain, you've increased your freezer meat profit by 400 percent. The exception to this rule of increase is the Boer goat. Boers are larger at birth and grow faster and larger than any other goat in the same amount of time.

The Goat Barn, Yard, and Pasture

Whenever you need to set up an area for goats—inside or out—it is beneficial to remember the adage of a goat, "like a three-year-old in a goat suit."

If a barrier can be jumped over, an electrical wire reached, glass windows pushed upon, grain accessed, or nails stepped on, it will be. Any object within reach will be challenged, broken, eaten, chewed, ripped, pushed, or punctured by a goat. If you wouldn't leave your three-year-old nephew alone for twenty minutes in the shelter or hope to hold him with the fence you just built, it probably isn't adequate for a goat either.

Goats won't take up much room on your farm. Their housing requirements are early as casual as those required for chickens. In fact, large shed will do just fine for a few goats. With just a little ingenuity and room in your budget you can have the ideal setup for keeping goats.

There are two primary methods for housing and containing goats. The first is to pasture them and provide a poor-weather and bedding shelter. The other method, "loafing and confinement," is to keep goats in a shed or small barn with a fenced yard for exercise.

The loafing-and-confinement system of raising goats is used mainly for dairy and fiber goats or by farmers who don't have ample pasture. Sufficient room is provided inside and out but keeps high-energy activity to a minimum. Lees energy expended allows for productive use of feed.

An average goat only requires twenty square feet indoors, plus two hundred square feet outdoors. Meat goats require more: thirty square feet inside, three hundred outside. Miniatures require a third less than the others.

The Goat Barn

An existing shed conversion may be perfect for housing goats and could save you building a new structure. Knowing the number of goats you will house at the height of the season (your does plus offspring that you keep for five to six months) will determine if an existing building is adequate. A communal stall takes 35 to 50 percent of your floors space and leaves adequate room for a milking station, feed storage, and one or more smaller stalls. The small stall will be used for isolation of a sick goat, quarantining a new goat, kidding, or weaning.

Shed Conversion Example

Two dairy does given forty square feet (twenty square feet each) for a communal stall, plus a smaller stall for kidding (twenty square feet), a section for milking and glain storage (thirty-five square feet), plus twenty square feet extra for two kids annually.

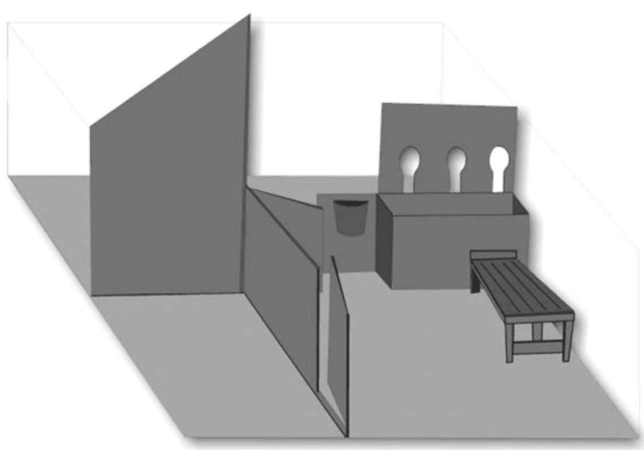
At less than 120 square feet required, a little planning can convert a 10-foot by 12-foot shed into an adequate loafing barn. Tight, but adequate.

Design your floor layout to accommodate the feeding and watering of goats without entering their communal stall. The easiest way to do so is to build a half wall between their space and yours. Your side contains the manger, water bucket, and soda/salt feeder. Their side contains slatted or keyholed head access to all three.

A slatted or keyholed access manger may be the most economical investment of your time in a shed conversion. Goats are not only notoriously picky about the hay they eat, they are also the most wasteful. If they can climb into a manger to eat they will do so, soiling their feed in the process.

At an open manger they are known for taking a mouthful of food, turning to see who might be behind them, and dropping half of their mouthful on the floor in the process. A slatted or keyholed access manger ensures that they can neither swing their heads around nor climb into the manger to eat.

The standard top width of a keyhole is eight to nine inches with a keyhole-shaped taper to the bottom at four to five inches wide. The full height of the keyhole is sixteen inches. Goats will crane their necks to put their heads in at the top and then lower their heads to a comfortable fit within the slot.



A converted ten-foot by twelve-foot shed showing a milking stand or bench, keyhole manger access, exterior water buckets, and good distribution of space: Sixty-square-foot communal stall, twenty-square-foot kidding stall, and thirty-five square feet of work and storage area. Add an access door to the back wall that opens to their yard and you're all set to bring a few goats home!

If the top of your wall is higher than most of your goats can reach through slats or keyholes, you could build a variable-height step on their side of the wall. Later, kids feeding at the manger will use the higher steps. Keyhole entries won't work for horned goats.

Temperature

Goats will huddle together and keep each other warm (enduring temperatures to freezing) as long as their goat house is free of drafts and leaks and the bedding is ample and dry. Take extra care for extremely cold days and nights, if kidding is imminent, or if you've had early-season births. Extra bedding, a supervised or safe heating unit, and/or a little extra hay for adult goats will help keep the cold out of your herd.

During the summer months you'll finds goats equally resilient, but do not lock them in during the hottest summer nights without a breeze blowing through and plenty of cool water.

Floors and Bedding

The flooring in a goat barn need be nothing more than dirt covered with a thick layer of bedding material. Straw and waste hay are easy to use and inexpensive, but wood shavings are easier for cleaning and more beneficial as a future compost.

Keeping a goat's bedding clean is of the utmost importance. You won't have to spend hours cleaning out their pen every morning, though. All that is required is to lay some fresh bedding over the existing every few days.

When you're cleaning out the stall, be sure to compost the rich organic waste material for at least six months, then add it to your gardens. Compost longer if you've been using waste hay as bedding material.

Lighting

As the days grow short over the winter months, you'll find yourself doing chores in the dark more than once. If you keep dairy goats the addition of lighting performs double duty. Natural and artificial lightning for eighteen to twenty hours per day will maintain milk production through the fall and winter months plus increase the success rates of early spring breeding.

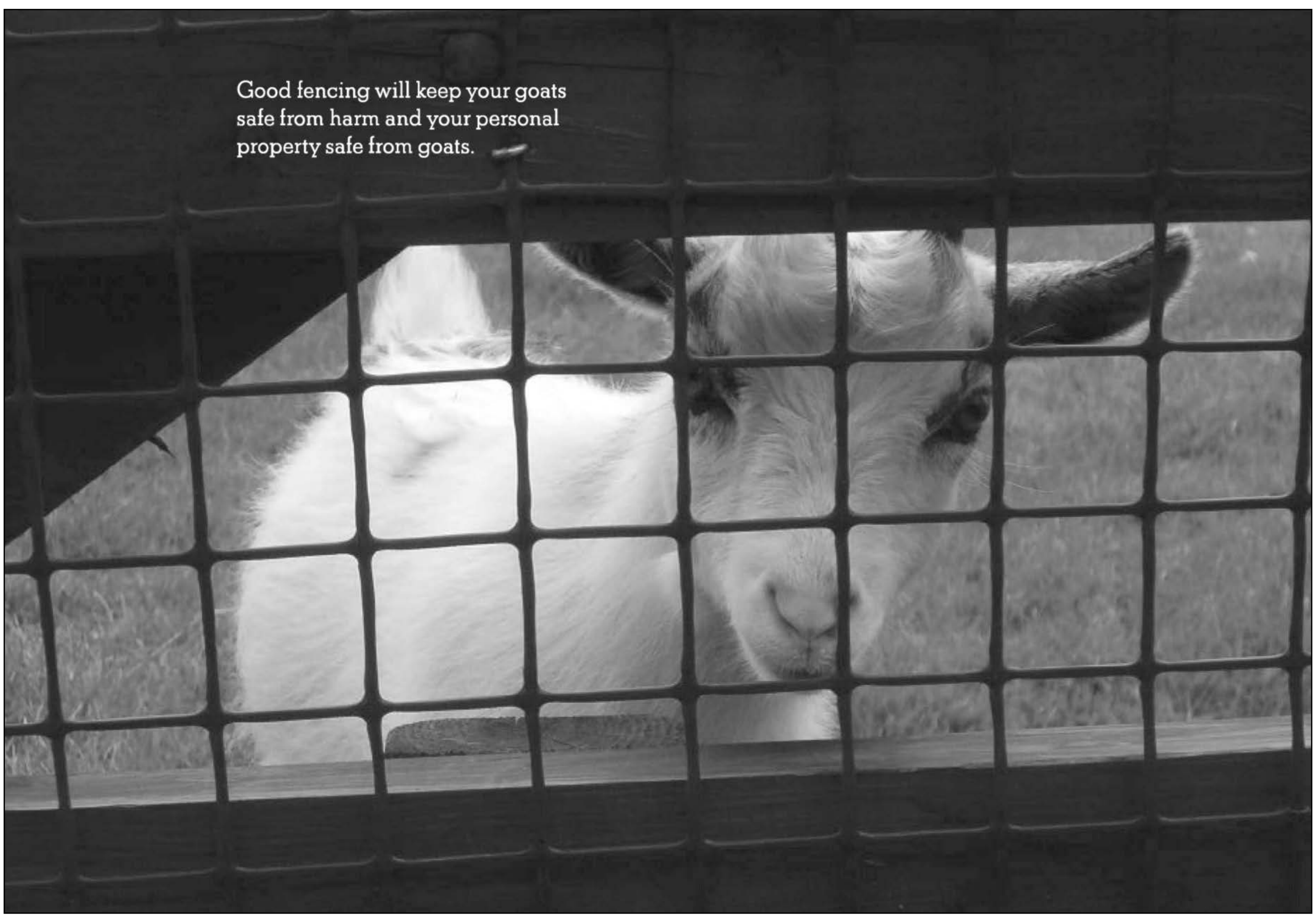
Graining or Goat Ration Storage

Store grain away from all moisture, out of the sun, off the ground, and certainly out of a goat's reach. Should a goat obtain access to the grain barrel it will eat until the grain is gone—gluttony that could result in death through bloat. A galvanized trash can with a snap-on lid placed well out of reach keeps goats and vermin out of the grain.

The Yard

The goat yard should be dry at all times to prevent bacterial infections in hooves. If you don't have a dry area available for goats, a poured concrete pad suffices during the rainy season. It will also keep their hooves neat and trim. Plan for at least part of the yard to be on the south side of the building.

Goats are happiest when they have something to climb on. An outcropping of rocks is ideal, but any sturdy structure will satisfy their instinctual nature to climb. Keep climbing objects well away from the fence or they'll use them as steps to freedom.



Good fencing will keep your goats safe from harm and your personal property safe from goats.

Fencing for Pasture or Yard

"A fence that can't hold water won't hold a goat" is an age-old axiom. Above all other considerations, the fence deserves the most attention. Goats will go over, under, or through a fence before you've taken three steps away from their yard if it hasn't been built correctly.

- Four-feet-high minimum. Five feet high for the highly active and nimble Nubians and miniature breeds.
- Page wire fencing with twelve-inch openings is acceptable if you will never need to contain kids; otherwise invest in a six-inch page wire. Chain link or stock panels with small openings are equally acceptable.
- Use eight-foot posts, eight to ten feet apart, buried at least thirty inches into the ground. Posts can be steel or wood.
- All corner post supports of a goat yard fence go on the outside. Goats will climb or shimmy up a fence support no matter how slim.
- If building an electric fence only, run the wire, from the bottom up, at five, ten, sixteen, twenty-three, and thirty-one inches, and a final strand at forty inches for all breeds. Electric fencing is not a viable option if power in your area is prone to blackouts, although you can also consider solar-powered electric fence chargers. They are common, effective, and not too expensive. Remove all weeds that touch the wire.

The Gate

Your goats will watch you enter and leave the yard. In doing so they will learn how to operate the lock. As soon as they've mastered the latch or handle, they'll be wandering through your flower garden, investigating activity on the road, taking their lunch in the grain fields, or bleating at your front door.

A goat can flip a hook out of the eye it rests in and has the determination to mouth and hoof at a lever latch all day until it opens. Determined goats have even been known to slide a large bolt to the open position.

- Place all side bolts, latches, or locks on the outside of the gate where the goat can't reach them.
- Install your gate to swing into the goat yard so that even if one of your escape artists managed to unlatch the gate, she might not know she did so.

The Pasture

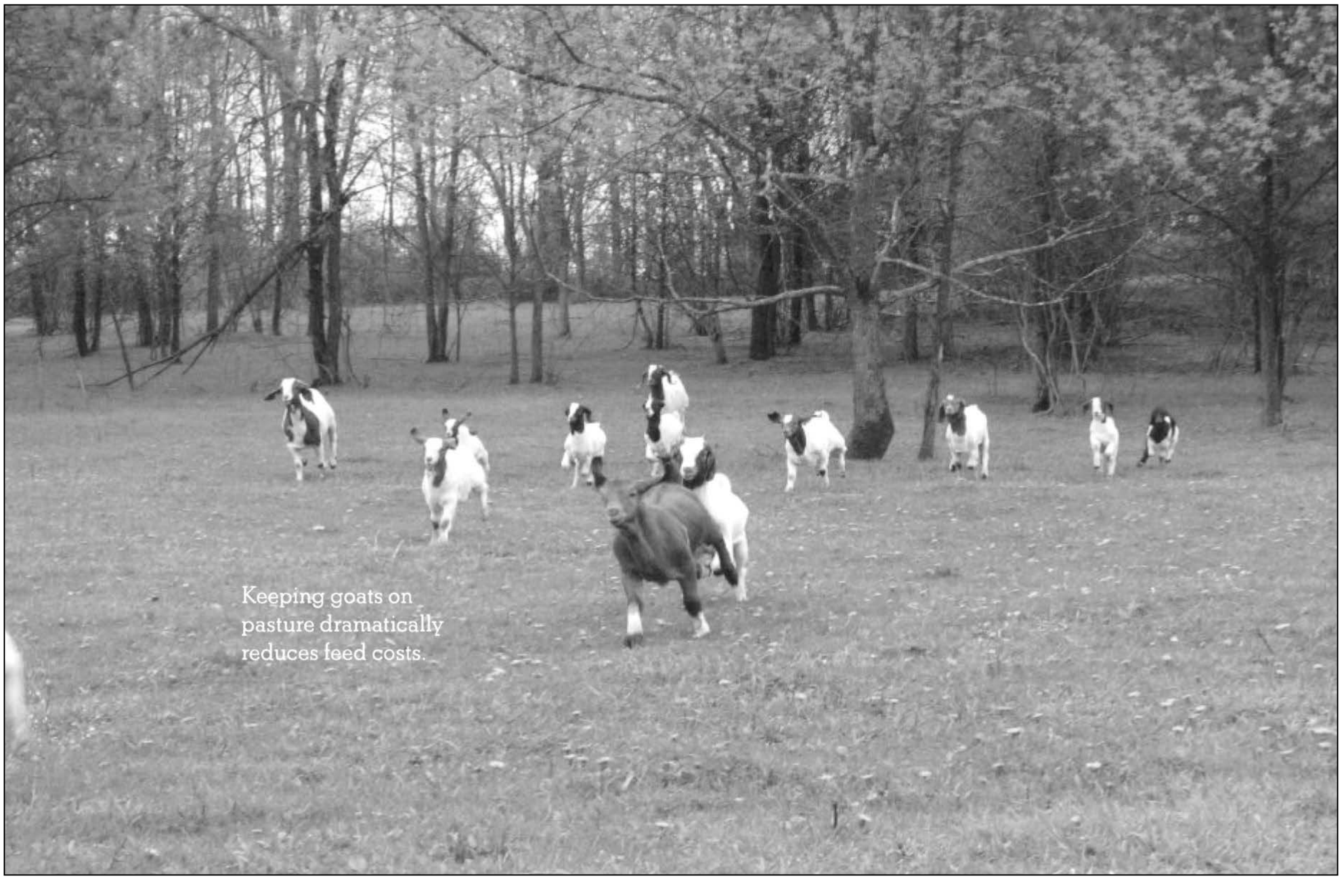
The practice of pasturing goats is a personal decision that may be based on breed of goats, farm economics, available pasture, or even your need to have brush cleared on acreage.

As feed can be 70 percent of the cost of keeping any goat, even partially pasturing meat breeds is frugal and wise. Milking does set to managed pasture will create more milk, but it will be lower in butterfat content.

If you will be pasturing your dairy goats, take heed that consumed pungent plants could alter the flavour of milk. Ensure as well that the does aren't in forest or overgrowth. A milk goat's udder could easily be scratched or damaged while foraging in such conditions.

Allow at least one acre for every ten goats and employ rational pasturing by moving their pasture as soon as each area looks sparse. Rotating ensures that each pasture remains viable and decreases the potential for parasitic infestation.

Goats eat a wide range of native plants on acreage, but should still have access to free-choice hay so that they are not forced to eat less than desirable forage. Your goat may have an instinctual nature not to ingest harmful plants, but take precautions by walking your pasture



Keeping goats on pasture dramatically reduces feed costs.

and knowing the plants growing in it. Local authorities maintain lists of known poisonous plant in your region. Even nonpoisonous plants can be toxic if they've been sprayed with pesticides that are not within the realm of instinctual knowledge.

Goats on pasture, like any other animal, may be stalked and attacked by predators. Losing a prized goat or kid to coyotes, feral dogs, wolves, cougars, bears, and the like is heartbreaking. No two situations are alike in the most effective legal manner to cope with predators. Possible options for protecting goats might be a herd-protecting dog, donkey, or llama; stronger electric fencing; or hunting the predators. Always check local regulations before taking extreme action. Even though farmers have the right to protect their livestock, your problem predator might be a protected species.

Getting Your Goat

As you've already read, every goat needs a companion. This might as well be another goat, although a ewe, cow, or horse will suffice.

If a particular goat hasn't already caught your eye and captured your heart, it's time find the best stock that suits both the goat shed you've created and your budget.

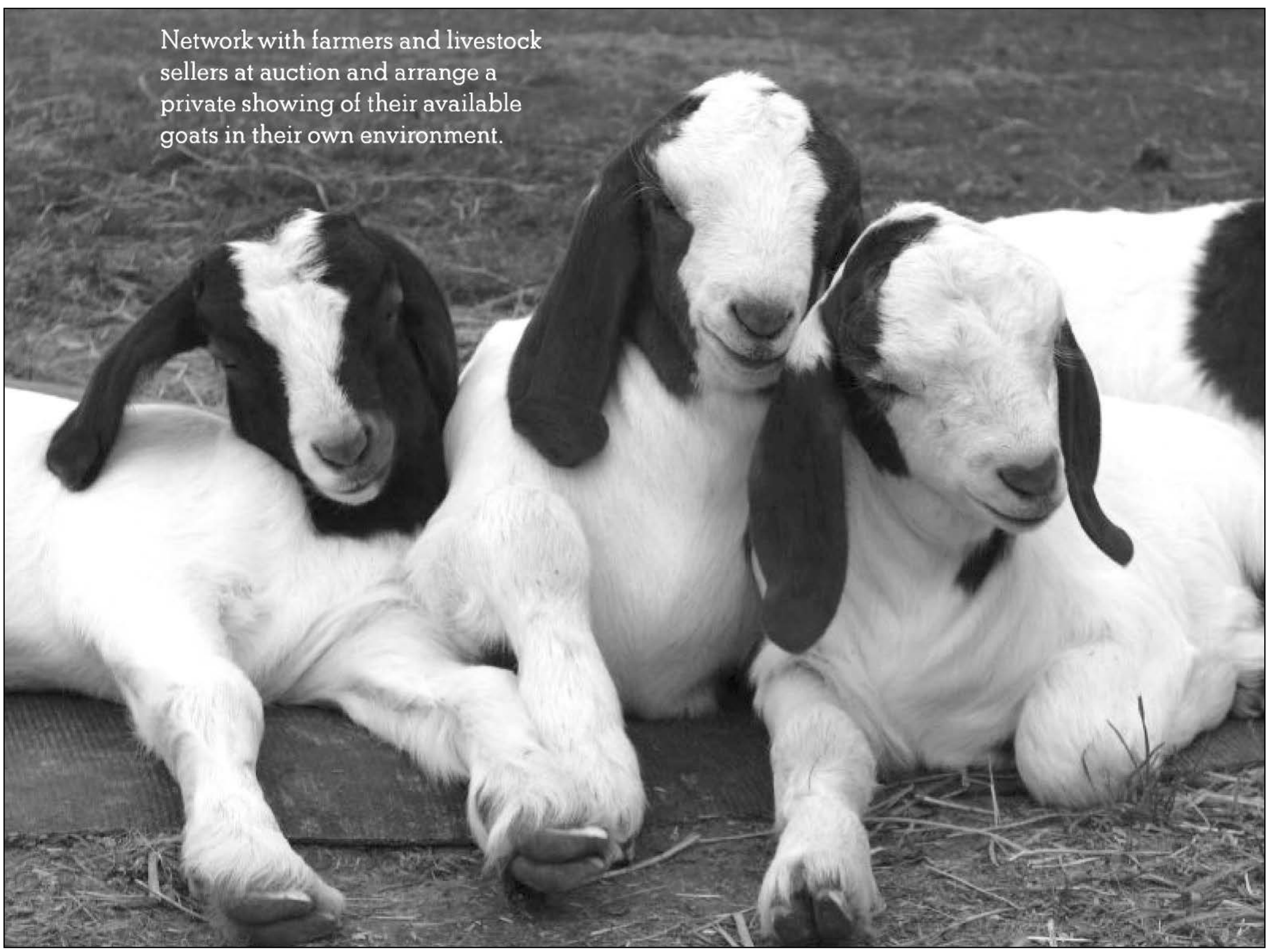
One of the best places to find local breeders and receive third-party opinions is your feed supply store. The cashier or staff in these stores know the people who purchase goat ration and medications. They are generally happy to help a potential new customer and offer their opinion in the same breath. Just one name and phone number could open up an entire network of nearby breeders and goat husbandry associations for you.

While you are at the feed store, check the bulletin board—every feed store has one—for advertisements. If no such listing exists, become proactive and write up a quick “Goats Wanted” flyer and post it on the bulletin board before you leave.

Other viable options are the local classifieds, livestock auctions, and county fairs. Over the last few years, the Internet has grown enough to find nearby breeders or associations through any search engine. Type in your state plus the breed you seek. You should find hundreds of listings and your goat as the result of just one click.

Before you head out to a livestock auction with an empty trailer, please read the next section on assessing goats to avoid costly mistakes. You may luck out and find a beautiful animal at the auction at a decent price. But there is a substantial margin for error for new farmers. If you haven’t owned goats before, either take someone with you who that knows goats and specifically the breed you seek, or use your time at the auction to network with the men and women selling or buying goats.

Most sellers are happy to arrange a private showing at their farm at a later date. Trade phone numbers and give them a call in a few days. Networking is, in fact, the better option. You’ll make new friends who obviously share your interest and you might end up purchasing a special goat that a seller was apprehensive to sell to “just anyone.” Viewing a goat in its comfort zone allows you to observe the breeder’s housing arrangements and have ample time to chat and discuss registration, an ancestry, and temperament, plus view any related barn records.



Network with farmers and livestock sellers at auction and arrange a private showing of their available goats in their own environment.

What to Look for

Price and paperwork aren't all there is to purchasing a goat. Health, age, production (even just in ancestry), and temperature are all key considerations.

Healthy, good-natured goats are easily handled and show neither shyness nor aggressive tendencies. Healthy goats will be as interested in you as you are in them. If she isn't looking at you with shining eyes and a sense of curiosity, you may want to move on to the next potential doe.

Know your breed. The body type should be a fair match to the breed you have chosen. Some goats have wide faces, some are without ears, others should fall within a certain height range by maturity. In all goats, look for a wide and strong back and chest, straight legs with trimmed hooves, and a clean, shiny coat. Avoid any goat with a sway back, a pot belly, bad feet, or a defective mouth.

The only way you'll develop an eye for healthy, productive goats is to closely observe as many of them you can. Whether you subscribe to a goat magazine, spend time at county livestock judging sessions, or discuss conformation with a local breeder, you will soon build up enough experience to be able to distinguish a strong, healthy animal from an unproductive underperformer.

Goat Registration Terminology

On the day you buy your goat you might hear some new terms from the private seller or auctioneer. Apart from doe (female), buck (male), wether (castrated male), and kid (not-yet-weaned offspring), here are some other descriptive terms.

Advanced Registry—Pertaining to milk does. This goat has been noted and registered as supplying a decent volume of milk over the course of a year. Dependent on their current age and health, Advanced Registry does have a proven record of milk production.

Star Milker—Pertaining to milk does. The star system is based on a one-day test of milk volume with extra stars awarded for ancestry performance. Points towards stars are calculated by a complicated formula used by goat dairies and registries.

Registered purebred—Comes with a traceable pedigree (much like a purebred dog comes with registration papers and a family tree).

Grade—A grade goat may or may not be a purebred animal. It is without papers and registration. If your goat meets certain requirements and you desire it, you might be able to register it as a "recorded grade" with the issuing authority in your area.

Americans, Experimentals, NOAs—These are grade goats. Americans and Experimentals are certainly purebred animals, but an NOA (native on appearance) might be.

Registered Goats Versus Grades

Although registration offers some reassurance that the animal you're buying is of notable heritage, it is not be mistaken as a guarantee. A registered doe with an impressive ancestry may not be such an impressive milker. She might not even produce enough to keep the barn cat interested, or she may have trouble kidding, or both.

Registration papers matter most to those who plan to show, breed, or otherwise profit from the animals. If your strategy in raising goats is for personal use, the added expense and paperwork (now and in the future) are likely a waste of your resources.

Registration of a farm animal is similar to registration of a purebred dog—unnecessary for the average person's needs. You can look at a dog and tell whether it is purebred without seeing the paperwork. You can make general assumptions of production, personality, and growth rate based on the breed. For personal or farm use, a dog's registration is little more than paperwork to be shoved in a desk drawer.

The same theory holds true for goats. Some may disagree. They'll disagree vehemently when trying to sell you a goat out of your price range while waving registration papers in your face.

Somewhere on your adventure of keeping farm animals you'll discover your own comfort level and need for paperwork and registration. At the end of the day, no amount of registration beats trusting in the seller and your own ability to assess the age and health of an animal within reasonable doubt.

Keeping a Buck

You would do well never to keep a buck. Even though you will need to breed your milk does to keep their production up and your meat does to keep producing kids, there are better ways to accomplish the task than to keep a buck year round.

A buck requires separate housing, extra fencing, and twice as many chores. More often than not he is left in a shed of only adequate size and treated worse than a junkyard dog. Far too often I've visited or driven by farms and noticed unhappy bucks, isolated from all activity on the farm, in less than pleasant living quarters. Not only is this unfair to the animal, the buck's story almost always ends in grief. A buck all but ignored will eventually become too aggressive to handle at breeding time, and will become stressed due to his lonely living conditions. Stress decreases an animal's resistance to disease and does little for his breeding performance.

That same buck would be happiest an a larger farm with committed breeders who allow many does from farms to be brought in for breeding.

Bringing Your New Goat Home

Any change in a goat's surroundings and routine will cause stress. Know your goat's current feed program (right down to the very hour) and bring a week's supply of her pervious ration and hay home with her. For a few days don't alter her old routine. If you need to make changes, do so slowly over the course of a few weeks.

The seller should supply you with the following:

- Registration papers (if applicable)
- Veterinarian contact information
- List of past medications and vaccinations
- Feed (ration and hay supply) for the first transitional week
- Hooves trimmed and horn buds removed (if applicable)

Most sellers will worm the goat twenty-four hours before you pick her up. This ensures that she does not introduce worms onto your land. If the seller has not wormed her, do so while you keep her in quarantine.

Kid goats can be transported in a pet carrier or dog kennel in the back seat of your car. I have seen people transport full-size goats in the back seat of the family car, but I wouldn't do so unless the trip was twenty minutes or less and the route accommodated slow speeds.

The back of a pick up truck with acap is perfect for transporting goats if you don't own a livestock trailer. Add three to four inches of straw, cover any metal loops or clasps, and you're set for the ride home. Take it easy on the turns and curves, and if your drive is longer than an hour, stop and check on the goat from time to time.

Quarantine any new goat for a week until the new surroundings become familiar and worming medication (if appropriate) has worked its way through her system. Slowly switch the feed over to your standard feed and spend plenty of one-on-one time with the new goat.

Feeding Goats

Goats are classified as ruminants and belong to the Bovidae family. They have a four-part stomach and will both graze pasture and browse woodland and brush.

In the wild, goats will eat leaves, branches, bushes, and tree bark. They enjoy variety in their food and would rather reach up than chow down.

Your goat may or may not have an instinctual ability to stay away from poisonous plants.

Contrary to popular belief, a goat will not eat everything in its path. Goats are prone to oral exploration and will mouth an object to experience it. Their interest in new adventures dictates that they must fully explore, rip at, tear apart, stand on, or conquer anything new to them. For their safety and that of your personal property, goats are not to be free-ranged around the homestead. Before you bring a goat home, take a look around and consider the potential trouble should they ever break free.

Feed Requirements

Goats require both hay (or pasture plus hay) and grain. If you are raising your goats for production you will want to be acutely aware of their nutritional needs and intake. You cannot assume a goat is fed nutritiously simply because it has filled up on brush, is on pasture, or has been given free-choice hay.

Goat ration is readily available at the feed store. The label will disclose added nutrients and vitamins as well as a protein count. A milking doe, for instance, require 16 percent protein in her diet, while meat goats and wethers only require 12 percent.

Other nutrients may be required through supplemental feed. A prime example is selenium, a trace element required for the health of gazing animals but which has been depleted from the soil in some regions of the United States and Canada. Many feed manufacturers are aware of local depletion and have made up for this by adding selenium as a supplement to goat ration. Pay close attention to the labels and by all means collaborate with local herd owners or associations regarding supplemental nutrients.

Hay

Your goats won't get fat on hay or eat more than they require. Keep free-choice hay available at all times even when your goats are on pasture. A belly full of fresh pasture and nothing else could result in fermentation, excess gas, and the potentially life-threatening condition of bloat.

The average goat eats 3 percent of her body weight in hay each day. Based on an average square bale weighing 35 to 40 pounds and an average goat weighing 120 pounds, you'll need approximately thirty-five to forty square bales of hay per year, per goat.

Kids and pregnant or lactating does will benefit from a higher-legume hay if you can find it. Legume hays are alfalfa, clover, soybean, vetch, and lespedza. Hay that is adequate for cows will not provide enough nutrients for goats. Cow hay is just barley suitable as bedding for a goat. You need hay fit for a horse or better. A 50/50 ratio of legume to grass is perfect.

The amount of hay you put out each morning or evening will vary through the seasons. It is completely normal for goats to eat the best part of the hay and leave half of the bale in the manger. Don't let old hay sit in the bottom of the manger. Rotate it for a day perhaps, then delegate waste hay to bedding.

When you're keeping goats, the biblical idiom "make hay while the sun shines" is changed to "store hay while the sun shines" for farmers on a budget. With two goats to care for you'll be using eighty bales of hay throughout the year. Storing it on your own property as soon as it comes off the farmer's field is both economical and wise. You don't want to be scrambling for hay in February, paying a higher price per bale, and worrying about moving it around during freezing weather.

Ration

Every goat requires grain for good health, and goats in production even more so. Nutritionally designed goat ration (also called goat chow) exists to match a goat's age, breed, purpose, and current condition. Every goat type, in fact every goat in your herd, will require a different amount of ration per day. Use the chart below as a starting point to determine your goat's needs, then adjust quantities based on physical condition, seasonal changes, and the quality of hay you're currently feeding. With minor adjustments throughout the year you will find the perfect quantity for every goat in your barn.

Some quick adjustment guidelines per individual goats are:

General Ration Guidelines for Goats

Type	**Condition**	**Daily Amount (in pounds)**
Kid	Nursing	If interested, a bite or two
	Weaned on pasture	¼–½
	Weaned on pasture	1
Wethers/Open Dry Doe		½–1 (maintenance)
Non-Dairy Does	Bred and Dry	½–1(maintenance)
	6 weeks before kidding	1 (concentrate)
	Nursing	1–1¼ (concentrate)
	12 weeks after kidding	½–1 (maintenance)
Dairy Does	Bred and Dry	1 (concentrate)
	2 weeks before kidding	Up to 3 (concentrate)
	Lactating	1 plus ½ per pound of milk produced (concentrate)

- Decrease ration to goats on pasture, overweight goats, wethers, and dry (non-lactating) does.
- Increase ration to recently weaned kids, underweight goats, goats on pasture in bad weather, and pregnant or lactating does.

Water

Your goat needs fresh, clean water accessible at all times. No exceptions. The quantity goats consume will change with the seasons, their condition, and their present food supply. On average, one goat will consume one to four gallons per day.

As with hay, the best way to supply goats with water is head access only. Place water buckets outside of their pens where they cannot spill or soil them, but can reach them to drink. Empty water buckets daily, then sanitize weekly to prevent bacteria-related illnesses.

Extra Supplementation

Goats need a low level of acidity in their four-part stomach to maintain proper digestion. Grain and rich pasture may increase acidity and upset the balance. Increased levels of fermentation could prove fatal to a goat. Given the correct supplementary aids, a goat self-manages its acidic range without further intervention. Access to soda and salt is all that is required.

The average goat will consume two tablespoons of soda per day. Feed-grade baking soda is available at your feed store, but the grocery store version will get you through until your next visit to the feed store without harming a goat (it just costs more).

Salt is available in block form as well as loose. Request a trace mineral salt mix formulated specifically for goats. If not available, horse or cow salt mixes can be appropriate if they contain copper, iodine, and selenium (in region that are depleted). Staff at the feed store or your veterinarian will know if your region is high or low in selenium and other trace minerals and if extra supplementation is required. Unlike excess protein, which harmlessly flows right through a goat, excess minerals can upset a goat's healthy balance.

Maintaining Good Health in Your Herd

A goat can be kept healthy for most of her life by following standard barn practices of cleanliness, maintenance, and prevention. There will be times, though, when the cause of illness is so minimally within your control that you couldn't have prevented it and your goat gets sick. Opportunities for the introductions of illness, parasites, toxic reactions, and bacterial infections are everywhere on a farm—there is no way around it. Learn to recognize the warning signs and take appropriate action when necessary. In my opinion, being overprotective of animals in your care is not a character flaw.

First Aid Kit

It took me a full year to wise up to the fact that keeping supplies and notes in a barn was a good idea. After multiple trips to the house and back gathering supplies to treat my animals, I eventually assembled a first aid kit for the barn. Once you've raised goats for a few years you'll have your own favourites to keep on hand, but to get you started, here are the contents of my own kit:

- Rectal thermometer and isopropyl alcohol (to sterilize it)
- Three clean towels wrapped individually in plastic bags (to keep them clean)
- Antibiotic ointment
- Udder balm (for chapped udders)
- Deworming medication (watch the expiration date!)
- Hydrogen peroxide

- Tetanus antitoxin
- Mineral oil (for bloat)
- Propylene glycol (for doe ketosis)
- Electrolyte powder (for dehydrated kids)

Although you may not be one for keeping notes (and to be honest neither am I), forcing yourself to keep a barn journal may one day save your goat's life. A reference of a goat's change in eating habits, energy levels, or appearance is the best tool you can hand a veterinarian called in for diagnosis and treatment.

Barn records serve a secondary purpose. If you are ever called away or can't get back home to do chores, any friend or neighbour armed with these records could walk into your barn and take over with minimal risk of adverse effects.

For each animal you might record daily ration amount, daily milk given, changes in eating habits, quarterly weight and temperature, last breeding date, hoof trimming dates, and vaccination records. Although warning signs of illness vary, you'll know when your goat is not feeling up to par at a glance. Take note of the subtle changes and you may catch an illness, infection, or disease before it becomes life-threatening.

Any breeding herd should be vaccinated against enterotoxemia, chlamydiosis and tetanus annually. If you vaccinated a doe four to six weeks before kidding, some immunity will be passed on to her kids. Based on your veterinarian's recommendation, you may also vaccinate four to six weeks before breeding. Kids should be vaccinated against enterotoxemia and tetanus at two months of age, followed by a booster a month a later.

It is also good practice to treat your goats for worms in the fall and spring. This may also require your veterinarian's assistance. A fecal sample is submitted for assessment before treatment is prescribed or recommended.

Changes in Weight

Measuring and recording a goat's weight monthly is good barn practice. Weight is a benchmark used to measure health, preparation for breeding, kid development, and if ration amounts require adjustments. A sudden drop in weight is the earliest signal that health is waning.

Weigh your goat again before medicating for illness or treating for worms. Too much medication could cause an overdose; too little medication and the treatment won't be effective. To further complicate the matter, consistently underdosing literally trains organisms (bacteria and worms), to become resistant to the drug. Later on, even a corrected dosage will not be effective.

You can arrive at a quick approximation of weight using a measuring tape and the following chart. The measurement is taken from the goat's heart girth, the area directly behind the front legs. If you are weighing kids with a heart girth of less than eighteen inches, use a house scale to weigh yourself first, and then again with the kid in your arms. Subtract your weight from the combined weight and you'll have the kid's weight.

Signs of Illness

Your goat's mannerisms and appearance are the next telling signs of illness, infection, or disease. Some temperamental and physical warning signs might be:

- Lethargy
- Teeth grinding
- Coughing
- Shallow breathing
- Disinterest in ration
- Change in manure color or consistency
- Change in milk color, quantity, or consistency
- Rough coat

- Dull eyes and/or change in color of the eye socket, gums, or facial skin (usually pink—watch for pigment changes to pale or blue)

Weight Chart for Large Breed Dairy Goats	
Inches	**Pounds**
18.25	23
19.25	27
20.25	31
21.25	35
22.25	39
23.25	43
24.25	51
25.25	57
26.25	63
27.25	69
28.25	75
29.25	81
30.25	87
31.25	93
32.25	101
33.25	110
34.25	120
35.25	130

Common Diseases and Illness

Some of the most common goat viruses and illness are listed on the following pages. For each listing I've tried to provide a preventive measure to help you maintain good health in your goats. In a few of the listings you'll find that there are no known cures or treatments. Please check with your veterinarian for recommendations on any animal's care. Curses and treatments are discovered every year, as are new diseases. If you have any concern over the health of a goat, take a temperature reading, isolate the animal in a quite stall, and call the veterinarian.

Common Illnesses

Abscess
Firm to hard fibrous lumps under the skin of an animal caused by a bacterial infection of the lymph nodes. Most bacterial infections resulting in an abscess can be traced back to a flesh wound.

Prevention: Provide the safest yard and house for your goats. Metal protrusions from the ground, fences, and barn walls can cut through a goat's hide.

Treatment: Isolate the goat from the herd and call the veterinarian to discuss severity. An expensive surgical operation might be required to remove the abscess.

Bloat
Bloat is a life-threatening, painful buildup of excess gas. If you see a growing swelling on the goat's left side and the goat is very restless, don't hesitate to place a call to the veterinarian's emergency number.

Prevention: A change in diet or too much ration is usually the culprit. Keep grain and ration well out of a goat's reach and introduce new foods slowly.

Treatment: While waiting for the veterinarian to arrive, try to keep the goat on its feet with the help of family, a wall of hay, or any other means. Rub the goat's stomach area to help move and alleviate gas buildup. Drench the goat orally with two cups of mineral oil and follow up with a half cup of baking soda dissolved in room-temperature water. Do not attempt this if you've never given a goat oral medication before.

CAE/CAEV

This deadly virus—caprine arthritis encephalitis—is still without a cure. The virus is passed from one goat to another and is easily recognizable by swollen and stiff knee joints in mature goats and weak rear legs in kids.

Prevention: Have your goats tested for the virus annually. Only purchase goats that are certified clear. Quarantine any new additions for at least a month and have your vet test the animal before releasing into herd population.

Treatment: None.

Chlamydiosis (Chlamydial Abortion)

This deadly disease is contagious to humans. If you are assisting with a live birth, wear long plastic gloves and scrub thoroughly after kidding. Warning signs are a premature abortion during the final eight weeks of pregnancy. If the doe carries the kids to full term, they are either stillborn or very weak.

Prevention: Part of your vaccination schedule.

Treatment: None. Discuss each doe's future with your veterinarian and immediately remove affected does from the herd to prevent spreading the disease.

Coccidiosis

A potentially life-threatening parasitic infestation. You'll notice a lack of appetite and energy. Your goat may lose weight quickly or develop bloody droppings. Cause of coccidiosis is a protozoal parasite.

Prevention: Keep the goat house, feeders, and watering stations clean.

Treatment: Coccidiostat available at most feed stores or through your veterinarian.

Diarrhea/Scours

The trouble with scours and kids is that they will very quickly become dehydrated and too weak to feed. Scours are often brought on by a change in diet, but could be the signs of other problems.

Prevention: Keep the goat house, feeders, and watering stations clean. Pregnant does may be vaccinated to assist in the prevention of scour-causing illnesses.

Treatment: Isolate any kid with scours immediately. Disinfect every bit of your barn or goat shed. Call the veterinarian for advice and bottle-feed electrolyte fluids to any affected kid (available at the feed store) instead of milk ration for two days.

Enterotoxemia

Classified as a life-threatening bacterial infection. This condition is also called overeating disease. Goats are seen to twitch, show signs of bloat, grind their teeth (a sign of pain in goats), and have an increase of temperature.

Prevention: Part of your vaccination schedule. Avoid changes in diet.

Treatment: None.

Hoof Rot

If there were one good reason a goat's yard and bedding should always be dry, hoof rot would be it. This bacterial infection can result in death, but you'll notice it and have time to treat it well before that happens. Symptoms are smelly feet, lameness, loss of weight, and potentially tetanus.

(continued)

Common Illnesses *(continued)*

Prevention: Trim hooves regularly. Keep bedding clean and yard dry.

Treatment: Trim away hoof to a consistent length and to healthy tissue. Soak the foot for two minutes in water with dissolved copper sulphate (at ratio of one gallon water to one half pound copper sulphate, respectively). If the condition is severe, consult with your veterinarian for antibiotic treatment.

Internal Parasites and Worms

Repeated pasturing in one area without rotation is the main cause of repeated worm infestation. The goat consumes worm eggs in the grass and they hatch and mate in the stomach and then lay eggs in the intestine. The eggs are released with every bowel movement, the grass grows, and the eggs are consumed again. Although completely natural and an inescapable part of life, parasitic infestation can drag a goat's health down with poor appetite, coughing, reduction in or strange-tasting milk, and weight loss.

Prevention: Rotate pasture. Keep all feed and water dishes meticulously clean. Follow your veterinarian's suggested worming schedule based on available pasture and regional climate.

Treatment: Have your veterinarian test a fecal sample and provide medication.

Ketosis (Pregnancy Toxemia)

Ketosis is a metabolic disorder that could be life-threatening. Usually brought on by feed quality not matching a doe's condition (age, breed, weight, health) and her body starts giving of itself to facilitate fetal growth. Most often seen in does a few weeks prior to, or just after, kidding. The doe goes off her feed, may appear lame, and may have sweet-smelling breath or urine.

Prevention: Follow a responsible feeding schedule with bred does. Ensure that the feed supplied is of the highest quality and is offered free-choice. As fetal growth draws energy and nutrients from the doe, and less space is available within the doe's stomach, she cannot consume large amounts of feed at a given time. Does that were overweight before breeding and then fed a nutrient-lacking diet are more susceptible to ketosis, but it is also common in first-time mothers and does carrying multiples.

Treatment: If you catch ketosis in time (by noticing that the doe's not eating), add a feed-grade dry molasses to her ration or concentrate to entice her to eat. Separate her from the herd to monitor her fluid intake. You need to ensure she gets some type of energy (in the form of sugars such as molasses or propylene glycol) and sufficient water to flush the ketones out of her kidney. Ketones are the byproduct of the doe's system metabolizing fat into glucose. If she worsens, call the veterinarian.

Lice

Consistent scratching and biting, loss of weight and hair, and decreased milk production could be warning signs of a lice infestation—especially if your goats are currently living in a damp environment.

Prevention: Keep living quarters dry and avoid contact with infested animals.

Treatment: Any powder, dip, spray, or pour-on insecticide approved for livestock or diary animals will work and should all be available at your local feed store.

Mastitis

A painful bacterial udder infection for does. Your doe may stop eating. Her udder may be hard, swollen, or abnormally hot or cold. Her milk might smell bad or show signs of blood.

Prevention: Keep living quarters clean, dry, and safe. Apply a teat dip after every milking session. Once a month, check your does with a mastitis test available from your local feed store (dairy cattle tests work fine for goats).

Treatment: Based on your veterinarian's recommendation, antibiotics might be in order. Milk the doe three times a day to relieve pressure and apply hot packs to the udder four times a day. Isolate from herd. Dispose of her milk if antibiotics are used, and consult with the veterinarian for a clear date.

Orf

Also known as sore mouth, scabby mouth, contagious pustular dermatitis, and ecthyma. This viral condition cause thick scabby sores on the lips and mouths of kids and may last up to four weeks. Kids may have trouble nursing and as a result could suffer malnutrition. Nursing kids with orf can pass the infection onto the teats of a doe, which can quickly escalate into mastitis. Your veterinarian may suggest quarantine of nursing kid with does and a sterilizing teat and udder wash four times per day for at least four weeks after the first signs of orf. There is a human health risk associated, with this virus. Wear rubber gloves and sterilize all equipment thoroughly.

Prevention: There is nothing you can do to prevent this virus.

Treatment: An after-infection, veterinarian-supervised vaccine is now available to prevent further incidence.

Pinkeye

Caused by bacteria or virus. Goats will squint and have watery eyes.

Prevention: Contagious. Avoid contact with infected goats.

Treatment: The entire herd should be treated with antibiotic drops.

Pneumonia

Various bacteria and viruses attack an already stressed or ill goat. May also brought on by unrelated allergic reactions. Warning signs are coughing, loss of appetite, fever, and runny nose and eyes. Drafts and wet living conditions exacerbate the potential for pneumonia.

Prevention: Keep your goat as stress-free as possible. Ensure their housing is free of cold drafts.

Treatment: Call your veterinarian for antibiotic treatment.

Ringworm

Ringworm is brought on by fungi in the soil that attacks the skin of an animal. It shows up as circular skin discoloration resulting in hairless patches on the head, nose, neck, or udder.

Prevention: Highly contagious to both animals and humans. Avoid contact with infected animals.

Treatment: Wear rubber gloves and follow a strict sterilization practice. Scrub the patches with warm, soapy water and coat with iodine or fungicide available from your local feed store.

(continued)

Common Illnesses *(continued)*

Scrapie

Scrapie is a neurological disease (similar in nature to mad cow disease) that has been under steady investigation since 1952 to determine cause and discover a cure. Only seven cases have been reported in goats, and in all cases the disease has been acquired from contact with sheep. Further information on scrapie can be found in the sheep health section of this book, on the Internet at www.keepingfarmanimals.com, or (if in the United States) by calling the USDA Animal and Plant Health Inspection Service at (866) 873-2824.

Tetanus

Harmful bacteria enter through a flesh wound and create stiff and spasmodic muscles. Early warning signs are wide eyes and flared nostrils.

Prevention: Part of the kids' vaccination schedule at four weeks and then eight weeks of age.

Treatment: Detected early, tetanus can be halted with veterinary care and medication. Advanced cases are without cure and result in death.

Ticks

If your goats pasture and browse in wooded areas, ticks may be a problem—for both you and your goats. You may find them rubbing or scratching the tick's point of entry as well as losing hair and weight. Check forest-pastured goats daily during tick season in your region and remove any you find immediately.

Wounds

Goat are prone to cuts and scrapes due to their curious and adventurous nature. Although the cuts themselves aren't much of a problem, the introduction of diseases and infections through flesh wounds can be life-threatening. Knowing how to sanitize and treat those wounds immediately and routinely is a necessity.

Treatment: Clean the wound with hydrogen peroxide. Stop any bleeding by applying pressure with a clean towel. Clip hair around the wound and flush the area with warm, soapy water. Rinse with clear water to remove any soap residue, apply hydrogen peroxide once again, and cover the area with an antibiotic ointment. Every day check, clean, and redress the cut until it is fully healed. If the wound becomes infected, call your veterinarian immediately.

Goat Vital Signs and Growing Cycle

- Rectal temperature:101.5 to 105 degrees Fahrenheit
- Pulse rate: seventy to eighty beats per minute
- Breathing rate: twelve to twenty breaths per minute
- Puberty: At five months to a year of age, dependent on breed
- Average birth weight: eight pounds
- Heat cycle: every eighteen to twenty-four days
- Heat period: approximately one day

Grooming

A hoof trim is one maintenance tasks that doesn't take much time but is absolutely necessary to your goat's health. Without proper hoof care your goat can become sick, lame, or permanently crippled. Frequent attention to hoof care, no matter how minor, is decidedly easier than infrequent major trimming. From the age of two months I make all goats stand and allow inspection, or a trim, of their hooves every month.

If you pasture your goats like I do (on somewhat rocky pasture) the hoof will wear down naturally, which minimizes the monthly task. Goats restricted to a small yard seldom have that opportunity, but the addition of a small concrete slab or a stack of large rocks to climb on will help them maintain their hooves and lighten your chore load.

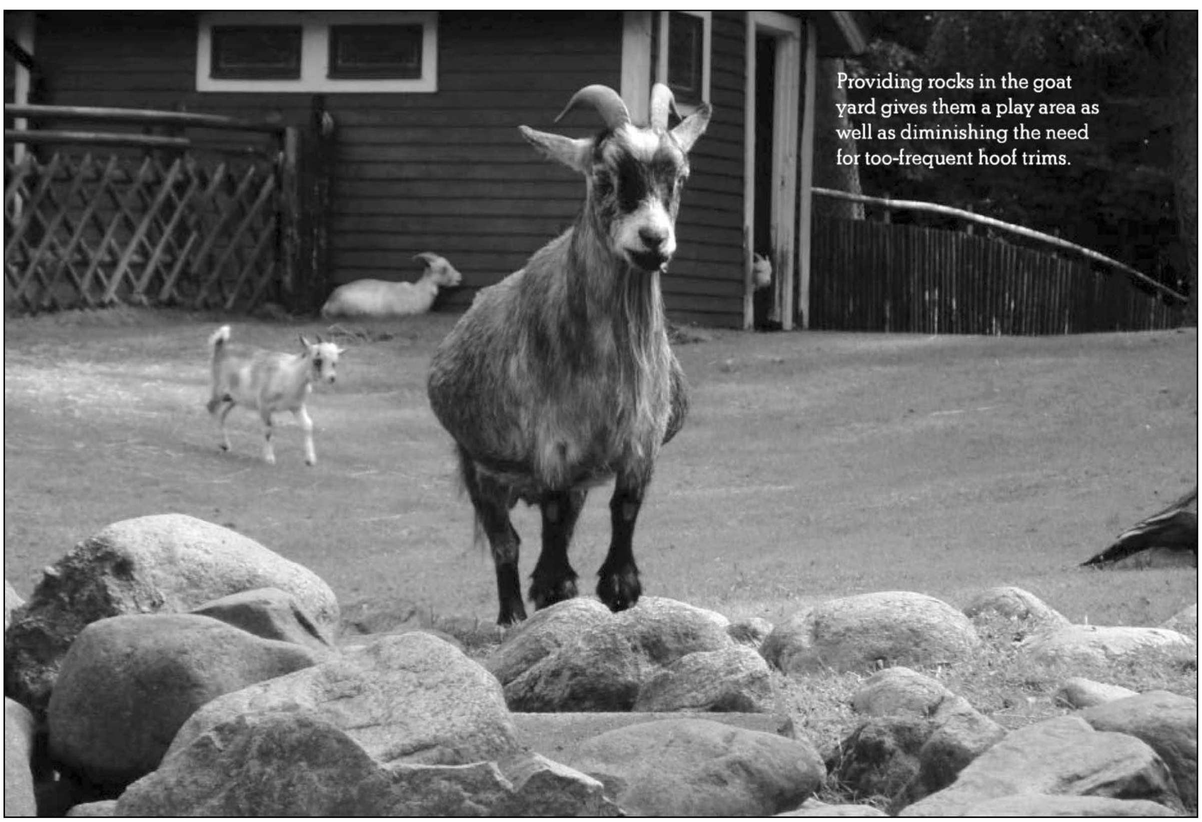
To Trim a Hoof

Confine each goat in a manner that prevents escape. A dairy stand with stanchions, leash and collar tied to a barn wall or fence, or a helpful friend are all great ways to keep a goat confined for a few minutes. If your goat is being particularly difficult, lean your shoulder into her side with her other side against a wall while you work on each hoof. Angoras and kids can be “sat” on their rumps, leaning against your legs while you work.

Stay calm while you work and you will find that your goat remains calm as well.

- Wear gloves.
- Bring shears, a rasp, and hydrogen peroxide to the barn with you.
- Soft hooves are easier to trim than dry hooves. Allow your goats an hour in the yard, as hooves are softened by morning dew.
- Constrain the goat in a manner that allows you easily and comfortably to bend the goat’s leg for observation of, and work on, the entire bottom of the hoof.

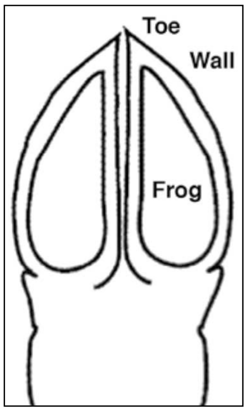
Step 1: Gently scrape out any impacted dirt in the curve of the hoof with a hoof pick or the point of closed shears. Work gently inside the wall. Impacted dirt at the toe of the hoof does not need to be forced



Providing rocks in the goat yard gives them a play area as well as diminishing the need for too-frequent hoof trims.

out. Get the debris that falls out easily as you trim. It will all have fallen away by the time the hoof is trimmed.

Step 2: Snip away the overgrowth at the toe of the hoof (it will be the longest), then move on to the sides and remove any folds or excess found there. Your objective is a level foot—a hoof wall that just barley extends and protects the frog.

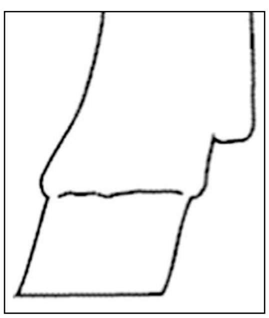


The anatomy of a hoof

Step 3: Use a hoof rasp to create a smooth finish on the hoof wall.

Should a goat arrive on your farm with a severely overgrown hoof, only take a little off at a time every five to seven days. It may take a month, but eventually you will have a neat and trim hoof.

If you happen to snip too far and your goat bleeds, clean the wound with hydrogen peroxide and check daily for signs of infection.



A nicely trimmed foot. The base of the hoof is parallel to the coronary band (the area where the hair ends and the cuticle begins).

Gifts of Keeping Goats

Milk from a doe that has proper care tastes so similar to cow milk that most people would be hard-pressed to tell the difference. Even though only a fraction of North Americans know that goat milk is palatable, more people worldwide drink goat milk than any other milk.

In the milk industry, goat milk is never measured in gallons or quarts but by weight. Small-herd farmers just keeping a few goats for personal use, however, continue to measure their daily supply in standard liquid measurements. A good milk doe can supply your home with nine hundred quarts of milk over the course of a year. Some dairy breeds are known to give milk that is rich in milk fats, making it perfect for creating a variety of cheeses in your own kitchen.

Milk Production Management Issues

A goat's milk production is dependent on the kidding cycle. Peak production is two months after kidding, but a good dairy goat continues to produce milk long after her kids are weaned.

When a doe first gives birth her body begins producing milk. The term for this is "freshening." For the next eight weeks her supply increases, levels off for four months, and then begins decreasing until she is bred again.

Standard small-herd practice is to breed the milkers once per year, dry them out for two months previous to kidding, and breed them again. If you follow that strategy, most does will supply you with milk for 240 to 300 days of the year. If your doe dries out early—only supplying milk for eight months or so—she's still a good milker for any family.

Your doe will be at the height of her production in her fourth and fifth years. Negative factors affecting milk production are stress, insufficient natural or artificial lightning, weather, injury, feed quality, illness, or major disruptions in their routines. Milk does thrive on routine and goats require milking twice per day. You get to set the time, but for best results remain consistent with their schedule and keep milking sessions above twelve hours apart.

Equipment and Supplies for Milking Goats

Although you could get by in a pinch with a high-quality stainless steel bowl from your kitchen, a cheap milk strainer, and some quart canning jars, you will be milking twice a day for at least 250 days a year, so you might as well have the proper equipment.

Equipment for Milking

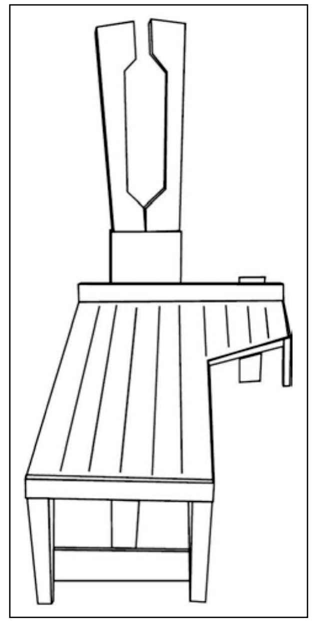
- Milk stand (with or without stanchions)
- Clippers and a brush to trim and brush hair away from back, sides, and udders to prevent hairs shaking down into the milk
- Udder wash to remove any debris and to sanitize hands
- Small bowl or mug used as a strip cup (Squirt in the first milk from each teat for a visual quality check.)
- Stainless steel milk pail
- A made-for-goats teat dip to prevent bacterial infections
- Bag balm (to prevent chafing or chapping of the udder and teats)
- Notebook to record milk amount from every session
- Dairy strainer with disposable milk filters
- Milk scale for weighing milk per session (I don't personally use these.)
- Home pasteurizer (Pasteurize milk yourself with a double boiler and a candy thermometer. Heat milk to 165 degrees Fahrenheit and maintain for 30 seconds.)
- Glass milk jars
- Chlorine bleach
- Stiff-bristle (plastic) brush
- Dairy acid cleaner

A relatively skilled carpenter can create a simple milking stand including stanchions in just a few hours and with less than one hundred dollars' worth of lumber. Goat stanchions can also be purchased online—new or used.

Sanitizing Equipment

Sanitize all equipment before and after milking, including udder, teats, and hands, to ensure a healthy, happy doe and high-quality milk.

To sanitize equipment between uses, first rinses in warm water to remove fat residue. Next scrub with a bristle brush using hot water, dish detergent, and an ounce of chlorine bleach. Rinse in clear water and then in a diary acid cleaner. Never use dishcloths to wash or towels to dry. These items, even fresh out of the laundry, are loaded with bacteria. Allow your equipment to drip dry.



A homemade milking stand offers stanchions (to hold the goat's head in place), a sturdy stand for the goat, and even a small sitting area for the milker.

How to Milk a Goat

When it comes right down to brass tacks, farmers have been milking goats for centuries without all the fancy equipment. I'm half embarrassed to tell you my own story, but I want to make a point about getting by with what you have. Picture this: A doe and her needing-to-be-weaned kid landed in my barn and I, knowing nothing other than the rules of sanitation and pasteurization, proceeded to milk her twice daily.

She was young and small, and in retrospect I guess she had been bred too young. This worked in our favour, though, as she had never given milk and I have never taken it. She would not stand idly on the barn floor and let me milk her. I had never heard of a stanchion, but I was determined that she stand without fussing or kicking over the buckets. The only way I could hold her in place by myself was to lock her head between my legs, bend forward across her back, and milk her. I did this twice a day, every day, for a month before I started asking around for advice.

Although that method is neither conventional, efficient, nor 100 percent effective, we still drank healthy, delicious milk every day. Today I have a milking stand.

The Milking Process

There is a rhythm to milking a doe. You can learn it just by watching the kids. Bump. Lock. Draw.

Once you have positioned your doe, prepare her for a milking session by brushing her coat to prevent hair from dropping into the milk pail and wash her udder and teats with a teat dip. With your milk pail in place, lock your forefinger and thumb around a teat at the base of the udder and draw down. Never squeeze her udder, only her teat.

There will be milk waiting in the teat, which you will guide out with a squeeze, *drawing* downward, not *pulling* downward. If the difference doesn't make immediate sense to you, think of how you might squeeze all of the toothpaste out of the tube with only one hand. Better yet, imagine guiding your doe's milk along a straw, softly pushing it down, one finger tightening at a time

After a full draw down and into the bucket, release the pressure on your top two fingers to allow more milk to enter the teat, and draw again. Release. Each time that you release your grasp that teat fills up with milk again.

Many first-time farmers will not get any milk out of the teat on their first try. Don't worry if this happens to you. The cause is most often an inadequate pressure at the top of the teat and into the bucket. Squeeze just a little tighter at the top of the teat and try again.

A few tries and you will have it. Your doe relaxes and you can move on to learning how to milk her with both hands in an alternating left-right-left-right fashion.

When the flow stops you can give a gentle bump to the udder with your hand still wrapped softly around the teat. Then tighten-squeeze-release once or twice more.

Before releasing your doe, cover and set the milk pail aside, then quickly dip and dry her teats and massage in a small amount of bag balm. You'll be hastening to the house to filter and cool the milk even if you choose not to pasteurize.

Unpasteurized Milk

For a host of reasons some people choose not to pasteurize their milk. If you've decided this method is for you, filter the milk immediately and begin the cooling process. Don't expose the milk to sunlight or fluorescent light during the cooling process. The basic rule of thumb is that goat milk should be cooled from 101 degrees Fahrenheit (at time of collection) down to 38 degrees Fahrenheit within one hour of milking.

Never add new milk to old milk or warm milk to cooled milk.

Excess milk can be frozen in glass containers. When you need the milk, simply let it thaw in the refrigerator for twenty-four hours, shake it up, and it is ready for use. If you notice a change in flavor after freezing, use it for baking or to make cheese, butter, or soap.

Fiber Goats: Combining Cashmere and Shearing Angoras

The down-like hair that grows in small clusters under the main coat of a goat is cashmere. You will only see it if you live in a northern climate. As stated in the breed section, many breeds are capable of producing cashmere, but not many produce enough quantity to make collecting it worthwhile.

Cashmere can be obtained through shearing, but most of us with just a few goats opt to comb out the cashmere instead. Daily combing for fifteen to twenty consecutive days right before the goat's own bodies start shedding the hair in mid-December is required for the highest yields.

Save collected fibers in a cardboard box or paper bag without the long primary hairs that comb picks up. Expect to collect anywhere between one-third and one full pound per goat.

Angora goats create enough fiber to make the process viable through shearing. An Angora goat's short fibers are mohair. The longer fibers are called kemp.

Yearlings give the finest hair and yield the highest price as their mohair is used for clothing. Shearing isn't a rite of passage—any kid with four-inch-long hair can be sheared. Adult hair is used in carpets and upholstery. The average doe, buck, or wether hair is four to six inches in length and grows approximately three quarters of an inch per month.

Shearing of Angoras is performed just before kidding (in early spring) and then again in the fall (between weaning and being rebred for the next season). It is important not to procrastinate on the second shear of the year. Angoras need ample time to regrow their coasts before the weather turns cold.

You could shear your goats yourself or hire a professional either to train you on technique or to shear your goats for you. A few days before shearing, clean out the barn, bring the goats for you. A few days before shearing, clean out the barn, bring the goats in, and keep them dry. Wet mohair is not only difficult to remove, it is also prone to mold during storage. You do not need to wash and dry the fleece before sale, but you could net a higher price if you do.

If you have kids, shear them first on a clean workspace. Have a helper on hand to pick short hairs and any irregular, stained, or matted clumps out of the fleece. Then roll each fleece inside out and bag it individually in a cloth bag, paper bag, or cardboard box. Tag each package with the goat's name so you can record and track fleece weights from season to season. When you are finished with the kids, sweep the area clean and follow the same guidelines with the adults.

After shearing you may need to keep your goats inside for a full thirty days (the average length of time to grow three-quarters to one inch of hair) if the weather is harsh. Complications of exposure are sunburn, hypothermia, or pneumonia.

You can expect three to four pounds of the finest hair from a yearling and six to twelve pounds per shearing from an adult Angora.

Goat Meat

Gram per gram, goat meat is lower in calories, fat, saturated fats, and cholesterol when compared to beef, pork, lamb, and even to skinless chicken. (USDA National Nutrient Database for Standard Reference, Release 20, 2007)

Goat meat is also known as chevon (meat from a young, but mature, goat), cabrito or chevrette, (meat from a milk-fed kid) and chivo or mutton (meat from an older goat). The flavour and tenderness of the meat is similar to wild venison—the most coveted coming from a young animals—can be prepared in stews, as steak or burgers, or a dinner roast.

As you've read in the strategy section on raising goats (above), goats vary in their sizes and growth rates across the breeds and the youngest dairy goat up to a sixty-five pounds from an eight-month-old Boer.

Breeding, Kidding, and Care

Even though your doe might think she is ready to breed at six months of age, don't allow it until she is at least eight to nine months old. A better measurement is to wait until she has reached at least 80 percent of the average mature size for her breed. If bred too young, a doe's growth will be stunted, and she'll have less chance of future multiple births.

Milk goats are bred every year, usually during September and October. After a five-month-long gestation they give birth at the start of spring, when fresh pasture naturally provide the most nutrition. Meat and fiber goats are often bred every eight to nine months with the optimum breeding time between August and October. Angora goats are bred between August and November, right after a fall shearing to ensure they're ready to kid right after the spring shearing. Goats raised for cashmere are bred well before November. All kids should be weaned by mid-June, as lactation slows the growth of cashmere.

Choosing a Buck

Finding a suitable buck can be challenging. Although goats are gaining in popularity, not many people keep bucks on hand for breeding. If you keep specialty goats and want kids to keep, register, or sell for any purpose other than meat, the qualities you desire in a buck may not exist within a day's drive.

With dairy breed bucks, look for owners who keep good barn records on ancestry. A dairy breed buck will pass on the genetics of his dam if a doeling is produced. Furthermore, if your doe is polled and she breeds with a polled dairy buck, the offsprings will only have a 50 percent chance of fertility.

If you are only breeding to freshen a dairy doe and aren't planning on keeping the kids long-term, any healthy buck of any breed and comparable size will do.

Bucks and Breeding

A buck should be wormed and in excellent health. He should also have been on a concentrate ration for at least two months prior to breeding. Ask to see the buck's immunization and vaccination schedule. Check carefully for a CAE/CAEV clear certification.

Steer clear of bucks with poor conformation, bad legs, or improper hoof care—no matter what registration or paperwork is shown and even if you only plan on raising the kids for meat. A buck with a dull coat, very thin hair, or with patches missing may have lice, ticks, or ringworm—which will all be passed on to your doe.

A ready-to-be bred doe will stand quietly by a buck when placed in the same area. A doe who is not ready will repeatedly move away at his every advance. A buck may mount a doe several times during breeding. Successful mating is noted by the extreme arch in the buck's back upon completion.

If you will be registering the kids, ask the buck owner for a service memo. The information you'll need for registration includes the date of breeding, the names and registration numbers of the doe and the buck, both owners' signature.

Artificial Insemination

Artificial Insemination (AI) is relatively new to goat breeders but saves the hassle of keeping a buck or transporting one goat to the other. You'll be able to pick and choose amongst hundreds of available registrations to find the exact traits required to improve your herd from one breeding to the next.

Although I have heard of some small farmers performing the insemination themselves, the process is far beyond the scope of this book. If you think AI is your best option, find a practitioner in your area and obtain a service catalog of candidates. Veterinarians are a great place to start, as are goat husbandry magazines or Internet search engines.

A practitioner or veterinarian will assist you in locating a buck that has all the qualifications required, obtain the semen, and inseminate your doe. You may need to transport your doe to the practitioner or he may come directly to you on the date you specify.

Pre-Breeding Considerations

Before breeding your doe you'll want to put a few extra pounds on her. This fattening up before breeding is called flushing. When a doe gains weight more eggs move from her ovaries and are available for fertilization. Not only will she have a better chance of becoming pregnant, but she'll also have a better chance at multiple births.

Your doe may have already stopped producing milk before she is due to be bred. If you doe is still producing milk but her body is thin, dry her off (see below) so that she can gain the necessary weight for successful breeding and gestation. A young, healthy, and strong doe can be milked right up until two months before kidding without complication.

A month before breeding, deworm her and move her to fresh pasture once twenty-four hours have passed.

The Expectant Mother

A successfully mated doe is said to have settled, and you'll find she sleeps much more during the 150 to 160 days of gestation. New mothers and does having multiple births often kid early. A doe that is late to kid may have extra-large kids and may require assistance. Keep watch!

Two Months before Kidding Date

Drying off a doe is most often a natural, uncomplicated process. The doe, no longer being milked twice daily, will stop producing milk and her feed will be converted into energy that serves the kids she's carrying as well as her own health.

When you decide to dry off a doe you must do it instantly—do not dry her off gradually thinking it will be easier on her. Does dried off gradually have been noted to develop fibrosis, lower milk production in later cycles, and a higher risk of mastitis. After a week of not milking her, if she looks terribly uncomfortable, you can take some of the udder pressure off. Only do this once. Although opinions vary, I don't suggest milking her completely as it may encourage milk production. Just take enough to relive the pressure.

Signs of Heat in Does

Most does come into a breeding cycle every twenty-one days. Not all are obvious about their desire to breed, but some of the signs might be:

- Crying, bleating, or generally being more vocal than usual
- Producing a higher milk volume right before heat, then lesser for the actual heat (a few days) with a return to normal production
- Mounting other does
- Frequent urination
- The under-tail area may darken, appear swollen, or be wet with mucus.
- Wagging or twitching the tail more often than usual

A gradual switch from concentrate to maintenance ration will help slow down milk production and ease the pressure as well.

One Month before Kidding Date

At least a month previous to kidding, talk to your veterinarian about a vitamin and mineral booster of A, D, E, and selenium. Make gradual changes to your doe's diet over the coming month to ensure she is receiving proper nutrition.

One Week before Kidding Date

A week before kidding date, remove the doe from the herd, trim her backside and udder of any hair, and move her into a quiet stall where she can kid in peace and you can keep a watchful eye over her.

Here's how to tell when the kids will be born. All goats carry their kids on the right side. As the day approaches you'll be able to see and feel them moving there. Twelve hours before they're born, they'll stop moving—you can almost set your watch to it.

Other signs that kidding is imminent:

- A change in the doe's belly. As the kids move into the birth canal the roundness of her belly shifts with them.
- If she's having multiple births her tail may go up and stay up.
- She will have a mucus discharge on her backside.
- She may paw at the ground. She may repeatedly lie down and stand up, never seeming comfortable in either position.
- She may be extra affectionate to her owners.

Seldom do problems occur during kidding, but be prepared to assist just in case. Keep a kidding supply box at the barn ready for any last-minute emergencies that includes old but clean towels, a stack of old newspapers, a large cardboard box, iodine, a bathroom scale, and a newborn-sized baby bottle and nipple. If the temperature is still chilly add a blow dryer and a heat lamp to your supplies.

Although lamb nipples are well-sized for goats, inexpensive, and readily available at your feed store, the store isn't usually open at 2 a.m. when a doe decides to kid. A human baby bottle with an enlarged hole in the nipple works equally well in a pinch.

The kidding process usually follows in this manner:

- Doe begins to strain in a laying position.
- A water sac shows, then breaks. Two hooves appear and then a nose. A few more pushes and the kid is born.
- The doe will lick her kid and the kid will take its first breath of air into its lungs.
- A second, third, or even fourth kid may follow (dependent on breed, doe, and flushing).

Most kid births happen without interference from human keepers, but there are ways to help without being obtrusive.

Cover the wet birthing area with fresh bedding or newspapers to absorb the mess.

If the second kid is coming before the first kid is fully cared for, dry off the first kid with clean towels, paying special attention to the kid's nose and mouth. If the kid has not taken its first breath, gently tickle the inside of his nose. If the breath doesn't sound clear, lift the kid's back legs a few inches off the floor to clear mucus from air passages.

If your doe is distracted with a consequent birth and if the weather is cold, use a hair dryer (carefully) to dry the kid off. Place it in the cardboard box until the doe has finished birthing the second kid. Pull the box near a heat lamp (not too close) to ensure extra warmth is provided but only until the doe has finished kidding.

Tie off the cord with a soft string a few inches from the kid's body. Sever it at the doe's side and spray or dip the end with iodine.

Within the next twelve hours your doe will pass afterbirth and attempt to eat it. This is instinctual behaviour only (to prevent predators from finding the doe and kids) and unnecessary. Wrap it up in newspapers and remove it. If the afterbirth does not fully emerge, call the vet—do not attempt to assist with this.

You can help your doe feel better after the kids have been born and are settled by providing a few tablespoons of cider vinegar or livestock molasses mixed into warm water. Ensure she has free-choice hay and fresh water as always.

How to Know If You Need Help

If complications occur during kidding you might be able to help, but if this is your first live birth, instructions from a book will be of little use. A friend or neighbor who has livestock and your veterinarian are helpful allies during your first kidding.

In any event, if your doe has been struggling for more than thirty minutes without progress, it is time to get some help no matter what hour of the day it is.


GOAT
breeding and birth record

Doe's Name
Reg. No. | Registry
Date of Breeding / / | Buck's Name
Buck's Reg. No. | Buck's Registry
Buck's Owner Name | Address
Buck's Owner Signature
Expected Kid Date / / | Actual Birth Date / /
Name / ID Kid #1 | Sex | Weight
Descriptive features and notes:
Name / ID Kid #2 | Sex | Weight
Descriptive features and notes:
Name / ID Kid #3 | Sex | Weight
Descriptive features and notes:

Breeding and birth records (as well as other farm management forms) are found in the back of the book.

The Birth Record

If you will be keeping your does for repeated breeding over the years, record each one's gestation period and time of labor. She will be a sure bet next year to follow the same schedule—often to the same day and hour as the previous birth.

Start your barn records off right for kids you plan on keeping before you get too busy training and bonding with the new kids. Blank health dockets are at the back of this book to record vaccinations, weight, and other equally important dates and events.

Feeding Kids

The first milk a doe lets down after birth is called colostrum and it is loaded with extra nutrients and antibodies. If your doe is messy after kidding you can clean and dry her udder. As she's been dried off for the last sixty days, her teats may be blocked with a waxlike plug. You can release the plug by milking a strip from each side.

Within two hours every kid should feed. If not, assist the newborn to the teat and squirt a small amount into his mouth. He should do the rest.

Many dairy goats breeders remove kids instantly from their mother's side and bottle-feed them. This is to protect the teats, wean kids at a younger age, produce tamer adult goats, and to keep a doe's milk for household use or sale.

If your reason to bottle-feed kids is to keep the milk flowing for household use, before committing yourself to feeding every four to six hours per day, every day, consider allowing kids full-time access to their dam for the first two weeks, then splitting them up in the evening. This method allows you to milk your doe in the morning for personal use and then let her back in with her kids for the remainder of the day.

Newborn kids require feeding every few hours. By the time they are two to four weeks of age they only require feeding every four to six hours. Kids consume 15 to 25 percent of their own body weight daily.

After a week or so, kids will start eating a bit of hay or pasture and you can gradually introduce kid ration to their diets.

By eight weeks they should be completely weaned. The best way to decide if weaning is

Many dairy goat breeders choose to bottle-feed the kids on a rigorous schedule to protect the teats of their does. This ten-pound Nubian goat has no trouble feeding from a rubber nipple and will bond more quickly to humans throughout his life as a result.

appropriate is to triple the kid's birth weight. When he has grown to this size, he is ready to be weaned. Although you won't need to wean fiber or meat goats (they do it naturally), you will need to wean the dairy kid. Separation from the doe for 4–7 days is the norm, but once reunited watch each kid closely. If he is allow to nurse again, separate them for another week.

Keeping Barn Records

Even if you only have one or two goats you'll want to keep a clipboard or notebook for each to record their progress, output, change in feed weight, and so on.

The records are valuable should you ever sell your goat or her offspring, to assist your veterinarian to determine any cause of illness, to estimate next kidding dates, and to track medications and vaccinations.

Breeding and Birth Record: Every time you breed a doe, record the buck's name, owner and contact information, date of breeding, and notes. Attach all service memos to this docket and record breeding dates on a doe's individual docket. Estimate kidding date and record, as well as date kids were done. Note descriptions, difficulties, and other pertinent information for each kid.

Barn Kid List: This allows you to record each kid as it is born, listing the maternal doe, weight at birth, expected weaning date, polled or horned, tag or tattoo or features, disbudding requirement, and notes. You'll eventually transfer individual information to separate dockets for any animals you keep long-term.

Individual Goat Docket: Use this form to track weight, lineage, date of birth, milk production, vaccinations, ancestry, and any changes in health.

Purchase Agreement: Print and fill out this form in duplicate. One for the seller, one for the buyer.

Did you know?

The life expectancy of a well-cared-for goat is nine to twelve years.

Castration of Bucklings

If a male kid has been born on your farm and you have decided to grow him past weaning age, you will need to castrate him. This task can be put off until anytime before puberty, but it is easier on the keeper and the buckling (as well as less risky) when performed before weaning. You can call in the veterinarian or pay an experienced local to perform the task, but the cost has the potential to nullify the economic reasons you set out to grow your own food in the first place.

The very quick castration happens at home, between the third and fourth weeks, using a lamb Elastrator—available at your feed supply store. The "operation" itself is fast and simple. By using a strong set of pliers you stretch a very strong elastic band around the scrotum of the buckling. Within a few days the testicles die off.

Feed store staff can show you how to use one, but instructions are also on the box. As always, it comes in handy to have a friend who keeps goats or sheep for first-time demonstration.

A castrated buckling is called a wether, and therefore the act of castration is known as wethering. Don't make the mistake of allowing your bucklings to mature without being wethered. The meat from a buck is distasteful and of no use. Wethers grow faster than intact bucks and won't need to be separated from your does on pasture or in the shed.

Horned or Polled

Some purebred dairy goats are born with horn buds that will grow into dangerous and difficult-to-manage horns. The polled (non-horned) trait is interestingly linked to genetic infertility. Polled bucks bred to polled does result in infertile offsprings 50 percent of the time. If you need to breed a polled doe, you'll need to find a disbudded or horned buck.

Disbud any dairy kids born in your farm for the safety of herd-mates and yourself. Non-dairy breeds spending most of their time on pasture are usually left with their horns intact.

A polled goat is born with hair that lies flat where horns might have been. A kid that will eventually grow horns will have swirls of hair where the horns will appear within the next two weeks. Remove buds as soon as you see them or arrange to have someone else remove them.

I am not certain what bothers me more about the disbudding process—the bleating of the kids or knowing that I'm the one doling out the pain to such a young animal. Every time I take part in this process I swear it will be my last even though I know it will ensure a successful future for each kid.

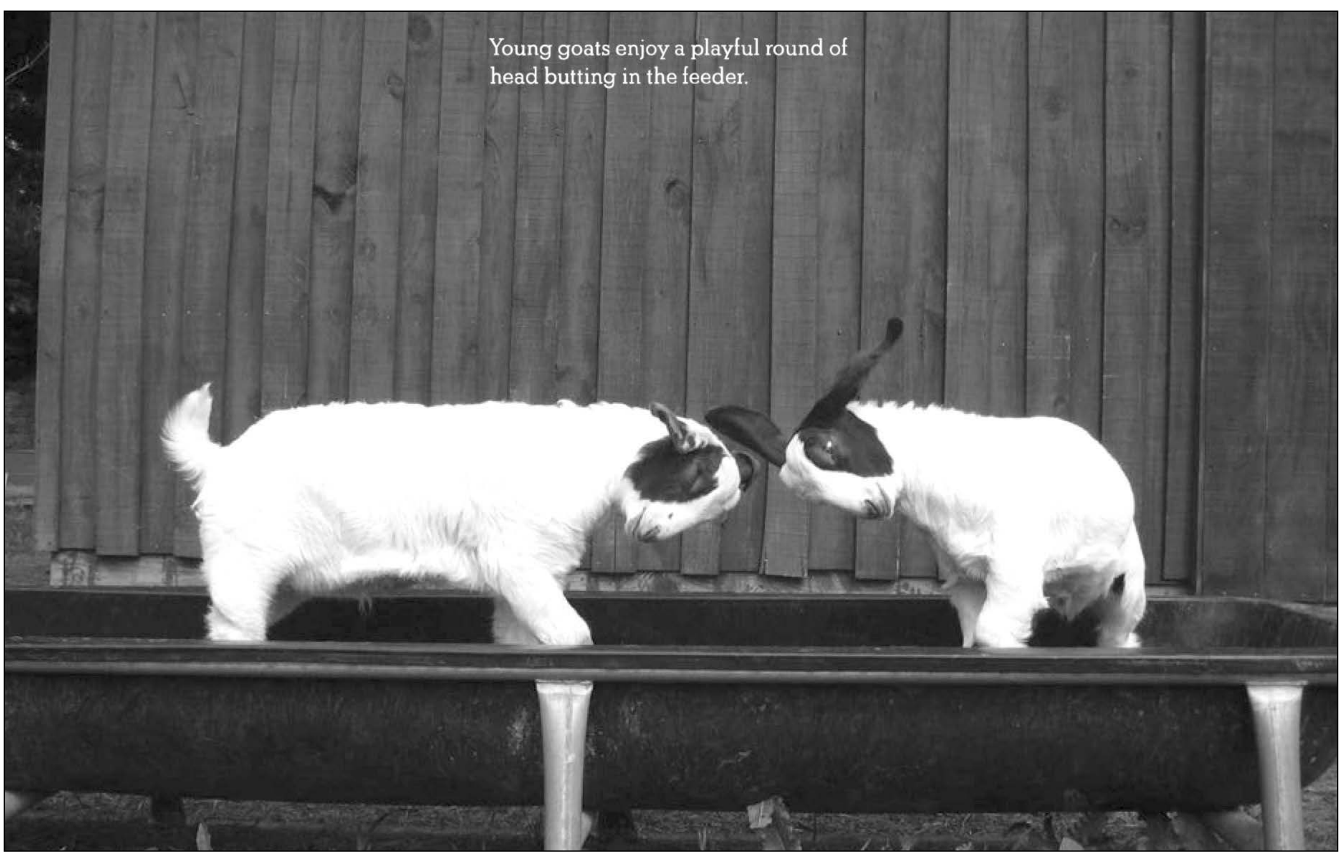
Disbudding Kids

The technique of disbudding is to burn out (cauterize) horn buds, which prevents further growth. The inexpensive tool required is an electric disbudding iron available at most farm supply stores. Once the iron is hot enough to mark a small piece of wood, it is held to the horn bud for fifteen seconds, then repeated on the other side.

To help ease the pain and potential for complications, trim the hair around the bud and feed each kid a baby aspirin a few minutes before the procedure. After the disbudding, hold a bag of crushed ice to the spot for thirty seconds on each side to numb the pain. If you have a spare set of hands, give each kid an injection of tetanus antitoxin (available from your feed store or veterinarian) before returning him to his mother for own brand of consolation—a nudge at the udder. If your goat is bottle-fed, have a bottle on hand for an instant distraction.

Fifteen minutes later the painful memory is forgotten and kids can be seen engaging in head-butting play.

Caustic paste is an old-timers' method of removing buds. This substance is still being sold for calf disbudding, but it can cause blindness if applied incorrectly. The paste can burn through hair and skin and is better left on the shelf. Skilled herders trim the hair around the bud, apply petroleum jelly to the surrounding area, and then dab on the caustic. When used on goats, someone would need to be on hand to hold each kid for at least one half hour—while they bleat and cry and squirm to get away from their tormentors and back to momma. Without holding or confinement of the kid, the paste might shake off and burn other areas of the kid's face or other animals.



Young goats enjoy a playful round of head butting in the feeder.

Butchering

Kids under the age of three months should be allowed water only for their last eight hours. Older kids (up to one year) should not be fed for twelve hours before butchering, and mature goats for one full day. This practise is to clean out their intestinal system and stomach, so there will be less weight to hoist over your head, less intestinal volume to clean up and out, and less chance of tainting the meat.

You can employ the service of a slaughterhouse to kill and butcher your goat for you, but the economics of outside service fees may be impractical. Goats are small animals. This is one task you can perform yourself at home.

One aspect that makes the task difficult is the requirement for room to hang and chill the carcass. Goat (and lamb) meat must age for five to seven days. If you need to take the carcass to a butcher for this, be sure to prearrange your slaughter date.

You will need a rifle (a .22 is adequate), sharp knives, meat hooks and/or ropes and chains for hanging, clean running water, a large bucket, and a place to hang and chill the carcass for five to seven days (or until a butcher can accommodate you).

The kindest way to shoot a goat is to place a dish of grain on the ground. Once his head is in the down position, shoot for the spot under the ear. When he falls, slit the throat area and immediately insert hooks or rope between the thick tendon and bone of the lower back leg. Hang at a comfortable working height and allow time for the animal to bleed out.

You must now cut off the head and tail, and all feet at the hocks. With a sharp knife and for the purpose of skinning, cut—shallowly and only into the hide—around the anus and sexual organs. Make two more shallow slits, in the inner lines of the hind legs and along the inner of the front legs. Halfway between these two shallow cuts, slit down the centre from chest to belly.

Begin at the back legs and work slowly to skin the goat. You'll be pulling with one hand and gently cutting connecting tissue with the other until all the skin has been removed.

Wash off the carcass. Cut around the anus again, not deep but this time with the intention of removing it from the animal. Tie off the anus with a small piece of rope and move the bucket underneath the carcass. With a clean and sharp knife, cut lightly into the abdomen from mid-rib to pelvis, until you can reach inside and pull the anus into the body of the animal. Now pull all contents of entrails out and into the bucket, again cutting any connective tissue to release as required.

Wash out the inside of the carcass and let hang for five to seven days at temperature of 32 to 35 degrees Fahrenheit. If you don't have available space or facility, a local butcher could finish chilling and cutting the meat for you.

Fish

Starting a Fish Farm

Raising your own fish ensures that they are healthy and safe to eat and you can sell or trade your fresh fish to neighbors for other things that you need. You can also use your fish to stock your local pond or lake, increasing the fish population in your area.

Before starting your fish farm, check your state and local laws—some states require a license to run a fish farm. Also, pick the particular fish you want to raise and research everything about it; you will need to know the species' specific life cycle, habitat, and dietary needs in order to properly care for your fish.

You'll need a pond to raise your fish in. If you do not have one naturally, you will have to build one. Dig a hole in the ground to the desired width and depth. Check the dirt at the bottom; if it is too porous the water will sleep into the ground. If this is the case use tamped down clay or thick plastic to cover the bottom. If you want your pond to be specifically for fish farming, put topsoil at the bottom of the pond for plants. If you are going to release fingerlings, place some tree stumps or dead bushes in the water for the smaller fish to hide in.

Be sure to choose freshwater fish that are adapted to life in non-flowing waters. It is preferable to raise vegetarian fish, as they will eat any plant matter, while carnivorous fish require expensive protein-rich fish food.

Make sure that you keep records of everything; how many fish/fingerlings you put in the pond, how many fish you take out, and the basic conditions the pond is in on a consistent basis. This will help you decide when it is time to restock or go fishing!

Carp—Carp is a very popular fish farming choice. They are hardy, and a lot of fish can be obtained for little effort. They will eat any sort of rotting vegetation in the water, and you can supplement their diet with oatmeal, barley, or vegetable waste. Keep the carp in your larger pond—they will breed naturally. Choose the grown ones you would like to eat or sell and isolate them in a smaller, shallow "stew pond." Keep in mind the stew ponds need to be deep enough to stay ice-free in the winter.

Tilapia— Since Tilapia are a tropical fish, they will require a heated tank kept at a round 80 degrees Fahrenheit. They do not require running water, although it is important to keep an eye on the tank's filters and air pumps. They are a Very hardy species, and do not often get stick. They can produce tilapia fry almost every week year round. This combination of continuous production and high survival rate allows the tilapia farmer to have a constant supply of fingerlings to replace those that get big enough to eat.

One way to get started is to purchase a "hen mother" and several other tilapia. Alternatively, you could buy some fingerlings from a hatchery. Keep a few "breeding fish" in a separate tank.

Tilapia eat algae or any vegetation you put in the water. Tilapia fry, however, need some protein, so live zooplankton, brine shrimp, or protein flakes are necessary until they grow. You can move the fingerlings to the main tank when they are about one inch long.

Aquaponics

Aquaponics is a sustainable food production structure that incorporates traditional aquaculture, like raising aquatic animals such as fish, prawns, or crayfish in tanks, with hydroponics, the method of cultivating plants in water. The fish and plants have a cooperative relationship and live in a harmonious, symbiotic environment.

Fish produce waste and effluents that accumulate in the water, and since too much waste can be toxic, the hydroponic system filters it out and utilizes it as vital nutrients for the plants. After this is done, the cleansed water re-circulates and returns to the animals.

Regardless of the size of an aquaponic system, the technology used is the same, and it is usually relegated into several subsystems. There is a rearing tank used for raising and feeding fish, and there is a unit that removes the solids: uneaten food, detached biofilms, fine particles, etc. In addition, there is a biofilter, an area where nitrification bacteria can grow and convert the ammonia into nitrates that plants can use. Nitrification is one of the most important processes because high concentrations of ammonia can kill the fish and aren't easily absorbed by plants. The biofilter contains *Nitrosomonas,* bacteria that convert ammonia into nitrites, and the *Nitrobacter*, bacteria convert the nitrites into nitrates.

The hydroponics subsystem is the portion where plants are grown by absorbing the excess nutrients; their roots are immersed in the nutrient-rich, effluent water. This may be done in various ways: Styrofoam rafts floating in an aquaculture basin in troughs, closed loop aquaponics (utilizing solid media like gravel or clay beads held in a container that is then flooded by water from the aquaculture), flood-and-drain aquaponics (solid media in a container that is alternately flooded and drained utilizing different types of siphon drains), towers that trickle the water from the top, nutrient film technique channels, etc. Finally, there is also the sump which is the lowest point in the system and where the water flows to and from once it is cleaned.

An aquaponics system relies on the relationship between the plants and animals; a stable aquatic environment must be maintained with minimal fluctuations in the nutrient and oxygen levels. Occasionally, water must be added when water is lost, whether because the absorption and transpiration lead to water loss or evaporation of the surface water.

The three main components of the system are water, food given to aquatic animals, and the electricity that pumps water between the aquaculture and the hydroponics. With those three things, you can a successful aquaponic system that can help you have an even more successful fish farm.

Set Up an Aquaponics System

Thanks to aquaponics master Market Broadstock for the use of these directions for setting up your own aquaponics system!

For a very basic system on a small scale, you'll need:

250 L pond bin

150 L grow tub

1000 L/ph pond punp capable of pushing water to a height of 1 meter

Double outlet air pump, 10 m extension cable

Plant choice (for example, tomato plants from seed packets)

Grow medium (for example, 50 kg of fine gravel)

Digital timer/surge protector; this is used to run the pump and to circulate the water to the plants

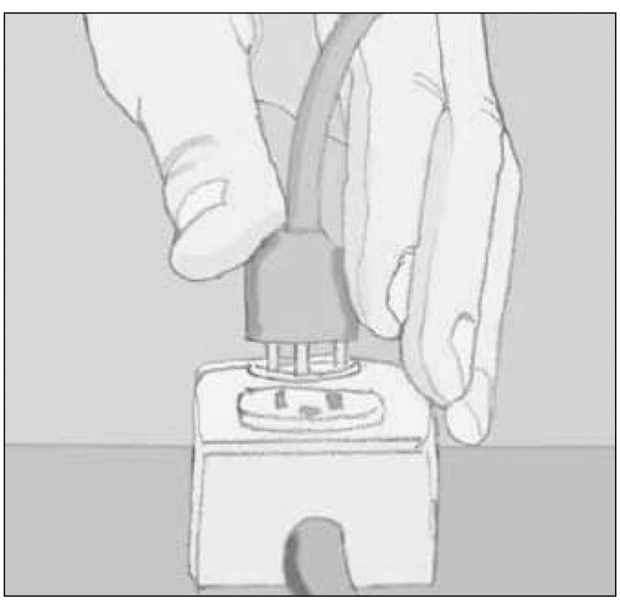
Fish (for example, 6 Comet goldfish)

Bricks and roof tiles

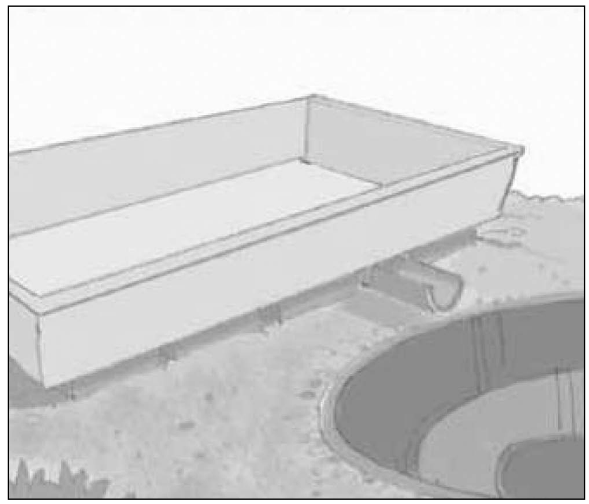
Directions

Dig a hole in which the fish tub will go. Ensure that the tub has some shade to avoid evaporation and is also below ground level to maintain a good, steady water temperature.

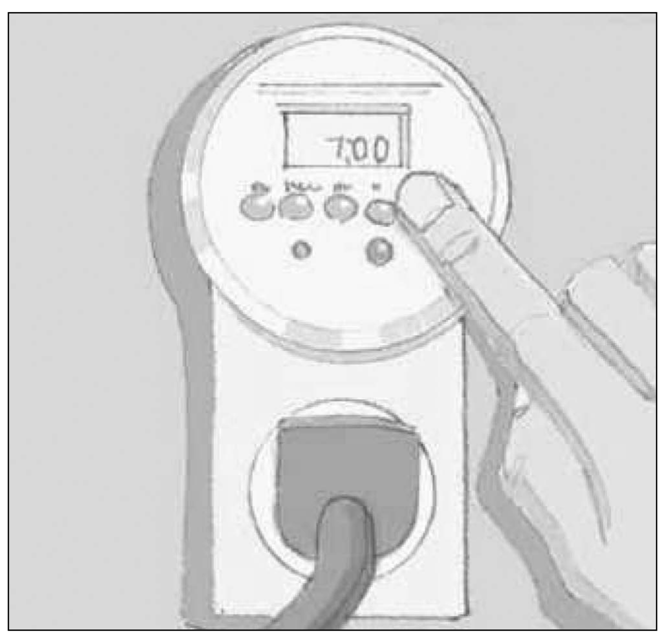
Run a 10-meter long outdoor/waterproof extension cable from a power outlet (whether in a shed, garage, house, etc.) to the fish area, and connect the pump and the air pump to the power outlet. Place all leads and sensitive electrical parts in a waterproofed box. Bury it in a small, easily accessible hole.



Drill or make some holes in the bottom of the grow tub so that the water can drain out and back into the fish tub. Next, set up a place for the grow tub to sit, preferably as close as possible to the fish tub so the pump won't have to work as hard to get the water into the grow tub from the fish tub. For example, you can set your grow tub on a higher level than the fish tub, letting gravity control the water flow back into the fish tub with the help of a basic roof tile.

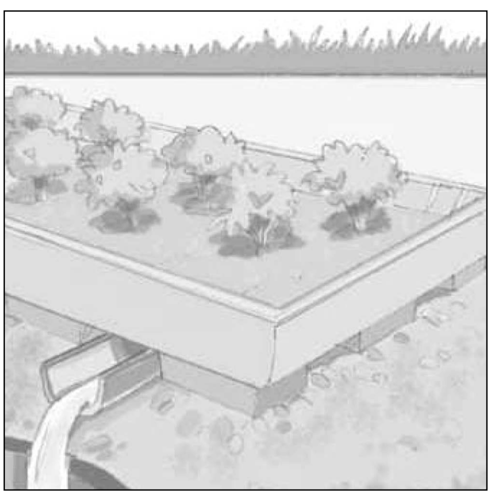


Connect a hose from the 1000 L pond pump to the grow tub, and set it up with the digital timer to control when you want the pond pump to turn on and off.



Fill the fish tub with non chlorinated water and fish. Have a few trial runs to see if the water flows from the fish tub to the grow tub and back out correctly. Monitor how fast the water escapes as this will slow down after you add your grow medium (for example, fine gravel).

Wash your grow medium and add it to the grow tub (make sure that you're happy with the location because it gets extremely heavy and impossible to move). From here, you can simply drop seeds into the grow tub and cover lightly with the medium and wait for germination to occur.



When you first put the seeds in, you will have doubts that the plants will even come up, but be patient. You will see plenty of little seedlings start to spring up. Otherwise, you can always add plants transplanted from a soil garden. Germination is always faster in hotter weather.

Maintenance

Fish feed:

Some try to keep their systems totally organic by feeding the fish organic feed such as duckweed and worms. This method is perfectly fine and, in fact, truer to the idea of aquaponics, but you may not be able to breed worms, grow duckweed, or buy expensive feed. Cheap feed from supermarkets will work just as well as the organic kinds.

Pump cycle:

This is determined by how fast your grow tub fills with water. Ideally, you want the water to fill up to about 3–5 cm. below the surface of the grow medium. Play around with the time setting, until you find a nice spot.

Plant selection and care:

Most plants will work very well in an aquaponics type system, especially ones like tomatoes, spinach, and most green vegetables. The choice of plants to grow depends on the size of your system and how much experimentation you're willing to try as to which plants/vegetables will grow best. Like any plants, even aquaponically grown plants can show deficiencies in some vitamins and minerals. It's wise to add an organic, fish-friendly fertilizer, like a seaweed fertilizer, to your system every 2 weeks or so as you would a dirt garden to fix any signs of deficiencies.

If you'd like to increase the size of your aquaponics systems, it's actually an easy process. Abide to the general rule: For a 100 L fish tub, you can have a 200 L grow tub worth of plants.

Hunting, Trapping, Fishing, Gathering

Tracking

BY LEN McDOUGALL

Tracking Wildlife

Tracking is a skill that everyone with an interest in wild animals should possess to some degree. By learning to recognize a species' tracks and other signs, you can piece together enough clues left by its passing to form a very good picture of what the animal was, where it had been, where it was going, its size, its diet, and sometimes its sex.

Generic tracking tips include the knowledge that nearly all four-footed animals designed for running walk weight-forward, on the toes, and sometimes their heels print lightly or not at all. Hind prints normally register on top of fore tracks, an almost universal characteristic that allows forefeet to be placed visually, and that precise spot stepped onto by the hind foot on that same side, important when you have four legs in rough terrain. Another trait common to 4-legged animals is a little toe on the inside of the foot, opposite our own, and forefeet that are noticeably larger than hind paws. Nearly all 4-legged animals run with a "rocking-horse" gait, in which the forelegs print close together and slightly behind more widely-separated hind prints.

Recognizing prints is only the first step in learning to track, and while that seems simple enough, most beginners are surprised at how little they actually have to work with. Clear, complete impressions are rare except in mud, wet sand, and fresh snow, so what a tracker follows are not clear footprints but marks made by the animal's passing. Partial tracks—where toes, claws, or the edge of a hoof have pressed noticeably into the earth—can help you identify the species and sometimes the individual, but you might need to follow a trail some distance to get a complete track picture. Of course, you first need to know what a perfect track looks like to recognize partial prints, and the accompanying track identification table provides this information.

Easier to follow and usually more obvious are disturbances left by an animal's feet and body. A half circle of four or five perforations in leafy humus tells you a clawed animal stepped there; twin scrape marks on a moss-covered log show where a deer's hoof slipped; broom-like sweepings on sand denote the wagging of a porcupine's tail as it waddled along; a trough-shaped furrow in grass leading to the water's edge was made by beavers; larger furrows through tall grass tell where a dear or bear crossed; a twisted spiral of crushed grass stems was made when a heavy animal changed direction abruptly by spinning on one foot. Try to imagine yourself as the animal you're trailing, able to slip over low branches or leap over high ones, stopping to nibble a plant here, abruptly changing direction in response to a scent on the breeze.

Trackers who make their job look easy also employ a technique I call "looking wide." The trick is to avoid focusing your eyes on the ground, trees, or any single component of the surrounding terrain; instead, take in all of these components as a single picture. Allow your eyes to settle naturally on discontinuities and disturbances left by an animal's passing. You don't need tracks if you can follow a trail. Intersections may still require detective work to discern which prints belong to the animal you're tracking, but a practiced ability to look wide makes following any trail much faster.

Look, too, for territorial marks left by dominant animals advertising their claim to an area, its foods, and any potential mates living there. Most territorial sign is left by dominant males, and all of it is meant to be conspicuous. Bobcats scratch tree trunks with their claws, then urinate on the trunks to leave a pungent, distinctly feline aroma that even humans can smell at some distance. Bears leave proportionately larger claw marks on wooden bridges and standing trees, communicating their size and strength to fellow bruins by reaching as high up the trunk as they can. Most territorial animals employ a variety of visual and olfactory markings to attract mates and warn off competitors, usually accompanied by a musky, vaguely skunk-like scent that animal watchers should always be alert for.

Animal droppings, known collectively as scat, can also reveal a good deal about their makers, including species, diet, and likely feeding grounds,. Territorial predators from bobcats and coyotes to bears and wolves, use scat to mark the perimeter of their domains, typically leaving fresh scat very near older deposits to refresh their claim every day or so. Members of the deer family evacuate their bowels whenever the urge takes them, usually on well-traveled trails, to disperse their scent widely and to confuse predators. If you can conquer your natural aversion to examining poop, breaking scat apart to reveal its contents will tell you what the animal has eaten and, through deduction, where it was feeding.

Bears (*Family Ursidae*)

With these generalities in mind let's move on to individual species, starting with bears. No wild animal in North America is more feared by humans, and none has suffered more at the hands of fiction writers seeking to create thrills by painting bears as aggressive, bloodthirsty man killers. Early settlers armed with muzzleloading smoothbores feared these most powerful of land carnivores because of their tremendous strength and sometimes enormous size. Adult brown, or grizzly, bears can exceed half a ton by age five; black bears, which may be black, brown, blond, or even mostly white on Alaska's Gribble Island, can reach mature weights of more than 600 pounds. In either species females are usually about 20 percent smaller than males.

Long canines identify black and brown bears as carnivores, but their feeding habits and lack of hunting prowess classify them as omnivorous, with a diet that consists largely, or at some times of year entirely, of grasses, roots, berries, and other vegetation. Newborn deer fawns and elk or moose calves are frequently stalked along overgrown trails in late spring, and occasionally a hapless ground squirrel is dug from its burrow, but meat is a highly prized delicacy in the diets of both black and brown bears. Polar bears, being adapted to a habitat with almost no vegetation, are almost wholly carnivorous, but their darker-colored brethren normally have to settle for carrion they appropriate from more skilled but less powerful hunters.

Aside from a brief midsummer mating season, or rut, all bears are solitary and concerned only with gaining the layer of fat—about 25 percent of their body weights—they'll need to nourish them through a five-month winter denning period. To accomplish that, these large animals must feed constantly, following seasonal foods on an annual trek that might encompass more than 100 miles.

Active mainly from late afternoon to midmorning, bears bed down in secluded thickets to sleep away the warmest part of the day. A nomadic lifestyle makes them less territorial than animals with smaller, permanent domains, but all bears are known to have a "personal space" inside which intruders won't be tolerated.

Few hikers ever see a bear in the midst of prime bear country because both black and brown bears typically withdraw at the first scent or sound of a human, but there are instances where you might suddenly find yourself facing a bear. Approaching from downwind, which is what you'd want to do when stalking deer and other harmless animals, may be a bad idea in bear country. A bear's nose is as sensitive as any, but no animal can detect scent from upwind. Adding to the ease with which you might catch a bear unawares are small ears with a sense of hearing not much better than our own, and myopic, color-blind vision.

Surprising a bear is never good, regardless of its species. Black bears can be counted on to hightail it into the bushes, and so will most grizzlies, but occasionally there comes a bear that refuses to withdraw. These animals are always large, dominant adults, and nearly always have something worth defending, like cubs, a bee tree, or a deer carcass.

Stumbling onto an obstinate bear doesn't mean you'll be attacked, and even a grizzly mother is reluctant to risk possible injury if she can avoid a fight. The first rule in any surprise encounter with any animal is, don't run. By running, you identify yourself as prey, which may excite the bear's hunting instincts and cause it to give chase. Stand your ground, then slowly back away, never turning your back on the animal until at least 100 yards stand between you. The objective is to convince the bear that you're a potentially dangerous foe, regardless of how untrue that may be, but also that you're willing to withdraw without conflict.

Current bear-avoidance strategy recommends never looking an animal directly in the eye, ostensibly because this conveys a willingness for confrontation. Where more aggressive brown bears are concerned, I must defer to experts like fellow Michigander Doug Peacock, author of the book, *Grizzly Years*. But if the animal is a black bear, an exhibition of anything but total dominance over the beast goes against the teachings of my Indian mentors. I've always locked gazes with every aggressive animal I've encountered, from bears and dogs to moose and elk, and I'll continue using that technique so long as it works.

Be aware, too, that dominant bears especially have been known to charge humans during surprise encounters. Having experienced black bear charges several times, I can attest to the sheer terror inspired by 500 pounds of growling bruin moving toward you at high speed, but once again it's essential that you stand your ground. No human can outrun a bear, but enough have come through bear charges unscathed to prove that nearly every one is a bluff, meant to determine whether you're frightened prey or formidable foe.

Bear tracks are distinctive. Every species has five toes on every foot, each toe terminating in a thick functional claw. Brown bear claws are long and nearly straight, well suited to digging and inflicting mortal wounds, while black bears have shorter, hooked claws that are better suited for climbing trees to escape brown bears, the black's only natural predator.

Most striking are a bear's hind feet, which look nearly human if you discount claws and the fact that bears, like most animals, walk heavily on the outsides of their feet, so their big and little toes are opposite our own. Tracks are typically toe-in, a trait common to powerfully built, flat-footed animals not designed for speed, a group that includes badgers, raccoons, wolverines, and humans. At a relaxed walk all four feet usually leave individual prints, with front paws registering slightly behind hind feet on the same side. At a run the forepaws still register behind rear paws, but this time both front and hind feet print in pairs, next to or slightly diagonal to one another. Typical of all running animals the bear's toes will be dug in more heavily than its heels, often with a spray of loose soil thrown to the rear.

Wild Canids

The family Canidae includes the coyote, gray wolf, gray fox, the imported red fox and man's best friend, the dog *(Canis domesticus)*. There has always been a strong bond between humans and the dog family and, tall tales notwithstanding, no non-rabid wild wolf or coyote has ever posed a danger to humans of any age or size. I've been spending nights alone in the woods with wolves and coyotes since boyhood, and my personal experience has been that any fear of these wild dogs is totally unfounded. Being near these wild hunters, listening to them howl messages across the forest to one another, is a thrill not to be missed.

Coyote (*Candis Iatrans*)

Coyotes are the most common and widespread wild dogs in the Americas. Smallest of the wolves, coyotes share their long-legged, lanky build, but stand only 24-inches at the shoulder and weigh just 30 to 45 pounds, with males slightly larger than females. At a top running speed of about 45 mph, they're natural predators of rabbits and hares, but carrion and rodents—the latter stunned by pouncing onto them with both front paws—make up the majority of any coyote's diet. Fawns and chickens are occasionally taken, but coyotes mostly respect human boundaries, and healthy deer are too much for the little wolf to handle, even in a pack of up to seven adults.

Because a large portion of their diet is rodents, many adults fit the Old West image of a lone coyote. But when winters get tough in the North, five to seven adult family members may form a pack to bring down already dying deer. The little wolf isn't keen on tackling prey several times its own size, even with the help of its kin, but deer too weak to use their lethal hooves effectively are sometimes dispatched and eaten quickly, before larger carrion eaters (wolves) find and appropriate the carcass.

Coyotes are normally shy, staying well away from campers and human habitation, although there are places and instances where human practices cause them to become pests. In the late 1950s and '60s, during the paving of California, homeowners who'd settled in what were to become suburbs discovered that local coyotes were smart. They learned not only the milkman's delivery schedules but also how to uncap glass bottles and dump the milk onto concrete—the only nonabsorbent medium available—where it could then be lapped up. Today, as new housing continues to gobble up wilderness, rural homeowners are having similar problems with trash left outside for pickup.

No coyote has ever approached any camp I know of, whether people were there at the time or not, probably due to the shoot-on-sight status coyotes have always enjoyed with hunters. If you should happen upon a pack of coyotes that show reluctance at leaving, say, a fresh-killed fawn, simply brandishing a stick will set the entire pack to running. Be aware, however, that early spring (March and April) is a time when rabies takes a lethal toll on overcrowded animal populations, especially coyotes, raccoons, and skunks. Never, ever approach any wild animal that exhibits no fear, seems disoriented, or has greasy-looking, matted fur. Foaming at the mouth, that classic symptom of hydrophobia (rabies), is seen only at the disease's latter stages, just before the victim dies.

Although such a lightweight and soft-footed animal rarely leaves a clear, whole print, coyote tracks are unique. Like all dog tracks, front and hind prints show four toes with fixed claws, all pointing forward, but the heel pads of the rear feet leave distinctive forward-pointing winged impressions rather like a mustache on each side of their imprints.

Gray Wolf (*Canis Lupus*)

It has always seemed a bitter irony that the dog should be considered mankind's best friend while the wolf, which has never been known to attack any human being, has been used to frighten small children and hunted to extinction over most of its range. Native Americans revered the wolf for the way a pack worked together for its own preservation, for the way pairs mated till death did them part, and for the drill-team hunting maneuvers a pack used to bring down prey much larger than themselves. With a running speed of more than 40 mph and body weights that can exceed 140 pounds for males (about 120 pounds forfemales), wolves running in packs of from two to more than six members are a formidable hunting machine for prey as large as a yearling moose.

In fact wolf and coyote packs are always formed of family members. Some offspring elect not to mate in order to stay with the strength of the pack, where only the original parents, the alpha male and the alpha female, are allowed to breed. Offspring that remain for a year or more take an active role as babysitters after the next generation of siblings has been weaned, feeding the pups on demand with regurgitated stomach contents and defending them from predation.

But for all their savage efficiency against animals they intend to eat, wolves, like coyotes, pose zero threat to humans, and there is not one verifiable report of a wolf or wolves attacking any human being for any reason at any time in history. I've spent many nights in woods where wolf packs were hunting, listening as they made kills; once I even managed to call an entire curious pack to the perimeter of my camp, but they refused to approach further. Put simply, there is no reason to fear brother wolf.

Wolf tracks can be confusing, even to trained biologists, because they are virtually identical to the tracks of dog breeds that have close ties to their wild cousins. Typical of the dog family, wolf tracks have four forward-pointing toes with thick fixed claws, but the heel pads of front and hind paws may be indistinguishable from those of the husky breeds, like Samoyeds, malamutes, and Siberian huskies. Differences include size, because the tracks of a full-grown gray wolf may reach 5 inches long by 4 inches wide, with front paws larger than hind paws. Note too that man's best friend is considered a prey animal by timber wolves. Dog tracks found in wolf country, which is by definition remote, were almost certainly made by a wolf or coyote.

Raccoon (*Procyon Lotor*)

Everyone can recognize a raccoon, with its distinctive masked face, fluffy ringed tail, and long, monkeylike fingers that are notorious for being able to manipulate catches and locks on henhouse doors. The common name stems from the Algonquan Indian name *ah-roo-cown*, which translates roughly to "scratches with hands." *Lotor*, the suffix of its scientific name, is Latin for "washer," an allusion to the omnivorous species' habit of washing food in a stream or pond before eating. The truth is that raccoons, like humans and primates, use their sensitive fingers to separate edible flesh from inedible bones, seeds, and rinds—why eat undigestible matter when you don't have to?

Officially raccoons can reach weights of 12 to 48 pounds, but in the fur-trading days of my youth I took two that topped 60 pounds. Preferred habitat may range from hardwoods to swamp, but always near a source of fresh water, which also provides delicacies like crayfish and clams. They don't hibernate, but in the hardest parts of winter in the Far North, raccoons may den for several days at a time, living off stored body fat.

Cartoonists and movie directors have always opted to portray the raccoon as a cute little imp, capable of property damage but always friendly to humans. This simply isn't true. The once popular *Grizzly Adams* TV series was canceled after several youngsters, ostensibly influenced by cute and cuddly trained animal actors, were injured while attempting to handle raccoons drawn to campground garbage cans.

No healthy raccoon has ever attacked a human in my experience, but all are fierce, willing fighters when cornered, and numerous campers have had to endure rabies vaccinations after learning the hard way that a fearless animal isn't necessarily friendly. Raccoon hunters, who typically love their coon dogs like children, are careful to protect their much-larger bluetick, walker, and redbone hounds from the sometimes serious injuries a cornered raccoon can inflict on them. Most feared is that a dog might pursue a coon into deep water, where the raccoon can be counted on to turn and climb onto the stricken dog's head, drowning it. Never approach any wild raccoon, no matter how tame it might appear.

Raccoon tracks are typical of other plantigrade animals, like bears and humans, with elongated hind feet and five toes on each paw. All toes are extraordinarily long, like fingers, and these are perhaps the most distinctive identifying feature of raccoon tracks. Also, remember that nocturnal raccoons always frequent shorelines after dark, and wet sand or mud near the water will often yield plaster-cast-quality tracks.

Beaver (*Castor Canadensis*)

This uniquely American rodent is a marvel of nature. Many Indian cultures credit the beaver with teaching humans to build houses, French voyageurs believed the foul-smelling castoreum glands on the beaver's anus were a cure-all, and no animal in the world does more to promote the health of its own habitat. Today beavers sometimes run afoul of man by flooding power lines and real estate, by toppling commercially valuable birch trees on vacation properties, and by diminishing water flow to cattle farmers on the downstream side of dammed waterways.

In the natural sense, however, beavers do only good: creating ponds and excellent fish habitat where forest once dominated and providing nesting and feeding areas for all types of waterfowl and other birds. Thinning fast-growing trees like poplar, aspen, and birch, the bark of which serves as the beaver's main source of nourishment year-round, promotes new growth and health in the surrounding forest, and every animal in the area will visit the pond to drink at some point every day. Years later, when the largest food trees are exhausted and the beavers move on to establish new ponds, the abandoned pond will dry up and become a rich garden of lush growth.

Largest of North America's rodents, beavers can officially reach weights in excess of 100 pounds, though 30 to 40 pounds is average for adults. None poses a danger to humans unless cornered on land, but never underestimate a beaver's ability to fight. The famed Lewis and Clark Expedition suffered its first near-fatal casualty when Captain Meriwether Lewis' huge Newfoundland retriever had its throat torn open by a cornered beaver.

Despite a plethora of tracks along muddy or sandy shorelines, easily recognizable beaver tracks are rare. Reasons for that odd scarcity include the fact that beavers seldom walk along a shoreline; instead they travel straight from water to work area, leaving a wide, flattened, furrowlike trail through tall grasses at the water's edge. Webbed hind paws help make beavers among the best swimmers in the mammal world, but print only faintly because of their wide surface area. Fortunately, gnawed trees with bark stripped off, dams, lodges, and, of course, ponds are proof enough that beavers live there.

When tracks are in evidence, there are five toes on every foot, although the small inside toe of the hind feet may not print at all. Front tracks look remarkably like a small human hand with fingers and thumb spread wide. The walking gait is a toe-in waddling pace in which all four feet register independently.

White-Tailed Deer (*Odocoileus Virginianus*)

No wild animal in history has been more studied, manipulated, or revered than the white-tailed deer, and the strangest part is that all the money used to accomplish those things comes from people whose stated goal is to kill deer. Nearly exterminated by the mid-20th century because of unrestricted hunting, whitetails have made a phenomenal comeback, even to the point of becoming agricultural pests and serious driving hazards, especially after dark. Few species have adapted to the crush of civilization better than the whitetail.

Whitetails are one of five native species in North America belonging to the family Cervidae, which also includes mule deer, caribou, elk, and moose. All are ungulates (hoofed animals) of the order Artiodactyla, meaning they have an even number of toes. Other shared characteristics include antlers that are shed by males in winter, cloven hooves, a darker grizzled coat in winter, a purely vegetarian diet, a lack of top teeth, and twins born in early spring.

While I've heard some pretty tall tales from overexcited nimrods, I feel secure in saying that wild white-tailed deer are absolutely harmless to any human. The same applies to mule deer and caribou. Bull elk in the grip of raging hormones during the October rut, or mating season, have been known to charge photographers who got too close, but such instances are rare and roundly deserved. Moose, however, are scary; cows with calves are more protective than any other deer species, and rutting bulls have been known to charge anything up to and including locomotives. Once again, the safest rule of thumb is to give a wide berth to any large deer that seems reluctant to flee at your approach.

Whitetail tracks are typical of deer tracks, printing in the classic split-heart pattern. Each half of the cloven hoof is actually a modified toenail; paired dewclaws located above the hooves to the rear of each ankle are another pair of apparently useless toes that will probably disappear one day. Like those of most four-leggers, hind prints register precisely on top of foreprints at a casual walk. At a fast run of 35 mph, whitetails and other deer adopt a rocking-horse gait, with paired foreprints registering between and slightly behind more widely spaced hind prints.

Wildcats (Family *Felidae*)

Discounting the jaguar, ocelot, and jaguarondi of Mexico, there are three wildcats in North America: the bobcat (*Lynx rufus*), the mountain lion (*Felis concolor*), and the long-legged lynx (*Lynx Canadensis*). All are superb hunters with pinpoint hearing, very good vision, and some of the most lethal armament in nature. These cats have the stealth to stalk small rodents, the speed to catch a rabbit, and the teeth and claws to bring down prey much larger than themselves. Unlike wild canids, all cats prefer to kill their own food, and none will eat carrion unless very hungry.

Mountain lions are the largest of American wildcats, reaching weights of more than 250 pounds, followed by the muscular little bobcat at 65 pounds and the long-legged lynx at 40. Each of these was once far more widespread than it is today, but people

have never been fond of wildcats in their backyards, and now all of them are more or less cornered in small pockets of wilderness.

While there have been tales of lynx and bobcats attacking humans, I find such stories very difficult to swallow—even a child is physically too large to be considered prey by such small felines. Mountain lions, though, have earned a good deal of prejudice by infrequently killing or mauling small-framed people, sometimes actually eating the bodies. As with bears, the culprits are always old, arthritic cats whose hunting skills are no longer sufficient to supply game. Humans are at the bottom of the list of wildcat food choices.

A chance meeting with a large mountain lion can be frightening. Most will hightail it for cover; if you should meet a cougar that seems reluctant to leave, it probably has a fresh kill or cubs that it's defending. As with a bear, the protocol for safe withdrawal includes maintaining constant eye contact while backing off slowly. Never turn your back on the cat, regardless of what it does, until you've put a minimum of 100 yards between you. barring this, a blank pistol, a compressed-air horn, or even a loud whistle has been sufficient to set even large cats to running.

Like canids, all felines have four toes on each foot, but while dogs have paws designed for digging, with stout fixed claws and forward-pointing toes, cats have retractable claws in toes that are arrayed in a semicircle. Cats can partially close their paws like a human fist, and widely spaced toes permit a better grip against flesh while needlelike fangs deliver a killing bite to the victim's throat.

Tracks of the three American wildcats are easily distinguished from one another. Mountain lion tracks are of course much larger and deeper than tracks from its two smaller cousins. Lynx tracks are disproportionately large and show long, widely splayed toes with almost formless heel pads; bobcats are unusual in that all four feet are nearly equal in size, while most animals have larger forefeet. Being retractable, claws are normally absent from the tracks of all species. An exception is on slippery surfaces like wet clay or ice where cats, like people, feel insecure about walking.

Planting Tips to Attract & Hold Wildlife

BY PETER J. FIDUCCIA AND LEO SOMA

This chapter is meant to provide DIY ideas to help you plant and grow food plots to attract and hold deer on your land from November to January—the time of year most hunters want to have deer feeding in their food plots! The plants I strongly recommend to achieve this goal are mostly in the *brassica* family, plus a few other plantings. The *brassicas* include purple-top turnips, forage rape and kale, and canola. The other winter-hardy plants include Kura clover—and my favorite: sugar beets.

For those who have never planted a food plot before, I have included some basic planting points. With that said, however, the following information is less about "how to" and much more about which winter-hardy plants will draw deer to your land in November, December, and January.

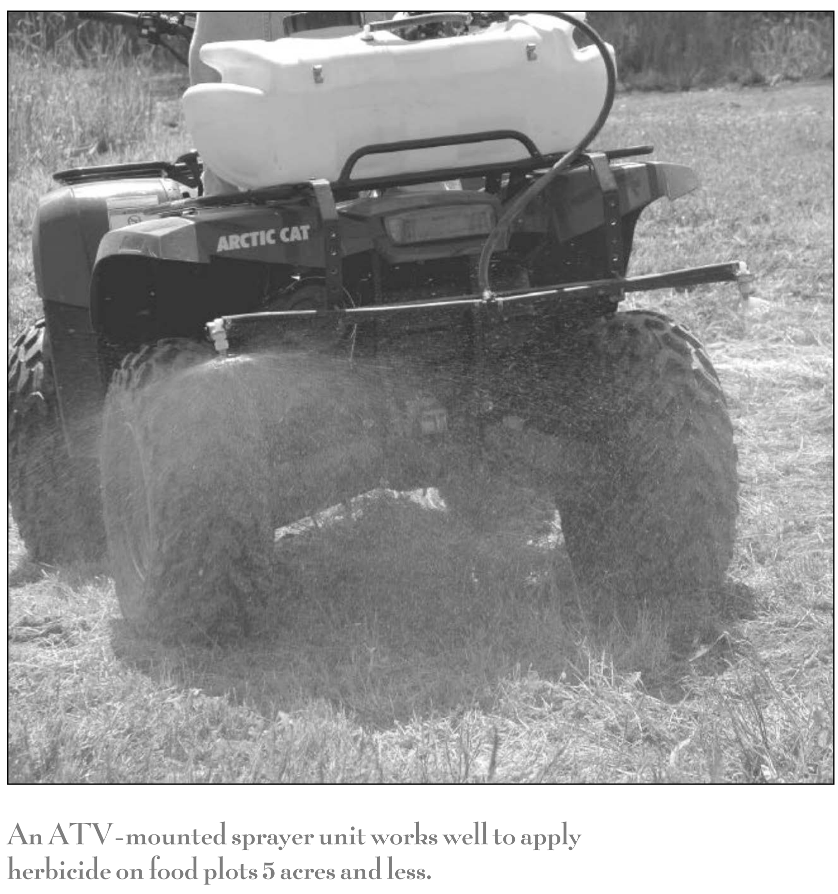
The plants I've mentioned are easy to grow, and require the least amount of work to maintain. One of the most attractive points about each of them is that they can be grown in plots as small as a fifth of an acre or in much larger plots, from one acre in size and up.

In planting your food plots, remember the adage, "The right tools make the job easier." When it comes to playing in the dirt, this phrase is worth repeating to yourself before you plant a single seed! If you believe that you can successfully plant healthy crops that will produce quality nutrition for deer by simply broadcasting seeds over hard ground—forget what you may have heard! All seeds do best on ground that has been properly prepared, so that they can grow to their maximum potential.

Know Your pH Level

For optimum results with the plants that are recommended here, the pH level of your soil should be between 5.9 and 6.5—that is, slightly acidic; 7 being neutral on the pH scale and levels higher than 7 being increasingly alkaline. Therefore, it is important that you test your soil to make sure its pH is at the correct level prior to planting.

In calculating pH levels, which involves measuring humic matter and exchangeable acidity



An ATV-mounted sprayer unit works well to apply herbicide on food plots 5 acres and less.

levels, a soil test will determine if lime is needed and, if so, how much to apply to the soil. Don't guess how much lime to add. These plants don't do as well when the pH is level is too high (above 6.6). In fact, a high pH may block plants' ability to absorb vital nutrients, such as iron, manganese, boron, copper and zinc, which in turn will affect deer nutrition, size, and quality.

Start by taking a small soil sample of each area you intend to plant. Then, send the samples to your local farm supply dealer, county extension service or even a seed company that provides pH testing. You do not need a lot of soil; most places only test a tablespoon to get the pH level. By simply using a soil sample report, you will be able to eliminate the guesswork. Some food-plot planters whose soil is very acidic don't realize just how much lime it takes to raise the pH levels: a few tons per acre! So even in small plots, you may have to apply several 100-lb. bags of lime to the soil to get it ready for planting.

Using Herbicides

No matter what type of seeds you plant, they will grow much better if you control the weeds in the plot. Before planting, spray the plot to kill both grasses and broadleaf weeds. Herbicides work best when the weather is warm and dry for at least a few days after spraying, and you will have to wait at least a week before planting after you spray any herbicide.

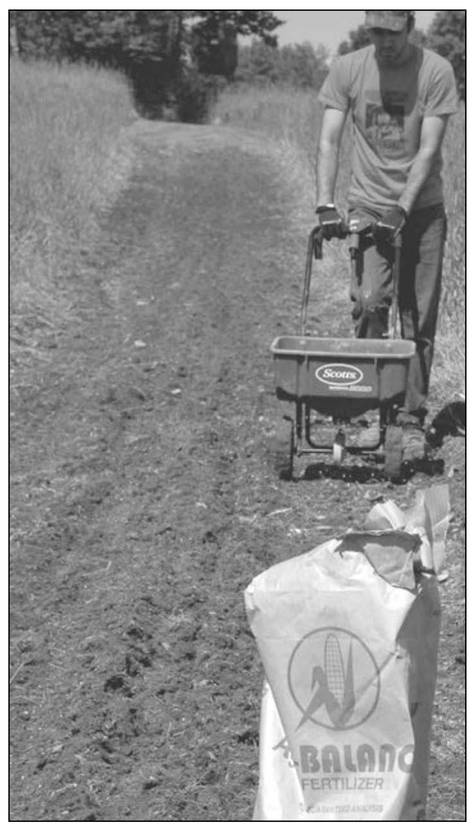
Using Fertilizer

Each of the crops in this chapter will grow better when fertilized with a blend of nitrogen, phosphorus and potassium—also known as N-P-K. The correct fertilizer mix will help the crops grow to their maximum potential. For instance, an average one-acre plot of turnips requires about 200 pounds or more of 19-19-19 (meaning that for every 100 pounds of fertilizer there are 19 pounds of nitrogen, 19 pounds of phosphorus and 19 pounds of potassium) topped off with about 100 pounds of ammonium sulfate. Nitrogen is the key element for plant protein production. Potassium and phosphorus are essential building-block elements for antler growth, bone, milk, and body growth for deer. Including these elements in your soil is important not only for the plants, but the deer as well.

Planting by Hand & ATV

If you plant only several really small areas (one-tenth of an acre or 4,330 square feet), the plots can be effectively worked using a combination of hand tools and an ATV. The equipment needed for hand planting includes:

- A quality three-gallon herbicide hand-held sprayer or a backpack sprayer



A push-type or hand-held seeder can also be used to spread seed or fertilizer in smaller-food Plots.

- A sturdy, heavy-duty push spreader with at least a 75-lb. capacity to spread the seeds and fertilizer on the plots
- A stout iron rake with steel teeth to smooth out the plot

That is the practical limit for the hand-held equipment. In addition, you will need a small ATV (400 ccs or so) that will comfortably pull a small disc (tiller) and a chain drag harrow to smooth out the plot.

Deer-Barrier Systems

Small plots can be quickly and easily over-browsed by deer. To lessen the potential damage, you should either plant a "nurse crop" (like a winter-hardy clover) near them to prevent deer from over-browsing the plot, or use a deer-barrier system.

I have used the Plot Saver Deer Barrier System and find it works well to deter deer from getting into my small plots, at least temporarily, so my plants can reach maturity. It is a lot less expensive than using a high-fence system. All you have to do is place the stakes that come with the kit around the area you want to protect, stretch the three-quarter-inch Plot Saver Ribbon around the perimeter and spray the ribbon with Plot Saver deer-repellent formula. Each application is effective for about two to three days—sometimes longer—and the system comes with enough repellent to keep deer away for 100 days.

An 840-foot spool of the braided Plot Saver Ribbon, an absorbent poly-tape that lasts approximately six years, is included in the kit (enough for one acre) as well as a 16-ounce bottle of Plot Saver Concentrate. The system can be purchased in most sporting-goods stores, all the big catalog stores and online at www.plotsaver.com. Fiberglass stakes (not included), which are 39" tall and come with clips to hold the ribbon in place at the optimum height of 30", and an extra 16-ounce bottle of concentrate also are available at the same locations.

ATVs

If you plan to plant in plots that are at least one-tenth of an acre and up, the reality is that you will need to make an investment to purchase more heavy-duty equipment: an ATV with at least 500 ccs or more of power, if you can afford it. A hefty ATV can pull a one- or two-row plow, a heavier disc, a larger chain-drag harrow, a small brush hog, grass cutter, seeder, herbicide sprayer, compactor and other implements without over straining the engine.

This photo shows a foodplot that was staked out with a Plot Saver Ribbon (on the left) and the same plants were planted without the ribbon on the right. (Photo courtesy of PlotSaver)

Here I transport heavy seed bags and some started plants in the back of my Arctic Cat ATV to one of our food plots. I use the tractor and compactor/seeder to plant seeds in larger plots while my son Cody plants the started pumpkins in a nearbyplot.

I highly recommend Arctic Cat ATVs and their entire line of food-plot implements for both large and small plots. The company designed their planting implement equipment specifically to be used with their line of ATVs, and after using them successfully for years when planting my property, Arctic Cat quads and planting equipment remain my first choice. Don't kid yourself. If you're going to plant wildlife food plots seriously and don't have either the budget or the need for a tractor, your only logical choice is an ATV with an array of implements to get the job done right.

Because accomplishing work on the farm totally depends on equipment that is reliable, durable, and affordable, you may also want to include a good utility ATV that will hold plenty of planting equipment (shovels, rakes, bags of seed, fertilizer, lime, etc.). Later in the year, that utility vehicle comes in handy to carry hunting equipment, hunters, and harvested deer, too. You will get years of service from utility ATVs—our Prowler fits in all those categories and is a "work horse" of a machine. As an added bonus, they are also capable of pulling most planting attachments.

Pay your favorite ATV dealer a visit. He will give you the best advice available and help you make the right choice in purchasing the type of equipment that will work best for your land, needs and budget.

Now that you have chosen the type of equipment for creating a food plot, there are very specific steps you must take before planting even a single seed.

What to Plant

Now it is time to get down to the crux of this chapter. As I said at the start, the plants I suggest (purple-top turnips, grain sorghum, forage rape and kale, forage chicory, Kura clover, and sugar beets) will all do well in small- or large-sized plots.

Think about this for a moment: Your neighbors and nearby hunting clubs are not likely to be growing most of the plants I've mentioned. If they have food plots, they are probably planting mostly clovers, although some may also include chicory and turnips, and local farmers are most likely growing plenty of corn, clovers, timothy, soybeans, etc. By planting the different types of crops I've named, you will entice deer to your property from surrounding lands and keep your resident herd from leaving your property.

It is important to mention here that if you have several fields available to plant and you have the

Grain sorghum is a terrific plant to replace corn. It is much less expensive and offers equal cover and nutrition when compared to corn for deer and it is much easier to plant and grow.

equipment, time, and money to plant them all, then you may also want to include other winter-hardy plants, such as corn, Austrian winter peas, birdsfoot trefoil, and the small grains like winter wheat and winter rye (which should not be confused with perennial ryegrass). Remember, these plants require large plots of an acre or two in size to grow to their full potential.

I stopped planting corn for a variety of reasons. First, every farmer around me has a majority of his land planted in corn, so the deer have enough of it to eat. Second, corn is very expensive. A bag of Round-Up Ready Corn in 2010 costs more than $225! On top of that, it requires an expensive piece of machinery to plant it correctly—a one- or two-row planter for small acreage and a larger one if you plant more than 10 acres of corn. Then, you have to buy a lot of lime and nitrogen to keep it growing well. And you have to buy herbicide to keep the weeds from overtaking the crop.

In other words, planting corn is expensive, time-consuming and a lot of hard work. Grain sorghum, on the other hand, is much less expensive, requires much less maintenance, and I have found it is more attractive to deer—especially if corn is grown all around you!

Forage Rape

Forage Rape is a cold-weather *brassica* and, like other *brassicas*—such as kale, turnips, cabbage, canola, radish, Swede and rutabaga—its leafy greens work well to draw deer to food plots throughout most of the United States and Canada.

During my 30 years of planting food plots, I have found that forage rape and kale are among the easiest to plant and maintain. Deer will browse the rape leaves in summer, but they really don't hit the plant hard until there are a few hard frosts in late fall, which is whyI would not go a season without planting several small (one-quarter acre to one full acre) plots of forage rape on my farm.

To give rape the best start possible, it must be planted early. In the North, I suggest planting it anytime after the 4th of July. Rape is ready to browse from 30 to 90 days after it has established itself. In the South, it should be planted no later than September for best results.

For optimal production, plant rape in a plot that has good soil drainage. While rape will tolerate pH levels between 5.5 and 6.5, it does best in soil with a pH of 6.0. Rape seed is tiny, and like all tiny seed plants, it can be successfully top-sown on bare

Here is a plot of forage rape planted at the base of a hill with one of our tree stands nearby.

soil. However, I prefer top-sowing on soil that has been tilled. In either case, plant your rape crop just prior to a forecasted rainfall for best germination.

First, till your soil no deeper than three inches to help keep the weeds down. Tilling the soil deeper only stimulates weed growth. Use a combination of herbicides to kill unwanted grass, broadleaf and other noxious weeds. Be careful to follow all instructions exactly and wait to plant according to the directions as well. I like to use herbicides after the weeds begin to emerge and are three inches high or so. Whatever the date is that I plan to plant, I spray my herbicides at least a full week beforehand.

Plant five to 10 pounds lbs. of forage rape seed per acre. If your plot is smaller than an acre, calculate its square footage by measuring and multiplying the length of its sides, then divide that total by 43,560 (which is the total square footage of an acre) to get the size of your plot in acres. That will help you break down approximately how much fertilizer and/or seed is required for each plot you plant. Be sure not to over-seed. Planting more seed than recommended accounts for more plot failures than planting less! This fact is true of all plantings.

I like to plant most of my food plots with just one seed. Sometimes I mix them, but when it comes to brassicas, I prefer to plant them alone or near a nurse crop of the winter-hardy clover—Kura. I plant this legume close by to take the browsing pressure off my other plants during the summer months.

Make sure that you achieve good soil-to-seed contact. Using a compactor will help. Short of that, you can ride an ATV over the seeded plot very slowly to help press the seed into the ground.

To get the best production and forage, fertilize as you're planting with 300 lbs. of 19-19-19 per acre and 100 lbs. per acre of 34-0-0. When properly fertilized, rape leaves will have crude protein levels that are between 15 to 30 percent. The total digestibility nutrients (TDN) could reach 60 to 75 percent, with a dry matter reaching about 10 to 15 percent. Basically, rape rates highly as a very digestible forage for deer.

Like the other *brassicas* I mentioned, you will discover that deer will seek out forage rape very enthusiastically from November through January! You will be surprised how many deer will visit the plot even during daylight hours in the hunting season—and that is true for all *brassica* plots.

Forage Kale

Kale is among the top three fall forage *brassicas*, with crude protein levels ranging from about 15 to 28 percent. The only downside to kale is that it is a slower growing plant than turnips and rape. If you plant kale, you have to allow at least four months for it to grow to maturity, or about 100 to 150 days.

Forage kale grows well in cool areas and, in fact, will produce best in northern zones. It should be planted in June or July—about four to five lbs. per acre. If you plant smaller plots, calculate their size in acres (using the method explained in the forage rape section) to help you estimate how much fertilizer and/or seed is required for each plot you plant. Kale should not be planted deeper than one-quarter inch under the soil. With that said, however, let me add that I have had excellent success top-seeding the tiny seeds of kale.

Kale grows well when the pH level is between 5.9 and 6.6. If the pH gets too high the leaves will begin to molt. Like the other brassicas, forage kale should be fertilized with at least 300 lbs. of T 19-19-19 when you plant it. You should also include two to four pounds of boron, 50 to 100 pounds of magnesium, and one-eighth to one-fifth of a pound of copper and zinc—especially if your soil test suggests they are necessary.

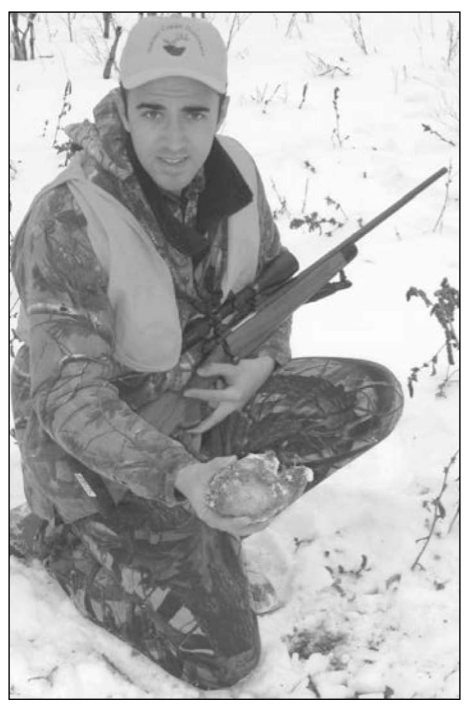
I use a variety called Maris Kestrel kale, but there are many types of forage kale available. Because kale is a slow grower, I often split the plot in half with rape on one side and kale on the other. Again, in very small plots, it is advisable to include a nurse crop of Kura clover to prevent deer from over-browsing the brassica plantings.

Kale is easy to plant and maintain. It will provide forage when you most want it . . . during the hunting season. As soon as there have been a couple of deep freezes, deer will march into your kale stand with a serious intent to eat as much as they can. I plant about an acre or more each year and I'm never disappointed by how it attracts deer to my land or by the results during the hunting season. Once you plant kale and witness the use by deer in winter, it will become a vital part of your yearly plantings, too.

Sugar Beets

There is a good reason why I say (without hesitation) that my favorite food-plot planting is sugar beets. Nothing else I have ever planted over the last 30 years has worked better to draw deer into my plots and hold them there during the hunting season.

Deer simply go "bonkers" for sugar beets once they discover what they are. Even when the plot is covered with snow, deer still actively seek them out, pawing up the snow until they unearth the tasty treat. As far as deer are concerned, sugar beets are ice-cream! Many times I have seen the same group of does or individual bucks returning to a sugar beet plot several times in one day!



My son P. Cody with a sugar beet from one of our food plots. It had been dug up by a deer in late December.

Once there have been several hard frosts by mid-November, deer will enthusiastically and relentlessly dig for sugar beets in a plot until they have devoured each and every one of them.

During the 2009 deer season on our farm in New York, the regular firearm season proved to be frustrating. The weather was milder than normal and we had a hard time seeing good bucks the entire three weeks of the rifle season. It wasn't until two days before the muzzleloader season opened that the temperatures dipped dramatically. For the next couple of days after opening day of muzzleloader season, it snowed and the thermometer didn't climb much over single digits.

That was all it took for the sugar beets to "sweeten-up" and become a primary food source for the deer on our place. The sugar beet field looked like the deer were digging them up with shovels. By the third day of the season, I shot a dandy 8-point buck with a 21-inch plus inside spread at 11 am. He came into the sugar beet plot with a group of does.

Only two-and-a-half days later, Jeff Elliott, the CEO of Coventry Log Homes, shot another terrific buck in the same sugar beet plot at 1:30 p.m. Jeff said he had watched well over a dozen deer come in and out of the plot all morning. When he saw his 9-point buck come in, he didn't waste a second before putting the crosshairs on him!

In less than a week, two good bucks were taken after not seeing a "keeper" buck for three weeks prior to that. Clearly, if you want to see deer in your food plots from November to January, sugar beets must be a vital part of your late season list of plantings!

Some food plotters think that sugar beets are classified as a *brassica*. In fact, they are a biennial vegetable. What makes them a top-rated seed to plant, however, is that like any of the brassicas, sugar beets are a cold-weather crop that makes a terrific, if not the best, attractant food plot for deer, especially during the critical periods of winter when deer are stressed to find quality foods.

This wide-antlered 8-point buck was taken as it dug through the snow to get a sugar beet in the plot just behind the corn during the late muzzleloader season in December.

Sugar beets have a very high digestibility rate. Some experts say they have the highest digestibility of any forage (95 percent), and I certainly wouldn't argue that point. Sugar beets have a protein content of 12 to 15 percent as well. While that isn't as high as many of the other plantings have, it is still noteworthy.

Because they have a short growing season of only 90 to 100 days, sugar beets can be planted in early spring or, for northern areas, in late June or early July. I plant my beets no later than the 4th of July. By the end of September, and no later than the first week of October, they have matured.

As the weather cools in the fall, the sugar content in the plant begins to increase. Usually, by mid-November, most northern climates have undergone a few hard freezes, which help to increase the sugar content of the roots even further and makes the plants more palatable to deer.

The first time I planted sugar beets, I was surprised to discover that deer eat the tops of the plant as well. Speaking of that, don't mow the leaves of the sugar beets as they are growing. It will encourage additional leaf growth, which ends up decreasing the sugar content in the plant's root system—the key to attracting deer.

I have heard some folks tell me that it took "a couple of years" before their deer discovered sugar beets. If that is the case when you plant them, you may have to dig up a few to help the deer find out they like them (check your local game laws before doing this). Since the sugar beet itself sometimes sticks as much as halfway out of the ground, deer don't take long to learn that they love eating this plant.

Plant your beets in a medium-to-heavy, loamy soil that receives ample moisture. Be careful about the site you select, however. While the beets will need adequate water in the summer, as young plants they are vulnerable to drowning if they get too much water.

It is absolutely crucial to make sure that the plot you intend to plant sugar beets in is weed-free prior to planting the seeds in order to assure a successful crop. Once the plants begin to shoot up, their leaves will sufficiently block out the sun to prevent weed growth and competition. I spray my sugar beet plots thoroughly about two weeks

Jeff Elliott, president of Coventry Log Homes, shot this big 9-point buck as it was heading to a turnip plot in December!

before I intend to plant them with Pronto Big N' Tuf (available at Tractor Supply).

Before planting sugar beets, take a soil test to determine the exact pH level. If it is lower than 6.0 you will have to lime it heavily in order to get the pH level to 6.5 to 7.5, which sugar beets prefer.

You should also prepare the plot by fertilizing it with at least 400 lbs. of T-19 (19-19-19) per acre. Also plan to add about 20 lbs., per acre or so, of manganese sulfate. Till both fertilizers about three inches under the soil. When the plants are almost fully grown (about eight weeks later), broadcast with a push spreader about 100 lbs. of urea (46-0-0) per acre.

If your plot is smaller than an acre, calculate your seed, fertilizer and lime amounts by first measuring the plot accurately to break down approximately how much of each is required for that particular plot. (See the forage rape section.)

I try to plant my beets when there will be an expected rainfall. It is recommended that the seed is planted about one-quarter to one-half inches deep. They should be cultipacked well so they have good soil- to-seed contact. I have had very good success with top-sowing them and then using a compactor to press the seeds into the soil tightly. Either way has worked for me, but if you are planting sugar beets for the first time, you may want to stick with the seed-depth directions on the package.

There was a time when Roundup Ready sugar beets were available, but not as recently as this writing. The word is, however, that Roundup Ready seeds will be in the works again soon. Before you purchase your seed, check to see if RR seeds are available. If they are, it will make your job of controlling weeds easier, even though it will cost more for the seed.

Remember that sugar beets have to be rotated each year. You can plant a winter-hardy clover like Kura or a winter wheat or rye in the plot the following year. Once you plant sugar beets and see how enthusiastically the deer feed on them, sugar beets will become a yearly crop that you will not want to do without.

Turnips

Deer love to eat turnips, which are closely related to rutabagas and Swedes. What makes turnips desirable in a food plot is that they are classified as a cold-weather planting. The leaves of the turnip are also prized by deer from mid-September until January, adding to their value for early-fall bowhunters. The leaf tops have between 15 to 25 percent crude protein content. Even the plants' roots contain 10 to 15 percent protein. An acre of turnips can provide a crop anywhere from one to five tons per acre of dry matter, which includes the turnip bulb as well.

It may take one season for deer to "discover" what turnips are. But once they do, deer will become addicted and will seek them out feverishly as temperatures head south.

Turnips are an excellent choice as a food-plot planting for the colder regions of the Northeast, Midwest and other cold-weather areas of the country. They are also drought tolerant, which means they can be planted throughout the country and in Canada. Additionally, turnips can be planted late—in northern latitudes, they can be planted in July or early August; in southern regions, they can be planted in August or September—making them a terrific fall and winter crop. I find that planting them no later than the July 4th weekend gives them a longer growing period and helps them to fully mature 90 days before bow season in October.

Turnips like a slightly acidic soil pH between 5.9 and 6.5. I have had the most success when I plant them in medium loamy soil or heavy loamy soil. They will not do well, however, in wet ground or heavy clay soils.

Forage turnip seeds are tiny. There are a lot of different forage varieties to choose from. I like

Once deer find a field planted with turnips, it won't be long until you find half-eaten turnips like this everywhere!

Purple Top and Royal Crown because they produce the largest turnip bulbs of all the varieties. Turnips are best seeded by using a quality drop seeder with strong wheels, a Pro Broadcast Spreader with a rain cover (it helps to keep the seed from bouncing out over rough ground), or a quality hand-operated Harvest Broadcast Spreader—all of which can be found at Tractor Supply stores.

Because of the tiny size of the seed, the plot should be tilled until the soil becomes a fine, firm seedbed. After tilling the plot, use a half-gallon glyphosate (per acre) to kill any emerging weeds. Wait at least five to seven days and then plant three to four pounds of turnip seed per acre. Turnips can be top-sown very successfully—especially just prior to an expected rainfall. If they are top-sown, make sure they make good soil-to-seed contact. If they are planted by drilling, don't cover them with soil any deeper than one-quarter inch.

As soon as they are planted, I like to fertilize them. For best results, use 400 lbs. of T-19 (Triple 19-19-19) per acre (300 pounds will work, too, if your budget is tight). About six weeks later, the plot should be top-dressed with about 100 to 200 pounds of ammonium sulfate (34-0-0) per acre. This will help increase the production of the plant and bulb. (Again, use the process explained in the forage rape section to determine how much is needed for any plot less than an acre.)

As I mentioned earlier, always get a soil test prior to planting any plot. If lime is needed to raise the pH, do so as early as possible before planting. Lime takes time to do its work. I also test to see which minerals are lacking in my soil. For instance, I discovered that my turnip plot was in need of boron and sulfur, and I had to add trace amounts of them to help my turnips. That is why I always recommend not skipping a soil test before planting.

When the plant gets to be about 10 inches high, deer will start eating it. It will take 90 to 120 days for turnips to fully mature. Unfortunately, if the deer graze on the turnip plants before then, they can hurt the production of both the tops and bulbs. That is why I like to plant an extremely winter-hardy clover (like Kura) near all my winter-hardy plants (sugar beets, turnips, kale, rape, canola, etc.). The succulent clover helps to distract and deflect the deer from eating my precious brassicas. I want them to be in prime condition from November to January, when I'm hunting deer!

You will find that turnips make a terrific crop and they will be an integral part of your winter-hardy planting program. Once the deer discover what they are, they won't leave them alone! But remember that all brassicas should not be planted in the same plot more than two consecutive years. It would be even better to rotate them yearly.

Canola

Canola is a leafy *brassica*, and deer will eat it through the summer and from November to January. I have included canola in my food plots every year since I first planted it. I wouldn't go a season with out it!

Canola requires at least a one-acre plot; it can not be planted in small plots or the deer will eat it long before it has a chance to get started. It is a fast-growing brassica that is actually a quality form of rape seed, and it has a high yield when planted as directed. Canola's leaves have a crude protein level that ranges from 20 to 30 percent—hard to beat when it comes to protein levels. The TDN (total digestible nutrients) can range from 50 to 75 percent dry matter, and the dry matter can be from 10 to 18 percent. Interestingly, when canola seeds are crushed, they contain up to 40 percent vegetable oil.

It is a cold-hardy fall plant that deer find especially attractive from October through January. I have found that deer will feed on both the stems and leaves as soon as the crop is ready to graze, which is about 60 to 90 days after planting.

In the North, canola can be planted in August or in early spring (April or May). In the South, it should be planted in September. Like most *brassicas*, it should not be planted in the same plot more than two consecutive years to prevent disease problems.

As with all *brassicas*, canola is cold tolerant, and this particular plant is also tolerant of drought and heat. It needs a plot that has good drainage, with a pH level between 5.5 and 7.5. It will do best, however, in soil with a pH of 6.0 to 7.5.

Prepare your canola plot by using a combination of herbicides to kill any emerged broadleaf weeds and grasses prior to planting. Wait two weeks and then till the soil as fine as possible. To prevent stimulating new weed growth, don't till the soil any deeper than three or four inches.

Like most *brassicas*, the canola seeds are tiny, and you'll have excellent success top-sowing them. Plant canola in a firm, well-tilled seed bed, then broadcast about eight pounds of seed to the acre. I find using a quality hand-pushed drop seeder with strong wheels, or a Pro broadcast spreader with a rain cover (it helps to keep the seed from bouncing out over rough ground), or even a quality hand-operated Harvest Broadcast Spreader works best to plant tiny seeds. The seed must have good soil-to-seed contact. If possible, use a compactor to make sure it does. You can also ride over it gently with an ATV, which will press the seed firmly into the soil. By planting the seed just prior to a forecasted rainfall, you will greatly enhance germination.

For canola to have the best production, you will need to provide 200 to 300 lbs. of 19-19-19 per acre and 200 lbs. per acre of ammonium sulfate or 200 lbs. Per acre of 46-0-0 (urea). When a plot of canola is fertilized properly, it will provide about two tons of forage per acre!

A field of canola that we planted in early May.

I have found that planting canola early is crucial to the plot's success. If rain is predicted, I plant it in early July or sometime soon thereafter. Canola needs 60 to 90 days to fully mature, so I never plant it any later than the first week in August because it will not mature if hit by frost before the 90-day period is up. By planting it in July, the canola should be up and running when the October bow season rolls around.

While I like to plant most of my plots as "pure plots," meaning only one type of seed, I have had success planting canola with other *brassicas* such as kale and rape. I always try to plant cold-weather clovers near my brassica plots to help divert the deer from over browsing them before November. This plan has saved several of my kale, rape, canola, turnip and sugar beet plots from being over eaten by deer. They prefer the sweet, tender Kura clover and birdsfoot trefoil from May to September—especially when those crops have been maintained well with fertilizer and cuttings.

You will be pleasantly shocked to see how often deer eat canola from November through January. A canola plot will help bring and hold deer on your property during the time you want them there—deer season! Give canola a try. You won't regret it.

One last word: Canola seed is hard to locate, but I found a reliable firm called Elk Mound Seed Company that carries it. Look for them on the Internet and check out their offerings.

Be sure to make the appropriate adjustments in the spreader for the size of the seed you are planting.

Kura Clover

Kura is a spreading, perennial clover that is one of the honeybees' most sought-after plants. It is winter hardy and will stand up to extreme cold-weather conditions. It can also tolerate severe, heavy grazing, making it an ideal nurse crop when you're planting small food plots.

Kura has an extensive root system and is more tolerant of drought than most other clovers which makes it perfect to plant in more arid locations. It has an upright stem that blooms with a large, whitish-pink flower in the spring. Its leaves, which are larger than other clovers and more pointed, have distinctive white, V-shaped markings.

As an extremely high-yielding, winter-hardy clover, Kura will not only survive, it will thrive. It withstands severe northern winters that are common on my farm in Otsego, NY, when other legumes don't. It will even outlast the other so-called cold-hardy clovers. The only down side to Kura clover is that it establishes slowly. Once it gets going, however, stands can last for many years.

Kura can tolerate a pH range from 6.0 to 7.5, but it prefers a higher pH level rather than a lower one. Like other clovers and legumes, Kura must be inoculated with the correct Rhizobium strain—Trifolium Spec 3—before planting in a firm seed bed.

When planting Kura, make sure to get good seed-to-soil contact. It should be planted no deeper than one-quarter to one-half inch deep. If you plant Kura by itself, plant eight to 12 lbs. per acre. (Once again, see the section on forage rape to determine how much seed and fertilizer are required if you're planting a small plot.)

Kura can be planted in April or May, or it can be planted in late July or early August. It is much

Kura clover is an easy-to-grow plant that deer, turkey, and other widlife forage on.

like alfalfa with regard to growth, production, and quality, but it is a lot easier to grow and manage, and once it gets established, it is sturdier than alfalfa.

Kura is my first choice when it comes to planting a pure stand of clover as well as when I'm planting other seeds that need a nurse crop to distract deer. It can also be mixed with birdsfoot trefoil, which is another extremely winter-hardy legume that is able to withstand severe winter temperatures. When planted by themselves or together, Kura and birdsfoot trefoil provide not only quality tonnage but also high levels of protein for your deer herd. They are top choices if you want to attract and hold deer from November through January.

To Sum It Up . . .

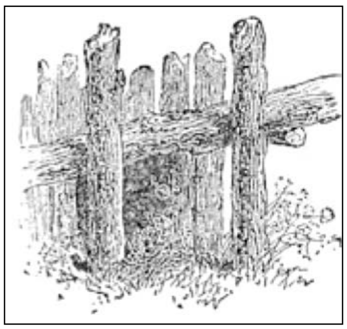
These are the plantings that will keep deer on your land during the important hunting months of October through December. Add something different from what is “typically” planted—and you will increase your hunting success!

Traps and Trapping

Traps for Large Game

Editor's Note: This chapter was excerpted from an old-time book about trapping. While these traps can help you stay alive in a survival situation, be aware that many of these are not legal anymore. Be sure to check the trapping regulations of your state before using any of them.

BY W. HAMILTON GIBSON

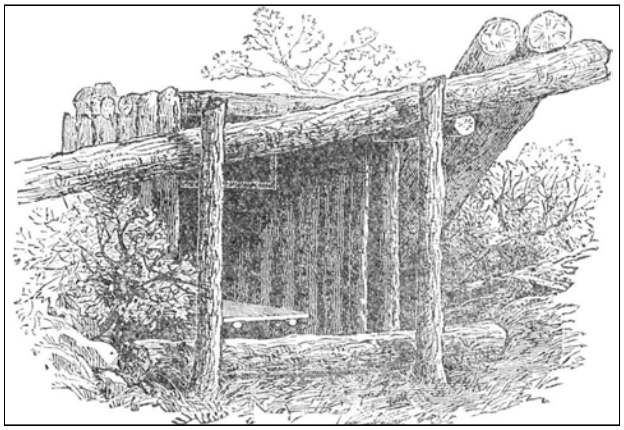


However free our forests may be from the lurking dangers of a tropical jungle, they nevertheless shelter a few large and formidable beasts which are legitimate and deserving subjects of the Trapper's Art. Chief among them are the puma, or cougar, bear, lynx, wolf and wolverine.

Although commonly taken in steel traps, as described respectively in a later portion of this work, these animals are nevertheless often captured by dead-falls and other devices, which are well known to the professional Trapper, and which serve excellently in cases of emergency, or in the scarcity of steel traps.

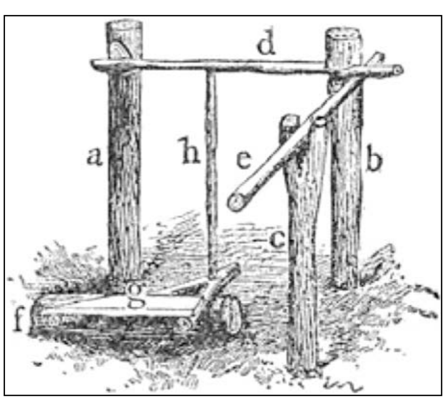
The Dead-Fall

There are several varieties of this trap, some of which are described in other parts of this volume. In general construction they all bear a similarity, the methods of setting being slightly changed to suit the various game desired for capture. For large animals, and particularly the bear, the trap is sprung by the pressure of the animal's foot, while reaching for the bait. Select some favorite haunt of the bear, and proceed to construct a pen of large stakes. These should consist of young trees, or straight branches, about three inches in diameter, and should be of such a length as to reach a height of four or five feet when set in the ground, this being the required height of the pen. Its width should be about two and a half or three feet; its depth, four feet; and the top should he roofed over with cross pieces of timber, to prevent the bait from being taken from above. A straight log, about eight inches in diameter, and six feet in length should now be rolled against the opening of the pen, and hemmed in by two upright posts, one on each side, directly on a line with the sides of the enclosure. Another log, or tree trunk, of the same diameter, and about fifteen or twenty feet in length, should next be procured. Having this in readiness, we will now proceed to the construction of the other pieces. In order to understand the arrangement of these, we present a separate drawing of the parts as they appear when the trap is set: An upright post (a) is supplied at the upper end with a notch, having its flat face on the lower side. This post should be driven into the ground in the left-hand back corner of the pen, and should be three feet or more in height. Another post (*b*) of similar dimensions, is provided with a notch at its upper end, the notch being reversed, *i. e.,* having its flat side *uppermost.* This post should be set in the ground, *outside* of the pen, on the right hand side and on a line with the first. A third post *(c)* is provided with a crotch on its upper end. This should be planted outside of the pen on the right hand side, and on a line with the front. The treadle



piece consists of a forked branch, about three feet in length, supplied with a square board secured across its ends. At the junction of the forks, an augur hole is bored, into which a stiff stick about three feet in length is inserted. This is shown at *(h)*. Two poles, *(d)* and *(e),* should next be procured, each about four feet in length. These complete the number of pieces, and the trap may then be set. Pass the pole *(d)* between the stakes of the pen, laying one end in the notch in the post *(a),* and holding the other beneath the notch in the upright *(b)*. The second pole (*c*) should then be adjusted, one end being placed in the crotch post (*c*), and the other caught beneath the projecting end of the pole *(d),* as is fully illustrated in the engraving. The dead-log should then be rested on the front extremity of the pole last adjusted, thus effecting an equilibrium.

The treadle-piece should now be placed in position over a short stick of wood *(f),* with its platform raised in front, and the upright stick at the back secured beneath the edge of the latch pole *(d)*.



The best bait consists of honey, for which bears have a remarkable fondness. It may be placed on the ground at the back part of the enclosure, or smeared on a piece of meat hung at the end of the pen. The dead-log should now be weighted by resting heavy timbers against its elevated end, as seen in the main drawing, after which the machine is ready for its deadly work.

A bear will never hesitate to risk his life where a feast of honey is in view, and the odd arrangement of timbers has no fears for him after that tempting bait has once been discovered. Passing beneath the suspended log, his heavy paw encounters the broad board on the treadle-piece, which immediately sinks with his weight. The upright pole at the back of the treadle is thus raised, forcing the latch-piece from the notch: this in turn sets free the side pole, and the heavy log is released, falling with a crushing weight over the back of hapless bruin.

There are many other methods of setting the Dead-fall, several of which appear in another section of this book. The above is the one more commonly used for the capture of bears, but the others are equally applicable and effective when enlarged to the proper size.

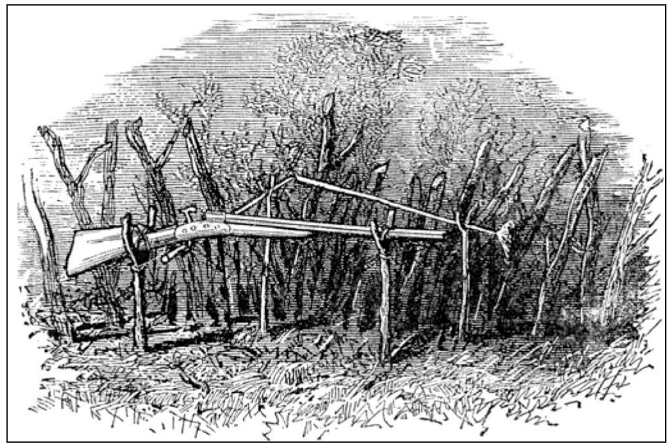
In South America and other countries, where lions, tigers, leopards, and jaguars abound, these and other rude extempore traps almost the only ones used, and are always very successful. The pit-fall often allures the Bengal tiger to his destruction, and the leopard often terminates his career at the muzzle of a rifle baited as seen in our page illustration. A thus arranged forms a most sure and deadly trap, and one which may be easily extemporized at a few moments' warning, in case of emergency. The puma of our northern forests, although by no means so terrible a foe as the leopard, is still a blood thirsty creature, and while he shuns the gaze of man with the utmost fear, he is nevertheless constantly on the alert to spread upon him unawares, either in an unguarded moment or during sleep. A hungry puma, who excites suspicion by his stealthy prowling and ominous growl, may easily be led to his destruction at the muzzle of a gun, baited as we shall now describe (where legal—check your state's regulations).

The Gun Trap

After a puma has succeeded in capturing his prey, and has satisfied his appetite by devouring a portion of its carcass, he leaves the remainder for a second meal, and his early return a second banquet is almost a matter of certainty. Where such a remnant of a bygone feast is found, the capture of the cougar is an easy matter. Any carcass left in a neighborhood where pumas are known to exist is sure to attract them, and day after day its bulk will be found to decrease until the bones only remain. By thus "baiting" a certain place and drawing the pumas thither, the way is paved for their most certain destruction. The gun-trap is very simply constructed, and may be put in working order in a very few moments. The weapon may be a rifle or shot-gun. In the latter case it should be heavily loaded with buck-shot. The stock should be first firmly tied to some tree, or secured in a stout crotch driven into the ground, the barrel being similarly supported.

The gun should be about three feet from the ground, and should be aimed at some near tree to avoid possible accident to a chance passer-by within its range. The gun should then be cocked, *but not capped,* due caution being always used, and the cap adjusted the very last thing after the trap is baited and set. Where a rifle is used, the cartridge should not be inserted until the last thing.

It is next necessary to cut a small sapling about a foot or two in length. Its diameter should allow it to fit snugly inside the guard in front of the trigger, without springing the hammer. Its other end should now be supported by a very slight crotch, as shown in our illustration. Another sapling should next be procured, its length being sufficient to reach from the muzzle of the gun to the end of the first stick,



and having a branch stub or hook on one end. The other extremity should be attached by a string to the tip of the first stick.

Now take a portion of the carcass and draw it firmly over the hook in the long stick. Prop the latter in such a position as that the bait shall hang directly in front of the muzzle. The crotch supporting the bait stick should be firmly implated in the ground in order to hold the bait from being drawn to either side of the muzzle.

The gun-trap is now set, and its merits may be tested. Before adjusting the cap the pieces should be tried several times to insure their perfect working. A slight pull on the bait from the front will draw the short stick forward. This immediately acts on the trigger and causes the hammer to snap. By a few trials, the sticks can be arranged so as to spring the trigger easily, and where a hair trigger is used, a mere touch on the bait will suffice to discharge the gun. When all is found to work perfectly, the trap should be surrounded by a rude pen of sticks and branches, extending two or three feet beyond the muzzle, in order to insure an approach directly in the aim of the gun. The cap should now be placed on the nipple, after which the deadly device may be left to do its certain work. The remaining portion of the carcass should be removed, and where the locality is likely to be frequented by other hunters or trappers, it is well to put up a "danger " signal to guard against accident. If desired two or three guns may be arranged like the spokes of a wheel, all aiming near the bait. Even with one gun tine victim stands but little chance, but where two or three pour their contents into his body, his death is an absolute certainty.

By fastening the gun three feet above ground the load is discharged upward into the mouth of its victim, and thus directly through the brain. Where two or more guns are used, it is advisable to aim at least one in such a direction as will send its charge into the *breast* of the animal.

The Indian panther is very commonly taken by the gun trap, and even lions are sometimes secured by the same device, only increased in power by a larger number of guns.

There are several other methods of setting the gun trap. One way consists in attaching a string to the finger piece of the trigger, passing it back through a small staple or screw eye inserted in the under side of the stock for that purpose, and then drawing the string forward and attaching it to the top of the bait stick. This latter is stuck in the ground directly in front of the muzzle and the bait secured to its extremity. When the tempting morsel is grasped, the bait stick is drawn forward and the string pulled, the result of course being the discharge of the gun. By still another method, an elastic is passed through the screw eye in the stock and over the finger piece of the trigger, thus tending continually to draw it back and spring the hammer. To set the gun a short stick is inserted behind the finger piece, thus overcoming the power of the elastic. It should be very delicately adjusted, so that a mere touch will dislodge it. Its length should be about six inches, and to its other end the bait stick should be attached and arranged as first described. Although a rather dangerous trap to be set at random it is nevertheless often utilized and has brought many a dreaded marauder to his doom.

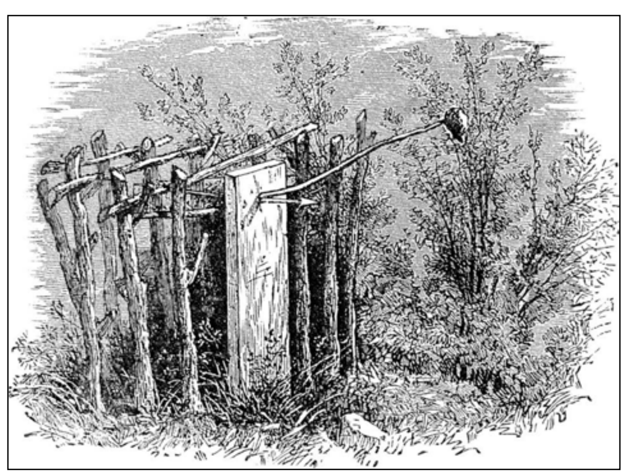
The bear, lynx, and other large animals are sometimes taken by the gun trap, but it is most generally set for the puma.

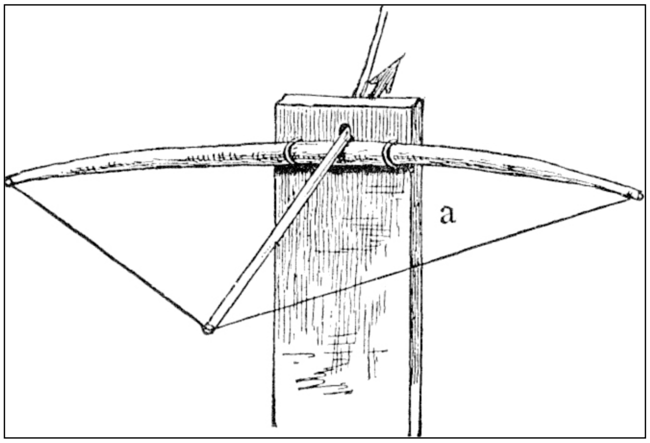
The Bow Trap

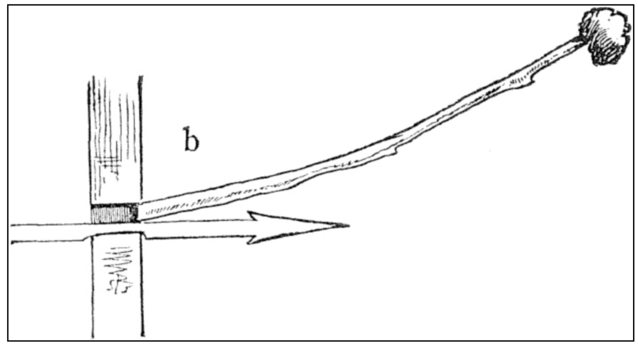
This device does duty in India and Southern Asia, where it is known as the *tiger trap*.

It is easily constructed as follows : First cut a stout board five inches in width, two and a half feet in length and about two inches in thickness. Shave off one end to a point so that it may be driven into the ground. At the other extremity, in the middle of the board and about two inches from the edge, a hole one half an inch in diameter and three quarters of an inch in height, should be made; two auger holes, one directly above the other with the sides flatly trimmed, will answer perfectly. The arrow should next be constructed. This should be made of seasoned oak or ash, two feet in length, perfectly straight, smooth and round, and one third of an inch in diameter. One end should be notched for the bow string and vaned with thin feathers after the manner of ordinary arrows. The other extremity should be armed with a steel barb sharply pointed, and firmly riveted in place. Any blacksmith can forge such a tip; the shape of which is plainly seen in our engraving. The bow should consist of a piece of stout seasoned hickory, oak or ash four feet long, if such a bow is not at hand, a stout sapling may be used. The bow string may consist of cat-gut, or stout Indian twine.

Before setting the trap, it is advisable to attract the game to the spot selected as already alluded to



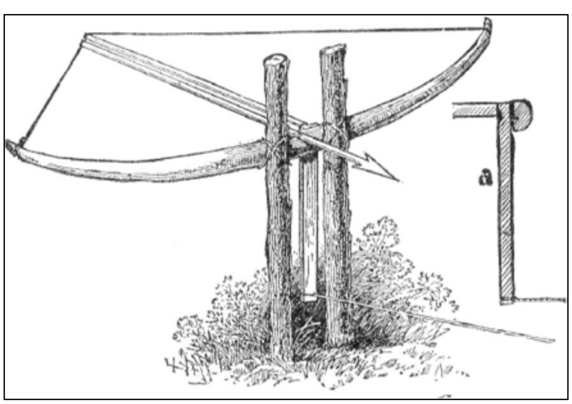




in connection with the gun trap, and particularly so when the puma is the victim sought. In our illustration we see the trap as it appears when set, and the same precaution of aiming at some tree should be exercised as advised with the gun trap. The bow should first be secured in place directly beneath and one eighth of an inch from the edge of the hole in the board, as seen at *(a)*. Two large wire staples may be used for this purpose, being passed over the bow through holes in the board and clinched on the opposite side. The bend of the bow and length of string should now be determined, one end of the latter being attached to the tip of the bow and the other end supplied with a loop. The board should then be driven into the ground lo the depth of about eight inches. We will next take up the arrow. Pass the barb through the hole in the board and adjust the notch over the bow-string, draw the arrow back and release the string. If the arrow slide easily and swiftly, through the board, keeping true to its aim, the contrivance is in perfect working order and is ready to be set. This is accomplished by the very simple and ingenious mechanical arrangement, shown at (*b*). On the under side of the arrow just behind the barb, a fiat notch one eighth of an inch in depth and two and a half inches in length is cut, with rounded ends, as seen in the illustration. The bait stick should consist of a sapling about three feet in length, the large end being trimmed so as to fit in the hole over the arrow while the notch in the latter rests in the bottom of the aperture as seen in the illustration *(b)*. The trap may then be set. Draw back the arrow, until the notch rests in the hole in the board. Insert the bait stick *very lightly* about the arrow as shown at (*b*), propping it in place at the angle seen in the main drawing. The bait for a puma should consist of a portion of some carcass, or if for other animals, any of the baits given in our section on "trapping" may be used. In order to secure the bait firmly to the bait stick, a small hole and a peg at the side of the baited end will effectually prevent its removal and the trap will thus most surely be sprung. The prop which sustains the bait stick need be only a small crotch inserted a little to one side of the trap. The bow should now be surrounded by a wide pen, allowing room for the spring of the ends. The top of the enclosure should also be guarded by a few sticks or branches laid across. Directly in front of the trap and extending from it, a double row of rough stakes three feet high should be constructed, thus insuring an approach in the direct range of the arrow. Without this precaution the bait might be approached from the side, and the arrow pass beneath the head of the animal, whereas on the other hand it is sure to take effect in the neck or breast of its victim. Of course the success of this trap depends entirely upon the strength of the bow. When a large and powerful one is used its effect is almost surely fatal.

Another form of the bow trap, much used in the capture of the tiger, forms the subject of our next illustration; no bait is here used. The trap is set at the side of the beaten path of the tiger and is sprung by the animal pressing against a string in passing. The bow is large and powerful and is secured to two upright posts about eight inches apart. The string is drawn back and a blunt stick is then inserted between the bow string and the inside centre of the bow, thus holding the latter in a bent position. A stout stick, with a flattened end is next inserted between the end of the blunt stick and the inside of the bow, the remaining part of the stick extending downwards, as our illustration shows. To the lower end of this stick a string is attached and carried across the path in the direct range of the arrow, being secured to a stake on the opposite side. The arrow is generally barbed with a steel or flint point, and wound with thread saturated with a deadly poison. This is now rested on the top of the bow between the upright parts, and its notch caught in the bow-string. Everything is then in readiness. The tiger soon steals along his beaten track. He comes nearer and nearer the trap until at last his breast presses the string. Twang, goes the bow and the arrow is imbedded in the flesh of its victim. He writhes for a few moments, until he is released from his torments by the certain death which follows the course of the poison through his veins.

The use of the poison is very dangerous: a mere scatch through the skin is likely to prove fatal, and the trapper is thus likely to prove his own victim. Poisoned arrows are little used by trappers; and the bow trap, when properly constructed, is sufficiently effective without the venom.

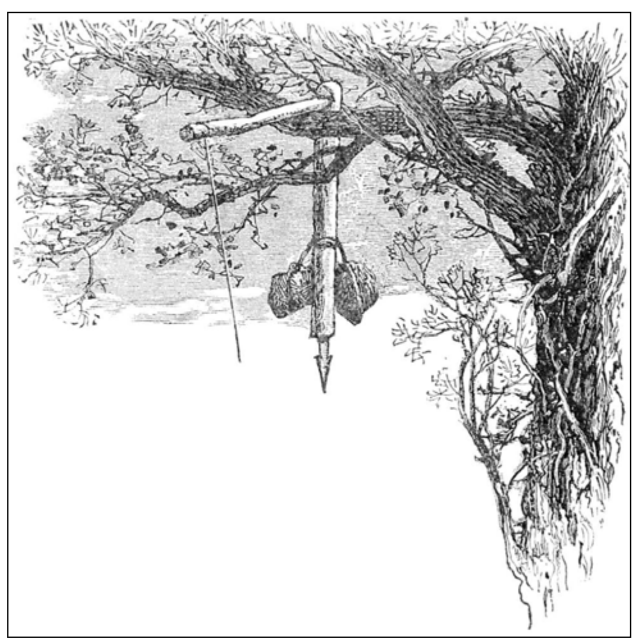


The Down-Fall

This is the famous harpoon trap, so commonly used in Africa for the capture of the hippopotamus. There is no reason why it may not be successfully employed in our own country for taking large game, or modified on a reduced scale for smaller animals.

The hippopotamus makes his daily rounds in regular beaten pathways; and the trapper, knowing this peculiarity, turns it to advantage. This is a common habit with many animals; and these "runways" are easily detected by the matted leaves and grass and the broken twigs. Over such a beaten track the harpoon-trap is suspended.

The harpoon used by the native African trappers somewhat resembles a double-barbed arrowhead, and has a reflexed prong on the shaft just behind the barbs,—a sort of combination between a spear and a fish-hook, ft is a terrible weapon; and, when once launched into the flesh of its victim, its withdrawal is impossible, on account of the reflexed barb. Any sharp steel shaft will answer the purpose of the harpoon; it should be eight or ten inches in length, and filed to a keen point. We will now construct the trap. The first requisite is a straight section of the branch of some tree. This should be about four inches



in diameter, and four feet in length. Into one end of this beam the harpoon should be firmly imbedded, allowing the point to project about six inches. This beam should then be weighted with two large stones, attached firmly by a rope, about eighteen inches above the harpoon. At about six inches from the other end of the log a notch should be cut, having its flat side uppermost, as shown plainly in our illustration. The implement is now ready.

Select some favorably situated tree, whose branches extend over the pathway chosen for the trap. By the aid of a rope secured to the log, and thrown over the limb, the weighted beam may be drawn up into the tree. While thus held by a person below, the trapper should climb the tree to complete operations. For this purpose, a smaller branch about three feet in length should be cut. One end should be flattened off on both sides, so as to fit in the notch in the beam; and the part which rests on the limb, as seen in the illustration, should also be flattened to prevent turning. A piece of stout Indian twine should next be fastened to the unwhittled end of the stick, which may then be adjusted in the notch of the harpoon beam, as seen in the engraving. The string may then be thrown down, and grasped by the companion below, who holds it firmly, after which the original rope may be removed. It will be noticed that the weight of the harpoon and accompaniments rests on the short arm of the lever which passes over the limb of the tree, and the tension on the string from the long arm is thus very slight. This precaution is necessary for the perfect working of the trap. To complete the contrivance, a small peg with a rounded notch should be cut, and driven into the ground directly plumb beneath the long end of the lever. It should be inserted into the earth only sufficiently to hold the string without pulling out, and the *side* of the notch should face the path; its height should be about a foot. Into the notch the string should be passed, being afterwards drawn across the path and secured on the opposite side at the same height. The trap is now set; and woe to the unlucky quadruped that dares make too free with that string! A very slight pressure from either side is equally liable to slip the string from the notch, or loosen the peg from the ground; and the result is the same in either case,—down comes the weighted harpoon, carrying death and destruction to its victim.

For large animals, this mode of setting will be found to work perfectly. When constructed on a smaller scale, it may be slightly modified. It will be noticed that, when the string is approached from one side, it is merely slipped out of the notch,—a slight pressure being sufficient to dislodge it,—while the pressure from the opposite direction must be strong-enough to lift the peg out of the ground bodily. This is easily done when the peg is lightly inserted; but, to insure success, even with *light* pressure from either side, an additional precaution may be used, if desired. Instead of fastening the end of the string securely to some object on the further side of the path, it is well to provide the end of the cord with a ring or loop, which should be passed over a nail or short peg driven in some tree or branch, or fastened into an upright stake, firmly embedded into the ground. The nail should point in the opposite direction from the notch in the peg, and its angle should incline slightly toward the path. It will thus be seen that an approach from one side forces the string from the notch in the peg, while an opposite pressure slides the ring from the nail.

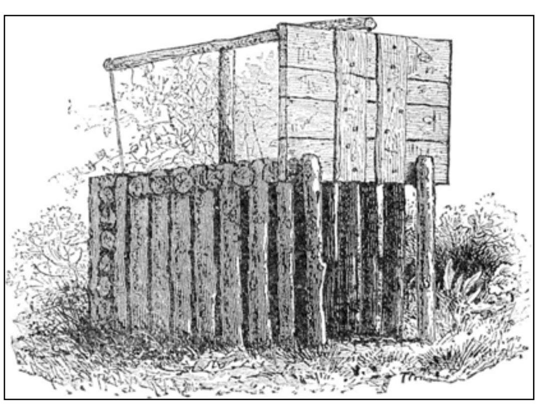
This mode of setting is especially desirable for small animals, on account of its being more sensitive.

Such a trap may be successfully used for the Puma, Bear, and the Lynx. When constructed for smaller animals, the harpoon may be dispensed with, a large stone being equally effective in its death-dealing qualities.

The Bear Trap

This trap is constructed after the idea of the old-fashioned box or rabbit trap, and has been the means of securing many a hungry bear, or even puma, whose voracity has exceeded its canning. The lynx and wild-cat are also among its occasional victims; and inasmuch as its prisoners are taken alive great sport is often realized before the captive is Draught under control.

Our illustration gives a very clear idea of the affair. The sides are built of stout young tree-trunks, cut into sections and firmly driven into the ground close together. For a large animal—a bear, for instance—the enclosure should be about seven feet deep, two and a half feet wide, and four feet high. The top should be built in with the sides, after the manner of the log cabin previously described. The two posts at the entrance should be first set up. On the back side of each, near the end, a deep notch should be cut for the reception of the cross piece at the top. This should likewise be notched in a similar manner on both sides of each end, so as to fit singly into the notches in the uprights on the one side, and into the second pair of uprights on the other. These latter should next be inserted firmly into the ground, having been previously notched on both sides of their upper ends, as described for the cross piece. They may either be fixed in place and the cross piece sprung in between them at the top, or the latter may be held in the notches of the first pair, while the second are being inserted. Continue thus until the full length of the sides are reached, when the end may be closed by an upright wall of plain logs, either hammered into the ground, after the manner of the sides, or arranged one above another in notches between the two end uprights. The sliding door is next required. This should be large enough to cover the opening, and should be made of stout board slabs, firmly secured by cross pieces. It should be made to slide smoothly into grooves cut into perpendicular logs situated on each side of the opening, or may be arranged to slip easily between the flattened side of one log on each side and the front of the pen. Either way works well. In the latter an additional upright or short board should be inserted in the ground at the edges of the sliding door, to prevent the latter from being forced to either side by the efforts of the enclosed captive.



There are two or three ways of setting the trap, depending upon the desired game. For a bear it is arranged as in our illustration. An upright post, two feet in length, should be cut to an edge at one end, and wedged in between the logs at the top of the trap, near the middle. Across the top of this, a pole seven feet in length, should be rested; one end being attached by a loop, or secured in a notch in the sliding door, and the other supplied with a strong string about four feet in length, with a stick eight inches in length secured to its end. Through the centre log, in the back of the pen, and about two feet from the ground, an auger hole should be made. The bait stick with bait attached should be inserted through this hole from the inside, and the spindle caught on the outside beween its projecting end and a nail driven in the adjoining upright. This principle is clearly illustrated left at (*a*), and, if desired, the method (*b*) may be used also. For a bear, the bait should consist of a piece of meat scented with burnt honey-comb. The odor of honey will tempt a bear into almost any trap, and even into such close quarters as the above he will enter without the slightest suspicion, when a feast of honey is in view.

For the cougar, or puma, the best bait is a live lamb or a young pig, encaged in a small pen erected at the end of the trap. A fowl is also excellent. When thus bailed, the setting of the trap is varied. The upright post at the top of the trap is inserted nearer the front, and the cross pole is stouter. The auger hole is bored in the top of the trap, through the center of one of the logs, and about twenty inches from the back end of the trap. The spindle is dispensed with and the end of the string is provided with a large knot, which is lowered through the auger hole, and is prevented from slipping back by the insertion of a stick beneath. This stick should be about three feet in length, and of such a size at the end as will snugly fit into the auger hole. It should be inserted delicately, merely enough to hold the knot from slipping back, and so as to be easily released by a slight movement in any direction,

This mode of setting is more fully detailed on. As the puma steals in upon his prey he dislodges the stick, the lid falls, and he finds himself imprisoned with his intended victim. This trap is much used in India and Asia for the capture of the tiger, and the jaguar of South America is frequently entrapped by the same devices.

The Pit-Fall

The tiger is the scourge of India and Southern Asia, and some sections of these countries are so terribly infested with the brutes that the inhabitants are kept in a continual state of terror by their depredations. Many methods are adopted by the natives for the destruction of the terrible creatures, some of which have already been described. The pit-fall is still another device by which this lurking marauder is often captured and destroyed. It sometimes consists of a mere pit covered and baited in the haunts of the tiger, or is constructed in a continuous deep ditch surrounding the habitations of the natives, and thus acting as a secure protection. The pit is about twelve feet deep and ten feet in width, and its outside edge is lined with a hedge five or six feet in height. As the fierce brute steals upon his intended prey, he nears the hedge and at one spring its highest branch is cleared. He reaches the earth only to find himself at the bottom of a deep pit, from which there is no hope of escape, and where he speedily becomes the merciless victim of a shower of deadly arrows and bullets.

Happily we have no tigers in the United States, but the puma and the lynx are both fit subjects for the pit-fall. These animals cannot be said to exist in such numbers as to become a scourge and a stranger to the inhabitants of any neighborhood, and for this reason the “Moat” arrangement of the pit-fall is not required. The simple pit is otten used, and when properly constructed and baited is a very sure trap. The hole should be about twelve feet in depth and eight feet across, widening at the bottom. Its opening should be covered with sticks, earth and leaves, so arranged as to resemble the surroundings as much as possible, but so lightly adjusted as that they will easily give way at a slight pressure. One edge of the opening should now be closely built up with stakes firmly inserted into the ground, and so constructed as to form a small pen in the middle, in which to secure the bait, generally a live turkey, goose, or other fowl. The other three sides should also be hedged in by a single row of upright stakes three or four feet in height, and a few inches apart in order that the hungry puma may whet his appetite by glimpses between them.

They should be firmly imbedded in the earth directly at the edge of the pit, and as far as possible trimmed of their branches on the inside. There will thus be a small patch of solid ground for the feet of the fowl, which should be tied by the leg in the enclosure. Our trap is now set, and if there is a puma in the neighborhood he will be sure to pay it a call and probably a visit.

Spying his game, he uses every effort to reach it through the crevices between the stakes. The cries of the frightened fowl arouse and stimulate his appetite, and at last exasperated by his futile efforts to seize his victim, he springs over the fence of stakes and is lodged in the depths of the pit.

The puma is very agile of movement, and unless the pit is at least twelve feet in depth there is danger of his springing out. Any projecting branch on the inside of the stakes affords a grasp for his ready paw, and any such branch, if within the reach of his leap, is sure to effect his escape. For this reason it is advisable to trim smoothly all the projections and leave no stub or knot hole by which he could gain the slightest hold. The construction of a pit-fall is a rather difficult operation on account of the digging which it necessitates. On this account it is not so much used as many other traps which are not only equally effective but much more easily constructed. The following is an example.

The Log Coop Trap

This is commonly set for bears, although a deer or a puma becomes its frequent tenant. As its name implies it consists of a coop of logs, arranged after the principle of the Coop Trap described on. The logs should be about eight feet in length, notched at the ends as described for the Log Cabin. Lay two of the logs parallel about seven feet apart. Across their ends in the notches, lay two others and continue building up in “cob-house” fashion until the height of about six feet is reached. The corners may be secured as they are laid by spikes, or they may be united afterward in mass by a rope firmly twisted about them from top to bottom. Logs should now be laid across the top of the coop and firmly secured by the spikes or rope knots. There are several ways of setting the trap. A modification of that described on page 67 works very well, or an arrangement of spindle and bait stick, as in the Box Trap, may also be employed. In the latter case, the bait stick is either inserted between the logs at the back of the coop, or a hole is bored through one of them for this purpose. For this mode of setting, the coop should be constructed beneath some tree. It is set by means of a rope attached to the upper edge of one of its sides, the rope being thrown over a limb of the tree and the loose end brought down and secured to the bait stick by a spindle, as described for the trap on. The limb here acts in place of the tall end piece of the Box Trap, and by raising the coop up to such an angle as that it will be nearly poised, the setting may be made so delicate that a mere touch on the bait stick from the interior will dislodge the pieces and let fall the enclosure. The *simplest* mode of setting the trap is that embodied in the “snare” method on. The rope is here provided with a knot, which must pass easily between the logs, or through the hole at the back of the coop, the length of rope being so arranged as that the coop shall be sufficiently raised where the knot projects into the interior. The introduction of the bait stick beneath the knot will thus prevent the latter from being drawn back, and thus our trap is set, The bait stick in any case should be about two feet in length; and with this leverage but a slight touch will be required to spring the pieces. In the latter method the limb of the tree is not necessary. A stout crotched stake driven into the ground about twenty feet, at the back of the coop, will answer every purpose, and the coop may be constructed wherever desired. This is a most excellent trap for large animals. It secures the game alive, and is thus often productive of most exciting sport. For the bear, the bait should consist of honey or raw meat. Full directions for baiting all kinds of American game are given under their respective heads in another part of this book. The Coop Trap may be constructed of any dimensions, from the small example on to the size above described.

There are several other inventions commonly used for the capture of large animals in various parts of the globe, which would be of little avail in this country. Such is the African Corral, or Hope, by which whole herds of quaggas, elands, and buffalo are often destroyed. The trap consists of two hedges in the form of the letter V, which are very high and thick at the angle. Instead of the hedges being joined at this point, they are made to form a lane about two hundred feet in length, at the extremity of which a giant pit is formed. Trunks of trees are laid across the margins to prevent the animals from escaping. The opening of this pit is then covered with light reeds and small green boughs. The hedges often extend miles in length and are equally as far apart at these extremities. The tribe of hunters make a circle, three or four miles around the country adjacent to the opening, and gradually dosing up are almost sure to enclose a large body of game, which, by shouts and skilfully hurled javelins, they drive into the narrowing walls of the Hopo. The affrighted animals rush headlong to the gate presented at the end of the converging hedges and here plunge pell-mell into the pit which is soon filled with a living mass. Some escape by running over others; and the natives, wild with excitement, spear the poor animals with mad delight, while others of the brutes are smothered and crushed by the weight of their dead and dying companions. It is a most cruel and inhuman device, and its effects are sometimes appalling.

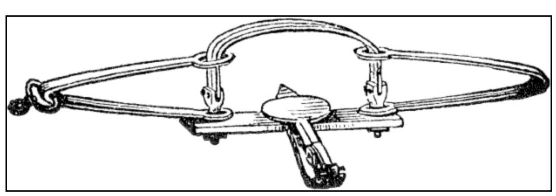
The Net Trap

The lion and tiger are often taken in a net, which is secured to a frame work and suspended over a tempting bait. When the latter is touched the net falls, and the victim becomes entangled in the meshes and is securely caught. So far as we know, this mode of capture is never tried in this country. For the puma, lynx and wild-cat we fancy it might work admirably. The net should be of stout cord, and should be secured to a heavy square frame work, tilted as in the coop trap, already described. There should be plenty of slack m the net, and the looseness should be drawn flat over the framework in folds. The contrivance maybe set by a large figure four trap, or the device described under the coop trap.

The use of bird lime, for the capture of a tiger, certainly seems odd; but it is, nevertheless, a common mode of taking the animal, in the countries where this marauder abounds. The viscid, tenacious preparation known as bird lime is described on and is familiar to most of our readers. For the capture of birds it is unfailing, when once their delicate plumage comes in contact with it. Its effect on the tiger is surprising, and many a hunter has secured his striped toe by its aid. For this purpose, the cans of the preparation are arranged on elevated boards around a bed of leaves, in which the bait is placed. A small platform is so placed that the tiger shall step upon it in reaching for the bait, which, by the aid of strings, tilts the boards and tips off the cans. The lime spills on its victim and over the bed of leaves, and the tiger, in his endeavors to free himself from the sticky substance only succeeds in spreading it, and as he rolls and tumbles on the ground he soon becomes completely smeared and covered with the dry leaves, from which it is impossible for him to extricate himself.

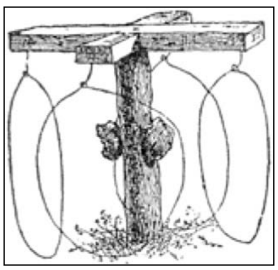
In his frantic rage he writhes upon the ground and becomes an easy prey to the hunter, who is generally on hand for the fray.

Steel traps are much used for the capture of large game, and are made in sizes especially adapted for the purpose. These are described under the proper head, in another portion of this work; and the various baits and modes of setting required for the different animals, are clearly set forth raider their respective titles of the latter.



Snares or Noose Traps

These devices, although properly coming under the head of "traps," differ from them in the sense in which they are generally understood. A *snare* naturally implies an entanglement; and for this reason the term is applied to those contrivances secure their victims by the aid of strings or nooses. Inventions of this kind are among the most useful and successful to the professional Trapper, and their varieties are numerous. The "Twitch-up" will be recognized as a familiar example by many of our country readers, who may have seen it during their rambles, cautiously set in the low underbrush, awaiting its prey, or perhaps holding aloft its misguided victim.

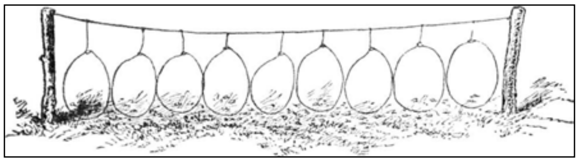


Snares are among the most interesting and ingenious of the trap kind, besides being the most sure and efficacious. They possess one advantage over all other traps; they can be made in the woods, and out of the commonest material.

Let the young trapper supply himself with a small, sharp hatchet, and a stout, keen edged jack-knife,—these being the only tools required. He should also provide himself with a coil of fine brass "sucker wire," or a quantity of horse-hair nooses (which will be described further on), a small ball of tough twine and a pocket full of bait, such as apples, corn, oats and the like, of course depending upon the game he intends to trap. With these, his requirements are complete, and he has the material for a score of capital snares, which will do him much excellent service if properly constructed. Perhaps the most common of the noose traps is the ordinary.

Quail Snare

Which forms the subject of our first illustration. This consists of a series of nooses fastened to a strong twine or wire. They may be of any number, and should either consist of fine wire, horse-hair, or fine fish-line. If of wire, common brass "sucket wire," to be found in nearly all hardware establishments and country stores, is the best. Each noose should be about four inches in diameter. To make it, a small loop should be on one end of the wire, and the other passed through it, thus making a slipping loop, which will be found to work very easily. Fifteen or twenty of these nooses should be made, after which they should be fastened either to a stout string or wire, at distances of about four inches from each other, as seen in our illustration. Each end of the long string supporting the nooses should then be fastened to a wooden peg. After selecting the around, the pegs should be driven into the earth, drawing the string tightly, as seen in our illustration. The ground around the nooses should then be sprinkled with corn, oats, and the like, and the trap is set. As a general thing, it is advisable to set it in a neighborhood where quails are known to abound; and as they run all over the ground in search of food, they are sure to come across the bait strewn for them, and equally as certain to be caught and entangled in the nooses. The writer has



known as many as six quails to be thus caught at a time, on a string of only twelve nooses. Partridges and woodcock will occasionally be found entangled in the snare, and it will oft-times happens that a rabbit will be secured by the device.

Hoop Nooses

This is a variation from the above, the noose being attached to a barred hoop and the latter being fastened to two stout posts, which are firmly driven into the ground. By their scattering the bait inside the hoop, and adjusting the loops, the contrivance is complete.

This is a very old and approved method.

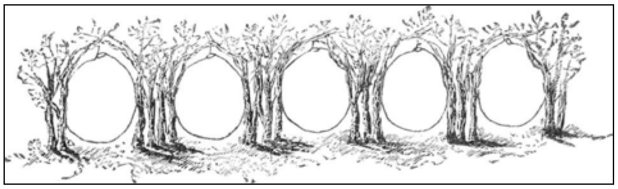
In the initial (T) at the head of this section we give also meat, according to the wish of the trapper, should then he suspended in the centre of the noose, after which the contrivance should he hung in some tree to await events. As they are so easily made and can he carried with so little trouble, it is an excellent plan to set out with a dozen or so, hanging them all in different parts of the woods; as, under circumstances of so many being set, scarcely a day will pass in which the trapper will not be rewarded by some one of the snares. The writer once knew of a case where a hawk was captured by one of these simple devices. In this case it had been set expressly, and the wire was extra strong. This trap, we believe, is quite common in parts of Germany, but, as far as we know, has not been utilized to any great extent in our country. We recommend it with great confidence.

For the capture of woodchucks, muskrats and house-rats, the wire noose may also be adapted to good purpose. Many a wood chuck has been secured by the aid of this simple invention. It is only necessary to arrange the loop in the opening of the burrow, securing the wire to a stout stick, firmly driven into the ground. If properly "set" the animal on emerging from the burrow, will become entangled, and by his efforts to disengage himself will only tighten the loop and thus render escape impossible. For rats, the noose should be attached to a nail, and the wire similarly arranged over the hole.

The slipping-noose thus simply adapted becomes a most effective trap, and is always sure to hold its victim once within its grasp, as every struggle only tends to draw the noose tighter. They are quick in their action, and produce death without much pain, and for this reason are to be commended.

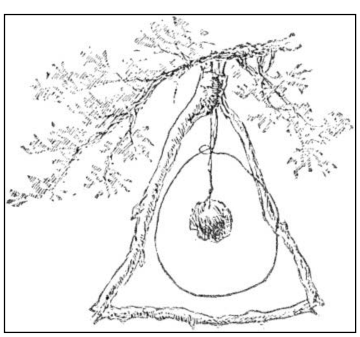
The "Twitch-up"

Our next example of the snare, we imagine, is one which all our boy-readers will immediately recognize; for it would certainly seem that any country boy who does not know the "Twitch-up" must be far behind the times, and live in a locality where there are no rabbits, quail, or even boys, besides himself, to suggest it. This snare is a universal favorite among nearly all country boys, and our illustration will immediately bring it to mind. Its name, "The Twitch-up," conveys perfectly its method of working. Our illustration represents the trap as it appears when set. It has many varieties, of which we will select the best. They may be divided into two classes—those with upright nooses, and those in which the noose is sooner or later. It is a well-known fact about these birds, that they will always seek to pass *under* an object which comes in their way rather than fly over it; and although the hedge of this trap is only a foot or more in height, the birds will almost invariably run about until they find an opening, in preference to flying over it. It is owing to this peculiarity of habit that they are so easily taken by this method. Our illustration gives only a very short section of



hedge; it may be extended to any length. The writer's experience with the hedge nooses has been very satisfactory, although never using a length greater than ten feet. It is well to set the hedge in the locality where quails or partridges are *known* to run. And in setting, it is always desirable to build the hedge so that it will stretch over some open ground, and connect with two trees or bushes. Cedar boughs are excellent for the purpose, but any close brushwood will answer very well. Strew the ground with corn, oats and the like. A small quantity only is necessary.

There is another noose trap commonly used abroad, and very little known here. It is a *tree* trap, and goes by the name of the "triangle snare." It is not designed for the capture of any *particular* kind of bird, although it often will secure fine and rare specimens. It consists of a sapling of wood, bent and tied in the form of a triangle, as shown in our illustration. This may be of any size, depending altogether on the bird the young trapper fancies to secure. A noose should be suspended in the triangle from its longest point. This noose should hang as indicated in our illustration, falling low enough to leave a space of an inch or so below it at the bottom of the triangle. The bait, consisting of a. piece of an apple, a berry, insect, or piece of spread on the ground, the latter of which are commonly called "ground snares." We will give our attention first to the "upright" style. These are rather entitled to preference on account of the harmless death which they inflict, invariably catching by the neck. Whereas the ground nooses as frequently lift their prey into the air by their feet, and thus prolong their suffering, Twitch-ups are the most successful and sure of any snares, and that, too, without being complicated. The writer, in his younger days, was quite an expert in trapping, and he can truthfully say that he found more enjoyment and had better success with these than with any other kinds of traps he employed.

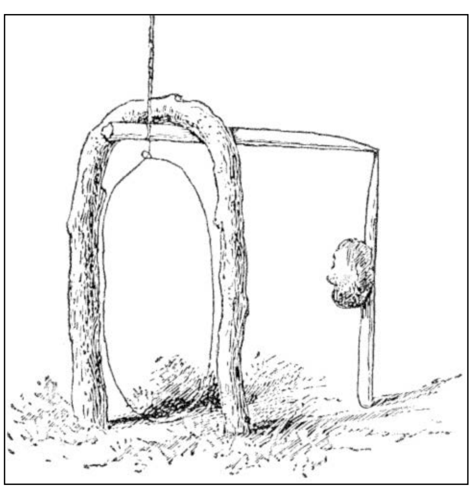


They are generally set in thickets or woods where either rabbits or partridges are known to abound. Having arrived at his chosen trapping ground, the young trapper should first select some selnder, elastic sampling; that of the hickory is the best, and is generally to be found in open woods—if not, some other kind will answer very well. It should be about five or six feet in length (trimmed of its branches), and in diameter need be no larger than an axe-handle or a broom-stick. When this is decided, some spot about five feet distant from the sapling should then be selected. The hatchet and knife will now come into excellent use, in cutting the sticks for the little inclostire shown in our drawing. This should be about eight or ten inches in diameter, and of about the same height. The sticks should be driven into the ground in a circle, leaving an open space of about six inches on one side. A stout switch as large as a man's little finger, and nearly two feet long, should then be cut and nicely sharpened at both ends. This should then be driven into the

ground in the form of an arch, at the opening of the enclosure.

We will now ask our readers to turn their attention to the next illustration, in order to understand what is to follow. This picture shows the method of setting the trap.

After the arch is firmly fixed in its place, a short piece of stick should be cut, of a length corresponding to the height of the arch. To the middle of this slick the bait should be attached, being either tied to it or stuck on a plug driven into the stick, the latter being sharpened on one end. Next proceed to cut another stick, of about six inches in length; let this be flattened on one end. The wire noose should then be fastned to the opposite end. The noose in this case should be large enough to fill the opening of the arch. We will now go back to the sapling again. It should be bent down slightly, and a piece of the strong twine should be tied to its tip. Taking hold of the string, proceed to bend down the end of the sapling in the direction of the inclosure, until it draws with a force strong enough to lift a rabbit if he were tied to the end of it. Thus holding it down with the string against the front of the inclosure, cut off the twice at the place where it crosses the top of the arch, as this will be the required length. It is now necessary to tie the end of this string to the same piece of wood and at the same place to which the noose was tied. When



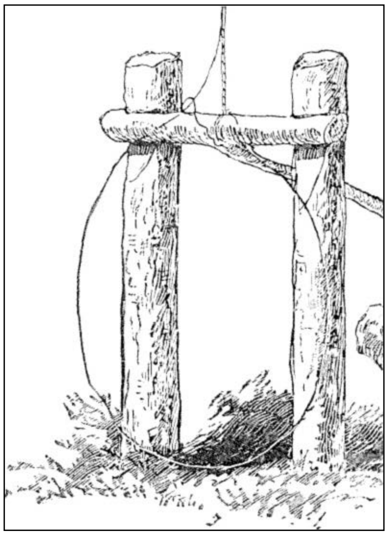
this is done the trap may be set as shown in the cut. The spring sapling should be bent as seen in the first illustration, the piece of wood holding the noose should be passed beneath the top of the arch, as far as it will go, with its long end pointing inside the inclosure. By now supporting the inside end with the bait stick, and carefully adjusting the noose so as to completely fill the arch, the trap will be set.

In order to reach the bail, the rabbit or bird *must* pass its head through the noose, after which, if the bait is scarcely touched, the animal's doom is sealed, and he is into the air, generally suffering almost instant death. It is well known that in the case of a rabbit the neck is broken by slight blow, a strong snap of the finger being often sufficient. It is therefore safe to conclude that when thus suddenly and lifted by the noose, death must occur almost instantaneously from the same cause.

It is not really necessary to success that the force of the sapling should be strong enough to lift the rabbit from the grass, a mere strong tightening of the noose would be sufficient to cause strangulation and death. But we recommend the first method as being less painful and more rapid in its effects.

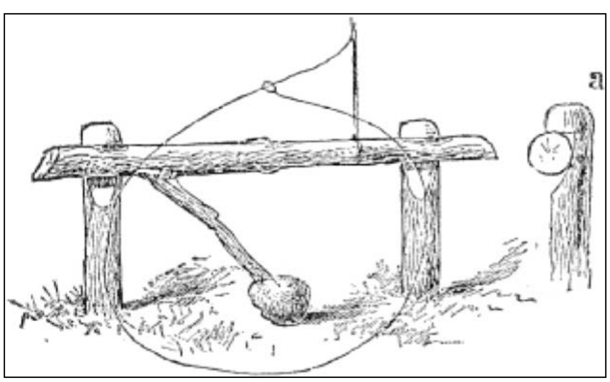
If the young trapper should experience any difficulty in finding saplings of the right size, in the locality where he desires to set his traps, the difficulty may be easily mended by cutting the poles elsewhere, and carrying them to his trapping ground, this answering the purpose equally well. They should be sharpened nicely on the large end, and firmly stuck into ground. The "Twitch-up" may be used for the capture of all varieties of game, and when set with the noose in the opening of a hollow tree, a stray coon will occasionally be entrapped.

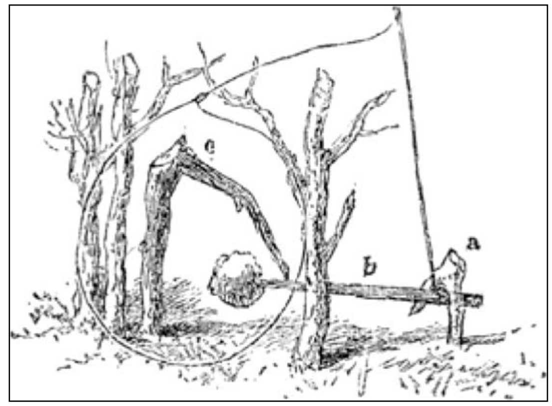
The next figure represents another method of constructing this trap. The picture explains itself. Instead of the arch, two notched sticks are driven into the ground, one on each side of the opening of the pen. The other piece should be of the shape shown in the figure, made either in one piece or



in two pieces fastened together. They may all be constructed from twigs in the woods. Let the noose and draw-string now be fastened to the middle of the cross piece, and when set it will appear as in our figure. It will easily be seen that a slight pull on the bait will turn the cross piece from beneath the notches, and allow it to fly into the air.

In our next instance the same principle is employed. The notched pegs are here driven in the back part of the pen, about five inches apart, with their notches towards the front. A forked bait stick of the shape shown is then procured. The draw-string should be attached near the end furthest from the fork. By now inserting the ends lightly beneath the notches in the pegs, at the same time letting the bait incline near the ground, the trap will be set on a very slight lift, as the bait will dislodge the pieces. Of course the noose must be arranged in the opening of the pen, as in the previous varieties. The bait stick

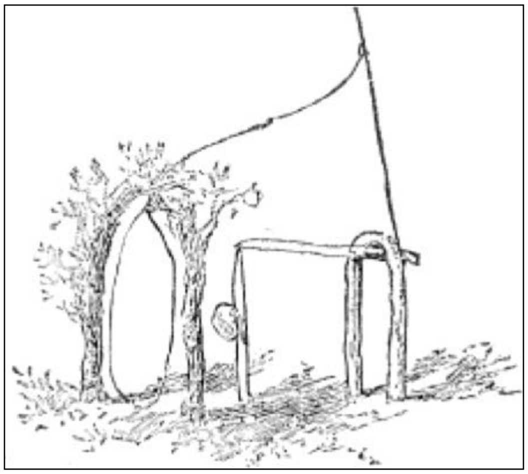


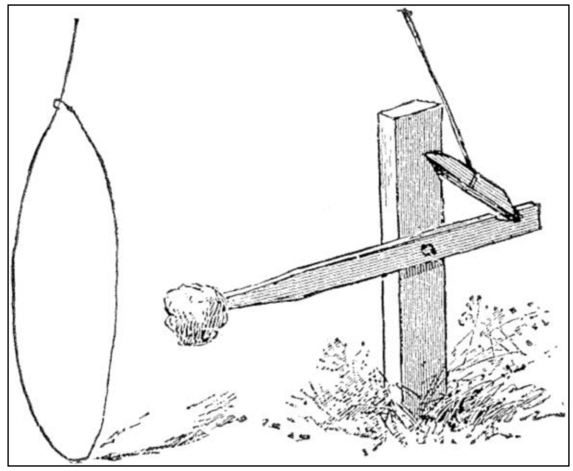


in both cases should be set cautiously beneath the notches, as shown at (*a*), so that the slightest turn will cause it to roll out of position.

A fourth method of snaring is shown in our next figure. In this instance the original arch is used, or else some circular opening constructed in the from of the pen. Inside, at the back part of the inclosure, a smaller arch is placed. Two sticks are then to be made similar to those mentioned in our first example of the "Twitch-up." Let the draw-string be tied to the end of one of these sticks; after which it should be passed under the inside arch, being brought out in from of it, and there supported by the bait-stick, as seen in our illustration. The noose should then be attached to the draw-string above the pen, and afterward brought down and arranged in front of the opening. The trap is then set, and will be found on trial to work admirably.

One of the simplest as well as surest of "Twitch-up" traps forms the subject of our next illustration. Like the foregoing varieties it is of course to be surrounded by its pen, and supplied with a circular opening or arch at one side, in which to hang the noose. It is constructed of three twigs. A simple crotch (*a*) should be firmly inserted in the ground at the back part of the pen; (*b*) the bait stick, consists of a straight twig, five or six inches in length, and should be attahced to the draw-string at about half an inch from the large end; (*c*) is another forked stick with unequal arms, the long one being driven into the ground near the opening of the pen and a little to one side, letting





the remaining arm point directly towards the crotch-stick at the back of the pen. The noose having beeen attached to the draw-string, the trap may now be set. Lower the bait stick and pass the large end under the crotch at the back of the pen, catching the baited end underneath the tip of the forked stick near the pen's opening. Arrange the noose in front of the entrance, and the thing is done. A mere touch on the bait will suffice to throw the pieces asunder. It is an excellent plan to sharpen the point of the forked stick (*c*) where it comes in contact with the bait stick, in order to make the bearing more slight, and consequently more easily thrown from its balance.

The Poacher's Snare

Our next example represents one of the oldest and best snares in existence—simple in construction, and almost infalliable in its operations. It is the one in most common use among the poachers of England, hence its name. The pieces are three in number, and may be cut from pine wood, affording easy and profitable employment for the jack-knife during odd hours and rainy days, when time hangs heavily.

The pieces are so simple in form and easy of construction that a sufficient number for fifty traps might be whittled in less than two hours, by any smart boy, who is at all "handy" with his jack-knife.

If a few good broad shingles can be found, the work is even much easier—mere splitting and notching being then all that is necessary. The bait stick should be about eight inches long, pointed at one end, and supplied with a notch in the other at about half an inch from the tip. The upright stick should be considerably shorter than the bait stick, and have a length of about ten inches, one end being nicely pointed, and the broad side of the other extremity supplied with a notch similar to the bait stick. About four inches from the blunt end, and on the narrow side of the stick, a square notch should be cut, sufficiently large to admit the bait stick loosely. The catch piece now remains. This should be about two and a-half inches in length, half an inch in width, and bevelled off at each end into a flat edge. The shapes of the different pieces, together with their setting, will be readily understood by a look at our illustration.

A hundred of these pieces will make a small bundle, and may be easily carried by the young trapper, together with his other necessaries, as he starts off into the woods. He will thus be supplied with parts for thirty-three traps, all ready to be set, only requiring the stakes for the pens, which may be easily cut in the woods. Having selected a flexible sapling about five feet in length, and having stripped it of its branches, proceed to adjust the pieces. Take one of the upright sticks, and insert it firmly in the ground, with its upper notch facing the sapling, and at about four feet distant from it. Bend down the "springer," and by its force determine the required length for the draw-string attaching one end to the tip of the sapling, and the other near the end of a catch piece, the latter having its bevelled side uppermost. The wire noose should then be attached to the draw-string about six inches above the catch-piece. The pen should now be constructed as previously directed. Its entrance should be on the side *furthest* from the springer, and should be so built as that the peg in the ground shallbe at the back part of the enclosure. The pen being finished, the trap may be set.

Insert the bait stick with bait attached into the square notch in the side of the upright peg; or, if desired, it may be adjusted by a pivot or nail through both sticks, as seen in our illustration, always letting the baited, end project toward the opening. Draw clown the catch piece, and fit its ends into the notches in the back of the upright peg and extremity of the bait-stick. By now pulling the latter slightly, and gently withdrawing the hand, the pieces wiil hold themselves together, only awaiting a lift at the bait to dislodge them. Adjust the wire loop at the opening of the pen, and you may leave the trap with the utmost confidence in its ability to take care of itself, and any unlucky intruder who tries to steal its property.

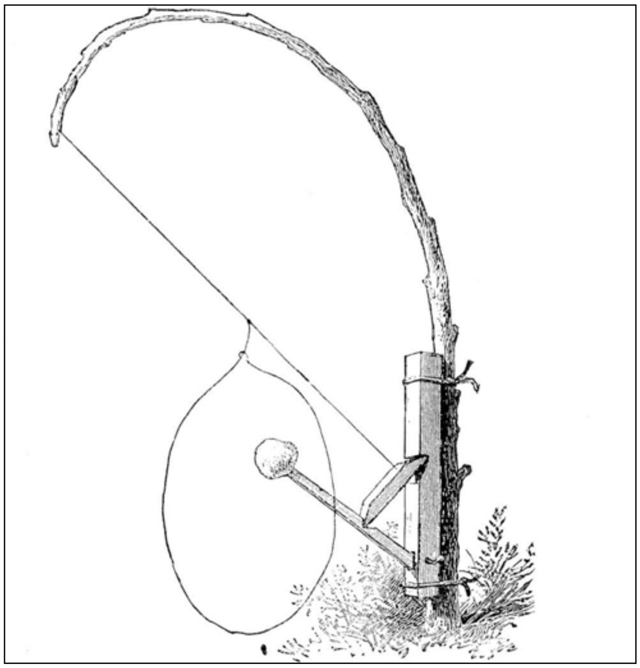
Most of the snares which we shall describe arc constructed from rough twigs, as these are always to be found in the woods, and with a little practice are easily cut and shaped into the desired forms. If desired, however, many of them may lie whittled from pine wood like the foregoing, and the pieces car. ricd in a bundle, ready for immediate use. In either case, whether made from the rough twigs or seasoned wood, it is a good plan to have them already prepared, and thus save time at the trapping ground when time is more valuable.

The Portable Snare

This is simply a modification of the snare just described, but possesses decided advantages over it in many respects, in the first place, it requires little or no protection in the shape of an enclosure. It can be set in trees or in swamps, or in short in *any* place where an upright elastic branch can be found or adjusted. Like the foregoing, it is to be commended for its portability, fifty or sixty of the pieces making but a small parcel, and furnishing material for a score of traps. We call it the "portable snare" partly in order to distinguish it from the one just described, but chiefly because this particular variety is generally called by that name in countries where it is most used.

It is composed of three pieces, all to be cut from a shingle or thin board. Let the first be about eight inches long, and three-quarters of an inch in width. This is for the upright. An oblong mortise should be cut through this piece, one inch in length, and beginning at about an inch from the end of the stick. Three inches from tiie other end, and on one of the broad sides of the stick, a notch should be made, corresponding in shape to that shown in our illustration. The bait stick should be four or five inches long, one end fitting easily into the mortise, where it should be secured by a wire or smooth nail driven through so as to form a hinge, on which it will work easily. On the upper side of this stick, and two inches distant from the pivot, a notch should be cut, similar to that in the upright. The catch piece should be about two inches in length, and bevelled off to a flat edge at each end. This completes the pieces.

To set the trap, it is only necessary to find some stout sapling, after which the upright stick may be attached to it close to the ground, by the aid of two pieces of stout iron wire, twisted firmly around both. It is well to cut slight grooves at each end of the upright for the reception of the wires, in

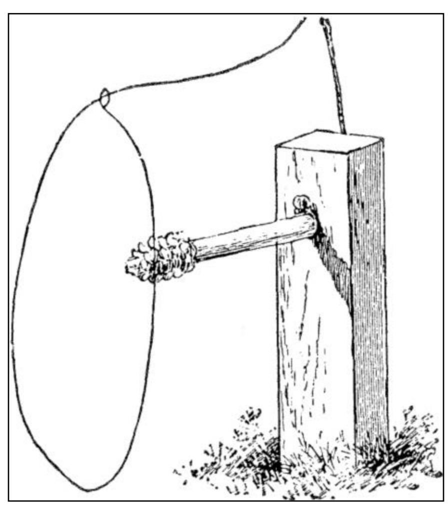


order to prevent slipping. Tie a strong piece of twine around one end of the catch piece, knotting it on the bevelled side. Cut the string about two feet in length, and attach the other end to the tip of the sapling. Adjust the bait stick on its pivot. By now lowering the catch piece, and lodging the knotted end beneath the notch in the upright and the other end in the notch on the bait stick, the pieces will appear as in out-drawing. Care should be taken to set the catch pieces as slightly as possible in the notches, in order to insure sensitiveness. At about four inches from the catch piece, the wire noose should be attached and arranged in a circle directly around the bait. By now backing up the trap with a few sticks to prevent the' bait from being approached from behind, the thing is complete, and woe to the misguided creature that dares to test its efficacy. By adjusting the drawstring so far as the upper end of the catch piece, the leverage on the bait stick is so slight as to require a mere touch to overcome it; and we may safely say that, when this trap is once baited, it will stay baited, so far as animal intruders are concerned, as we never yet have seen a rabbit or bird skilful enough to remove the tempting morsel before being summarily dealt with by the noose on guard duty.

For portability, however, the following has no equal.

The "Simplest" Snare

This is one of the most ingenious and effective devices used in the art of trapping; and the principle is so simple and universal in its application to traps in general as to become a matter of great value to all who are at all interested in the subject. There is scarcely a trap of any kind which could not be set with the knotted string and bait stick, at the expense of a little thought and ingenuity. The principle is easily understood by a look at our engraving, which probably represents the *simplest* twitch-up it is possible to construct. A stout wooden peg, having a hole the size of a lead pencil near the top, is driven firmly into the ground. The "knot" is made on the end of the raw-string, and passed through the hole in the peg from behind, being secured in place by the insertion of the bait stick in front. The latter should be about four inches long, and should be inserted very lightly—merely enough to prevent the knot from slipping back. The noose should be fastened to the draw-string six or seven inches from the knot, and arranged in front of the previously directed. The peg should be about six inches long and the hole



Method No. 1.

Method No. 2.

should be made with a 1-3 inch auger. Dozens of these pegs may be carried without inconvenience, and utilized in the same numbers of snares, in a very short time. We have already described the so-called "portable snare;" but, for portability, there is no noose-trap to be compared with the above. We give also a few other applications of the same principle.

In the second example, a horizontal stick is used instead of the peg, the hole being made in its centre. Its ends are caught in notches in opposite sticks at the back part of the pen, and the noose arranged at the opening.

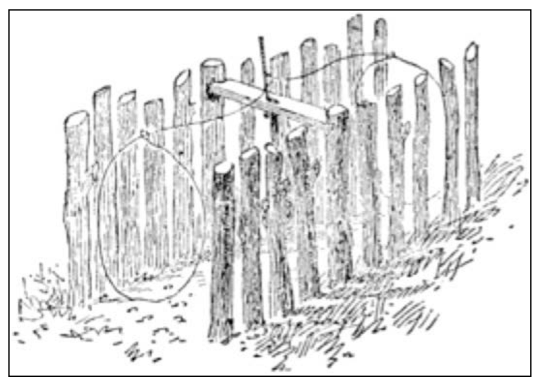
Again, by a third method (see engraving next page), these notched sticks may be driven into the ground first, and a row of twigs continued on them on both sides, thus leaving a passage-way between, as represented in the illustration. A noose may then be set at each opening, with the bait in the middle; so that, at whichever side it is approached, the result is the same, besides affording a chance of securing two birds at the same time.

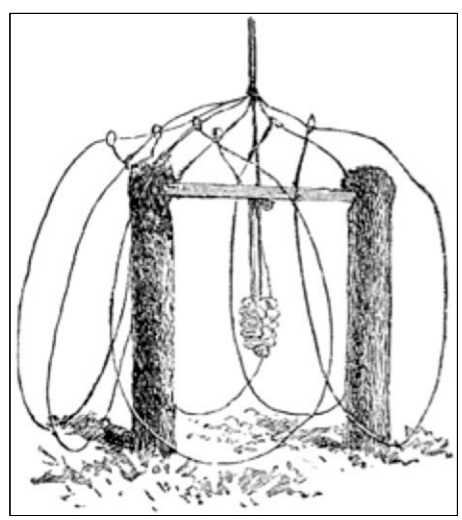
The Quail Snare

That quails are sociable in their habits, and that they run together in broods in search of their food, is a fact well known to all sportsmen. A most excellent opportunity is thus afforded the hunter to secure several at one shot, and the same advantage may be gained by the trapper by specially arranging for it. For this purpose there is no invention more desirable or effective than the snare we next illustrate; and on account of the companionable habits of the quail, it is just assure to catch six birds as one. The principle on which the trap works, is the same as in the three foregoing.

Two notched pegs are first driven into the ground, about four inches apart, and the flat stick with the hole in the centre caught beneath these summits, as just described. It should be firmly secured; he attached to the draw-string, and the trap set as already directed.

The best bait consists of a "nub" of pop-corn, firmly impaled on the spindle, together with a few loose grains scattered on the ground right beneath it. The noses should be arranged around the bait so

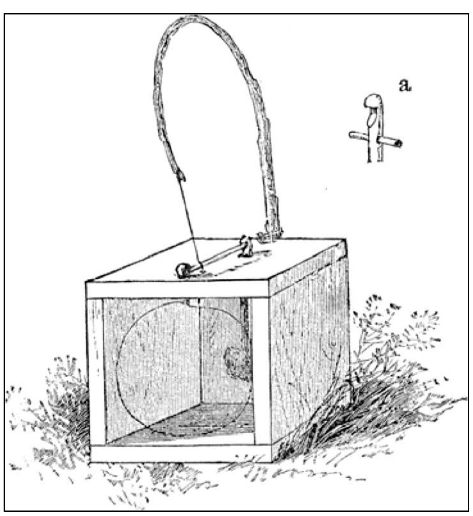




as to touch or overlap each other, and the bait stick introduced into the hole a little more firmly than when set with one noose. The quail on reaching the trap all rush for the corn on the ground, and thus fill nearly if not all the nooses. When the supply here is exhausted, then united attacks are directed towards the "nub" on the bait stick, which soon becomes loosened; the knot is thus released and each noose will propably launch a victim in mid-air. This invention is original with the author of this work, so far as he knows; and it will be found the simplest as well as most effective quail snare in existence. Pop-corn is mentioned as bait partly on account of its being a favorite food with the quail; but particularly because the *pecking* which it necessitates in order to remove the grains from the cob, is sure to spring the trap. If pop-corn cannot be had, common Indian corn will answer very well. Oats or buckwheat may also be used, as the ground bait, if desired.

The Box Snare

This is a most unique device, and will well repay any one who may desire to test its merits. It may be set for rabbits, coon, or feathered game, of course varying the size of the box accordingly. For ordinary purposes, it should be seven or eight inches square, leaving one end open. Place it in the position shown in the illustration and proceed to bore an



auger hole in the top board, one and a half inches from the back edge.

This is for the reception of the bait stick. Directly opposite to this and an inch from the front edge of the board a notched peg should be inserted. A gimlet hole should now be bored on a line between the auger hole and notched peg, and half an inch from the latter. A small stout screw eye should next be inserted at the rear edge of the board, and another one fastened to the back board, two inches from the bottom. With these simple preparations the box is complete. The bait stick should be about five or six inches long and supplied with a notch at the upper end. It should be of such a size as to pass easily into the auger hole, and provided with a peg inserted through it at about an inch and a half from the notched end, as shown in our illustration at (*a*). The object of this peg is to prevent the bait stick from being drawn entirely through the hole by the force of the pull from above. The catch piece should be only long enough to secure its ends beneath the notches in the peg at the top of the box and the projecting bait stick. It should be bevelled off at the tips as in the instances previous described, and attached to a piece of sucker wire, the point of attachment being at about an inch from the end of the stick. The wire should be about two and a half feet in length, the catch piece being fastened at about six inches from one end. To set this neat little invention it is first necessary to procure a strong and elastic switch about four feet in length, sharpen it slightly at the large end and insert it firmly in the screw eye at the back of the box, securing it in place at the top by strings through the screw eye at that place. By now attaching the short end of the wire to the tip of the sapling, inserting the bait stick from the inside of the box, and securing the catch piece in the notches, the other pieces will be in equilibrium, and the only remaining thing to be done is to pass the long end of the wire through the gimlet hole, and form it into a slipping noose which shall completely fill the opening of the box. In order to reach the bait the animal must pass his head through the noose, and it can be easily seen that the slightest pull on that tempting morsel will release the catch piece and tighten the wire around the neck of the intruder. Where the trap is small and the captured animal is large, it will sometimes happen that the box will be carried a distance of several feet before overpowering its victim; but it is sure to do it in the end if the spring powers of the sapling are strong and it is firmly secured to the box. If desired, the box may be tied to a neighboring stone or tree to prevent any such capers; but it will generally be found unnecessary, and a few minutes' search will always reveal it with its unlucky captive.

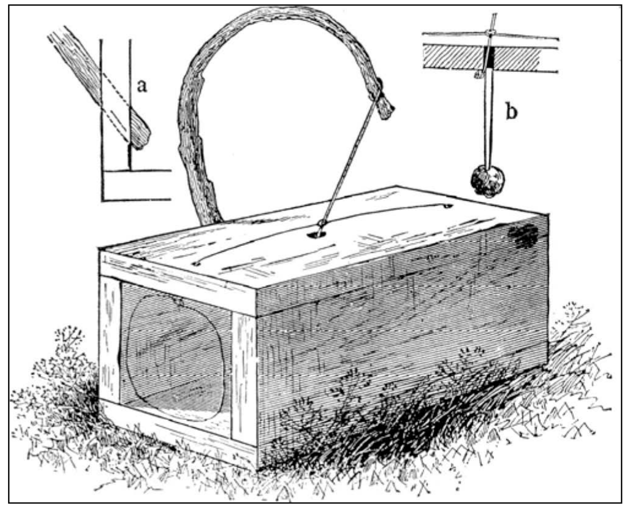
We have described the box with its spring attached; but this is not a requisite, as it may be used with growing sapling required.

The same trap may be constructed of a pasteboard box and whalebone, for the capture of small birds, and used with good success. The size we have mentioned is adaptable for rabbits and animals of the same size, but is really larger than necessary for feathered game.

The Double Box Snare

This is another embodiment of the same principle which has already been described, viz.—the knotted string. By many it is considered an improvement on the box snare just mentioned, owing to the possibility of its taking two victims at the same time. It may be set for rabbits, mink, or muskrat, and will be found very efficient.

It consists of a box about eight inches square, one foot in length, and open at both ends. In the centre of the top board a hole of the diameter of a lead pencil should be bored, and a smaller aperture also made in the middle of each end near the edge as seen in the accompanying engraving. The spring is next required. This should consist of an elastic switch or small pole, three or more feet in length. It should be inserted in a slating auger hole, made



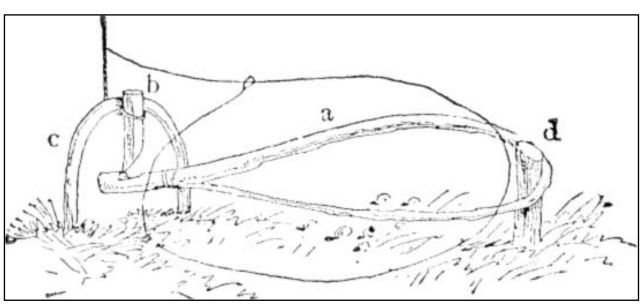
through the middle of one of the side boards near the bottom at the angle shown at (*a*). Should the switch fit loosely it may be easily tightened by a small wedge driven in beside it. The bait stick (*b*) should be about four inches in length, and large enough to fit easily into the hole in the centre of the top board. Next procure a stout bit of cord about eight inches in length. Tie one end to the tip of the switch and provide the other with a large double knot. A second knot should then be made, about an inch and a half above the first. A piece of sucker wire is the next necessity. Its length should be about five feet, and its centre should be tied over the uppermost knot in the string. If the bait is now in readiness, the trap may be set. Bend down the switch until the end knot will pass through the hole in the centre of the board. When it appears in the inside of the box, it should then be secured by the insertion of the top of the bait slick, as shown at (*b*). This insertion need be only very slight, a sixteenth of an inch being all that is sufficient to prevent the knot from slipping back. The spring is thus held in the position seen in the drawing, and the loose ends of the sucker wire should then be passed downward through the small holes and arranged in nooses at both openings of the box. Our trap is now set, and the unlucky creature which attempts to move that bait from either approach, will bring its career to an untimely end. The bait stick may be so delicately adjusted as to need only the slightest touch to dislodge it. Such a fine setting is to be guarded against, however, being as likely to be sprung by a mouse as by a larger animal. The setting is easily regulated, being entirely dependent upon the slight or firm insertion of the bait stick. Among all the "modi operandi" in the construction of traps, there is scarcely one more simple than the principle embodied in this variety, and there is none more effective.

The box snare already described maybe set by the same method, and indeed the principle may be applied to almost any trap, from the simplest snare described on to the largest dead-fall.

Ground Snares

The Old-Fashioned Springle

This is the variety of snare which has been in very common use for ages, and has always been the one solitary example of a noose trap which our "boys' books" have invariably pounced upon for illustration. For the capture of small birds it works very nicely; and as without it our list of traps would be incomplete, we will give an illustration of it as it appears when set and ready for its work. In constructing the affair it is first necessary to cut a flexible twig ot willow or bramble about eighteen inches in length, and form it into a loop as seen at (*a*), securing the tips by a few circuits of string, and allowing the larger end to project an inch or more beyond the other. This loop, which is called the "spreader," should now be laid down flat; ond on



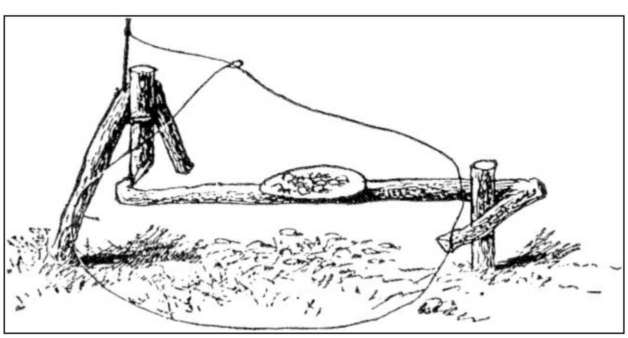
the upper side of the large end and about an inch from its tip, a notch should be cut as our illustration shows. The spring should next be procured, and should consist of a pliant, elastic switch, about four feet in length. A piece of fish line about two feet long, should now be fastened to the tip of the switch, and the loose end of the cord attached to a catch piece of the shape shown at (*b*). This catch may be about an inch and a half long, and should be whittled off to an edge on one end, the string being attached at about its centre. A slipping noose, made from strong horse hair, or piece of fine wire about two feet long, should now be fastened to the string about two inches above the catch. Having the switch thus prepared, it is ready to be inserted in the ground at the place selected for the trap. When this is done, another small flexible twig about a foot in length should cut, and being sharpened at both ends, should be inserted in the ground in the form of an arch (*c*), at about three feet distant from the spring, and having its broad side toward it. Insert the notch of the spieader exactly under the top of the arc, and note the spot where the curved end of the former touches the ground. At this point a peg (*d*) should be driven leaving a projecting portion of about two inches. The pieces are now ready to be adjusted. Pass the curved end of the spreader over the peg, bringing the notched end beneath the arc with the notch uppermost. Draw down the catch piece, and pass it beneath the arc from the opposite side letting the bevelled end catch in the notch in the spreader, the other end resting against the upper part of the arc. Arrange the slipping noose over the spreader as our drawing indicates, bringing it *inside* the peg, as there shown, as otherwise it would catch upon it when the snare is sprung. Strew the bait, consisting of berries, bird-seed, or the like, *inside* the spreader, and all is ready. Presently a little bird is seen to settle on the ground in the neighborhood of the trap; he spies the bait and hopping towards it, gradually makes bold enough to alight upon the spreader, which by his weight immediately falls, the catch is released, the switch flies up, and the unlucky bird dangles in the air by the legs. If the trapper is near he can easily release the struggling creature before it is at all injured, otherwise it will flutter itself into a speedy death.

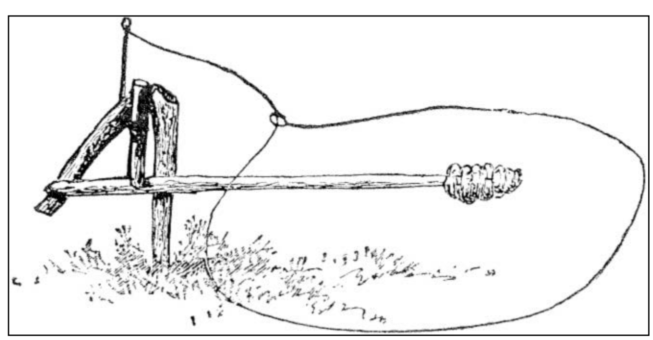
The Improved Springle

The accompanying cut illustrates an improvement on the last mentioned trap, whereby it can be used for the capture of larger game, and with most excellent success. In place of the "spreader" a crotched stick is used, the crotch of which catches around the peg, the other end being supplied with a notch as in the case of the spreader. On the upper side of this stick a small pasteboard platform is tacked, over which and beneath which the bait is thrown. Instead of the arc, a stout crotch stick is substituted. The noose should be at least ten inches in diameter and constructed of sucker wire. It should be arranged on the ground around the bait and inside of the peg. When the snare is set, the crotched end of the bait stick will thus rest near the earth, the notched end only being lifted in order to reach the catch piece. It is well to insert a few small sticks inside the edge of the noose in order to keep it in correct position. If properly set, the quail or partridge in approaching the trap will have to step inside the noose in order to reach the bait, and while thus regaling itself with a choice meal of oats, berries, or other delicacies, will be sure to press upon the bait stick either by pecking, or treading upon it, and will thus set the catch piece free, only to find itself secured by a grasp from which he will never escape alive. This is a very effectual snare ; but on account of its securing its victim by the legs and thus torturing them to death, it is to be deprecated. We would recommend in preference, those varieties already described as being fully as successful, and far less cruel. They effect almost instant death, either by broken necks or strangulation, and are in this regard among the most humane traps on record.

The Figure Four Ground Snare

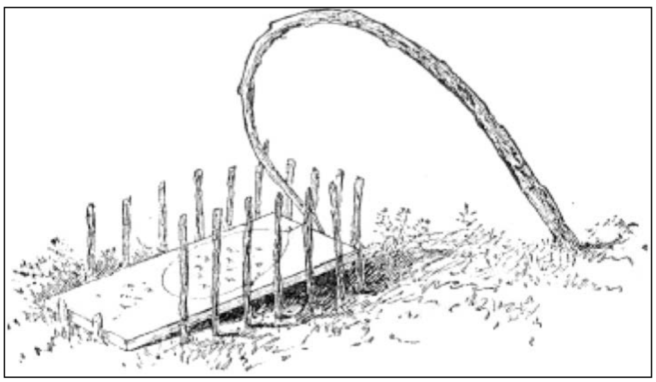
For simplicity in construction there are few snare traps which can compare with this variety, although it is somewhat similar to those last mentioned, and like them, catches by the feet. The trap consists of three pieces. A catch piece about three inches long, a bait stick of about six inches, and a stout crotch of the proportionate size shown in our illustration, a glance at which will make the setting too clear to need description. Be careful that the bait stick is set fine and rests just beneath the tip of the catch-piece so that a mere touch on the bait will release it. Arrange the noose as in the instance last described, and bait either as therein directed or with an apple or nubbin of corn, as our accompanying cut indicates. Always remembering that the noose should be sufficiently large to require the birds to step inside of it in order to reach the bait.





The Platform Snare

This odd invention will be found to work capitally as a game trap, and the only extra requisite necessary consists of a slab or light board about seven inches wide, and a foot in length. Having selected the spot for the trap, proceed to cut a stiff switch about five feet in length, and having sharpened the larger end to a nice point, insert it firmly into the ground in a slanting direction as our drawing illustrates. Next bend down the tip of the sapling, and resting none end of the board on the ground, catch the tip of the switch against the other end, as our illustration also shows. A little experimenting will soon determine the right place for the board, after which two pegs should be driven in the ground at it edge to hold it against the pressure on the opposite end. This being done fasten a wire noose to the tip of the switch, after which the pen is the only thing required. This should be built of simple little twigs arranged around three sides of the board, leaving the front end open. To set the snare, lower the switch and raising the board slightly at the back end, catch the tip of the springer behind it, afterwards arranging the noose over the platform, and scattering the bait inside. If the trap has been constructed properly and set "fine" it will take but a very slight weight on the platform to lower it from its bearing, the weight of an ordinary bird being sufficient, and the springer thus released will fly forward either catching its victim by the neck or legs, as the case may be. It may sometimes be found necessary to cut a slight notch in the end of the springer to receive the board, but in every case it should be tried several times in order to be sure that it works sensitively.



Traps for Feathered Game

Among the following will be four various net and cage traps commonly used in the capture of winged game besides several other unique devices the shape of box traps, etc., many of which are original with the author of this work and appear in the prior volume for the first time in book form. Commonest among bird-catching machines, is the well-known invention.

The Sieve Trap

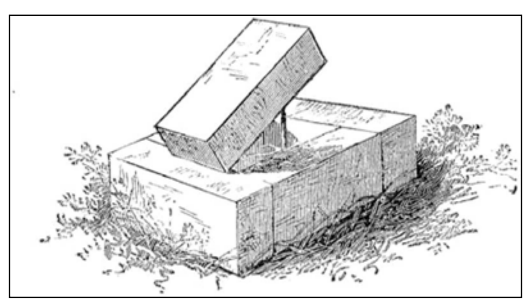
This device certainly possesses one great advantage: it is not complicated. Any one possessed of a sieve and a piece of string can get up the trap at two minutes' notice, and provided he has patience, and can wait for his little bird, he is almost sure to be rewarded for his pains—if he wait long enough. This of course depends upon circumstances: when the birds are plenty and are not shy, it is a common thing to secure three or four at once in very few minutes, while at other times an hour's patient waiting is unrewarded.

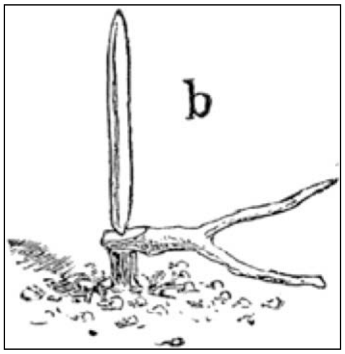
The trap consists only of a sieve tilted up on edge and thus propped in position by a slender stick. To this stick a string or thread is attached and the same carried to some near place of concealment, when the trapper may retire out of sight and watch for his "little bird." The ground beneath the sieve is strewn with bread crumbs, seed or other bait, and while the unsuspecting birds are enjoying their repast, the string is pulled and they are made prisoners. The sieve may be arranged with a spindle as described for the coop trap, and may thus be left to take care of itself. Where the birds are plenty and easily captured, the former method answers the purpose perfectly, but when tedious waiting is likely to ensue the self-acting trap is better.

The Brick Trap

This is a very old invention, and has always been one of the three or four stereotypes specimens of traps selected for publication in all Boy's Books. It is probably well known to most of our readers.

Take four bricks, and arrange them on the ground, as seen in our engraving, letting them rest on their narrow sides. If properly arranged, they should have a space between them, nearly as large as the broad surface of the brick. A small, forked twig of the shape shown in the separate drawing *(b)* having a small piece cut away from each side of the end, should then be procured. Next cut a slender stick, about four inches in length, bluntly pointed at each end. A small plug with a flat top should now be driven into the ground, inside the trap, about three inches from either of the end bricks and projecting about two inches from the ground. The trap is then ready to be set. Lay the flat end of the





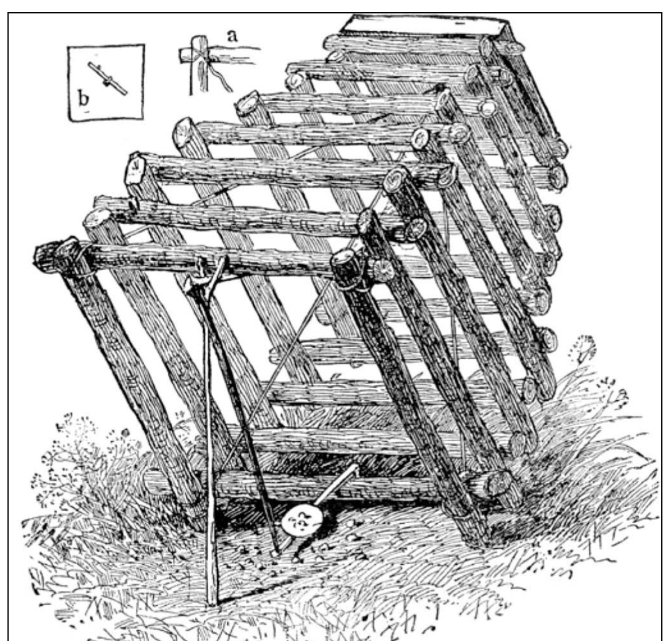
forked twig over the top of the plug, with the forks pointing forward, or toward the end of the enclosure nearest the plug. The pointed stick should then be adjusted, placing one end on the flat end of the fork, over the plug, and the other beneath the fifth brick, which should be rested upon it. The drawing *(b)* clearly shows the arrangement of the pieces. The bait, consisting of berries, bird-seed, or other similar substances, should then be scattered on the ground on the inside of the inclosure. When the bird flies to the trap he will generally alight on the forked twig, which by his weight tilts to one side and dislodges the pieces, thus letting fall the sustained brick.

It is not intended to kill the bird, and when rightly constructed will capture it alive. Care is necessary in setting the topmost brick in such a position that it will fall aright, and completely cover the open space. This is a very simple and effectual little contrivance, and can be made with a *box* instead of bricks, if desired. A piece of board may also be substituted for the top brick, and the enclosure beneath made larger by spreading the bricks further apart, thus making a more rooniy dungeon for the captive bird.

The Coop Trap

This is another excellent device for the capture of birds and large feathered game, and is used to a considerable extent by trappers throughout the country. Like the brick trap, it secures its victims without harm and furnishes the additional advantage of good ventilation for the encaged unfortunate. Any ordinary coop may be used in the construction of this trap, although the homely one we illustrate is most commonly employed on account of its simplicity and easy manufacture. It also docs away with the troublesome necessity of carrying a coop to the trapping ground, as it can be made in a very few minutes with common rough hewn twigs by the clever use of the jack knife. The only remaining requisites consist of a few yards of very stout Indian twine, several small squares of brown pasteboard, a dozen tacks and a number of pieces of board five inches square, each one having a hole through its centre, as our engraving *(b)* indicates. Having these, the young trapper starts out with material sufficient for several coops, and if he is smart will find no difficulty in making and setting a dozen traps in a forenoon.

In constructing the coop, the first thing to be done is to cut four stout twigs about an inch in thickness and fifteen inches in length and tie them together at the corners, letting the knot come on the inside as our illustration *(a)* explains and leaving a loose length of about two feet of string from each corner. This forms the base of the coop. Next collect

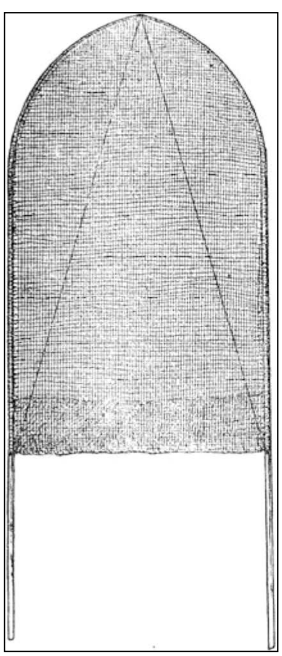


from a number of twigs about the same thickness, and from them select two more corresponding in length to the bottom pieces. Having placed the base of the coop on the ground, and collected the strings inside proceed to lay the two selected sticks across the ends of the uppermost two of the square, and directly above the lower two. Another pair of twigs exactly similar in size should then be cut and laid across the ends of the last two, and directly above the second set of the bottom portion, thus forming two squares of equal size, one directly over the other. The next pair of sticks should be a trifle shorter than the previous ones and should be placed a little inside the square. Let the next two be of the same size as the last and also rest a little inside of those beneath them, thus forming the commencement of the conical shape which our engraving presents. By thus continuing alternate layers of the two sticks cob-house fashion, each layer being closer than the one previous, the pyramid will he easily and quickly formed. After ten or a dozen sets have been laid in place, the arm should he introduced into the opening at the top, and the four cords drawn out, letting each one lay along its inside corner of the pyramid. Taking the strings loosely in the left hand and having the twigs in readiness, proceed to build up the sides until the opening at the top is reduced to only four or five inches across. The square board will now come into play. Pass the ends of the cords through the hole in its contre and rest the edge of the board on the top pair of sticks, taking care that it is the tip of the grain of the wood instead of its side, as otherwise it would be likely to crack from the pressure that is about to be brought upon it. Have ready a stout peg of hard wood, and laying it over the hole in the board, and between the strings, proceed to tie the latter as tightly as possible over it. By now turning the peg, the cords will be twisted and tightened and the various pieces of the coops will be drawn together with great firmness, in which state they may be secured by the aid of a tack driven in the top board against the end of the peg as shown at *(b)*. Thus we have a neat and serviceable coop, which will last for many seasons. To *set* the affair it is necessary to cut three sticks of the shapes shown in our illustration. The prop piece is a slender forked twig about ten inches in length from the tip to the base of the crotch. The spindle is another hooked twig of the same length, the bait piece is quite similar to the latter, only an inch shorter and supplied with a square notch at the tip. It is also slightly whittled off on the upper side to receive the square of pasteboard or tin, which is to hold the bait and which may be easily fastened in place by a tack. All of these twigs may be easily found in any thicket by a little practice in searching. In setting the trap, it is only necessary to raise up one side of the coop to the height of the prop stick, insert the short arm of the spindle through the fork and beneath the edge of the coop, while holding it thus in position, hook the crotch of the bait stick around the lower piece at the back ot the coop, and poshing the end of the spindle inside the coop, catch it in the notch of the bait stick where it will hold, and the trap is ready to be baited. The bait may consist of oats, wheat, "nannie berries" or the like, and should be strewn both on the platform and over the ground directly beneath and around it. If properly set, a mere peck at the corn will be sufficient to dislodge the pieces and the coop will fall over its captive. It is not an uncommon thing to find two or even three quail encaged in a trap of this kind at one fall, and after the first momentary fright is over, they seem to resign themselves to their fate and lake to their confinement as naturally as if they had been brought up to it.

The method of setting the coop trap above described is a great improvement on the old style of setting, and is an improvement original with the author of this work. In the old method a semi-circular hoop of rattan is used in place of the bait stick above. The ends of the rattan are fastened to one of the lower back pieces of the coop, and the hoop is just large enough to fit inside the opening of the coop. This rattan rests just above the ground, and the spindle catches against its inside edge in place of the notch in the bait stick already described, the bait being scattered inside the hoop. When tile bird approaches, it steps upon the rattan, and thus pressing it downward releases the spindle and the coop falls; but experience has shown the author that it does not always secure its intruders, but as often falls upon their backs and sends them off limping to regain their iost senses. By the author's improvement it will be seen that the whole body of the bird *must* be beneath the coop before the bait sticks can be reached and that when properly set it is absolutely certain to secure its victim. The author can recommend It as infallible, and he feels certain that any one giving both methods a fair trial will discard the old method as worthless in comparison.

The Bat Fowling Net

With English bird-catchers this contrivance is in common use, but so far as we know it has not been utilized to any great extent in this country. It is chiefly used at night by the aid of a lantern, and large numbers of sparrows and other birds are often secured.

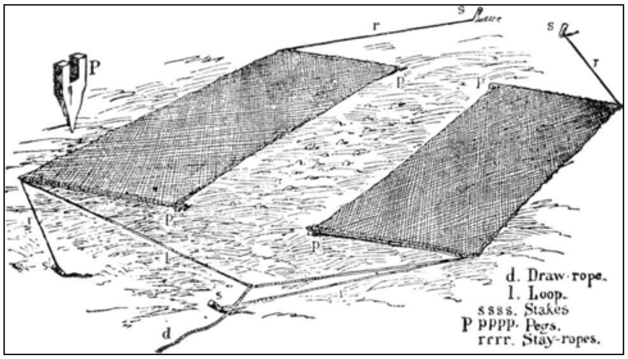


Our illustration gives a very clear idea of the net, which may he constructed as follows: Procure two light flexible poles, about eight feet in length; the tip of each a cord should be attached, and the same secured to the middle of the pole, having drawn down the tip to the bend, shown in our engraving. The two bent ends should now be attached together by a hinge of leather. A piece of mosquito netting is next in order, and it should be of such a size as to cover the upper bent halves of the poles, as seen in the illustration—the bottom edge being turned up into a bag, about ten inches in depth. The contrivance is now complete, and is used as follows: Three persons are generally required, and a dark night is chosen. Hay stacks, ever-greens, and thick bushes offer a favorite shelter to numerous small birds, and it is here that they are sought by the bird-hunters. A breezy night is preferable, as the birds perch low, and are not so easily startled by unusual sounds.

Great caution, however, is used in the approach. One party holds the light, which is generally a dark lantern, another takes the net, and the third arms himself with a switch with which to beat the bushes. The net is first held upright about a foot from the bush, and the light thrown upon the back of it. The bush is then moderately beaten, and the birds affrighted and bewildered fly against the net, which is instantly closed. The bird is thus captured, and when a full roost can be discovered a large number may he taken in a single night. The lantern should be closed while not in actual use, and everything should be done as quietly as possible. The dark lantern in itself is useful without the net. The light often so bewilders the bird that it flies directly in the face of the lantern and flutters to the ground, where it may be easily taken with the hand.

The Clap Net

In Asia, Africa, South America and Europe, this trap is a common resource for the capture of wild birds of various kinds. It may be called a "decoy" trap, from the fact that "call birds" are generally used in connection with it. They are placed at distances around the trap, and attract the wild birds to the spot by their cries. These birds are especially trained for the purpose, but almost any tamed bird that chirps will attract its mates from the near



neighborhood, and answer the purpose very well. Sometimes the "decoys" are entirely dispensed with, and the "bird whistle" used in their stead. This will be described hereafter, and inasmuch as the training of a "decoy" would be a rather difficult matter, we rather recommend the use of the bird whistle. The skill and absolute perfection of mimicry which is often attained by bird fanciers, with the use of this little whistle, is something surprising.

No matter what the species of bird—whether crow, bobolinks, thrush or sparrow, the song or call is so exactly imitated as to deceive the most experienced naturalist, and even various birds themselves. Of course this requires practice, but even a tyro may soon learn to use the whistle to good advantage.

The clap net commonly used, is a large contrivance—so large that several hundred pigeons are often caught at once. It is "sprung" by the bird-hunter, who lies in ambush watching for the game. The net is generally constructed as follows, and may be made smaller if desired.

Procure two pieces of strong thread netting, each about fifteen feet in length, and five feet in width. Four wooden rods one inch in thickness and five feet in length are next required. These may be constructed of pine, ash, or any other light wood, and one should be securely whipped to each end of the netting. Now by the aid of a gimlet or a red-hot iron, the size of a slate pencil, bore a hole through one end of every piece one inch from the tip, taking care that the ends selected lay on the same side of the net. The other extremities of the four poles should be supplied, each with a large screw eye. Four pegs are next in order—one of which is shown separate at *(P)*. It should be about eight inches in length, and three inches in width, and an inch in thickness, and sharpened to a point at one end. The other end should be supplied with a notch two inches in depth and of such a width as will easily secure the perforated end of one of the poles already described. By the use of the gimlet or a red-hot nail, a hole should now be bored through the side of every peg across the centre of the notch for the reception of a wire pin or smooth nail.

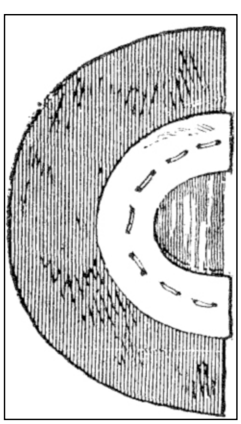
The nets may now be rolled up on the poles, and the trapper may thus easily carry them to his selected trapping ground. This should be smooth and free from stones and irregularities. Unroll the nets and spread them flatly on the ground, as seen in the illustration. Let the perforated ends of the poles be innermost, and allow a space of six feet between the inner edges of the nets. Draw the net flatly on the ground, and drive one of the notched pegs at each of the inside corners, securing the poles into the slots by the aid of the wire pins or nails. Next cut four stakes eight or ten inches long. The places for these may be seen by a look at our engraving. Each one should be inserted five feet distant from the notched peg, and exactly on a line with the inside edge of the net—one for each corner. They should slant from the net in every case. To each one of these stakes a stay-rope should be secured, and the other end passed through the screw eye of the nearest pole, drawing the string tightly, so as to stretch the net perfectly square. Next, take a piece of cord, about twenty feet in length, and fasten it across the ends of the net into the screw eyes in the poles. This is the loop to which the draw-string is attached, and either end of the net may be chosen for this purpose. To this loop, and a little one side of the middle, the draw-string should be fastened. If secured exactly in the middle-of the loop, the two nets will strike when the draw-rope is pulled, whereas when adjusted a little to one side, the nearest net will move a trifle faster than the other, and they will overlap neatly and without striking—completely covering the ground between them. When, the trap is spread the draw-rope should extend to some near shelter where the bird-catcher may secrete himself from view. Spreading the bait on the ground between the nets, and arranging his call birds at the proper distances, he awaits his opportunity of springing his nets. At the proper minute, when the ground is dotted with his game, he pulls the draw-string, and the birds are secured.

Immense numbers of wild fowl are often captured in this way.

The "bird whistle," already alluded to, is often used with good effect, it being only sufficient to attract the birds to such a proximity to the net as will enable them to spy the bait, after which their capture is easily effected.

The Bird Whistle

This instrument, also known as the prairie whistle, is clearly shown in our illustration. It is constructed as follows : First, procure a piece of morocco or thin leather. From it cut a circular piece one inch and a quarter in diameter. Through the centre of this disc, cut a round hole, one-third of an inch in diameter. A semi-circular piece of tin is next required. It should be of the shape of an arc, as seen in our illustration; its width across the ends being about three-quarters of an inch, and its entire length



being pierced with a row of fine holes. Next procure a piece of thin sheet India rubber or gold beater's skin. Cut a strip about an inch in length by half an inch in width, and lay one of its long edges directly across the opening in the leather disc. Fold the leather in half (over the rubber), an draw the latter tightly. Next lay on the arc of tin in the position shown in the illustration, and by the aid of a fine needle and thread sew it through the holes, including both leather and rubber in the stitches. When this is done, the whistle is complete. If the gold bearer's skin is not attainable, a good substitute may be found in the thin outer membrane of the leaf of a tough onion or leak, the pulp being scraped away.

To use the whistle, place it against the roof of the mouth, tin side up, and with the edge of the rubber towards the front. When once wet, it will adhere to the roof of the mouth, and by skilful blowing, it can be made to send forth a surprising variety of sounds. The quack of the duck and the song of the thrush may be made to follow each other in a single breath, and the squeal of a pig or the neigh of a horse are equally within its scope. In short, there is scarcely any animal, whether bird or quadruped, the cry of which may not be easily imitated by a skilful use of the prairie whistle, or, indeed, as it might with propriety be called, the "menagerie whistle."

The Wild Goose Trap

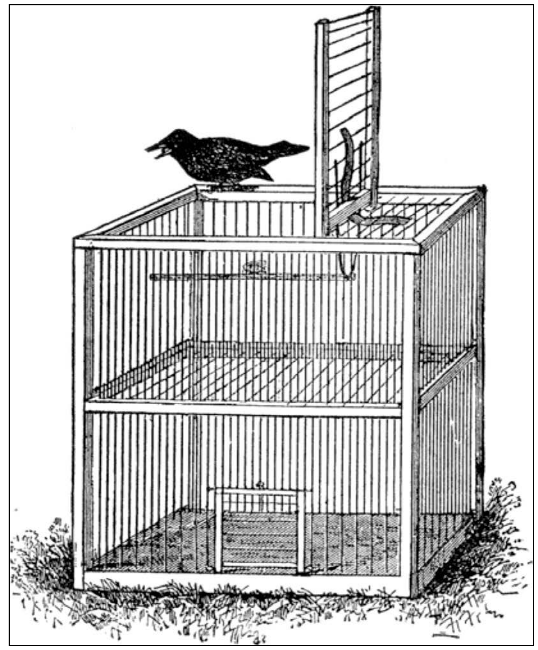
In our northern cold regions, where the wild geese and ptarmigan flock in immense numbers, this trap is commonly utilized. It consists merely of a large net fifty feet in length, and fifteen in width, arranged on a framework, and propped in a slanting position by two poles, after the manner of the sieve trap. It is generally set on the ice; and the trapper, after attaching his strings to the props, and sprinkling his bait at the foot of the net, retires to a distance to await his chances. Tame geese are often used as decoys, and sometimes the bird whistle already described is used for the same purpose. For the capture of the ptarmigan, the bait consists of a heap of gravel. It is hard to imagine a less tempting allurement, but, as the food of the birds during the winter is sapless and hard, it becomes necessary for them to swallow a considerable amount of gravel to promote digestion. The great depth of the snow renders this commodity very scarce during the winter season; and the Indians, taking advantage of this fact, succeed in capturing immense numbers of the game in nets by the use of that simple allurement. The gravel is packed on the surface of a pile of snow, placed under the center of the net, and the draw-string is carried to some neighboring shrubbery or place of concealment, where the trapper can always get at it without being seen by the birds under the net.

When everything is thus prepared, the hunters start out into the adjacent woods and willows, and drive their game toward the nets. This is generally an easy matter, and, no sooner do the birds come in sight of the heap of gravel, than they fly towards it *en masse,* and the ground beneath the net is soon covered with the hungry game. The hunter then goes to the end of the line, and, with a sudden pull, hauls down the stakes: the net falls over the birds, and they are prisoners.

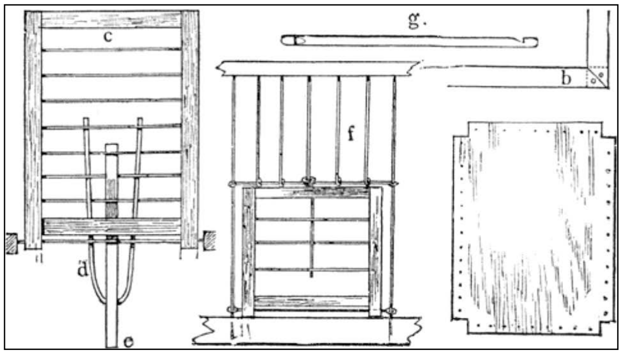
Hundreds of ptarmigan are often thus caught by a single sweep of the net. The trap is simply arranged, and may be constructed on a reduced scale for smaller birds, if desired.

The Trap Cage

Among bird-catchers generally, this is the favorite and most universal trap; and, where a decoy bird is used, it is particularly successful. The cage is arranged in two compartments, one above the other—the lower one being occupied by the call-birds. The making of the cage requires considerable ingenuity and much patience; and, for the benefit of those who may desire to exercise that patient ingenuity, we will subjoin a few hints, which may help them along in their efforts. For an ordinary cage, the height should be about one foot, the broad



sides the same, and the top and other two sides eight inches. First cut four corner uprights. These should be three-quarters of an inch square, and one foot in length. Next cut a bottom board of pine, twelve inches by eight inches, and one inch in thickness. From each of its corners, cut a small cube of the wood, exactly three-quarters of an inch square, thus leaving four notches, which will exactly receive the ends of the uprights, as seen at *(a)*. Before adjusting these pieces, the four sides of the boards should be pierced with small holes, as is also shown in the diagram *(a)*. These may be punched with a brad-awl, and should be about half an inch apart, and three-eighths of an inch from the edge of the board. Each one of the uprights may then be secured in place by two long brads, one being hammered each way into each side of the notch. Next proceed to cut four more of the square sticks. Two of these should be one foot in length, and the remaining two eight inches. The corners of these should now be neatly bevelled off, so as to fit after the manner of picture-frame. They should then be attached to the upper ends of the uprights by a brad through the corner of each, as seen at *(b)*, the dotted lines indicating the end of the upright beneath. These sticks should



likewise be pierced with holes to correspond with those in the bottom board, and running up and down in the direction of the wires.

The middle tier of braces are next required. Two of these should be ten and a half inches in length, and the other two six and a-half, and the ends should be perfectly smooth. These should now be punched with holes corresponding with those above, after which they may be inserted between the uprights as seen in the engraving, and secured by a brad at each end.

The trap door is shown separate at (*c*). The side sticks should be eight inches in length, and one-half an inch square, and the top and bottom sticks five inches in length. They should be set in between the side sticks, and the lower one should be secured about half an inch above the lower ends of the uprights, as seen in the illustration. The holes should be made in the side pieces, and the wire run across from side to side, as shown. Annealed iron, or copper wire is best for this purpose. The door should now be pivoted or hinged at the top of the cage, between the long sides, in such a position as that the top end shall rest on one of the narrow upper edges of the cage. A stiff wire should be used for the hinge, being passed through the top pieces of the cage into the lower ends of the door pieces. The cage may now be wired throughout. This is an easy matter, if the holes are properly made. About thirty-yards of the wire will be required: iron wire is generally used. It should be about the size of a hair-pin, and should work easily. Commence by passing it from the under side of the bottom board through one of the holes next to the corner. Pass the wire upward, through the centre braces, again upward through the top piece and across to the opposite broad side and corresponding hole. From this point it should pass downwards, through the center brace, and again through the bottom. Draw the wire tightly and passing it upward through the hole next to it, bring it over the top of the cage and around again to the bottom edge from which it started. Continue thus until the hinge of the door is reached; after which the wire should be passed up and down on the same side and thus carried around the small end of the cage until it finally meets at the door hinge on the opposite side. The two halves of the cage should now be separated by a grating of wire, as seen in the main illustration. This may be accomplished either by passing the wire from side to side, around the base of each upright wire, or an additional horizontal row of holes below the others may be punched for the purpose. The door through which the call-bird is introduced should next be made in the bottom section. There are two ways of doing this: one method consists in sawing a hole three inches square in the bottom board of the cage; and a cover consisting of a piece of tin is made to slide beneath the heads of four tacks, two of which are placed on each side of the opening. This form of door is perhaps the simplest of the two. The other is shown separate at (*f*), together with its mode of attachment.

It consists of two side pieces of wood, about a third of an inch square, and three inches in length, and two shorter ones, two inches in length. These are arranged into a square framework-side piece, at equal distances. Commencing at the top, the door should then be wired as directed for the cage. The lowest hole on each side should be left open for a separate piece of wire. The cage should now receive attention. The broad side is generally selected for the door. Find the seven centre wires and connect them across the middle by another horizontal bit of wire.

This may be easily done with a pair of pincers, by compressing a loop at each end of the wire around the two which run perpendicularly at its ends. When this is performed the five intermediate wires should be cut off about a quarter of an inch below the horizontal wire, and the projecting tips looped back over the cross piece, and made fast by the pincers. The lower parts of the upright wires may now be cut off close to the board. We will now take up the door. Pass a piece of wire through the holes at the bottom, clap the door over the opening, and loop the ends of the projecting wire loosely around the upright wires at each side. This will allow the door to slide easily up and down. Another wire should now be interlaced downwards through the centre of the door, and bent into a ring at the top. Let the door rest on the bottom of the cage, and, while in this position, adjust the ring at the top around the central wire directly behind it. The door is then complete, and, if properly made, will look neat and work easily.

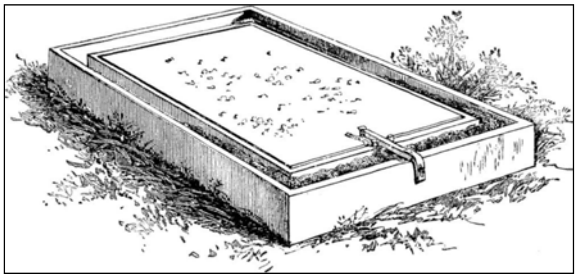
The "trap" at the top of the cage is next in order. To complete this it is first necessary to interweave a stiff wire loop, as seen at (*d*). The loop should extend on the *inside* of the lower piece of the door and about two inches below it. The spring power consists of a piece of stiff hoop-skirt wire, interwoven between the wires of the top of the cage, and those of the door, while the hitter is shut. The force of this will be sufficient to bring down the door with a snap; and for further security a catch, such as is described in may be added if desired.

The spindle is next required. This is shown at (*g*), and consists of a small perch of wood seven inches in length, and notched at each end. In setting the trap, the door should he raised as seen in the main illustration. One of the notches in the spindle should now be caught beneath the loop and the other around one of the central wires in the end of the cage. The bait, consisting of a berry, bird-seed, or what-not, may be either fastened to the spindle or placed beneath on the wires. The call-bird having been introduced, the trap may now be left to itself. If the call-bird is well trained it will not be many minutes before the birds of the neighborhood will be attracted to the spot by its cries. Ere long one less cautious than the rest will be seen to perch upon the top of the cage. He soon discovers the bait, and alighting upon the perch, throws it asunder, and in an instant the trap door closes over its captive. The cage is sometimes constructed double, having two compartments beneath for call-birds, and two traps above, in general resembling two of the single traps placed side by side. The decoy bird is not an absolute necessity to the success of the trap. Many birds are caught simply by the bait alone. The trap cage, when constructed on a larger scale, is often successfully employed in the capture of the owl. In this case it is baited with a live mouse or bird, and set during the evening in a conspicuous place. A trap working on this principle, being especially adapted to the capture of the owl, will be noticed hereafter.

The Spring Net Trap

Although slightly complicated in construction, our next illustration presents one of the prettiest bird traps on record, and may be made in the following manner, and by frequently referring to the picture, our explanation will be easily understood.

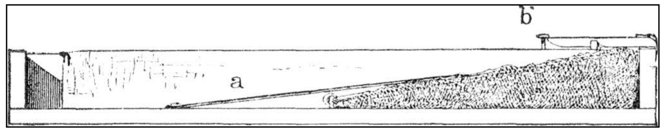
The first step is to make or procure a low flat box, about fifteen inches long, by ten inches in width, with a depth of about two inches. Next fasten an interior box, of the same height, leaving a space of about three-quarters of an inch between them all round. A platform should now be made. Let it be of such a size that it will just fit in the interior box, with a very slight space all around its edge. It should then be pivoted in the upper part of this box by two small slender pins, one being driven through into its edge, at the centre of each end. Let it be sensitively poised. The next thing to be done, is to arrange the spindle and catch. The latter should consist of a tack



or small bit of wood fastened on the middle of the platform, about an inch from one end, as seen both in the main illustration, and in the diagram at *(b)*.

The spindle should consist of a flat piece of wood, secured with a leather hinge to the edge of the outside box, directly opposite the catch. Let it be long enough to reach and barely hold itself beneath the catch. When thus in its position, two small plugs should next be driven into the edge of the inner box, one on each side of the spindle, thus holding it in place. A glance at our illustration makes this clear. The netting and "hoop" are next in order. The hoop should consist of an iron wire of the diameter of common telegraph wire.

For a box of the size we have given, a length of about twenty-eight inches will be found to answer. Before making the hoop, however, its hinges should be ready for it. Two screw eyes, or staples of bent wire should be driven into the bottom of the box between the two walls, one in the exact middle of each side. The iron wire should now be bent so as to fit round and settle into the space between the boxes, letting each end rest over the screws in the bottom. It will be found that there will be enough surplus wire on each end to form into a loop with the pincers. These loops should be passed through the screws or rings already inserted, and then pinched together; the hinge will thus be made, and will appear as at *(c)*. If properly done, they should allow the hoop to pass freely from one end of the box to the other, and settle easily between the partitions. If this hinge should prove too complicated for our young readers, they may resort to another method, which, although



not so durable, will answer very well. In this case the wire will only need to reach to the exact middle of the long sides. No surplus being necessary, a length of twenty-six inches will be exactly right. On each end a short loop of tough Indian twine should be tied. By now fastening these loops to the bottom of the box with tacks, in the place of screws, it will form a hinge which will answer the purpose of the more complicated one.

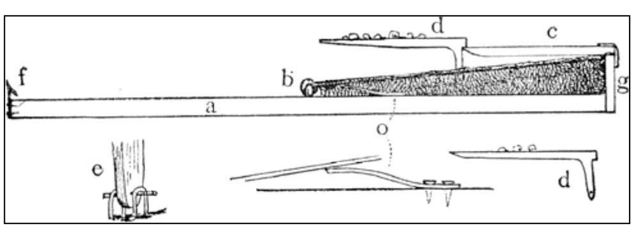
The netting should consist of common mosquito gauze, or, if this cannot be had, any thin cloth may be substituted. It should be sewed fast to the iron wire, from hinge to hinge, and then, with the hoops resting in its groove, the netting should be drawn over the platform, and tacked to the bottom of the groove, on its remaining half. It should rest loosely over the platform to allow plenty of space for the bird.

But one more addition, and the trap is finished. We have mentioned the use of elastics in other varieties: they are of equal use here, and should be attached to the hoop as seen at *(a)* in the section drawing, the remaining ends being fastened to the bottom of the groove, as there indicated. These elastics should be placed on both sides, and stretched to such a tension as will draw the hoop quickly from one side to the other.

It will now be easy to set the trap. Draw the hoop back to the opposite end, tucking the netting into the groove; lower the spindle over it, resting it between the two little plugs, and securing its end beneath the catch on the platform. If the bait, consisting of bread-crumbs, berries, insects, or the like, be now sprinkled on the platform, the trap is ready for its feathered victim. It will easily be seen that the slightest weight on either side of this poised platform will throw the catch from the end of the spindle, and release the hoop and the platform in an instant is covered by the net, capturing whatever unlucky little bird may have chanced to jump upon it. This is a very pretty little trap, and will well repay the trouble of making it,

A Simpler Net Trap

Much ingenuity has been displayed in the construction of bird traps of various kinds, but often the ingenuity has been misplaced, and the result has been so complicated as to mar its usefulness for practical purposes. The examples of net traps presented in this volume are so simple that the merest tyro can readily understand them. What can be more so than the present example, and yet it is as sure in its effect, and *surer* than those other varieties of more complicated construction. One necessary element in a trap of any kind is, that the bearings are slight and that they spring easily. To obtain this requisite it is necessary to overcome friction as much as possible, using only a small number of pieces, and having as few joints and hinges only as are absolutely necessary. The present variety possesses advantages on this account. It is constructed somewhat on the principle of the ordinary steel trap, and also resembles in other respects the one we have just described, although much simpler. We give only a section drawing, as this will be sufficient. The long side of a flat board of about eight by sixteen inches is shown at (*a*)/(*b*) indicates the loops of a bent wire, to which the netting is attached, as in the trap just described, the loops being fastened to the board as in the other variety; (*g*) consists of a small bit of wood an inch or so in length and half an inch in



width. It should be tacked on to the middle of the one end of the board and project about a half inch above the surface. To the top of this the spindle (*c*) should be attached by a leather or staple hinge. The spindle should be of light pine, five inches in length and a quarter of an inch square, bevelled; on the under side of one end (*d*) is the catch or bait piece, and should be whittled out of a shingle or pine stick of the shape shown, the width being about a half an inch or less. One side should be supplied with a slight notch for the reception of the spindle, and the other should project out two or three inches, being covered on the top with a little platform of pasteboard, tin, or thin wood either glued or tacked in place. To attach this piece to the main board, two small wire staples may be used, one being inserted into the bottom end of the piece and the other being hooked through it, and afterward tacked to the bottom of the trap, thus forming a loop hinge. Another method is to make a hole through the lower tip of the bait piece by the aid of a red-hot wire, as seen at (*d*), afterwards inserting a pin and overlapping its ends with two staples driven into the bottom board, as shown at (*e*). In our last mentioned net trap the spring power consisted of rubber elastic, and the same may be used in this case, if desired, but by way of variety we here introduce another form of spring which may be successfully employed in the construction of traps of various kinds. It is shown at (a) and consists merely of a piece of tempered hoop iron, so bent as to act with an upward pressure. It should be about three inches long by half an inch wide. About three-quarters of an inch should be allowed for the two screws by which it is to be attached to the board. The rest should be bent upward and thus tempered by first heating almost to redness, and then cooling in cold water.

One of these springs should be fastened to the board on each side, directly under the wire and quite near the hinge, in the position shown in the main drawing. Now draw back the net, lower the spindle and catch its extremity in the notch of the bait piece, and the trap is set as in our illustration. Sprinkle the bait on the platform, and lay the machine on the ground where birds are known to frequent; and it is only a matter of a few hours or perhaps minutes, before it will prove its efficacy. In order to prevent the bird from raising the wire and thereby escaping, it is well to fasten a little tin catch (*f*) at the end of the board. This will spring over the wire and hold it in its place.

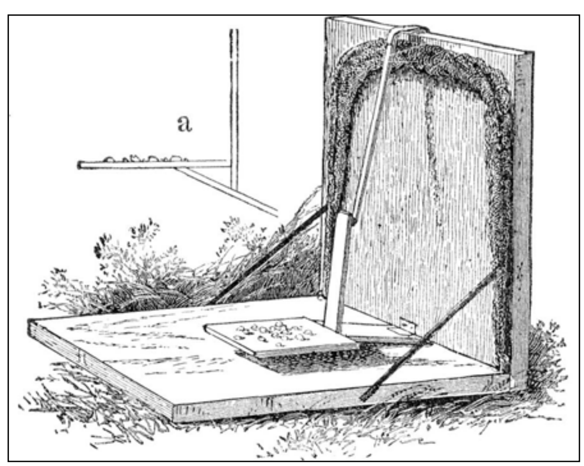
The Upright Net Trap

The following is another novelty in the way of a bird-trap, somewhat similar to the one we have just described, in its manner of working.

Procure two pieces of board about a foot square. Nail one to the edge of the other, as represented in our engraving. A stout wire is the next requisite. It should be about thirty inches long, and bent either into a curve or into two corners, making three equal sides. Each end of the wire should then be bent into a very small loop for the hinge. On to this wire the netting should then be secured as in the two previous examples, after which the ends of the wire may be tied with string or hinged on wire staples into the angle of the two boards, as seen in our illustration. Allow the wire now to lie flat on the bottom board, and then proceed to tack the netting around the edges of the upright board. Two elastics should next be fastened to the wire on each side, securing their loose ends to the bottom of the trap. They should be tightly drawn so as to bring the wire down with a snap. The spindle of this trap should be about eight or nine inches long, square and slender—the lower end being flattened, and the upper end secured to the top edge of the upright board by a hinge of leather or string. An excellent hinge may be made with a piece of leather an inch and a half long, by half an inch in width, one half of the length being tied around the end of the spindle, and the other tacked on to the upper edge of the board.

The platform is given by itself at *(a)* in the same picture. It may be made of very thin wood—cigar box wood, for instance, or even thick pasteboard. It consists of three pieces. The piece which is hinged into the angle of the boards should be about three inches in length; the platform piece ought not to be more than four inches square, and the upright piece only long enough to reach the tip of the spindle when the platform is raised, as shown in our engraving. The hinge piece should be cut to an edge on that end where the leather is fastened, the opposite end being bevelled off in order that the platform may rest and be tacked or glued firmly upon it. The diagram *(a)* will make this all very clear.

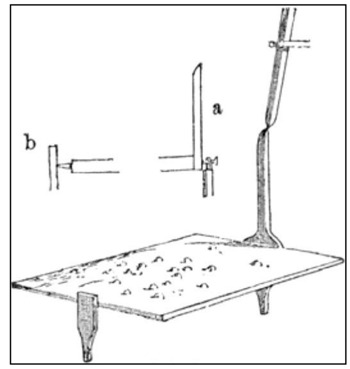
When the platform is all made and fastened in its place, the trap may be set. Draw the hoop back as far as possible, and lower the spindle over its edge, catching it behind the upright stick on the platform. If the trap is properly constructed, the pressure of the spindle on the platform will suffice to hold it up as seen in our illustration. The upright stick on the back of the platform should never be more than an inch and a half from the back of the trap. If need be, a slight notch may be made in the end of the spindle and a small tack driven into the back of the upright stick to correspond to it. By thus fitting the notch under the head of the tack, it will be sure to hold



the platform in the right position. But it should be carefully tested before setting, to see that it springs easily.

When thus set sprinkle the bait on the platform, scattering a little also on the bottom of the trap and on the ground directly around it. The little birds will soon spy the tempting morsels, and alighting on the trap are misled, and the slightest peck or pressure on the platform where the bait is most bounteously spread brings down the wire and net with a *snap,* and the little creature is secured without harm.

Our next illustration shows another method of constructing the platform. It should be about three or four inches square, and on the middle of one of its edges the upright catch piece should he fastened. This piece, as will be seen in our engraving, should be cut spreading at the bottom so as to admit of being secured to the platform by two brads, the tip being cut to a point. The total length of this piece should not be over two and a half inches. When tacked in place, a third brad should be inserted between the other two and exactly in the centre of the side of the platform. This latter brad is to act as the pivot, or hinge, and should project about a quarter of an inch, as seen at (*a*). On the opposite edge of the platform another larger brad should be driven, having its end filed to a blunt point, as in *(b).* If the filing would be too tedious, a plug of hard wood of the required shape would answer every purpose. The upright props which support the platform should be cut of thin wood. Let one be an inch and a half long and half an inch wide, the other being an inch in length. Each should have one end whittled to a point, which will admit of its being inserted in a gimlet hole in the bottom of the trap. These gimlet holes should be made at least half an inch in depth. Make the first at about an inch or so from the back of the trap. Into this insert the shorter pieces, broadside front. Lay the pivot brad of the platform on the top of this piece and insert over it a



small wire staple, as seen at *(a).* Elevate the platform evenly and determine the spot for the other gimlet hole, which should be directly beneath the point of the filed brad. Be sure that it is in the middle of the board, so that the platform may set squarely, and be perfectly parallel with the sides. Insert the remaining prop in its place, and the platform is complete. The overhanging spindle now requires a little attention. This should be whittled off on each side, bringing it to a point at the tip. On each side of the spindle a long plug should then be driven into the back piece, as our illustration shows. These should be far enough apart to allow the spindle to pass easily between them. The setting of the trap is plainly shown in our engraving. The spindle being lowered between the plugs is caught finely on the tip of the catch-piece. The blunt point at the opposite end of the platform should have a slight hollow made for it in the prop against which it presses. If the platform be now strewn with bait, the little machine is ready. It is certainly very simple and will be found very effective.

The Box Owl Trap

The use of a box trap for the capture of an owl is certainly an odd idea, but we nevertheless illustrate a contrivance which has been successfully used for that purpose.

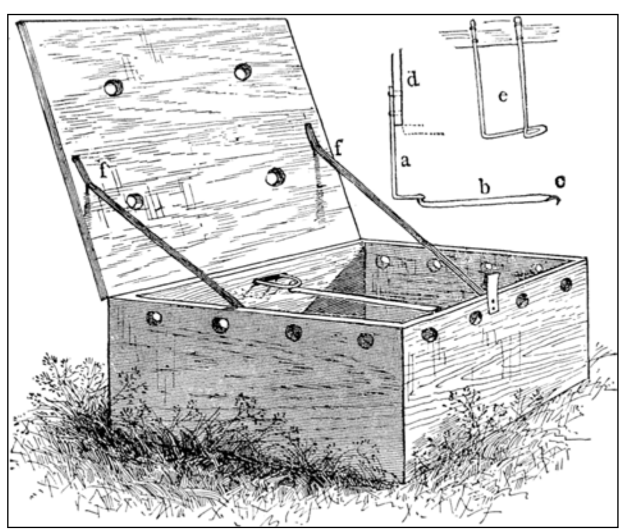
The box in this case should be of the proportions shown in our engraving, and well ventilated with holes, as indicated. (This ventilation is, by-the-way, a good feature to introduce in *all* traps.) Having made or selected a suitable box—say, fourteen or more inches wide, provided with a cover, working on a hinge—proceed to fasten on the outside of the lid a loop of stiff wire, bent in the shape shown at *(e)*. This may be fastened to the cover by means of small staples, or even tacks, and should project over the edge about two inches. When this is done, the lid should be raised to the angle shown in our illustration, and the spot where the end of the wire loop touches the back of the box should be marked and a slit cut through the wood at this place, large enough for the angle of tire loop to pass through. Two elastics should now be fastened to the inside of the box, being secured to the bottom at the side, and the other to the edge of the cover, as seen in the illustration. They should be sufficiently strong to draw down the cover quickly. The perch, or spindle, should consist of a light stick of wood, as shown at (*b*), one end provided with a slight notch, and the other fastened to the inside of the front of the box by a string or leather hinge, *(c),* keeping the notch on the upper side of the slick. It will be now seen that by opening the cover, until the loop enters through the groove, and by then hooking the notch in the spindle under the loop as seen at *(a)* the trap wilt be set, and if properly done it will be found that a very slight weight on the spindle will set it free from the loop and let the cover down with swiftness.

To secure the cover in place a small tin catch should now be applied to the front edge of the box, as shown in the illustration. A piece of tin two inches in length by a half an inch in breadth will answer for this purpose. One end should be bent down half an inch at a pretty sharp angle, and the other attached by two tacks, to the edge of the box, in the position shown in the cut. This precaution will effectually prevent the escape of whatever bird, large or small, the trap may chance to secure. It is a necessary feature of the trap, as without it the elastics might be torn asunder and the lid thereby easily raised.

This trap may be baited in a variety of ways. As it is particularly designed for a bird trap, it is well to sprinkle the bottom of the box with berries, bird-seed, small insects, such as crickets, grasshoppers, etc. These latter are very apt to jump out, and it may be well to fasten one or two of them to the bottom with a pin through the body, just behind the head.

There are many kinds of birds which live almost exclusively on insects; and as this bait is of rather a lively kind, there is scarcely any other method to retain them in their position. A bird on approaching this trap will almost irresistibly alight on the perch, and if not at first, it is generally sure to do so before long. If desired, a pasteboard platform may be fastened on the top of the perch with small tacks, and the bait scattered upon it. This will act in the same manner, and might, perhaps, be a trifle more certain. We will leave it to our readers to experiment upon.

We have given this variety the name of "owl-trap," because it may be used with success in this direction. When set for this purpose, it should be baited with a live mouse, small rat or bird, either fastened to the bottom of the trap, if a bird, or set in with the trap inclosing it, if a mouse. A small bird is the preferable bait, as it may be easily fastened to the bottom of the box by a string, and as a general thing is more sure to attract the attention of the owl by its chirping.



The trap should be set in an open, conspicuous spot, in the neighborhood where the owls in the night are heard to "hoot." The chances are that the box will contain an owl on the following morning.

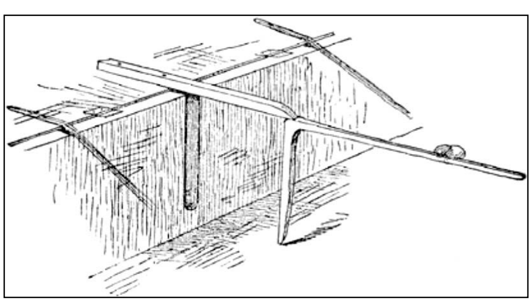
This bird is a very interesting and beautiful creature, and if our young reader could only catch one, and find rats and mice and enough to keep it well fed, he would not only greatly diminish the number of rats in his neighborhood, but he would realize a great deal of enjoyment in watching and studying the habits of the bird.

Should it be difficult to supply the above mentioned food, raw meat will answer equally well. The bird should either be kept in a cage or enclosure and in the latter case, its wings will need to be clipped.

The Box Bird Trap

Here we have another invention somewhat resembling the foregoing. Our engraving represents the arrangement of the parts as the trap appears when set.

The box may be of almost any shape. A large sized cigar box has been used with excellent success, and for small birds is just the thing. The cover of the box in any case should work on a hinge of some sort. The trap is easily made. The first thing to be done is to cut an upright slot, about two inches in length, through the centre of the backboard, commencing at the upper edge. To the inside centre edge of the cover a small square strap, about four inches in length, should then be secured. It should be so adjusted as that one-half shall project toward the inside of the box, as seen in the illustration, and same time pass easily through the slot beneath where



the cover is closed. The lid should now be supplied with elastics as described in the foregoing. Next in order comes the bait stick. Its shape is clearly shown in our illustration, and it may be either cut in one piece or consist of two parts joined together at the angle. To the long arm the bait should be attached and the upright portion should be just long enough to suspend the cover in a position on a line with the lop of the box. The trap may now be set, as seen in our illustration, and should be supplied with the necessary tin catch, described in the foregoing.

The Pendent Box Trap

This invention is original with the author of this work, and when properly made and set will prove an excellent device for the capture of small birds.

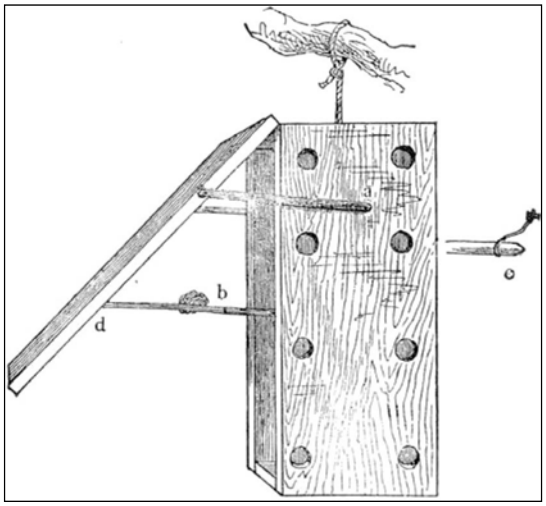
The general appearance of the trap, as set, is clearly shown in our illustration. A thin wooden box is the first requisite, it should be about a foot square and six inches in depth, and supplied with a close fitting cover, working on binges. The sides should then be perforated with a few auger holes for purposes of ventilation.

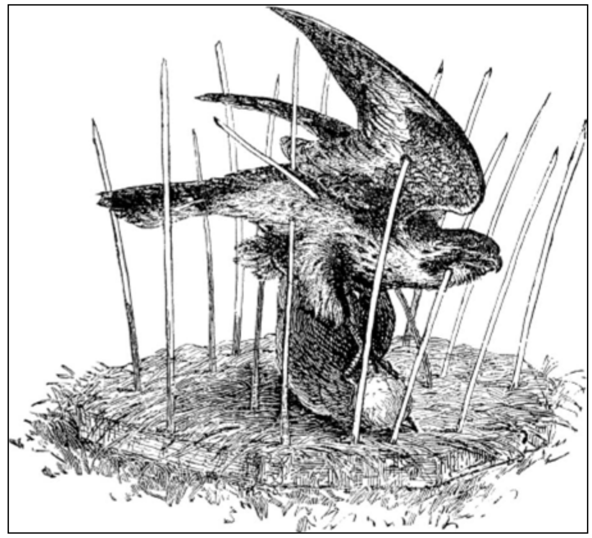
Two elastics are next in order, and they should be attached to the cover and box, one on each side, as shown at (*a*) They should be drawn to a strong tension, so as to hold the cover firmly against the box.

The mechanism of the trap centres in the bait stick, which differs in construction from any other described in this book.

It should be made about the size of a lead pencil, and eleven inches or so in length, depending of course norm the size of the box.

It should then be divided in two pieces by a perfectly flat cut, the longer part being six inches in length. This piece should be attached to the back hoard of the box by a small string and a tack, as shown at (*c*), its end being bluntly pointed. Its attachment should be about five inches above the bottom board, and in the exact centre of the width of the back.





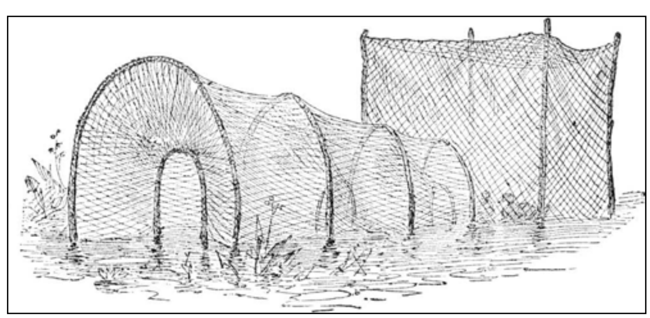
Near the fl at end of the other piece the bait consisting of a berry or other fruit, should be secured, and the further extremity of the stick should then be rounded to a blunt point. The trap is now easily set. Raise the lid and lift the long stick to the position given in the illustration. Adjust the flat end of the bait stick against that of the former, and allow the pressure of the lid to bear against the blunt point of the short stick at *(d),* as shown in the illustration, a straight dent being made in the cover to receive it, as also in the back of the box for the other piece. If properly constructed, this pressure will be sufficient to hold the sticks end to end, as our engraving represents, and the trap is thus set. The slightest weight on the false perch thus made will throw the parts asunder, and the cover closes with a snap.

The greatest difficulties in constructing the trap will be found in the bearings of the bait sticks (*b*), the ends of which must be perfectly flat and join snugly, in order to hold themselves together. The box may now be suspended in a tree by the aid of a string at the top. The first bird that makes bold enough to alight on the perch is a sure captive, and is secured without harm. If desired, the elastic may be attached to the inside of the cover, extending to the back of the box, as seen in the initial at the head of this chapter. If the elastic in any event show tendencies toward relaxing, the tin catch described on should be adjusted to the lower edge of the box to ensure capture.

The Hawk Trap

Our illustration represents a hawk in a sad plight. The memory of a recent feast has attracted it to the scene of many of its depredations: but the ingenious farmer has at last outwitted his feathered foe and brought its sanguinary exploits to a timely end. This trap is a "Yankee" invention and has been used with great success in many instances where the hawk has become a scourge to the poultry yard. The contrivance is clearly shown in art illustration, consisting merely of a piece of plank two feet square, set with stiff perpendicular pointed wires.

This affair was set on the ground in a conspicuous place, the board covered with grass, and the nice fat Poland hen which was tied to the centre proved a morsel too tempting for the hawk to resist.



Hence the “fell swoop “ and the fatal consequences depicted in our illustration. The own has also been successfully captured by the same device.

The Wild Duck Net

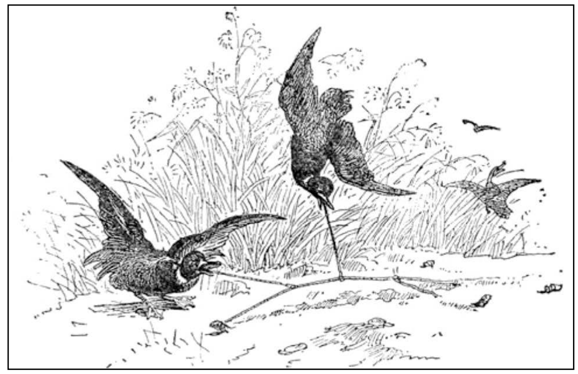
In the following section will be found two examples of traps in very common use for the capture of wild ducks, and in the region of Chesapeake bay, immense numbers of the game are annually taken by their aid. The first is the well known net trap, so extensively used in nearly all countries, both for the capture of various kinds of fish as well as winged game. Our illustration gives a very clear idea of the construction of the net, and an elaborate description is almost superfluous. It consists of a graduated series of hoops covered by a net work. From each a converging net extends backward ending in a smaller hoop which is held in position by cords extending therefrom to the next larger hoop. The depth of these converging nets should extend backward about three or four feet from the large hoop, and the distance between these latter should be about five feet. The length of the net should be twenty feet, terminating in a “pound” or netted enclosure, as seen in the illustration. The trap may be set on shore or in the water as seen, “Decoy” birds are generally used, being enclosed in the pound.

When set on land the bait consisting of corn or other grain should be spread about the entrance and through the length of the net.

It is remarkable that a duck which so easily finds its way within the netted enclosure, should be powerless to make its escape, but such seems to be the fact, and even a single hoop with its reflex net, has been known to secure a number of the game.

The Hook Trap

Our second example is one which we are almost tempted to exclude on account of its cruelty,



but as our volume is especially devoted to traps of all kinds and as this is a variety in very common use, we feel bound to give it a passing notice. Our illustration fully conveys its painful mode of capture, and a beach at low water is generally the scene of the slaughter. A long stout cord is first stretched across the sand and secured to a peg at each end. To this shorter lines are attahced at intervals, intervals, each one being supplied with a fish hook baited with a piece of the tender rootstock of a certain water reed, of which the ducks are very fond. The main cord and lines are then imbedded in the sand, the various baits oniy appearing on the surface, and the success of the device is equal to its cruelty.

The “Fool’s Cap” Trap

Of all oddities of the trap kind, there is, perhaps, no one more novel and comical than the “Fools’s Cap” crow-trap, which forms the subject of our present illustration. Crows are by no means easy of capture in any form, or trap, and they are generally as coy and as shrewd in their approach to a trap as they are bold in their familiarity and disrespect for the sombre scarecrows in the corn field. But this simple device will often mislead the smartest and shrewdest crow, and make a perfect fool of him, for it is hard to imagine a more ridiculous sight than is furnished by the strange antics and evolutions of a crow thus embarrassed with his head embedded in a cap which he finds impossible to remove, and which he in vain endeavors to shake off

by all sorts of gymnastic performance. The secret of the little contrivance is easily told. The cap consists of a little cone of stiff paper, about three or four inches in diameter at the opening. This is imbedded in the ground, up to its edge, and a few grains of corn are dropped into it. The inside edge of the opening is then smeared with *bird-lime*, a substance of which we shall speak hereafter.

The crow, on endeavoring to reach the corn, sinks his bill so deep in the cone as to bring the gummy substance in contact with the feathers of his head and neck, to which it adheres in spite of all possible efforts on the part of the bird to throw it off.

The cones may be made of a brownish-colored paper if they are to be placed in the earth, but of white paper when inserted in the snow. It is an excellent plan to insert a few of these cones in the fresh corn hills at planting season, as the crows are always on the watch at this time, and will be sure to partake of the tempting morsels, not dreaming of the result. The writer has often heard of this ingenious device, and has read of its being successfully employed in many instances, but he has never yet had an opportunity of testing it himself. He will leave it for his readers to experiment upon for themselves.

Bird Lime

This substance so called to which we have above alluded, and which is sold in our bird marts

under that name, is a viscid, sticky preparation, closely resembling a very thick and gummy varnish. It is astonishingly "sticky," and the slightest quantity between the fingers will hold them together with remarkable tenacity. What its effect must be on the feathers of a bird can easily be imagined.

This preparation is put up in boxes of different sizes, and may be had from any of tile taxidermists or bird-fanciers in any of our large towns or cities. Should a homemade article be required, an excellent substitute may be prepared from the inner bark of the "slippery elm." This should be gathered in the spring or early summer, cut into very small pieces or scraped into threads, and boiled in water sufficient to cover them until the pieces are soft and easily mashed. By this time the water will be pretty much boiled down, and the whole mass should then be poured into a mortar and beaten up, adding at the same time a few grains of wheat. When done, the paste thus made may be put into an earthen vessel and kept. When required to be used, it should be melted or softened over the fire, adding goose grease or linseed oil, instead of water. When of the proper consistency it may be spread upon sticks or twigs prepared for it, and which should afterwards be placed in the locality selected for the capture of the birds.

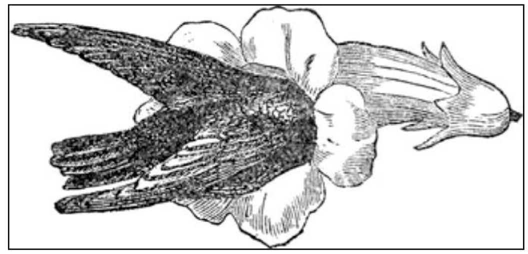
An excellent bird-lime may be made also from plain linseed-oil, by boiling it down until it becomes thick and gummy. Thick varnish either plain or mixed with oil, but always free from alcohol, also answers the purpose very well. The limed twigs may be either set in trees or placed on poles and stuck in the ground.

If any of our readers chance to become possessed of an owl, they may look forward to grand success with their limed twigs. It is a well known fact in natural history that the owl is the universal enemy of nearly all our smaller birds. And when, as often happens, a swarm of various birds are seen flying frantically from limb to limb, seeming to centre on a particular tree, and filling the air with their loud chirping, it may be safely concluded that some sleepy owl has been surprised in his day-dozing, and is being severely pecked and punished for his nightly depredations.

Profiting from this fact, the bird catcher often utilizes the owl with great success. Fastening the bird in the crotch of some tree, he adjusts the limed twigs on all sides, even covering the neighboring branches with the gummy substance. No sooner is the owl spied by one bird than the cry is set up, and a score of foes are soon at hand, ready for battle. One by one they alight on the beguiling twigs, and one by one find themselves held fast. The more they flutter the more powerless they become, and the more securely are they held. In this way many valuable and rare birds are often captured.

The Hummingbird Trap

One of the most ingenious uses to which bird lime is said to have been applied with success, is in the capture of hummingbirds. The lime in this instance is made simply by chewing a few grains of wheat in the mouth until a gum is formed. It is said that by spreading this on the inside opening of



the long white lily or trumpet-creeper blossom, the capture of a hummingbird is almost certain, and he will never be able to leave the flower after once fairly having entered the opening. There can be no doubt but that this is perfectly practicable, and we recommend it to oar readers.

The object in making the bird-lime from wheat consists in the fact that this is more easily removed from the feathers than the other kinds.

We would not wish our readers to infer from this that a hummingbird might be captured or kept alive, for of all birds, they are the most fragile and delicate, and would die of fright, if from nothing else. They are chiefly used for ornamental purposes, and may be caught in a variety of ways. A few silk nooses hung about the flowers where the birds are seen to frequent, will sometimes succeed in ensnaring their tiny forms.

The blow-gun is often used with good success, and the concussion from a gun loaded simply with powder, and aimed in the direction of the bird, will often stun it so that it will fall to the ground. If a strong stream of water be forced upon the little creature, as it is fluttering from flower to flower, the result is the same, as the feathers become so wet that it cannot fly.

Miscellaneous Traps

The Common Box Trap

The following chapter includes a variety of traps which have not been covered by any of the previous titles. Several novelties are contained in the list, and also a number of well known inventions.

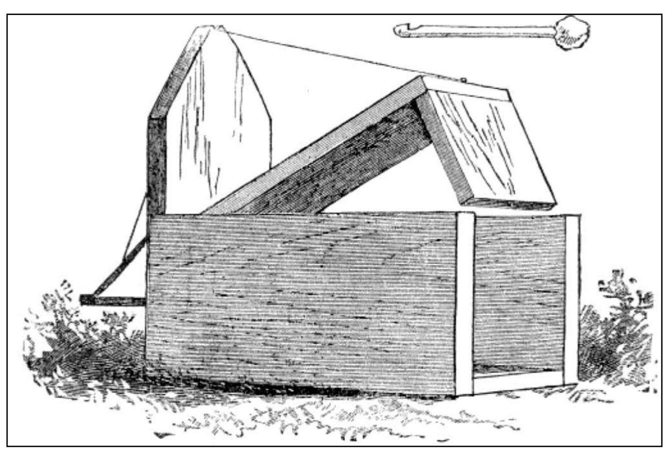
There is probably no more familiar example of the trap kind than that of the common wooden box-trap, better known, perhaps, by our country boys as the rabbit-trap. A glance at our illustration, will readily bring it to mind, and easily explain its working to those not particularly acquainted with it. These traps may be made of any size, but, being usually employed in catching rabbits, require to be made quite large. They should be made of hard seasoned wood—oak or chestnut is the best—and of slabs about an inch in thickness. The pieces may be of the following dimensions: let the bottom board be 20 × 7 in.; side board, 20 × 9 in.; lid board 19 × 7 in., and the end piece of lid 7 in. square.

The tall end piece should be about 16 inches high by 7 broad. Let this be sharpened on the upper end, as seen in the engraving, and furnished with a slight groove on the summit, for the reception of the cord. Now to put the pieces together.

Nail the two sides to the edge of the bottom board, and fit in between them the high end piece, securing that also, with nails through the bottom and side boards. Next nail the lid board on to the small, square end piece, and fit the lid thus made neatly into its place.

To make the hinge for the lid, two small holes should be bored through the sides of the trap, about four inches from the tall end, and half an inch from the upper edge of each board. Let small nails now be driven through these holes into the edge of the lid, and it will he found to work freely upon them.

The principal part of the trap is now made, but what remains to be done is of great importance. The "spindle" is a necessary feature in nearly all traps, and the box-trap is useless without it. In this case it should consist merely of a round suck of about the thickness of a lead pencil, and we will say, 7 or 8 in. in length. One end should be pointed and the other should have a small notch cut in it, as seen in the separate drawing of the stick. The spindle being ready, we must have some place to put it. Another hole should be bored through the middle of the high end piece, and about 4 in. from the bottom. This hole should be large enough to allow the spindle to pass easily through it. If our directions have been carefully followed, the result will now show a complete, closefitting trap.



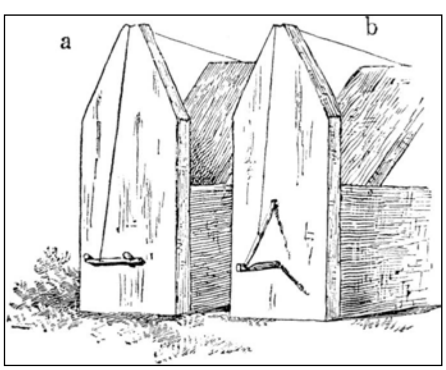
In setting the trap there are two methods commonly employed, as shown at *a* and *b*. The string, in either case, must be fastened to the end of the lid.

In the first instance (*a*) the lid is raised and made fast by the brace, holding itself beneath the tip of the projecting spindle, and a nail or plug driven into the wood by the side of the hole. Of course, when the spindle is drawn or moved from the inside the brace will be let loose and the lid will drop.

In the other method (*b*) the spindle is longer, and projects several inches on the outside of the hole. The brace is also longer, and catches itself in the notch on the end of the spindle, and another slight notch in the board, a few inches above the hole.

When the bait is touched from the inside, the brace easily flies out and the lid falls, securing its victim. Either way is sure to succeed, but if there is any preference it is for the former *(a)*. It is a wise plan to have a few holes through the trap in different places, to allow for ventilation, and it may be found necessary to line the cracks with tin, as sometimes the enclosed creature might otherwise gnaw through and make its escape. If there is danger of the lid not closing tightly when sprung, a stone may be fastened upon it to insure that result.

This trap is usually set for rabbits, and these dimensions are especially calculated with that idea. Rabbits abound in all our woods and thickets, and may be attracted by various baits. An apple is most generally used. The box-trap may be made of smaller dimensions, and set in trees for squirrels with very good success.

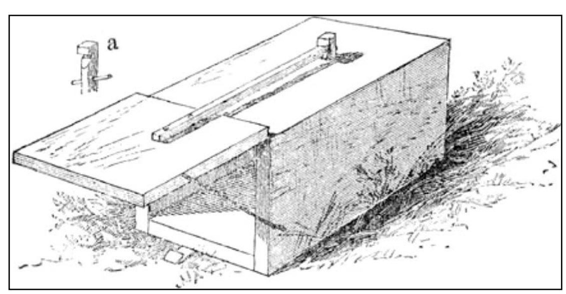


There is still another well known form of this trap represented in the tail piece at the end of this section. The box is first constructed of the shape already given, only having the lid piece nailed firmly in the lop of the box. The tall end piece is also done away with. The whole thing thus representing a simple oblong box with one end open. Two slender cleats should be nailed on each side of this opening, on the interior of the box, to form a groove into which a square end board may easily slide up and down, the top board being slightly sawn away to receive it. An upright stick should then be erected on the top centre of the box, in the tip of which a straight stick should be pivoted, working easily therein, like the arms of a balance. To one end of this balance, the end board should be adjusted by two screw eyes, and to the other the string with spindle attached. By now lowering the spindle to its place, the further end of the balance will be raised and with it the end board, and on the release of the spindle the board will fall. This plan is quite commonly adopted but we rather prefer the former. But as each has its advantages we present them both.

Another Box Trap

This works after the manner of the ordinary wire rat-trap; our illustration Must ration explains itself.

The box should be of the shape there shown, with one of its end pieces arranged on hinges so as to fall freely. An elastic should be fastened from the inside of this end to the inner surface of the top of

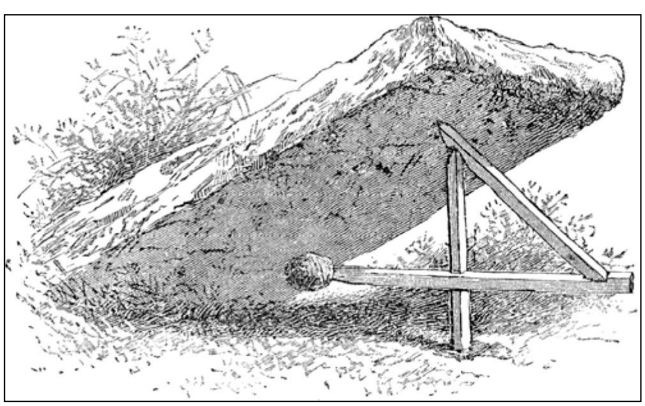


the box, to insure its closing. If desired, an elastic may be adjusted at the side as shown in the cut and a catch piece of stout tin should be attached to the bottom of the trap to secure the lid when it falls. A small hole should then be bored in the top, near the further end of the trap, and the spindle, having a notch on its upper end, passed through the hole thus made. The top of the spindle is shown at (*a*). It should be held in its place by a small plug or pin through it, below the surface of the box. A slender stick, long enough to reach and catch beneath the notch in the spindle should now be fastened to the lid and the trap is complete. It may be baited with cheese, bread, and the like, and if set for squirrels, an apple answers every purpose.

When constructed on a larger and heavier scale it may be used for the capture of rabbits and animals of a similar size, but for this purpose the previous variety is preferable.

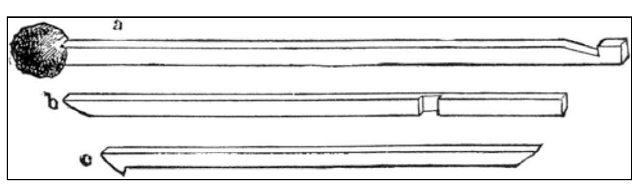
The Figure Four Trap

One of the most useful as well as the most ancient inventions in the way of traps is the common *Figure Four Trap,* which forms the subject of our next illustration. It is a very ingenious contrivance, and the mechanism, consists merely of three slicks, It possesses great advantages in the fact that it may be used in a variety of ways, and a number of the machines may be carried by the young trapper with very little inconvenience. Our illustration shows



the trap already set, only awaiting for a slight touch at the bait to bring the heavy stone to the ground. A box may be substituted for the stone, and the animal may thus be captured alive. The three sticks are represented separate at *a, b,* and *c.* Of course, there is no regular size for them, as this would greatly depend upon the purpose for which they are designed to be used. If fur rabbits, the following proportions will answer very well. The sticks should all be square, and about half an inch in thickness. The bait-stick, (*a*) should be about nine or ten inches in length, one end being pointed and the other furnished with a notch, as indicated. The upright stick, (*b*) should be a little shorter, one end being whittled to a rather sharp edge. At about three or four inches from the other end, and on the side next to that whittled, a square notch should be cut. This should be about a third of an inch in depth and half an incli in width, being so cut as exactly to receive the bait-stick without holding it fast. The remaining stick (*c*) should have a length of about seven or eight inches, one end being whittled, as in the last, to an edge, and the other end furnished with a notch on the same side, of the stick.

When these are finished, the trap may be set in the following manner: Place the upright stick, (*b*) with its pointed end uppermost. Rest the notch of the slanting stick, (*c*) on the summit of the upright stick, placing the stone upon its end, and holding the stick in position with the hand. By now hooking the notch in the bait-stick on the sharpened edge of the slanting stick and fitting it into the square notch in the upright, it may easily be made to catch and hold Itself in position. The bait should always project beneath the stone. In case a box is used instead of a stone, the trap may be set either inside of it or



beneath its edge. Where the ground is very soft, it would be well to rest the upright stick on a chip or small fiat stone, as otherwise it is apt to sink into the earth by degrees and spring by itself.

When properly made, it is a very sure and sensitive trap, and the bait, generally an apple, or "nub" of corn is seldom more than touched when the stone falls.

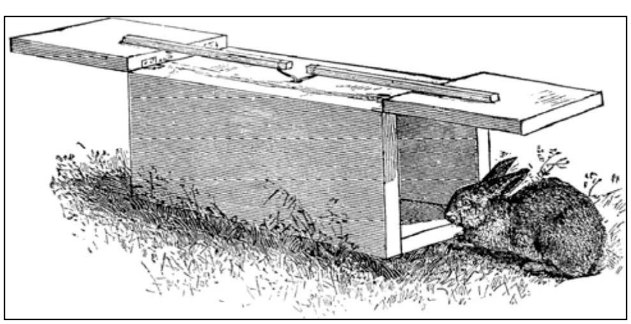
The "Double Enter"

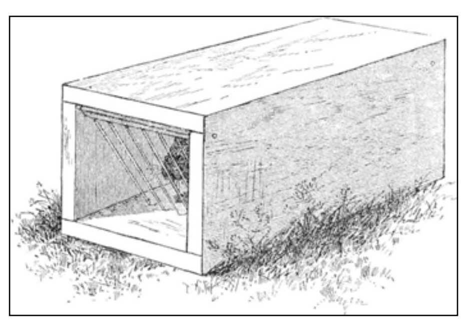
This is what we used to call it in New England and it was a great favorite among the boys who were fond of rabbit catching. It was constructed of four boards two feet in length by nine inches in breath secured with nails at their edges, so as to form a long square box. Each end was supplied with a heavy lid working on two hinges. To each of these lids a light strip of wood was fastened, the length of each being sufficient to reach nearly to the middle of the top of the box, as seen in the illustration. At this point a small auger hole was then made downward through the board. A couple of inches of string was next tied to the tip of each stick and supplied with a large knot at the end. The trap was then set on the simple principle of which there arc so many examples throughout the pages of this work. The knots were lowered through the auger hole and the insertion of the bait stick inside the box held them in place. The edge of the bottom board nn each end of the trap should be supplied with a tin catch such as is described on in order to hold the lid in place after it has fallen. No matter from which end the bait is approached it is no sooner touched than both ends fall and "*bunny*" is prisoner. Like many other of our four-footed game, the rabbit manifests a peculiar liking for salt and may be regularly attracted to a given spot by its aid. A salted cotton string is sometimes extended several yards from the trap for the purpose of leading them to it, but this seems a needless precaution, as the rabbit is seldom behind hand in discerning a tempting bait when it is within his reach.

The Self Setting Trap

One of the oldest known principles ever embodied in the form of a trap is that which forms the subject of the accompanying illustration. It is very simple in construction, sure in its action; and as its name implies, resets itself after each intruder has been captured.

It is well adapted for Rabits and Coons and when made on a small scale, may be successfully employed in taking rats and mice. It is also extensively used in the capture of the Mink and Muskrat, being set beneath the water, near the haunts of the animals and weighted by a large stone. Of course the size of the box will be governed by the dimensions of the game for which it is to be set. Its general proportions should resemble those of the illustration, both ends being open. A small gate, consisting of a square piece of wood supplied with a few stilf wires is then pivoted inside each opening, so as to work freely and fall easily when raised. The bait is fastened inside at the centre of the box. The animal, in quest of the bait, finds an easy entrance,





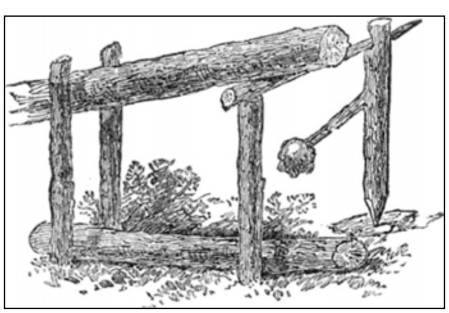
as the wires lift at a slight pressure, but the exit after the gate has closed is so difficult that escape is almost beyond the question.

The wires should be so stiff as to preclude the possibility of them being bent by struggles of the imprisoned creature in his efforts to escape, and to insure further strength it is advisable to connect the lower ends of the wires by a cross piece of finer wire, twisted about each.

The simultaneous capture of two rabbits in atrap of this kind is a common occurrence.

The Dead-Fall

In strolling through the woods and on the banks of streams in the country, it is not an uncommon thing to stumble against a contrivance resembling in general appearance our next illustration. Throughout New England, the "dead-fall," as this is called, has always been a most popular favorite among trappers, young and old; and there is really no better rough and ready trap for large game. To entrap a fox by any device is no easy matter; but the writer remembers one case where Reynard was outwitted, and the heavy log of the "dead-fall" put a speedy end to his existence. The trap was set in a locality where the fox had made himself a nuisance by repeated nocturnal invasions among the poultry, and the bait was cleverly calculated to decoy him. A live duck was tied within the pen, and the morsel proved too tempting for him to resist. Thrusting his head beneath the suspended log, in order to reach his prey, he thus threw down the slender framework of support; and the log, falling across his neck, put him to death.



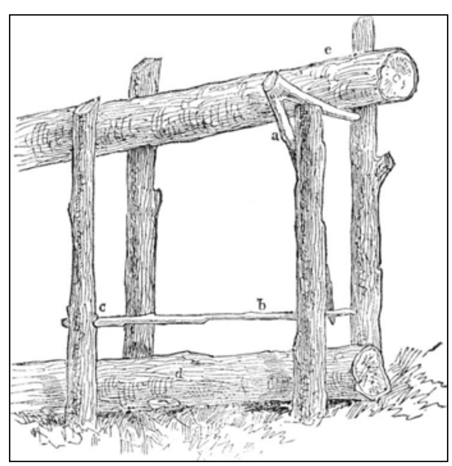
Our illustration gives a very correct idea of the general construction of the "dead-fall," although differing slightly in its mode of setting from that usually employed.

A pen of rough sticks is first constructed, having an open front. A log about seven or eight feet in length, and five or six inches in diameter, should then be procured. An ordinary fence rail will answer the purpose very well, although the log is preferable. Its large end should be laid across the front of the pen, and two stout sticks driven into the ground outside of it, leaving room for it to rise and fall easily between them and the pen, a second shorter log being placed on the ground beneath it, as described for the beartrap, page (17). A look at our illustration fully explains the *setting* of the parts. A forked twig, about a foot in length, answers for the bait-stick. The lower end should be pointed, and the fork, with its bait, should incline toward the ground, when set. The upper end should be supplied with a notch, square side down, and directly above the branch which holds the bait. Another straight stick, about fourteen inches in length, should then be cut. Make it quite flat on each end. A small thin stone, chip of wood, or the like, is the only remaining article required. Now proceed to raise the log, as shown in the drawing, place one end of the straight stick beneath it, resting its tip on the flat top of the upright stick on the outside of the log. The bait-stick should now be placed in position inside the inclosure, resting the pointed end on the chip, and securing the notch above, as seen in the illustration, beneath the tip of the flat stick. When this is done, the trap is set, but, there are a few little hints in regard to setting it finely,—that is, surely,—which will be necessary. It is very important to avoid bringing too much of the weight of the log on the flat stick, as this would of course bear heavily on the bait-stick, and render considerable force necessary to spring the trap. The leverage at the point where the log rests on the flat stick should be very slight, and the log should be so placed that the upright shall sustain nearly all the weight. By this method, very little pressure is brought to bear on the bait-stick, and a very slight twitch will throw it out of poise. The fork of the bait-stick should point to the side of the inclosure, as, in this case, when the bait is seized by the unlucky intruder, the very turning of the fork forces the notch from beneath the horizontal stick, and throws the parts asunder.

If the trap is set for muskrats, minks, skunks, or animals of similar size, the weight of the log will generally be found sufficient to effect their death; but, if desired, a heavy stone may be rested against it, or the raised end weighted with other logs to make sure. When set for a coon or fox, this precaution is necessary. To guard against the cunning which some animals possess, it is frequently necessary to cover the top of the pen with cross-slicks, as there are numerous cases on record where the intended victims have climbed over the side of the inclosure, and taken the bait from the inside, thus keeping clear of the suspended log, and springing the trap without harm to themselves. A few sticks or brandies laid across the top of the inclosure will prevent any such capers; and the crafty animals will either have to take the bait at the risk of their lives, or leave it alone. For trapping the moskrat, the bait may consist of carrots, turnips, apples, and the like. For the mink, a bird's head, or the head of a fowl, is the customary bait; and the skunk may usually be taken with sweet apples, meats, or some portion of a dead fowl.

In the case of the fox, which we have mentioned, the setting of the trap was somewhat varied; and in case our readers might desire to try a similar experiment, we will devote a few lines to a description of it. In this instance, the flat stick which supported the log was not more than eight inches in length; and instead of the bait-stick, a slight framework of slender branches was substituted. This frame or lattice-work was just large enough to fill the opening of the pen, and its upper end supported the flat stick. The duck was fastened to the back part of the pen, which was also closed over the top. The quacking of the fowl attracted the fox; and as he thrust his head through the lattice to reach his prey, the frame was thrown out of balance and Reynard paid the price of his greed and folly.

There is another mode of adjusting the pieces of the dead-fall, commonly employed by professional trappers, whereby the trap is sprung by the foot of the animal in quest of the bait. This construction is shown correctly in the accompanying cut, which gives the front view, the pen being made as before. The stout crotch represented at (*a*) is rested on the summit of a strong peg driven into the ground beneath the outside edge of the suspended log; (*b*) is the treacherous stick which seals the doom of any animal that dares rest his foot upon it. This piece should be long enough to stretch across and overlap the guard-pegs at each side of the opening. To set the trap, rest the short crotch of (*a*) on the lop of the peg, and lower the log upon it, keeping the leverage slight, as directed in our last example, letting much of the weight come on the top of the peg. The long arm of the crotch should be pressed inward from the front, and one end of the stick (*b*) should then be caught between its extreme tip, and the upright peg about ten inches above the ground. By now fastening



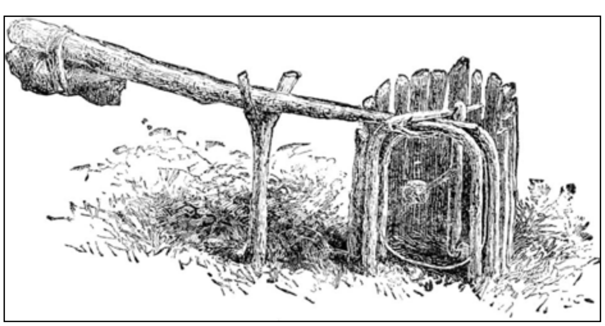
the bait to a peg at the back part of the pen, the affair is in working order, and will be found perfectly reliable. The ground log (*d*) being rested in place as seen in the illustration. To make assurance doubly sure, it is well to cut a slight notch in the upright stick at (*c*) for the reception of the foot-piece (*b*). By this precaution the stick, when lowered, is bound to sink at the right end, thus ensuring success.

The Figure-Four Trap, already described in another part of this book, is also well adapted to the dead-fall, and is much used. It should be made of stout pieces and erected at the opening of the pen, with the bait pointing toward the interior, the heavy log being poised on its summit.

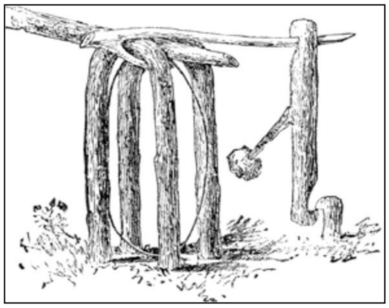
The Garrote

There is another variety of trap, somewhat resembling the dead-fall, but which seizes its prey in a little different manner. This trap, which we will call the *Garrote*, is trutily represented by our illustration. A pen is first constructed, similar to that of the dead-fall. At the opening of the pen, two arches are fastened in the ground. They should be about an inch apart. A stout forked stick should then be cut, and firmly fixed in the earth at the side of the arches, and about three feet distant.

Our main illustration gives the general appearance of the trap, but we also subjoin an additional cut, showing the "setting" or arrangement of the pieces. They are three in number, and consist: First, of a notched peg, which is driven into the ground at the back part of the pen, and a little to one side. Second, of a forked twig, the branch of which should point downward with the bait attached to its end. The third stick being the little hooked piece catching beneath the arches. The first of these is too simple to need description. The second should be about eight inches long; a notch should be cut in each end. The upper one being on the side from which the branch projects, and the other on the opposite side of the stick, and at the other end, as is made plain by our illustration. The third stick may consist merely of a hooked crotch of some twig, as this is always to be found. Indeed, nearly *all* the parts of this trap may be found in any woods; and, with the exception of a jack-knife, bait, and string, the trapper need not trouble himself to carry any materials whatever. When the three pieces are thus made the trap only awaits the "Garrote." This should be made from a stiff pole, about six feet in length, having a heavy stone tied to its large end, and a loop of the shape of the letter U, or a slipping noose, made of stout cord or wire, fastened at the smaller end. To arrange the pieces for their destructive work, the pole should be bent down so that the loop shall fall between the arches. The "crotch stick" should then be hooked beneath the front of the arch, letting its arm point inward. After this the bait stick should be placed in its position, with the bait pointing downward, letting one end catch beneath the notch in the ground-peg, and the other over the tip of the crotch stick. This done, and the trap is set.



Like the dead-fall, the bait stick should point toward the side of the pen, as the turning involved in pulling it toward the front is positively sure to slip it loose from its catches. Be careful to see that the loop is nicely arranged between the arches, and that the top of the pen is covered with a few twigs. If these directions are carefully followed, and if the young trapper has selected a good trapping ground, it will not be a matter of many days before he will discover the upper portion of the arches occupied by some rabbit, muskrat, or other unlucky creature,

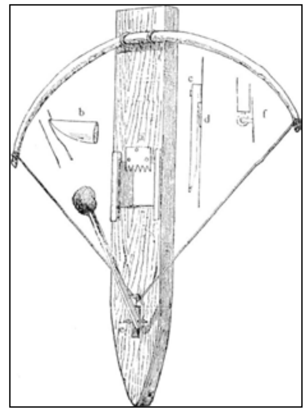


either standing on its hind legs, or lifted clean off the ground. Coons are frequently secured by this trap, although, as a general thing, they don't show much enthusiasm over traps of any kind, and seem to prefer to get their food elsewhere, rather than take it off the end of a bait stick.

The Bow Trap

This most excellent and unique machine is an invention of the author's, and possesses great advantages, both on account of its durability and of the speedy death which it inflicts.

Procure a board about two feet in length, by five or six in width, and commencing at about nine inches from one end, cut a hole four or more inches square. This may readily be done with a narrow saw, by first boring a series of gimlet holes in which to insert it. There will now be nine inches of board on one side of the hole and eleven on the other. The shorter end constituting the top of the trap. On the upper edge of the hole a row of stout tin teeth should be firmly tacked, as seen in the illustration. On the other side of the cavity, and three inches from it a small auger hole (the size of a lead pencil), should be bored. After which it should be sand-papered and polished on the interior, by rubbing with some smooth, hard tool, inserted inside. A round plug of wood should next be prepared. Let it be about half an inch in length, being afterwards bevelled nearly the whole length of one side, as shown at (*b*), leaving a little over an eight of an inch of the wood unwhittled. This little piece of wood



is the most important part, of the trap, and should be made very carefully. The remaining end of the board below the auger hole should now be whittled off to a point, in order that it may be driven into the ground. The next requisites consist of two pieces of wood, which are seen at the sides of the square hole, in our illustration, and also seen at (*c*), side view. These pieces should be about six inches in length and about an inch square. A thin piece being cut off from one side of each, to the distance of four inches, and ending in a square notch. The other end should be rounded off, as is also there plainly indicated. Before adjusting the pieces in place, two tin catches should be fastened to the board, one on each side of the hole. This catch is shown at (*d*), and consists merely of a piece of tin, half an inch in width, and three-quarters of an inch in length, tacked to the wood, and having its end raised, as indicated. Its object is to hold the bow-string from being pulled down after once passing it. The upper edge of these catch-pieces should be about an inch and a half from the top of the hole, and, if desired, two or three of them may be arranged one above the other, so that wherever the string may stop against the neck of the inmate it will be sure to hold. The catches being in place, proceed to adjust the pieces of wood, letting the notch be on a line with the top of the pole, or a little above it. Each piece should be fastened with two screws to make secure.

We will now give our attention to the bait stick. This should be about six inches in length, and square, as our illustration shows. There are two ways of attaching the bait-stick to the board, both shown at (*e*) and (*f*). The former consists merely of a screw eye inserted into the end of the stick, afterwards hinged to the board by a wire staple. The point for the hinge, in this case, should be about an inch below the auger hole. In the other method (*f*), the bait stick should be a half inch longer, and the spot for the hinge a quarter inch lower. At about a quarter of an inch from the square end of the bait stick a small hole should be made by the use of a hot wire. An oblong mortice should next be cut in the board, so as to receive this end of the stick easily. A stout bit of wire should then be inserted in the little hole in the stick, and laying this across the centre of the mortice, it should be thus secured by two staples, as the drawing shows. This forms a very neat and simple hinge. To determine the place for the catch, insert the flat end of the little plug fairly into the auger-hole above the hinge. Draw up the bait stick, and at the point where it comes in contact with the point of the plug, cut a square notch, as shown in (*b*). Everything now awaits the bow. This should be of hickory or other stout wood; it is well to have it seasoned, although a stout sapling will answer the purpose very well. It should be fastened to the top of the board by two heavy staples, or nails driven on each side of it. The string should be *heavy* Indian twine. Our illustration shows the trap, as it appears when ready for business. The plug is inserted, as already described, with the bevelled face downward, and square end in the hole. Draw down the bow-string and pass it beneath the plug, at the same time catching the tip of the latter in the notch of the bait stick. If properly constructed the string will thus rest on the slight uncut portion of the under side of the peg, and the trap is thus set. If the bait is pushed when approached, the notch is forced off from the plug, and the string flies up with a *twang!* securing the neck of its victim, and producing almost instant death. If the bait is pulled, the bait stick thus forces the plug into the hole in the board, and thus slides the cord on to the bevel, which immediately releases it, and the bow is sprung. So that no matter whether the bait is pushed or drawn towards the front, the trap is equally sure to spring.

In setting this curious machine, it is only necessary to insert it into the ground, and surround the bait with a slight pen, in order that it may not be approached from behind. By now laying a stone or a pile of sticks in front of the affair, so that the bait may be more readily reached, the thing is ready. Care is required in setting to arrange the pieces delicately. The plug should be very slightly inserted into the auger hole, and the notch in the bait stick should be as small as possible, and hold. All this is made clear in our illustration (*b*).

By observing these little niceties the trap becomes very sure and sensitive.

Bait with small apple, nub of corn, or the like.

The Mole Trap

If there is any one subject upon which the ingenuity of the farmers has been taxed, it is on the invention of a mole trap which would effectually clear their premises of these blind burrowing vermin. Many patented devices of this character are on the market, and many odd pictured ideas on the subject have gone the rounds of the illustrated press, but they all sink into insignificance when tested beside the trap we here present. It has no equal among mole traps, and it can be made with the utmost ease and without cost. The principle on which it works is the same as the Fish Trap on.

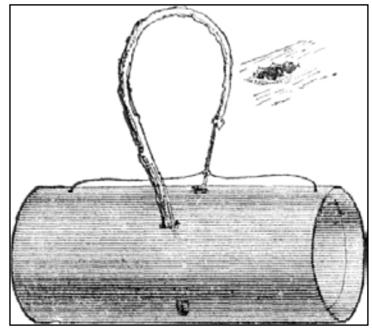
Construct a hollow wooden tube about five inches in diameter, and eight inches in length. A section of a small tree, neatly excavated with a large auger is just the thing. Through the centre of one of the sides a small hole the size of a lead pencil should be bored, this being the upper side. About half an inch distant from each end a smaller hole should be made for the passage of the noose. The spring should consist either of a stout steel rod, whalebone or stiff sapling, a foot or more in length, inserted downward through holes in the side of the tube after the manner of the Fish Trap already alluded to. No bait is required. A simple stick the size of the central hole at one end, and an inch in width at the other being sufficient. The trap is set as described in the other instances, and as the introduction of the spindle-stick is sometimes attended with difficulty owing to its position inside the trap, the bottom of the latter is sometimes cut away for two or three inches to facilitate the operation. The trap is then to be imbedded within the burrow of the mole. Find a fresh tunnel and carefully remove the sod above it. Insert the trap and replace the turf. The first mole that starts on his rounds through that burrow is a sure prisoner, no matter from which side he may approach.

Immense numbers of these troublesome vermin have been taken in a single season by a dozen such traps, and they possess great advantages over all other mole traps on account of their simplicity and unfailing success.

A Fish Trap

Our list of traps would be incomplete without a Fish Trap, and although we have mentioned some contrivances in this line under our article on "Fishing" we here present one which is both new and novel.

Its mode of construction is exactly similar to the Double Box Snare. A section of stove-pipe one foot in length should first be obtained. Through the iron at a point equidistant from the ends, a hole should be made with some smooth, sharp pointed instrument, the latter being forced outward from the inside of the pipe, thus causing the ragged edge of the hole to appear on the outside, as seen in our illustration. The diameter of the aperture should be about that of a lead pencil, Considering this as the upper side of the pipe, proceed to pierce



Maternal advice

two more holes downward through the side of the circumference, for the admission of a stout stick or steel rod. This is fully explained in our illustration. The further arrangement of bait stick and nooses is exactly identical with that described on It may be set for suckers, pickerel, and fish of like size, the bait stick being inserted with sufficient firmness to withstand the at tacks of smaller fish. The bait should be firmly tied to the stick, or the latter supplied with two hooks at the end on which it should be firmly impaled. To set the trap, select a locality abounding in fish. Place a stone inside the bottom of the pipe, insert the bait stick and arrange the nooses.

By now quietly grasping the curve of the switch the trap may be easily lowered to the bottom. The bait soon attracts a multitude of small fishes; these in turn attract the pickerel to the spot, and before many minutes the trap is sprung and may be raised from the water with its prisoner. This odd device is an invention of the author's, and it is as successful as it is unique.

The Dead-Fall, Sliding Pole, Clog, Spring Pole, and Balance Pole

In the early days before the steel trap came into general use, the dead-fall and the snare were used almost exclusively for the capture of the fur-bearers, but at present when steel traps have reached a high state of perfection, are sold at prices which place them within the reach of all, they are preferred by most trappers and many of the most expert have discarded the wooden traps entirely. However, both the dead-fall and the snare are good traps for certain animals and it is well to know how to make and use them for one may sometimes see a good place in which to place a trap but may not have a steel trap along. In such cases the knowledge of how to construct a practical dead-fall will be of value. It is true that many of the fur-bearing animals are too cunning to be captured by such a contrivance but some of the most wary fall easy victims to the snare. Some of the most expert fox trappers use the snare in preference to the steel trap but the number is comparatively small.

The dead-fall can be made anywhere, with an axe and hard work. It consists of two large poles (or logs when set for bears and other large animals) placed one over the other and kept in place by four stakes, two on each side. The upper pole is raised at one end high enough above the lower to admit the entrance of the animal, and is kept up in that position by the familiar contrivance of the stick and spindle, or "figure four." A tight pen is made with sticks, brush, etc., on one side of this structure at right angles to it, and the spindle projects obliquely into this pen, so that the bait attached to it is about eight inches beyond the side of the pole. The animal, to reach the bait, has to place his body between the poles at right angles to them, and on pulling the spindle, springs the "figure four," and is crushed.

The objections to this contrivance are, first, that it takes a long time to make and set one, thus wasting the trapper's time, and second, the animals caught in this way lie exposed to the voracity of other animals, and are often torn to pieces before the trapper reaches them, which is not the case when animals are caught in steel traps, properly set, as will be shown hereafter. Moreover, the dead-fall is uncertain in its operation, and woodsmen who have become accustomed to good steel traps, call it a "miserable toggle," not worth baiting when they find one ready-made in the woods.

Poisoning

The objection to this method is that it spoils the skin. Furriers say that the poison spreads through the whole body of the animal, and kills the life of the fur, so that they cannot work it profitably. Poison is used very little by woodsmen at the present time, and dealers dislike to buy or handle skins that have been poisoned.

Shooting

This method of killing fur-bearing animals is still quite prevalent in some countries. It is said to be the principal method in Russia, and is not altogether disused in this country. But it is a very wasteful method. Fur dealers and manufacturers consider skins that have been shot, especially by the shot-gun, as hardly worth working. The holes that are made in the skin, whether by shot or bullets, are but a small part of the damage done to it. The shot that enters the body of the animal directly are almost harmless compared with those that strike it obliquely, or graze across it. Every one of these grazing shots, however small, cuts a furrow in the fur, sometimes several inches in length, shaving every hair in its course as with a razor. Slits in the skin have to be cut out to the full extent of these furrows, and closed up, or new pieces fitted in. Hence when the hunter brings his stock of skins to the experienced furrier, he is generally saluted with the question, "Are your furs shot or trapped?" and if he has to answer, "They were shot," he finds the dealer quite indifferent about buying them at any price.

Steel Traps

Many styles of traps have been invented and some of the most promising styles were placed on the market but it is doubtful if any trap will ever be designed which will equal in popularity and general usefulness the old time jaw trap, commonly known as the "steel trap". These traps have been improved in many ways until at present they are almost perfect and are made in sizes and styles to meet all requirements and all conditions of trapping.

The jaw traps possess decided advantages over all other styles of steel or wooden traps. They will capture the most wary animals as well as the most stupid and will work perfectly under all conditions whether set in the water or on dry land, on the snow or on a log or stump or the side of a tree. They may be used with or without bait and if the proper size of trap is used and it is set in the right way it will capture almost any animal that comes that way. What other style of trap possesses all of these advantages?

The experience of modern trappers, after trying all other methods, and all kinds of new fashioned traps, has led them almost unanimously to the conclusion that the old steel trap, when scientifically and faithfully made, is the surest and most economical means of capturing fur-bearing animals. Some of the reasons for this conclusion are these: Steel traps can be easily transported; can be set in all situations on land or under water; can be easily concealed; can be tended in great numbers; can be combined by means of chain and ring with a variety of contrivances (hereafter to be described) for securing the animal caught from destruction by other animals, and from escape by self-amputation; and above all, the steel trap does no injury to the fur.

Requisites of a Good Trap

The various sizes of traps adapted to different kinds of animals, of course require different forms and qualities, which will be spoken of in the proper places hereafter. But several of the essentials are the same in all good traps.

1. *The jaws should not be too thin, nor sharp cornered.* Jaws made of sheet iron, or of plates approaching to the thinness of sheet iron, and having sharp edges, will almost cut off an animal's leg by the bare force of the spring, if it is a strong one, and will always materially help the animal to gnaw or twist off his leg. And it should be known, that nearly all the animals that escape, get free in these ways.
2. *The pan should not be too large.* A large pan, filling nearly the whole space of the open jaws may seem to increase the chances of an animal being caught, by giving him more surface to tread upon in springing the trap. But there is a mistake in this. When an animal springs the trap by treading on the outer part of a large pan, his foot is near the jaw, and instead of being caught, is liable to

be thrown out by the stroke of the jaw; whereas, when he treads on a small pan, his foot is nearly in the center of the sweep of the jaws, and he is very sure to be seized far enough up the leg to be well secured.

3. *The spring should be strong enough.* This is a matter of good judgment, and cannot well be explained here; but it is safe to say that very many traps, in consequence of false economy on the part of manufacturers, are furnished with springs that are too weak to secure strong and desperate animals.
4. *The spring should be tempered scientifically*. Many springs, in consequence of being badly tempered, "give down" in a little while, *i e.,* lose their elasticity and close together; and others break in cold weather, or when set under water.
5. *The spring should be correctly proportioned and tempered.* Without this, the stronger it is and the better it is tempered, the more liable it is to break.
6. *The form of the jaws must be such as to give the bow of the spring a proper inclined plane to work upon.* In many traps, the angle at the shoulder of the jaws is so great, that even a strong spring will not hold a desperate animal.
7. To make-a steel trap lie flat so that it can be hidden nicely, turn the spring around toward the jaw that is fastened, and then pull the loose jaw down.
8. *The jaws must work easily on the posts.* For want of attention to this, many traps will not spring.
9. *The adjustments of all the parts and their actual working should be so inspected and tested that every trap shall be ready for use—"sure to go," and sure to hold.*

German and English traps are almost universally liable to criticism on all points above mentioned and many of the traps made in this country fail in one or more of them.

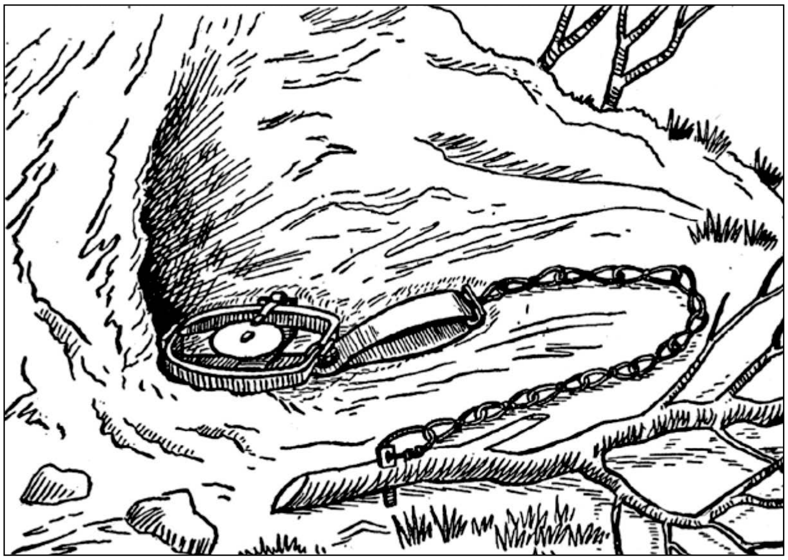
In addition to the foregoing requisites, every trap should be furnished with a stout chain, with ring and swivel. It is important that the swivel should be well made so that the eyes will turn freely; otherwise, the animal caught may escape by twisting off either his leg or the chain.

As most of those who have never done any trapping know practically nothing regarding the use of traps, I will outline briefly the methods usually employed for the capture of fur-bearing animals before proceeding farther.

Most of the animals which are caught in traps are decoyed by means of bait—something in the line of food which appeals to its appetite—so placed that in attempting to reach it the animal places its foot in the trap. The most common way is by setting the trap in the entrance to some natural enclosure, such as a hollow log or stump, a hollow between trees, or a hole in the rocks, or under a stump the bait being placed in the enclosure beyond the trap. Failing to find a natural enclosure, the trapper constructs one, using such material as may be found on the spot. It is advisable as a rule to make as little disturbance as possible and to give the enclosure a natural appearance.

It sometimes happens that an animal can not be induced to approach bait and in such cases the "blind set" is resorted to,—in other words the trap is set without bait in a trail where the animal travels or at the entrance of its den. Failing to find such a place the trapper carefully studies the route of the animal and selects a place where some natural or artificial obstruction will crowd it into a certain spot where he carefully sets his trap in such a way as to catch the animal the next time it comes along. These blind sets are as a rule very successful and many trappers use such methods exclusively.

In setting steel traps, great care is advised for the one who learns to do this most neatly, leaving everything natural is, as a rule, the most successful. One should always be certain to get the trap in the right position for to miss catching an animal not only means its loss for the time being but many of



Trap Set in Correct Position at Entrance of Den.

them will become wiser from such experiences and their capture will be more difficult afterwards. The trapper is wise also who gives sufficient attention to the fastening of the trap, thus reducing the animal's chances of escape after it is once caught.

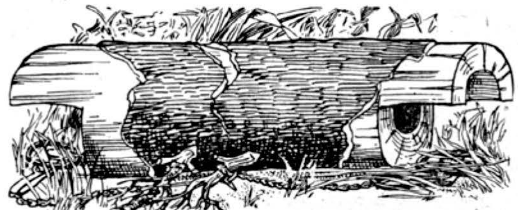
To properly set a steel trap on dry land one should dig a "nest" for the trap, deep enough to allow the cover ing to be flush with the surroundings and just a little larger than, and of the same shape as the trap when set. This hollow should be lined with dry leaves or moss and the trap placed therein. To make the trap rest solidly so that there is no danger of it being tipped over also to make the jaws set level, the spring should be twisted around towards the jaw which is held down by the trigger or "dog". The trap should then be covered with some light, dry material in keeping with the surroundings, a few dead leaves or a sheet of paper being used first to prevent the covering from rolling under the pan and in that way prevent the trap from springing. Instead of doing this some trappers place a bunch of cotton or dry moss under the pan but I do not think this advisable.

In all cases when setting traps at dens, on trails or at the entrances of enclosures, the trap should be so placed that the jaws will be lengthwise of the animal's approach so that it will step between the jaws and not over one of them. If the setting is reversed the rising jaw will sometimes throw the animal's foot out of the trap.

The Sliding Pole

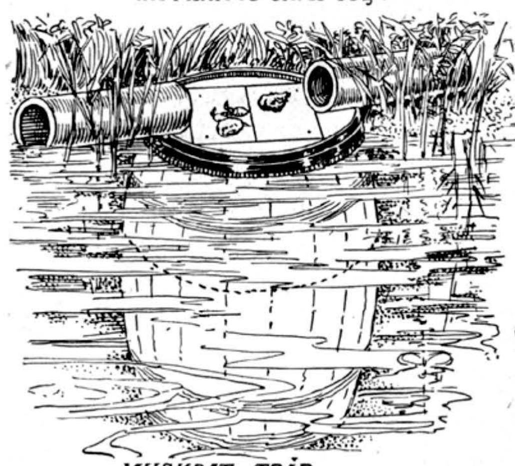
There are various good methods of fastening and the proper one to use depends on the nature of the surrounding and the species of animal that one is setting for. Water animals should be drowned as quickly as possible after they are caught and in order to secure this result the "sliding pole" is used.

Animals of aquatic habits, when caught in traps, invariably plunge at once into deep water; and it is the object of the trapper, availing himself of this plunge, to drown his captive as soon as possible, in order to stop his violence and keep him out of the reach of other animals. The weight of the trap and chain is usually sufficient for this purpose in the case of the Muskrat. But in taking the larger amphibious animals, such as the Beaver, the trapper uses a contrivance which is called the sliding pole. It is prepared in the following manner: Cut a pole ten or twelve feet long, leaving branches enough on the small end to prevent the ring of the chain from slipping off. Place this pole near where you set your trap, in an inclined position, with its small end



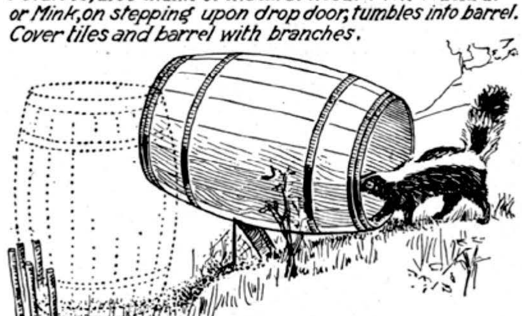
HOLLOW LOG with 2 STEEL TRAPS HOUSED. Protects traps from weather and invites the Mink to enter log.

MINK, MARTEN or WEASEL TRAP. 2 inch hole. 4 horse shoe nails. Use bait.

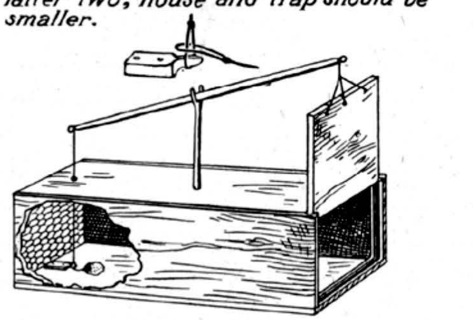


MUSKRAT TRAP.
Sink water tight barrel on edge of Lake where their houses are numerous, so as to protrude 3 to 4 inches above water level. Arrange two 5 inch tiles also trap doors as per illustration. Bait with Parsnips, Potatoes, also chunk of muskrat meat. The Muskrat or Mink, on stepping upon drop door, tumbles into barrel. Cover tiles and barrel with branches.

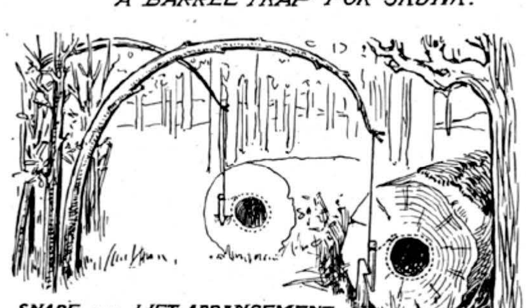
STEEL TRAP SET FOR LYNX.
Used also for Marten and Mink; if for latter two, house and trap should be smaller.



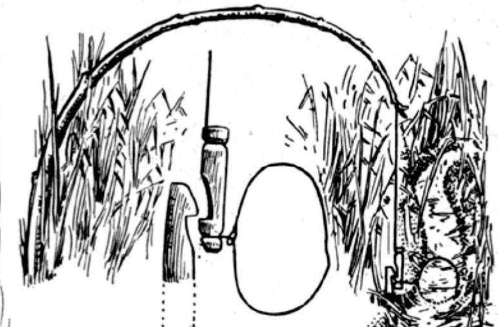
A BARREL TRAP FOR SKUNK.



TO CATCH LIVE ANIMALS FOR BAIT, OR RABBITS.



SNARE AND LIFT ARRANGEMENT.
Good for Mink, Marten and Raccoon.
Use bait.



A SNARE AND SPRING POLE.

reaching into the deepest part of the stream, and its large end secured at the bank by a hook driven into the ground. Slip the ring of your chain on to this pole, and see that it is free to traverse down the whole length. When the animal is taken it plunges desperately into the region toward which the pole leads. The ring slides down to the end of the pole at the bottom of the stream, and, with a short chain, prevents the victim from rising to the surface or returning to the shore.

In order to make this outfit more certain when setting for large animals such as otters and beavers, a stone of six or eight pounds should be tied firmly to the chain but not near enough to the trap to interfere with the action of the swivel.

In trapping for muskrats and mink the usual practice is to simply stake the trap the length of the chain into the deepest water available, the weight of the trap being sufficient to hold the animal under water.

The Clog

Some powerful and violent animals, if caught in a trap that is staked fast, will pull their legs off, or beat the trap in pieces; but if allowed to drag the trap about with moderate weight attached, will behave more gently, or at least will not be able to get loose for want of purchase. The weight used in such cases is called a clog.

This is simply a chunk of wood, a pole, brush or stone, the object being to hamper the animal in its movements and prevent it from getting a dead pull on the trap and chain. In fastening to the clog the staple may be used or the chain may be dropped through the ring so as to form a loop which is slipped over the clog, a few snags being left stand to prevent the chain from being drawn over the end. When setting for bears the ring is slipped over the clog—a pole—and fastened with a spike or wedge. Some trappers prefer to use a pronged iron drag and this is especially desirable when trapping for the more cunning animals such as the fox, coyote and wolf as the drag may be covered without leaving much sign. A stone may be used in the same manner by securing with wire to the end of the chain.

For the animals mentioned the traps are sometimes staked down solidly, the stake being driven out of sight but this gives the animal a dead pull and they will sometimes escape.

As the object of it is to encumber the animal, but not to hold it fast, the chain should be attached to it near one of its ends, so that it will not be likely to get fast among the rocks and bushes for a considerable time.

The Bush Clog for Foxes and Some Other Animals

Some experienced trappers recommend fastening a fox trap to the butt of a suitable bush cut for the purpose, as a better clog than a pole, intending that the Fox should be able to drag it a short distance. He will not go very far with it, and another trap can then be set in the same place where he was caught. One trapper claims that he caught eight Foxes in one season in a cattle path, and in the same trap-bed, by this method.

The Spring Pole

In taking several kinds of land animals, such as the Marten and Fisher, it is necessary to provide against their being devoured by other animals before the trapper reaches them, and also against their gnawing off their own legs, or breaking the chain of the trap by violence. The contrivance used for this purpose is called a *spring pole,* and is prepared in the following manner: If a small tree can be found standing near the place where your trap is set, trim it and use it for a spring as it stands. If not, cut a pole of sufficient size and drive it firmly into the ground; bend down the top; fasten the chain ring to it; and fasten the pole in its bent position by a notch or hook on a small tree or stick driven into the ground. When the animal is caught, his struggles, pulling on the chain, unhook the pole, which, flying up with a jerk, carries him into the air, out of the reach of prowlers, and in a condition that disables his attempts to escape by self-amputation or other violence. The size of the pole must be proportioned to the weight of the game which it is expected to lift.

In theory this device works nicely but in practice it is not found to be perfect as the wood will lose its "spring" if kept beat for some time, especially in freezing weather. The balance pole is more faithful in its action.

The Balance Pole

In some cases where no sapling grows near the place where you wish to set a trap, such as could be used for a spring pole, a balance pole can be rigged. Get a suitable pole and pass it through the fork of a tree or a forked stake driven in the right spot. Fasten a weight to the end opposite the trap, and then elevate this weight by fastening down the trap end of the pole so that it will be released by the struggles of the animal when caught, when the weight will throw both animal and trap in the air.

Weighted Cord

In some situations the same result as the above can be obtained by running a weighted cord or wire over a hook, a nail, or a branch of a tree, fastening the trap to the other end. The main thing is to see that it will work easily and smoothly and the weight not fall off.

Rule for Baiting

There is one general principle in regard to baiting animals that may as well be recorded and explained here, as it is applicable to all cases. It is this: Never put bait on the pan of the trap. The old-fashioned traps were always made with holes in the pan for strings to tie on bait; and many if not most novices in trapping, imagine that the true way is to attract the animal's nose straight to the center of action, by piling bait on the pan, as though it were expected to catch him by the head. The truth, however, is that animals are very rarely taken by the head or the body, but almost always by the leg.

The balance pole

When an animal pulls at a bait on the pan of the trap, he is not likely even to spring the trap, for he lifts in the wrong direction; and if he does spring it, the position of his head is such, especially if the bait is high on the pan, that he is pretty sure to give the jaws the slip. Besides, bait on the pan calls the attention of the wary animal to the trap; whereas he ought to be wholly diverted from it, and all signs of it obliterated. Bait should always be placed so that the animal in attempting to take it shall put a foot on the pan. This can be done in several ways, all of which will be explained in detail hereafter. But this general direction can be given for all cases that are not otherwise prescribed for: Place the bait either on a stick above the trap, or in an enclosure so arranged that the animal will have to step in the trap to reach it.

Deer Hunting Tips

BY STEPHEN D. CARPENTERI

Regardless of the phase of the rut, deer are creatures of thick brush and dense cover. They like to use hedgerows, forest edges and waterway borders to move between feeding and bedding areas. In general, if you can't see through it and it's too thick for hunters to move around in it without making a lot of noise, it's perfect for deer.

Some hunters are able to walk into unknown woods at dawn on opening day with no advance preparation and they will shoot a deer. It happens all the time. One hunter I know had one day to hunt and asked me about a good spot. I gave him some directions to a local wildlife management area I was familiar with and, later that week, he went there, walked in before daylight to a place he'd never seen, climbed into his tree stand and, by noon, had three deer on the ground! He might have shot more (the limit was five deer at the time and is now up to 12 deer!) but he ran out of arrows!

Now, I have hunted that same spot many times and have seen a few deer there, but this just illustrates the fact that luck has a lotto do with hunter success. In other words, don't be afraid to go with your gut feeling when it comes to picking a stand site. Any place can be "the place" when it comes to deer hunting.Your odds for success are higher if you go with what is known about deer behavior and habitat, but there is no reason you can't wander down the middle of an old woods trail at high noon swigging a cold soda, as happened to me when I shot my first deer!

That said, there are some odds-on choices the hunter can make when selecting places to hunt. The options are endless, of course, because deer will, over the course of their lifetime, utilize nearly every inch of their home territory. In good deer country, you can find tracks and other signs everywhere you look—in the woods, along the highway, beside the lake, on lawns, in gardens. Deer are mobile, curious and reactionary—a chance encounter with another hunter, a coyote or a dog will send them bounding for the hillsides, perhaps right into your lap!

Field Edges

In early fall, field edges are ideal places to find deer, especially in late afternoon. Many hunters pick a stand close to or within the thin brush within sight of the open field or pasture, and often they will get a shot at deer that have entered the field. However, the better choice is to select a stand site inside the woods on trails approaching the field. The reason is that deer will come to the field from distant bedding areas and often linger in the shadows away from the field edge until nearly dark. If you're set up along a deer trail leading to the field and some distance away, you're more likely to

see deer as they come to the field or pause nearby to wait for darkness to fall.

Most often, deer enter fall fields in low corners, high knolls or in low, swampy areas—wherever hunters are least likely to be because conditions, visibility or the wind favor the deer's approach. Expect them to come into a field slowly, tentatively and on high alert, does and fawns first, followed (sometimes!) by the bigger bucks.

In general, the best field stand sites are with the sun at your back and the wind in your face, but deer are not often fooled by conditions that favor the hunter. Their counterattack invariably includes coming into a field with the sun at their backs and the wind in their faces, so they can see or smell danger on the way into the open field. Deer have been dodging danger for thousands of years and they are very good at it!

The game, of course, is to pick the ideal spot so that you can see the area around you clearly yet the deer can come in without detecting your presence. Finding each field's "sweet spot" may take several trips, and in most cases you will make plenty of mistakes before you find out where the deer like to enter or leave a field using the surrounding brushy cover.

Hedgerows

The brushy strips of cover that separate fields from each other, border urban back yards or that surround creeks and ponds are ideal travel lanes for deer. In many areas of the Mid-West, for example, hedgerow hunting is the name of the game. Deer feed in the open crop fields, bed in big blocks of woods and travel to and from these areas via hedgerows and strips of brush and saplings.

Good stand sites include areas where:

- Woods and hedgerows meet
- Short breaks in the hedgerow cover (access roads, bar-ways and gates)
- Where the hedgerows narrow down to thin strips of cover near water, swamps and fallow land

There are invariably many well-used deer trails inside hedgerow cover, and these will give hunters some good ideas about where to place stands for specific situations. Wind is not so much of a concern here because the cover is thin and deer will not break from the protection of the brush unless serious danger threatens. If the wind is blowing directly down or up the hedgerow, the deer will have the advantage unless you can utilize a tree stand that puts you above the prevailing breezes.

Water Crossings

Water in any form (streams, rivers, lakes or ponds) surrounded by woods or brush offer ideal places to hunt for deer. Not only are these areas generally undeveloped, brushy and wooded, they are usually in areas where deer are naturally funneled to or around them by the topography of the land. There is normally higher ground around water (because water generally lays or flows in the lowest areas of a region), and deer moving to and from the higher elevations will cross or skirt waterways in areas that are convenient to them.

Water crossings are easy to find. Simply hike along any brook or stream or skirt the edges of a lake or pond, and you will find deer tracks and trails

that converge on the areas that are most convenient to cross—areas of low water, strips of thicker cover, peninsula bases or the like. In most cases, hunters will find that deer cross in the same places hunters would cross—deer are remarkably similar to us in their desire to make things easier on themselves!

Stand placement is simple enough when hunting such crossings. Build a blind or place a tree stand in such a way that the crossing or its approaches are in range, downwind and such that the sun will not be in your eyes at prime dawn and dusk hunting times.

Road Crossings

If you drive a car, you've seen "deer crossing" signs. These are probably the best indication of where deer can be found in any area because the number of car-deer accidents were so high in those areas that signs were placed to warn motorists. Because generation after generation of deer use the same natural crossings (until or unless the topography of the land is drastically altered by major airport, industrial park or subdivision construction), places where "deer crossing" signs are placed make excellent stand locations.

Of course, hunters should always seek landowner permission to hunt, install stands or build blinds, and this may not always be possible at every deer crossing in North America. However, such crossings exist by the thousands, wherever paved roads are found. Study a topographic map of the region, note the flow of the land, the things that make deer use these crossings (cover types, waterways, land elevations) and find a place that meets all of the hunter's requirements: Lots of deer activity, easy access, plenty of potential stand or blind locations.

The ideal road crossing is a narrow strip of cover or lowland topography that naturally funnels deer from one side of the road to the other, normally from woodlots to crop fields, pastures or other food sources. They may also consist of travel lanes deer use to avoid human activity or bypass open country. Scouting will reveal the heaviest travel lanes.

When a "deer crossing" seems to be nothing more than a wide, flat expanse of featureless country, such as the middle of a vast cornfield, swamp or other open area, simply examine a map or drive around the area till you find thick cover, topographic changes or other funneling sources where you can begin your quest for a stand site.

Keep in mind that some of the best road crossings can be the worst places to hunt from an aesthetic point of view. Forget the "wilderness" aspect of deer hunting—often, these crossings are near busy highways, roads or developments where human activity is loud and distracting. It is often the greater test of the hunter's mettle to remain focused and enthusiastic while vehicles, farm equipment, church bells and other annoyances clang and clamor throughout the day. However, such hunts are often worth the effort.

State Forests

Perhaps one of the most underutilized of all our public hunting grounds are our state forests. Most are managed for timber production, but these days wildlife management (which benefits deer and other game) is also included in forest management plans. Access is normally free and most forests are open to hunting under the general state rule (with some exceptions, which may be obtained from the state forest manager's office).

The key to hunting state forests is keeping track of the forest's timber management program. Most state forests are covered with climax-phase trees, those big, old "virgin" stands that tourists adore. However, there are also many miles of clear-cuts, those big, new stands of new growth that deer adore! Many of these timbering projects are tucked far back in the forest's holdings, rarely visible from nearby roads and practically unknown except to the loggers, haulers, foresters and hunters wise enough to ask where they are!

One clear-cut I discovered a few years ago produced a 10-point buck on my first trip and several smaller deer on subsequent expeditions.The clear-cut is essentially the entire back side of a mountain as it faces the road. You can't see it driving by, but if you park at the foot of the mountain by a gated road, walk about 30 minutes to the top and look over, the entire valley before you is one gigantic clear-cut and it is full of deer! In the 10 years I've successfully hunter there, I've never seen another hunter!

Cutting is conducted annually throughout these forests and in many cases access roads are gated, blocked off, or closed to motorized traffic. All of this means excellent opportunities for the hunter who has the energy and ambition to find and hunt these places.

Most state forests are clearly designated on maps. Local roads and trails are usually noted. For a clearer look, visit the state forest office and examine the official forest map. Ask the forester to point out clear-cut areas that are three to seven years old—these will be prime deer habitat this season.Thank the forester, study your maps,get in there and scout prior to the season and, as you're dragging your big buck out of the woods, be thankful there are such things as state forests!

Hunting Unfamiliar Areas

One of the greatest tools a hunter can have is a topographic map. Detailed maps of any area in North America are available online or through various mapping companies that allow hunters to pinpoint locations within a few feet utilizing any of the global positioning systems now on the market. Getting in and out is as easy as entering your present position and your destination. The GPS will do the rest!

When looking at topographic maps of potential hunting areas, elevations are the key. Find the places where deer can travel easiest such as mountain saddles, creek bottoms, river valleys and lake shorelines. Many times the "lay of the land" will dictate where deer will find the easiest traveling, and it's a simple matter of putting yourself there in time for a daylight or afternoon hunt.

In mountainous areas, peaks and valleys are good places to look for deer, as are saddles, plateaus and finger ridges, which deer use as travel lanes from higher ground into valley croplands or browsing areas.

No Substitute for Scouting

Probably the most used (and most ignored) word in deer hunting is "scouting." Apparently it sounds like work, takes too much time and confuses hunters who think "scouting" means you have to be a Jim Bridger or Daniel Boone to master the task. It's easier than you think! Scouting for deer is no different than what you do when you shop for cars, houses or furniture—guns and gear, too. You go, you look, you see what's out there, and you make your decision.

Perhaps the biggest mistake hunters make (especially the ones who complain that "there are no more deer") is failing to scout their hunting area or, after hunting the same place for a generation or more, failing to see that things have changed. If you have changed since you took your first deer at 13, be able to admit that those woods have changed, too. Sure, it's great to spend time hunting the same rock or tree where Grandpa shot his first deer, but take a good look around and tell yourself the truth—what in the world is a deer going to do today in all that open, mature forest? There's no food, no cover—no reason for a deer to be there! Deer may have been numerous during Grandpa's youth, but that was long ago. The brush is gone, the fields are gone—you're

standing in a sterile environment where, through most of the day, you'll be lucky to see so much as a boreal songbird because wildlife diversity does not rhyme with climax forest!

Deer and other game are able to adapt to habitat changes. It's not that the deer are all dead—they simply moved to better conditions! Hunters must do the same, and scouting is simply a way of eliminating those sterile environments from your list of destinations. Go over the hill, down the road or across the county, but do your scouting. Find the places that attract deer like they did in Grandpa's day and start a new tradition there.

Scouting should not be a chore. You can "scout for deer" while pursuing other interests such as fishing, camping, turkey or small game hunting. Scouting is excuse enough for spending an early fall day in the woods, and what you learn about the woods from even one trip can turn your hunting season around. The track you're looking for, the rub, the scrape or trail that says "hunt here" is out there waiting for you—take some time and go look for it!

Bait Fishing for Bass

BY HAROLD BLAISDELL

Sometime, somewhere the Fishermen of this country should erect a national monument in honor of the black bass. Probably they should build two—one for the smallmouth, and another for his cousin, the largemouth. East and west, north and south, the two species thrive in uncounted lakes, ponds, and streams. True aristocrats among fresh-water game fish, they live in almost everybody's backyard where they stand ready to take on all comers, no holds barred and no quarter asked or given.

Thanks to a bucking two-pound smallmouth, I came to know the feel of a leaping, plunging fish at the age of six. What game fish but a bass would have grabbed the worm which dangled from my cane pole, and what but the mighty, gill-rattling leap which instantly followed would have left a six-year-old so thrilled and bug-eyed? I can still see the bronze bombshell which exploded before my startled eyes, and feel the powerful surge which doubled my pole and all but tore it from my grasp.This I knew, instantly and for all time, was something a man could live for.

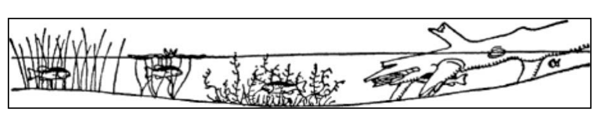
Bass not only live everywhere; they eat almost everything and anything. Consequently, you can take them on a wide variety of baits, though you won't find them pushovers for your natural offerings. Now and then you'll strike a day when they come to a certain bait—nightcrawlers, for example—like puppies to a feed pan, but these days come few and far apart. To take bass day in and day out on bait calls for skill, knowledge, and trickery, which is true for any worth-while fish.

Where to Look for Them

You can't take bass if you don't know where they are, so the first trick in bass fishing is knowing where to find them.

Where you look depends upon which kind of bass you're after, smallmouths or largemouths. The two species have individual preferences with regard to water temperature, depth, bottom characteristics, and cover which you should take into consideration when looking for one or the other. In general, look for largemouths in comparatively warm, shallow water along the shores.They like weed beds, coves, patches of lily pads, shoreline pockets, and the shade of overhanging foliage.They lurk under driftwood, and a submerged tree or brush heap almost always caters to a full house. Given suitable cover—shade, weeds, pads, or jutting logs—they take up positions within a few feet of shore in water no deeper than a couple of feet or so. Sunlight and warming water may drive them offshore during the middle of the day, but they move back in the evening and stay until the sun gets high the next day.

Smallmouths like cooler, deeper water over rocky, boulder-strewn bottoms. Look for them along the edges of sharp drop-offs where they can cruise briefly in the shallower level for bait fish, then drop back into the depths to cool off. Sunken reefs often



Typical habitat of largemouth black bass have bass along their edges, and the fish lie along the sides of stony points which continue underwater. Where the bottom falls away abruptly from shore, smallmouths generally lurk close by, waiting for small fish and frogs to make the fatal mistake of venturing too far afield. You'll find them along the faces of cliffs and ledges where large sections of rock have fallen to make underwater caves and retreats.

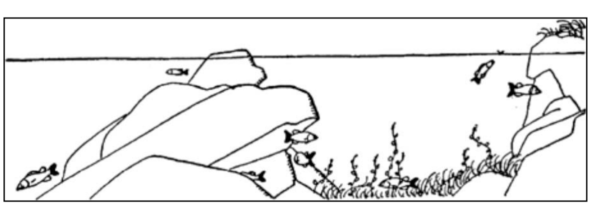
You can run down the largemouth hot spots by watching for visible clues to their location. Shoreline stumps indicate sunken trees, coves lead to areas protected by shade, and you can detect weed beds with little trouble. Finding the spots favored by smallmouths may not prove so easy. These may lie a considerable distance from shore with no tip-offs to help you discover them. Here a sounding weight comes in handy for probing the bottom and leading you to good bass grounds.

Let's say you know of a shallow bay with a weedy bottom—good breeding grounds for perch and other small fish—and you suspect smallmouths of raiding this supply of food. In the evening they come into the bay to feed, but where do they hang out during the day? Start at the mouth of the bay and work toward the open lake, taking soundings every few feet. Depth may increase only slightly for some distance, then drop suddenly to a much lower level. Return to the shelf, anchor close to the lip of the drop-off, and fish over the edge in the deep water. Don't forget that a few feet can make all the difference in the world. More than once I've anchored where my partner in the stern hooked bass after bass while I couldn't get a nibble fishing from the bow.

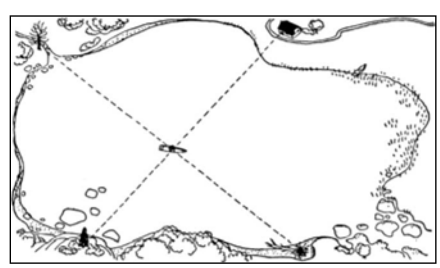
Reefs are tough to locate, for they may rise up anywhere in a lake. Sometimes they stand above the surface during periods of extremely low water, or they may lie so close to the top that waves break over them when the wind stirs up a heavy chop. Ordinarily, though, you locate these hallowed grounds purely by accident, if at all. Certainly you won't learn about them from other bass fishermen, though you can bet that each hidden reef is well known to at least a few.

Once you find a glory hole far removed from shore, make certain before leaving that you can come back again with reasonable accuracy. Pick out a landmark on shore, imagine a line running from it through the boat to the opposite side of the lake, and tie it in with an object on that side. Do the same with another pair of points whose connecting line runs roughly at right angles with the first.To return to the same spot, simply cruise along one of the imaginary lines until you cross the other; you should miss by no more than a few yards at the most. Better jot those landmarks down on paper, though; you can't afford to trust such an important matter to memory alone.

Just as it pays to differentiate between largemouths and smallmouths when seeking their feeding grounds, it behooves you to cater to the individual tastes of the two species in the matter of baits. Anything which works on one will work on the other, but not always with the same degree of success. In general, largemouths fall for big baits while the smallmouths find bite-size morsels more tempting. Just as you would suspect from



Typical habitat of smallmouth black bass



How to fix the location of a hidden shoal by cross bearings his oversize mouth and rounded paunch, the largemouth finds it hard to resist a six-inch chub or a big green frog—baits which offer complete meals. The trimmer smallmouth, on the other hand, likes tidbits—hellgrammites, for example—which his cousin sometimes scorns as too tiny to merit consideration. Of course, plenty of smallmouths tangle with big baits, and vice versa; just remember that the percentages are in favor of the general rule.

Hooks, Leaders, and Sinkers

Bass, compared to trout, for instance, are not particularly shy fish.They'll rip into almost anything, as a matter of fact, if they happen to feel in a fighting mood. But don't let their comparative lack of fear lead you into the mistake made so frequently by bass fishermen—that of overlooking the importance of small hooks, light leaders, and tiny sinkers. Bass may not flee for their lives at the slightest disturbance, but don't think for a moment that they lack shrewdness. For every one you catch on heavy, crude tackle, there are dozens you *won't* fool until you switch to lighter gear.

You don't need a big hook to land a bass; a No. 6 does the job just as well as a 6/0. In addition, the No. 6 gives greater freedom to your live bait than does a heavy hook, permits it to live longer, and doesn't detract nearly as seriously from its natural appearance. Many a bass has taken a minnow on a large hook, only to reject it instantly when he senses that he was a mixed mouthful of steel and minnow. A small hook not only brings more strikes, but it encourages more bass to hold the bait once they have taken it.

Most bass fishermen wouldn't dream of using a hook as small as a No. 6 for bass but it can double the number of strikes. Try it with all but the largest baits and see for yourself. You don't need a much bigger hook for large minnows, either; a No. 4 is as far as you need to go. Drop down to a No. 8, too, when you use small, tender baits such as crickets and grasshoppers. Small hooks, big bass!

Match your small hooks with light leaders and watch the production rate zoom upward.When fishing in deep water free from obstructions, a leader of three-pound test gives you all the strength you need to lick the biggest bass, and helps mightily to hook just such a cagey customer in clear water. Weed-loaded shallows give fish a chance to get a direct pull on the leader so here you must use a heavier weight. A leader which tests six pounds proves adequate in most instances, although ten pounds is safer when you hook a monster largemouth amid weeds or snags.

Important step number three: Go easy on sinkers! Many bass baits require no additional weight to sink in the quiet waters of ponds and lakes, and they produce many more strikes when fished with no sinker at all. Toss these baits out on a light leader, let them settle slowly and naturally, and bass frequently gather them in before they reach bottom—something they seldom do with a bait dragged down rapidly by a heavy weight. Larger, livelier baits such as minnows and frogs actually need but little sinker weight to drop them down to the bottom levels. Just pinch a couple of split shot on your leader and watch how it affects your minnow. He fights the drag of the small sinkers successfully for a few moments, then tires and the weight drags him down a foot or so before he resumes his efforts. Instead of plummeting downward, he fights a slow, losing battle with the two split shot and his gradual, struggling descent has almost irresistible bass appeal. Not only that, the tiny shot do not have the suspicious appearance of a heavy chunk of lead and don't drag against the fish alarmingly once he takes your bait.

Small hooks, light leaders, and little or no sinker: three big steps toward catching more bass. Unless you're a rare exception, you've fished for bass up to now with much heavier terminal tackle than you actually need for the job. No harm done? Those big hooks, coarse leaders, and heavy sinkers rob you of bass after bass. Scale down the size of your gear and see for yourself!

Bobbers?

Yes and no. In shallow-water fishing you can use a bobber to good advantage in keeping your bait away from the boat and out of the weeds. Use a light float to put as little drag as possible on a bass once he takes the bait. Don't use one unless it serves some purpose, though. In deep water you have better control over your line if you use no bobber. Besides, a float adjusted for a depth greater than the length of your rod prevents you from reeling in enough line to land fish.

In choppy water a bobber keeps your bait dancing and the constant motion helps to attract bass. In addition, the wind carries the float along slowly if you pay out slack and this gives you the chance to cover a good deal of water from an anchored boat. Snap a bobber to your line whenever a favorable wind lets you send your bait drifting along the shore or over likely spots.

Baits for Bass

Bass eat just about anything they can swallow and some even choke to death trying to down fish, sometimes their own kind, which are just too big for their gullets. Hardly any living creature small enough to be swallowed can venture safely into bass water or hover above it. Bass make short work of mice foolish enough to go for a swim, and leap to snatch sparrows and blackbirds from bending reeds or drooping branches. Insects, worms, fish, salamanders, ducklings, crawfish, as well as a host of other creatures go down the same hatch if they don't watch out.

In the face of his completely democratic tastes and appetites the bass shows surprising restraint when you go after him with bait. Tempt him with this, tease him with that, and he may have none of either. Try a third item on him—sometimes the one you judge the least promising—and he may go for it as though starving. More often it takes more than three different offerings to discover the favored item of the moment, so carry the widest possible variety of baits when you go bass fishing.

The Worm

Make sure that your collection includes this universal standby. You may try earthworms—nightcrawlers and the smaller variety—six days running and get skunked completely. Then, just as you have about decided that bass never take worms, you suddenly hit the jackpot with them.

To fish worms for all they're worth, don't just let them hang, once you have them near bottom. Hook them lightly—a single crawler or three or four small worms—and cast gently to keep them on the hook. Allow them to settle slowly—I *hope* you've resisted the impulse to clamp on a sinker—and when they reach bottom let them lie there for a few moments. Now, draw them up two or three feet and let them sink back on a slack line. Do this a half-dozen times and, if nothing happens, retrieve them and cast again, this time at a different angle to hit new water. If you merely dangle your bait, bass must cruise close before they discover it. Recast frequently, raise and lower your bait between casts, and the action calls them from a distance.

When fishing in water on the shallow side, try this worming technique: Use a nightcrawler and hook it once through the head (the darker end). Cast as far from the boat as you can without losing your bait, and let the crawler sink to the bottom. If nothing picks it up after a short wait, start it back again along the bottom with the slowest retrieve you can manage; make it *crawl,* literally. Twist in but an inch or two of line at a time and pause between hitches for the worm—it should be a fresh and lively one—to do some crawling and squirming of its own.

Try this, too, when a single nightcrawler fails to ring the bell: Change to a larger hook, and hang on as many as five or six crawlers. Makes a tremendous gob, but how those worms squirm and writhe if lightly hooked! Keep this big wad of bait bobbing gently just off the bottom to get the last squirm from each worm.The oversize bait sometimes proves too great a temptation for bass to resist.

Sometimes a spinner and nightcrawler make a killing combination.Try casting a June-bug blade ahead of a single, head-hooked crawler and retrieve slowly and haltingly. Make the spinner flash, let the bait settle, then start it up again.Troll the same rig slowly or let it trail behind the boat as you drift. Draw it ahead with the rod frequently to make certain the spinner revolves.

Finally, keep your worms fresh and lively if you hope to get results with them. A wooden box keeps them cooler than does a metal can. Put your box under a boat seat where the sun can't get at it. On hot days, cover the box with wet burlap or other cloth; it prevents drying, and condensation keeps the worms cool.

Minnows

Here's another proven producer—the minnow—so carry a well-stocked bait bucket on every bass fishing trip. All kinds of minnows work well on bass, but the list by no means stops with the various minnow species. Small fallfish three to six inches long invariably make superb bass bait. Change their water frequently or hang them over the side as they seem to require more oxygen than most bait fish. Tiny perch, the smaller the better, belong on the preferred list, though bass fishermen frequently overlook them. In addition to attracting bass, these tough little chaps seldom expire before bass grab them. Small bullheads make even tougher bass bait and work well if you snip off their spines before using. Suckers rank close to the top and they, too, have the ability to stand the confinement of the minnow bucket and live for long periods on the hook. Sunfish the size of a half-dollar take bass, but seemingly not quite so well as the others.

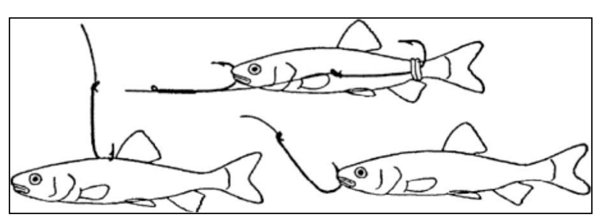
Among the minnows, the common shiner and the "golden" or "pond" shiner may hold a slight edge over their more drab relatives, though all species come through with flying colors. If you have trouble getting minnows, settle gladly for any you can get and ask no questions.You can be sure that all take bass.

Hooking the Minnow

When still-fishing in ponds and lakes, hook your minnow lightly, just ahead of, or under, the dorsal fin. Slide the barb under the skin and out to avoid injuring the bait. Lob it out gently and drop it to the water as lightly as possible. The livelier your minnow, the more strikes you get, so take pains to keep your bait fresh and vigorous.

In moving water or when you intend to "work" your minnow in any way, hook it through both lips. Hooked in this manner your bait stays alive for a long time but, of course, tears from the hook easily if seized toward the tail. Take exceptional care to feed slack line with the strike when you fish with lip-hooked minnows.

When still-fishing with minnows from an anchored boat, it pays, just as it does with all baits, to raise and lower your minnow frequently to call the bass in. You don't have to recast your minnow;



Three methods of hooking live minnows

just draw him to the top and let him sink back on a loose line. If he struggles against no more than a split shot or two, he sinks slowly and his vain efforts to resist the slight but steady drag advertise him as easy pickings. Stir him up often while he is near bottom, too, to keep him off balance and struggling.

Still-fishing at anchor works fine when you know your bass grounds. If, in strange water, you make the unfortunate mistake of anchoring an eighth of a mile from the nearest bass, you're in for a fairly dull afternoon if you decide to wait them out. Unless you've taken bass there before, don't stay in one spot for more than ten minutes or so if it produces nothing. Instead, raise the anchor a few feet off bottom, drift about 100 feet, and drop it once more. Keep on the move until you find fish. Incidentally, this type of probing often turns up those hidden hot spots—channels, reefs, and bars—which have no visible clues to their location. Make sure to line them up so you can return, for you'll probably find bass there each time.

A trailed minnow sometimes works wonders in deep water too, but here of course you need the weight of a sinker to take your bait down near the bottom. For this type of fishing it's wise to rig two hooks in tandem to increase your chances of hooking striking fish.Tie a No. 4 hook to the end of your leader and whip a No. 6 to the strand about a couple of inches higher. Run the smaller hook through both lips of the bait and secure the trailing hook back toward the minnow's tail by means of a tiny rubber band. Troll very slowly; try to give inspecting bass the impression that the minnow travels under his own power. Halt frequently to let the bait do some swimming on its own and to give the bass plenty of time to make up their minds.

If a slow pace produces nothing, rig a small spinner ahead of your bait and try stepping up your speed a notch or two. Lacking a spinner, kill the minnow and sew it on a hook so it spins slowly. Remember the sewing process: down through both lips with the hook, then down through the head, under the skin and out again near the tail, and draw the leader tight enough to produce the desired degree of curve. Even if you *do* have a spinner, sew on a minnow just the same and work the two in combination. Sometimes it takes all the flash and action you can supply to fetch a strike. Don't forget to use swivels with all spinning baits.

Setting the Hook

This is supposed to be a cut and dried business—the bass grabs your minnow, makes a run for it while you feed slack line, stops to swallow the bait, and you sock it to him when he moves off again. If you can find bass obliging enough to conform to this convenient behavior pattern,you shouldn't have much trouble hooking them. I haven't been that lucky. No two bass act alike with *my* minnows, and after 30 years of bass fishing I still yank and hope for the best.

I have a sneaking suspicion that when fishing with all but the largest minnows, you'll hook more bass by laying into them the instant they seize your bait! You hit on a short, tight line, the bass hasn't had time to reject the minnow, and generally has it completely enclosed in his mouth. Fine in theory to give a bass time to swallow the bait, but you also give him time to feel the prick of the barb, saw the line through weeds, feel the drag of any sinker and become suspicious for one of a dozen other reasons. One hint that the cards are stacked and he spits out your minnow and goes on his way. If you have trouble with the run-stop-swallow-run routine, try taking your chances in those first few seconds. Bet you miss fewer bass than you think you will.

Not so good though, to hair-trigger them when using a 6-inch minnow. Too often bass grab these big baits in positions which leave the hook outside their mouths. Better let them run and hope for the best. Have plenty of loose line stripped and coiled in the bottom of the boat and start stripping more as soon as a bass moves off with the minnow, lest a sudden spurt bring him against the reel and cause him to drop the bait. He'll probably stop before taking too much line and, you hope, swallow the minnow. Here again, you may only invite trouble by waiting until he moves off, for when he does he may leave the bait behind him. Better to give him time—a minute is plenty—to swallow the bait, tighten the line against him, and set the hook while you know he's still on. You won't connect every time, but you'll score more frequently than if you wait longer. Besides, nothing is more disappointing than to fiddle around for ten minutes or more and then have the bass leave before you even make your bid. Better to miss them hard and clean.

Frogs

Both species of bass like frogs, but you'll probably have better luck with tiny frogs for smallmouths and bigger ones for largemouths. The little, spotted leopard frogs make fine bait for smallmouths while the big, green fellows make the kind of a meal largemouths go for.

In general, you can fish frogs effectively by using the same tactics you employ with minnows. Still-fish them just above the bottom, trail them behind a slow-moving boat—on the surface near shore and weighted in deep water—or let them swim at the top over weeds or around pad patches. Hook frogs through both lips and they live until taken.

Hook a small, dead frog securely through the lips and you have an excellent skittering bait for bass (and pickerel, too). Cast it into the weeds or lily pads and bring it back with a series of jerks. Don't try to set the hook when you get a strike as the bass seldom has the hook in his mouth; give him a chance to engulf the entire bait first.

Sometimes you can lay your frog smack on a lily pad. Whenever you do this, let him rest there for several moments while you twitch the line very lightly to stir the supporting pad and create the impression that it holds a live frog.When you finally jerk the frog into the water a bass may be waiting with open mouth.

Tadpoles

You seldom see these little chaps in a bass fisherman's bait bucket, but put them in yours whenever you can get any. Best are the fat two-year-olds with bodies as big around as bottle caps. Hook tadpoles through the base of the tail and use no sinker, for they head for bottom of their own accord. They live almost indefinitely on the hook and wiggle constantly if you hold them just above the bottom. Give them an occasional twitch to keep them moving.

Live-bait dealers seldom offer tadpoles for sale and probably for that reason few fishermen use them. Let this be your cue to go to the nearest frog pond with a dip net and stock up with these fellows, for they make one of the finest deep-water bass baits. Use them in heavily fished waters to lure bass that shun the more conventional baits.

Hellgrammites

The dobson larva (hellgrammite) has won a well-deserved reputation as a bass bait, especially among those who go after smallmouths. Fished near the bottom, the hellgrammite frequently produces strikes when smallmouths will have nothing to do with any and all other baits.

Evil of appearance and mean of temperament—he'll give your finger a painful nip if you give him a chance—the hellgrammite has few attractive features save the hard shell which grows just back of his head. Grasp this shell between thumb and forefinger and slide the barb under it and out. Hooked under the collar he remains lively for a long time and won't tear loose if you handle him with reasonable care.

Hellgrammites work best when fished near bottom, but they crawl under rocks at the first opportunity. Once hidden, they anchor themselves firmly with a pair of tiny hooks which grow near the tail and you'll only succeed in tearing the hook free if you try to pull them loose. Snip those hooks off with a pair of scissors before fishing and you'll save a good many baits.

Use a leader at least six feet long of about three-pound test with a No. 8 hook. Weight the hellgrammite with a couple of split shot, let the line sink until the shot touches bottom, then take in just enough line to raise the bait clear. Jiggle the bait and recast frequently to attract the attention of all bass in the vicinity.

Once a bass takes your bait he'll swallow it at a single gulp, so don't hesitate to set the hook at the first sign of a strike. By hitting at once you hook the majority of bass in the jaw, allowing them to give a much better account of themselves than when hooked far back in the throat.

Very often you have difficulty obtaining hellgrammites from bait dealers, so it's wise to lay in a supply even if it means sacrificing time you could spend fishing. Dobson larvae live under rocks in the riffles of warm-water streams and can be caught by "screening." Frame a two-foot square of window screening, press it against the bottom on the downstream side of a rock, turn the rock over, and the current washes the dislodged insects against the screen where you can pick them off. You can speed up production greatly by enlisting the help of a fishing partner. Let him stir up the bottom and overturn stones with a stout hoe or rake while you hold the screen.

Hellgrammites have tough constitutions to match their appearance, so you can keep your supply alive for months. Place them in a tight wooden box, fill it with rotted wood, fix a screen over the top and store in a cool, dark place such as a dirt cellar. Keep the rotted wood slightly moist by sprinkling it sparingly with water from time to time, but don't let it become wet. Use a small wooden box for carrying hellgrammites on fishing trips and keep it in the shade as much as possible. Keep the box covered with a wet cloth on hot days as you do your supply of worms.

Crawfish

You have but to examine the stomachs of the bass you take to find conclusive proof that crawfish are a standard item of bass food. Both largemouths and smallmouths hold them in high esteem and give them more than passing attention to a hook baited with a live crawdad.

Crawfish, like hellgrammites, work best when fished just above the bottom with little or no sinker to hamper their natural movements. They also resemble dobson larvae in their efforts to hide under stones and crawl into crevices, so keep them raised a few inches above the bottom and move them often to make sure they remain visible to the fish.

Hook them through the tail and bring the barb clear to avoid missing strikes. Give bass time to get them in their mouths before you set the hook. Crawfish have pincers akin to those of the lobster, and bass swallow them only after working them into a position where they can't ply their nippers.

Each time a crawfish grows too large for his shell he sheds it to grow a bigger one.Though he makes haste to replace his cast-off armor, he must weather a period when he is in the soft-shell stage and doubly attractive to bass. Use soft-shelled crawfish whenever you can get them, but remember that bass love them hard or soft.

Look for crawfish under stones and waterlogged sticks along the shores of lakes and in the shallows of streams. You can grab them in your hand if you do it quickly, but a small dip net makes an easier job of it. Remember that the crawfish swims backward; hold the net behind him, threaten him with your hand, and he'll scuttle straight into the mesh. If you don't need them in a hurry, you can bait a trap with meat or fish, leave it overnight, and have crawdads galore, come morning.

Keep crawfish in a minnow bucket and see that they get plenty of fresh water. You want them alive and full of pep when you let them down for the bass to look over.

Crickets

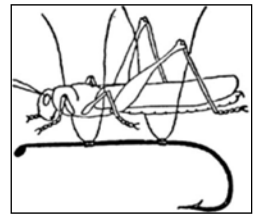
Under ordinary circumstances, bass must see mighty few crickets in the course of a summer, and certainly never enough to make up a significant portion of their regular diet. Nevertheless, they seem to have a taste for these fat insects, and smallmouths, especially, fall for them hard and often.Try a single cricket on a small hook to tempt finicky feeders and if that doesn't work, thread six or eight on a larger hook as a king-size attraction.You'll find it impossible to keep crickets alive on the hook for any length of time, but don't let it bother you. Bass like them dead or alive, and by piercing them with the hook you may let out the very juices which make them so attractive. A friend of mine has a Brittany pup who delights in pointing crickets, so they may smell good for all we know.

Crickets are too tender to stay on the hook long, so stock up abundantly before setting out, to have plenty for re-baiting. Catch them under boards and flat stones early in the morning before the dew has left the grass.

Grasshoppers

Fish grasshoppers exactly as you do crickets and you'll get equally good results. Like crickets, grasshoppers soon die when placed on a hook, but lack of life makes little difference when you fish them under the surface.

But bass like to have hoppers served alive and kicking on the top of the water, too, and there's a



Grasshopper rig

way of doing that. Make a hopper harness by tying two short lengths of thread to the shank of a long-shank, light-wire hook. Bind a live grasshopper to the hook with the thread, cast him gently, and let him kick up a commotion. A fussy job, but bass come to expect occasional wind-borne hoppers and put a sudden end to any which come to their attention. Use the largest grasshoppers you can get; they are much easier to tie to the hook and their lustier kicking stirs up more fuss on the water.

Do your grasshopper hunting early in the morning or late in the evening. Cool air makes the hoppers lethargic and they're much easier to catch than during the heat of the day. Keep an eye peeled for those big locusts, too. Fish one of these fellows while his wings flail the water and you can expect results in a hurry if bass are around.

The Early Bird

Almost every bass fisherman knows that the best fishing hours come early in the morning and in the evening. Many get to fish during twilight hours, but how many have the steely determination to crawl out of the covers early enough to fish at the misty break of day? Rugged medicine for most of us, but how the bass bite in those magic minutes when the first hint of daylight shows in the east!

Not enough to rise at dawn. You must be up and about in pitch darkness, row to your bass grounds before the first glimmer of light shows, and be anchored and fishing before you can make out objects on shore. Time it right and you won't have long to wait before things break wide open.

You owe it to yourself to sample some of that fast and furious dawn fishing. It takes raw courage to rise at two in the morning, but you'll find it well worth the suffering.

Less Noise, Please!

Probably bass couldn't hear you if you yelled your head off, but don't forget that they are keenly sensitive to vibrations transmitted directly to the water. Thump the gunwale with oar or paddle, scrape your tackle box along the bottom of the boat, or knock ashes from your pipe on the side and you warn every bass in the vicinity. Take care to preserve underwater silence by handling tackle box and minnow bucket without banging them against the boat and stow oars or paddles where they won't shift and roll. It's a good idea to wear sneakers or soft-soled shoes to avoid a constant scraping of feet. Some expert bass fishermen attach enough importance to the noise factor to lay a strip of old carpet material in the bottom of the boat to muffle the sounds of unavoidable movements.

Important, too, to observe silence and stealth while making your approach to a fishing spot. Cut the motor or ship the oars and drift into position whenever possible, instead of churning forward under a full head of steam. Go easy with the anchor. Lower it slowly on a tight rope; don't let it plunge down and thud to the bottom as though dropped from the sky. Shift about as little as possible while baiting up and lower your bait without fuss or splash. Many times a bass will grab your bait the instant it sinks down to his level . . . if you've taken care to come up on him quietly.

River Fishing

So far, we have treated bass fighing as strictly a pond and lake proposition, but bass also live in streams. Largemouth rivers are generally so sluggish that you can fish them exactly as you would a lake. Smallmouths, on the other hand, sometimes inhabit fast-moving, rocky streams where you can put your trout-fishing experience to good use. Quite often smallmouths share a stream with trout, and in such places it is common to catch one species while fishing for the other.

River smallmouths fall for all the baits which take their cousins in ponds and lakes, but the smaller baits handle with greater ease in moving water and you'll probably have your best luck with them. A lively nightcrawler makes a hard-to-beat river bait, though a drifted hellgrammite may deserve an even higher rating. Small minnows take plenty of river bass, too. Lip-hook them so you can handle them in the current and keep them alive at the same time.Try spinners ahead of minnows and worms when they produce no strikes by themselves.

Use only light sinkers—a couple of split shot—and depend upon the currents to drift your bait into likely places. Fish such baits as worms, nymphs, grasshoppers, and crickets on a slack line to prevent drag. While bass are not as shy as trout, they become suspicious if your bait behaves queerly so try to drift it as naturally as possible. Cast upstream and across and let the bait drift back toward you.

Look for bass in streams as you would for trout. Expect to find them wherever cover occurs close to major currents which they can watch for food. Bass seem to prowl about more than trout, so you'll also find them in quiet back-waters, dead-water coves, and shoreline shallows where trout seldom venture during daylight hours.They like pockets and caverns in ledges and lurk behind projecting tongues of rock.

Smallmouths never lack fighting ability wherever you find them but those living in streams head the list. Trimmer than lake bass and current-toughened, they give you a rousing fight on light tackle. Though on the average they run to smaller size in streams, you'll tangle with occasional lunkers.

Set the hook in a four-pound river smallmouth, and he'll take your mind off your troubles for quite a few minutes!

Spinning

The spinning outfit and the small, spinning bobber make an ideal combination under many conditions. In shallow water along shore or in weedy bays, you can cover wide expanses from an anchored boat by simply making long casts at varying angles. Hook on a lively minnow, attach your bobber three feet above the hook, and cast as far as you can toss the minnow easily. Let the float rest where it lands for several minutes, then bring it closer to the boat with a few turns of the reel. Start it up again if nothing happens, and continue with alternate rests and short retrieves until you have brought the minnow to the boat. Cast again at a different angle to reach new water. Fish such baits as frogs, crawfish, and nightcrawlers in the same manner. Try a large minnow with no sinker or bobber. Cast the minnow close to bass cover and let it swim at the surface.

In deep water, try a nightcrawler or hellgrammite with a buckshot pinched to the line for casting weight. Lay out a long cast, let the bait sink, then bring it along the bottom by barely turning the reel handle. Retrieve only an inch or two at a time and pause between turns. The slightest motion attracts fish and few bass can resist snatching at a slow-moving bait.

In river fishing you'll find the spinning rod a great help in hitting all the promising spots with the small baits which work so well on smallmouths. Fill your plastic spinning bobber nearly full of water—it will still float—and you can make long casts with a nightcrawler or hellgrammite. Shoot your bait upstream and let it float back. You'll get a long, natural drift and no hungry smallmouth will pass up your offering. If trout are present, you'll tangle with them, too!

When it comes to fishing with live minnows, spinning ranks head and shoulders above any other method. You can drop your minnow into all the pockets, reach likely spots close to the opposite bank, and cover broad pools which you could never fish thoroughly with minnows on a fly rod. You can make even longer casts by switching to a sewn minnow and spinner combination, for then you can handle the bait as roughly as you please.

In short, spinning fills the bill whenever you need to get distance in your bait fishing. With the help of the water-weighted bobber you can make reasonably long casts with the smallest baits, while those heavy baits which overtax a fly rod you can heave into the next county. Fishing fine-and-far-off swings the odds in your favor, so make spinning play a regular role in your bass fishing.

Try Everything

How does any bass survive long enough to gain respectable size under present-day fishing pressure? Many do, you can be sure; probably far more than you suspect. Every one of these large bass has learned to fear and avoid conventional baits and lures; either that, or he inherited such caution. In either event, results are the same—he hasn't yet fallen for the fisherman's old routine, and he has no intention of doing so in the future.

What better trick than to offer these sophisticated lunkers something which they seldom see on a hook? Tadpoles belong in this category of off-trail baits as we have seen, but what about a wriggling salamander, for instance? Or a June bug? Or the meat from a fresh-water clam . . . a big snail, shell and all . . . a turtle the size of a half-dollar . . . a tiny snake! Bass eat all these and many more with perfect safety, for these creatures invariably show up minus hooks. Use one as bait and you have a good chance of catching the big fellows off balance.

Sometimes you can throw them off stride by pulling a switch with conventional baits—serving them up with a change of pace. Ever hook two minnows side by side on a single hook? It sometimes turns the trick when a lone minnow goes untouched. Bass seldom see a frog or crawfish trolled behind a spinner, which may be all the more reason for trying it. Eccentric behavior of a bait may spur bass into striking, so don't hesitate to stray from the beaten path when ordinary methods fail.

Summing Up

Learn where to look for bass: Shorelines, weed beds, and protected shallows for largemouths; reefs, rocky points, sharp drop-offs, and bars for smallmouths. Watch the shore for signs of largemouth hot spots; sound the bottom for sharp irregularities in depth which mean smallmouth holes. Look for both species closer to shore in the evening and early morning.

Use small hooks, fine leaders no shorter than six feet, and little or no sinker!

Carry a wide variety of baits. In general, offer large baits to largemouths, smaller morsels to smallmouths. Move all baits frequently to attract bass. Jig them often and recast from time to time.

Go looking for bass instead of waiting for them to come to you. Fish in one spot ten minutes, then drift on to a new location if nothing happens. Keep at it until you find fish. Avoid banging things against the boat and setting up underwater vibrations. Approach your fishing spots quietly and stir around as little as possible while fishing.

Try the unorthodox. When you can, use baits which bass seldom see on a hook. Fish conventional baits in manners that break with tradition when other methods fail.

Remember that the choice bass fishing hours come at each end of the day—dawn and dusk. You may get more action during the first hour of daylight and an hour at dusk than over the rest of the entire day. Fish early and late whenever possible, and lay off during the midday hours.

Taking Trout on Bait

Whenever a fellow fisherman tells me curtly that he never uses natural bait for game fish because it "takes no skill to catch fish on bait," I merely force a grin and change the subject.

Just because the veriest dub can catch an occasional fish on bait doesn't mean that he can't do the same with a fly or other artificial lure. It doesn't mean, either, that it is any easier to become an expert bait fisherman than an expert fly fisherman or plug caster. It just looks easier, and that's what fools most people.

Worm fishing for trout isn't at all like pole vaulting or sword swallowing—you can't see at a glance what needs be done. It's almost as hard to discover what to do as it is to learn later how to do it. In short, it ain't easy to catch on to. Maybe "knack" is the only word for it, at that.

But even if the tricks of the bait-fishing trade are hard to define, this doesn't mean that they don't exist.

Worm Fishing

Let's first go back to an early June morning when I was a kid. The first rays of the rising sun find me perched on the end of a diving board over the ole swimmin' hole. I am engaged in a duel of nerves with a huge trout, his every spot visible through the crystal-clear water. In front of his nose hangs my worm-baited hook. Each time I try jigging it with my cane pole, the monster backs away. When I hold steady he creeps forward until only scant inches from the bait. He wants that worm. I earnestly want him to have it. Yet the old cuss won't take it—we just can't seem to get together.

I place the blame squarely on him. Doggone him, didn't I get there at daylight just to please him? Haven't I done everything that a human could do? Certainly I have. My conscience is clear.

Partly due to impatience and partly to the splinters that make themselves felt through the seat of my britches, I shift my position. The springy diving board dips, upsetting the open can of worms at my side. I catch the can with a quick grab, but too late—the contents already have spilled into the water. Down toward my trout drifts a veritable shower of worms. They stretch and squirm frantically, all plainly alive and full of pep. They settle slowly, naturally, neither restrained by a line nor dragged down by a heavy sinker and hook. Last but not least, they yield to the slow current and sink at just the correct downstream angle.

The trout's reaction is electrifying. Instantly he becomes a zooming, dipping form of fluid grace, banking and swirling to gobble worm after worm. Gone is his hesitation, his sense of caution. He darts after the last worm and snatches it just before it reaches bottom. Nothing remains in sight now but my baited hook. My scalp prickles and I clutch my pole, tense with anticipation. Surely, now, he'll take!

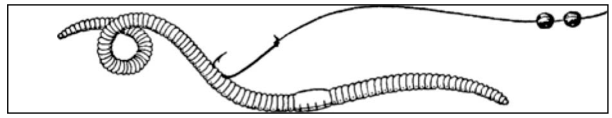
But wait, how can this be? Instead of racing in to collect this last tidbit, he edges toward it as cautiously as before—and halts! I jig my bait frantically (can't the fool see that here's another fat worm?). The trout turns scornfully and heads upstream, deliberately, without haste. His broad tail wags a final good-by as he disappears under the broken surface at the head of the pool. Thoroughly beaten, I hurl insults, and the empty worm can, after him and leave the scene in utter disgust.

There you have it—this matter of worm fishing. Here was a trout that asked for nothing better than a full meal of angleworms. He was hungry, on the feed. Nevertheless, he could not bring himself to tolerate the many suspicious aspects of my crudely presented bait. Had I known how to offer him a worm that looked and behaved as a worm should, I would have caught that trout!

But let's forget about this particular trout and see what you can do to make a worm on a hook behave like one that went out for a stroll and tumbled into the drink. Let's start with hooks, themselves, for they, at least, are pleasantly tangible and concrete.

Hooks

Suppose you sneaked up on a deep pool and tossed a loose worm into the run-in. If you hadn't been seen or heard, the first trout to spot the tumbling worm almost certainly would snap it up. Except for indigestion, he'd have no reason to do otherwise. Now, suppose you jab a large hook into the next worm and set it adrift with no line attached. Some trout in the pool probably would ignore the sprouting hook, as well as its dragging effect, and gobble the worm just the same. Others might dart in, nip at it, then drop it. But it's an even bet that at least half the trout in that pool would pass it up completely as just too darned suspicious-looking and -acting to monkey with. Finally, hang a third worm on a hook the same size, tie it to your leader and drift it into the pool. Lay you two to one that even the boldest fish in the pool would have nothing to do with this combination.



Worm rig: a nightcrawler lightly hooked on a small, un-snelled hook. Note placement of split shot.

Back to the starting point again, but, when you try worm and hook this time, use a small one—a No. 12, let's say. Bet not one trout in ten would notice this small bit of steel when buried in a loose worm. Tie hook to leader and business falls off sharply, of course, but this time at least *one* of the trout in the pool probably would take it if you fished it craftily.

In other words, you needn't fool all the trout in each pool to fill a creel. If you can just tempt one, the job doesn't take long. Yet, if you start with a big, heavy hook, by the time you have added the necessary drag of leader, line, and sinker, you have branded your bait as a booby trap so plainly that your chances of hoodwinking that all–important lone fish go tumbling into the cellar.

So, one of the first tricks of worm fishing, and certainly the easiest, is to use small hooks. Let No. 8's be your largest and use these when you can get by with the least deception—early in the season, in roily water, and in the heavier currents of large streams. As things get tougher, scale down the size accordingly. Use 10s, 12s, and even 14s, as the water grows lower and clearer, the currents lighter.

Remember, now, we're talking about fooling trout into hitting, not about landing them. Naturally, you can't take the liberties with a heavy fish hooked on a No. 12 that you can when using a No. 2 or 4, yet there is this to be said in favor of small hooks, even in this respect: You know that you can't horse your fish, so you handle them with extra care and lose no higher percentage of hooked fish than before, possibly not as high. Result: more fish hooked, more landed—and more sport landing them.

One more tip on hooks: Steer clear of the snelled variety. Comparatively speaking, you pay a dickens of a price for them, but what do you get? A bulky, visible loop close to the hook where, of all places, you don't want it; a snell that almost never matches the diameter of your leader point; a permanent snell-to-hook hitch-up that wears with use and becomes untrustworthy.

Buy loose hooks and tie them directly to your leader with a Turle knot. Select those with hollow-ground points and turned-down eyes—the kind used in tying wet flies of good quality. Bought by the hundred they cost hardly more than a cent apiece, and they result in a much neater and stronger terminal rig. I like a plain round bend, but the clutching appearance of the Eagle Claw, or other models with rolled-in points, may give you a feeling of confidence. Small matter; they'll all hook and hold.

Sinkers

A free-drifting worm will sink to the bottom of its own accord, even in a strong current. If you can make your bait tumble along the bottom with no sinker at all, then do so by all means. Remember that a sinker is an added reason for suspicion in direct proportion to its weight. If you need help in getting the worm down, keep the amount of lead you use to a minimum. If tempted to pinch on a single split shot, try first with none at all. See if you can't persuade the currents to carry your bait close to the bottom. If, in heavier water, you feel you need a buckshot, see if you can make out with only a couple of small shot. Utilizing dropping currents to suck your worm down is one of the important tricks of the game.The less you need to rely on artificial weight, the better the results.

Baiting

If trout fed regularly on pretzels, then there would be at least some reason for looping a worm on a hook in the manner employed by many fishermen. To the contrary, however, trout expect worms to come tumbling along, writhing and stretching to gain a foothold that will help them to get out of their watery predicament. Baiting so your worm remains free to twist and squirm is a worming trick that's every bit as important as it is simple. Merely slide the barb of your small hook in, and out free, at a spot near the center of the worm. Only when lightly hooked in this manner can a lively worm advertise the freshness and vigor which are its chief selling points.

But remember this little baiting trick: In heavy currents a worm hooked in the middle tends to fold at the point of hooking with the two halves dragging downstream ahead of the hook. In such fast-water spots try hooking the worm through the "head" or tip.This lets it lie straight in the current, look more natural. Many times you can coax a strike from one of the faster bits of water by making this simple change. Don't worry too much about short strikes. If a trout decides he wants it, he'll usually take worm, hook and all at one gulp.

Light hooking is but part of the secret of baiting, however. Even when properly hooked, a worm soon becomes "drowned-out"—limp, lifeless, flavorless, and holding little trout-appeal in general. In spite of this it never seems to dawn on many fishermen that a fresh worm every few minutes brings far more bites.

You drift your bait, fresh and lively, into a promising hole. A trout sees it, wants it, but can't quite get up courage to tackle it. You run your bait through the hole time after time, for you know the value of thoroughness and patience. Your unseen fish remains interested and on the verge of taking, but by now your worm has grown a bit bedraggled and washed-out. You reach for another and hang it on the hook in place of the first. It squirms and wriggles from the shock of the hook and you hurry to fish it while it still writhes. This promptly tears it; your fish, already sorely tempted, can resist no longer when faced with a worm that now looks more inviting than ever, and he falls for the pitch. I wish I had a dollar for every trout I have taken by means of nothing more than this simple trick.

Just one more little hint about baiting: When you renew your bait, renew it completely. Strip the hook clean to avoid a gradual accumulation of faded, chewed-up bits of worm on the shank of the hook, which makes your bait appear just that much more unnatural and gives added reason for alarming a fish. Hook your worms lightly, change them often (and I mean *often'*), and keep the hook clean. These three easy-to-follow rules will bring you more trout.

Angleworms or Nightcrawlers?

Which makes the better bait,ordinary small garden worms or the big crawlers? Seems to me that the big worms have a bit more appeal for larger trout, a little less for run-of-the-stream fish. I expect this profound observation to win me few prizes; but, lest you accuse me of trying to capitalize on the obvious, I hasten to add that the difference isn't as great as one might suppose. Small worms will account for some mighty big trout, and little fellows will tackle crawlers with surprising audacity.

When streams run roily and the big ones are on the feed, though, I want my bait box filled with crawlers and nothing else. Under average conditions I like to have both along—small worms for the runs and riffles, and night-crawlers to try in every deep hole where I suspect a lunker may hide.

I have found one very real difference between these similar baits, however: it pays to fish more slowly when using the crawlers than when fishing the smaller worms. Trout seem to deliberate longer over the bigger baits—need less time to decide in favor of something smaller.

When it comes to fishing the crawlers in clear water, there's a trick that's so important—and little heeded—that I'm going to stick it in right here where it won't get mixed up with something else.

Draw a nightcrawler from your bait box and there you have a critter the size of a not-so-small snake. When you fish with crawlers, play it smart: drop down to your smallest hooks and a long, tapered leader. Here's your chance to effect such a contrast—big, attractive bait, light tackle—that the result is as close to perfect deception as you can come in bait fishing.

With small worms you hope the trout won't notice your tiny hook; with a nightcrawler they *can't* notice it, for you can hide it completely in the body of the bait! Much in the same way, the effects of a light, flexible leader are much less noticeable when the bait you tumble with the current is heavy and bulky. In other words, the big crawler appears very real, very substantial, very inviting—the artificial aspects of its hook-up trifling by comparison.

Fish nightcrawlers on your most delicate tackle, then, and you have one of the most killing big-trout baits you can drift into a pool! You also have the tip-off to all successful fishing tricks: increase the inducement, and at the same time do everything possible to reduce cause for suspicion to the vanishing point.

Leaders

I have just plugged a light leader as a distinct help in worm fishing. Now, permit me to reverse my field and say this: Don't make the mistake of overrating its helpful effect. A leader reduces the visibility of the mechanical connection between hook and line, but does a trout fear a line, anyway? I don't think so, at least not a line that merely dangles in the water. Remember my diving-board trout? He didn't hesitate to snap up loose worms all around the coarse line that hung from my cane pole. He refused to take my baited hook only because of its suspicious behavior. We know that it behaved oddly, neither sinking nor drifting downstream, because of the restraining influence of the line. I refuse to believe, however, that the trout "knew" this or was capable of "knowing" it. He simply didn't like the way the bait *acted;* that other thing that was my line didn't interest or influence him one way or the other.

For my money, then, a leader pays off in worm fishing mainly to the extent to which you utilize its flexibility, and the minimum resistance it sets up in the water, to drift your bait without drag (unnatural response to both currents and gravity). In other words, the finest leader serves little purpose if you let it hold your bait against the current when the laws of nature say that it should go tumbling downstream. Sure, the thin strand is next to invisible, but this sells no pencils as long as you allow the leader to have an unwholesome effect on your bait's behavior. Only when you fish with just the right amount of slack does your bait get that extra bit of freedom that a leader allows. Even then you aren't as far ahead of the game as some people would have you believe.

Please don't get me wrong. I wouldn't think of worm fishing for trout without a leader. For general fishing I like a six-foot strand of level nylon in six-pound test. For special purposes—the nightcrawler business is one example—I use a nine-foot leader tapered to 2X. I'm sure that with a leader I get a little better drift, and, in spite of what I have just said, the visibility factor lies in my favor for whatever it may or may not be worth. Just the same, insofar as worm fishing is concerned, this matter of leaders isn't the tree that holds the big coon. I'm certain of that, for I have had demonstrated all too forcefully the fact that it's possible to catch a lot of trout without using any leader at all!

The most expert worm fisherman I ever hope to know used a rugged bait-casting line and tied this directly to his hook. Sounds like a crude rig, maybe, but there was a fellow who could really catch trout. He'd pluck them from behind you and all around you, until you wondered what in the world ever gave you the idea you knew the first thing about trout fishing.

The trout certainly saw that black line of his, but so what? The worm would come trickling down a run with the line limp and slack, off to one side or behind—always where it couldn't influence the drifting bait. Worms come down the stream like that plenty of times, with maybe a wisp of weed or a sunken twig drifting alongside. But this black thing is a line? Phooey who ever heard of a line? Wham!

I have given the subject of leaders this rather negative treatment deliberately, for it brings us face to face with the hard core of the worm fisherman's task: To fish his bait so that it rides the currents unhampered by the line (leader) to which it's tied.

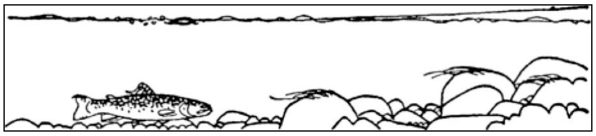
Be a Rod-Tosser

Watch a fellow who really knows the business of worm fishing. I don't mean just anybody who fishes with bait and has run-of-the-mill luck. I mean a chap who takes trout you measure in pounds where most others catch fish a few inches over legal length. No such fellow? You just don't get around. Find that guy and watch him!

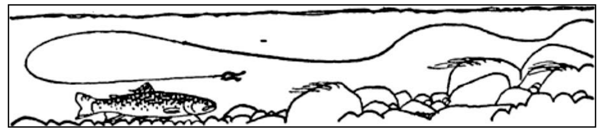
One thing you'll notice: he fishes a "live" rod. Always the tip of his rod is moving. Not much, maybe, but that constant slight motion holds the key to his success. Each little toss and flick of the rod gives his bait another free ride—causes it to drift naturally for that single moment that's all that's needed to bring a hit.

Let's say that you stand thigh-deep in the fast water above a likely pool. You have rigged up carefully and have a fresh, lively worm on your hook. Before you do another thing, strip plenty of slack from your reel and hold the loose coils in your free hand. This supply of slack is to be your ammunition in your coming fight against drag. Without it, you're licked before you start.

Okay, you're all set. Your first job is to have your bait close to the bottom when it rides into the pool—well sunk so the undertow can catch it and



Downstream worm casting with no slack line



Downstream worm casting with too much slack

suck it down where the trout lie watching for food. Thus, you must drop your worm almost at your feet, or the fast current will carry it into the pool before it has time to settle. Right here we have one of the basic tricks of worm fishing: Always drop your bait well upstream from the spot that holds the trout. Elementary, to be sure, but I've watched too many fishermen ignore this one important little detail not to mention it.They start the worm upstream a bit, yes, but they underestimate the speed of the current and seldom give the bait the time and distance it needs to sink to the fish-taking level.

Start your bait off as you should—in the fast flow well above the pool. Yes—but this doesn't guarantee anything. The fast current snatches the bait and, if you do nothing to prevent it, soon pulls the line taut. Your bait planes toward the top, just when it should drop into the depths, and this brings snickers from every trout in the pool. Here's where you must start working that rod.

To tumble downstream naturally your bait must have slack, but never too much at any one time.You toss the tip of your rod—waggle it up and down—and with each toss you slip just enough slack through the guides to match and rod. Why not dump all the slack on the water at once and have done with it? Doesn't work for one big reason. Bottom currents almost always are slower than those higher up. Faster water at the higher levels soon bellies the line out ahead of the bait and hurries the worm downstream at an unnaturally fast pace. More snickers from the trout!

Fish your bait on a slack line, but keep the slack always behind the bait! This is the wood that really makes shingles—the one worming trick that puts more trout in the creel than all the others combined. Not as simple as it sounds, for you're always busy striking the proper balance. Only by keeping the tip of your rod gently rising and falling can you sense whether to feed a bit of slack or to regain a trifle. Here's how to work it:

You lift the tip—flick it upward, really—with a short, quick wrist motion. If the line tightens against the bait (or sinker, if any) you can feel it through the sensitive tip—or learn to. The instant you feel this slight resistance, you let a little slack slide through your fingers. You do it quickly, automatically, releasing the slack before the rod can lift the bait or yank it against the current.

If you feel nothing but the line, then you know that you have regained slack that probably has been carried on ahead of the bait.You drop the tip for the next toss, and this deposits the retrieved bit of slack behind the bait where it belongs. You keep tossing, but you release no more slack until again you feel the direct pull of the bait.

Keep in mind that we're talking in terms of mere inches of line and tiny flicks of the rod. To do any good these hitches have to come fast—at least one to the second, I should say. That's why some expert worm fishermen give the impression that they're merely jigging the bait. They aren't! They're working on that line, mending and nursing it along so that it interferes as little as possible with the drift of the worm.

It takes practice to develop a feel for this subtle technique, but you've taken the biggest jump when you concede that possibly it exists and is worth trying. Can I prove that it does? Well, some people are mighty hard to convince. But show me a fellow who

Downstream worm casting with controlled slack

fishes a worm on a "dead" rod, and I bet I can dig up a real worm fisherman who'll catch two trout to his one, and probably twice as big. He'll do it because he has taken pains to learn how to control his line to produce the least drag. And he'll do *that* by pecking away constantly with the sensitive tip of his rod!

But why so fussy? Trout aren't overburdened with brains, so why should they give a hoot how a worm behaves, so long as it's fresh and full of flavor? Look at it this way: At least they expect familiar objects to respect and obey the physical laws of their medium, just as we look for them to honor those of ours. Suppose a waiter brings you a prime, juicy steak. He places the plate in front of you, but the steak refuses to follow it all the way to the table. It hovers in mid-air several inches above the crockery! Would you ask no questions and calmly ply knife and fork? Or would you promptly come down with a bad case of nerves?

You offer a trout the same cause for alarm when you fish a worm with pronounced and uninterrupted drag—a worm that rises when it should sink, hangs to one spot when it should tumble along downstream, or races faster than the particular current that carries it. Kill that drag with behind-the-bait slack. See if you don't fool more trout!

Look Things Over

No two pools, runs, or pockets are identical. Take a good look at each one before you fish it. Size up the situation in terms of likely currents and potential hiding spots, and start your bait on its way only after you have set a pattern for its behavior that will be natural for that particular place and, therefore, acceptable to the trout. Locate the hot spots—the pay-dirt areas—and concentrate on them. If tricky currents force you to compromise, destroy the illusion of free drift above these spots whenever drastic line correction is required to tumble the bait naturally through the promising areas. This ability to sense when to relinquish all pretense of deception, in order to regain it at just the proper time to encourage a strike, is one of the most valuable and difficult tricks of the trade.

Where the Heck Are They?

Half the battle is won if you can sense with accuracy just where the trout are likely to be. Remember that a feeding trout generally chooses a station which meets these three requirements:

1. It affords cover or concealment.
2. It permits examination of an important current.
3. It provides a cushion of "easy" water which allows the fish to stay put with a minimum of effort.

These three requirements can be met in an endless variety of ways, and it is up to you to recognize them wherever they occur in combination.

Look at the backwater in a large pool. Note that its slow, rotary current does not overlap the sweep of the channel; debris caught in the backwater will circle for hours. A trout can loaf against the mild push of the backwater while the main flow of the stream sweeps food in front of his very nose. Cover? Depth of water, alone.

A smooth slick looks barren of fish, but there is a large boulder on the stream bottom. A cushion of easy water exists around the entire boulder—in front of it, behind it, and along each side. Look for trout there, for they like to lie in the protecting shadow and watch for food in the water passing over them.

Sunken logs, overhanging branches, undercut banks, broken water surfaces, all afford cover for trout, so fish them carefully if they are near, or in, the main flow of the stream.

During the hot spells watch for the tiny inlets which signify springs.Trout, especially brookies, flock to the spring holes in midsummer, so be on the watch for these spots. Water dripping from an overhanging bank may be icy cold and attract fish. Drift your worm through these places whenever you find them.

Easy Does It

Patience in worm fishing is a virtue beyond measure.Trout, especially the big fellows, are not to be hurried. More than one fisherman has left a pool or run when one more drift of the worm would have brought the trout of his dreams. Fish slowly—do your worming at a worm's pace.

Minnow Fishing

Set a minnow trap in a trout stream, and everything you find in it the next morning will be trout bait. Shiners, striped dace, small suckers, and chubs—you can use all of these with good results along with any other species of small-bait fish native to the stream. If you have a choice, settle for shiners, for they seem to hold a slight edge. Not much, though.

Found in many Eastern trout streams is an excellent little bait fish that I know by no name other than "chuckle-head." This homely little chap looks like a miniature cross between a bullhead and a sculpin, but the trout are more than tolerant of his appearance. He hangs to the bottoms of small, cold streams where his coloration of mottled muddy-gray makes him hard to distinguish, though he can be captured quite easily in a small dip net once he has been located. It is always a bother to catch a supply of these little fellows, but there is no finer trout bait.

Dead or Alive

Unlike most game fish, trout seem to find a dead minnow as attractive as a live one and, if anything, prefer the former. I sometimes buy bait from a dealer who keeps his minnow boxes in a pool inhabited by a dozen big brook trout. These trout are not confined, but chose to remain in the pool to receive daily handouts of dead minnows as the dealer cleans his boxes. Feeding on little else, some of these trout have grown well into the three-pound class. This taste for dead minnows makes it unnecessary to keep the bait alive on the stream, and simplifies minnow fishing considerably.

Drift a dead minnow downstream or cast it up and across and let it float back, and it will produce fish.Work it in the current with a slow, erratic spin and you have added flash and action which will call trout from a greater distance and provoke more strikes.To make a minnow spin, it should be "sewn" on the hook.

Sewing Class

For best results you need an eyeless, short-shank snelled hook—No. 4 is about right—with the snell soaked for pliability if it is of gut. Run the point down through the lower jaw of a dead minnow and draw the hook through and clear, along with a few inches of snell. Thrust the point down through the top of the head and out at the bottom. Reverse the hook (point it toward the tail) and shove it into the side of the bait between dorsal fin and tail. Bring the point out near the back (it will point toward the minnow's head) and take up the slack in the snell, drawing the minnow's body into a curve which produces the spin.The more curvature, the faster the spin; a few experiments will disclose the proper amount.

With a baiting needle you can be real fancy with your stitching. File an opening in the lower part of the eye of a large darning needle, and catch the loop of the snell in the opened eye. Run the needle under the skin of the bait near the tail and bring it out halfway toward the head. Draw the snell up until the shank of the hook has been pulled under the skin and shove the needle straight through the minnow at the halfway mark. Pull the snell after it and drive the needle back through the bait just behind the gills. Insert the point in the gill opening and push it up through the top of the head and complete the job by coming down through the lower jaw. Tighten the snell to give the desired degree of curve.

With a sewn minnow you can fish a drifting bait or you can spin it in the current. Best results are obtained by interweaving the two methods. Allow the minnow to tumble with the current until it is near the bottom, then hit it softly with the rod a few times to spin it and to start it toward the top. The action is likely to attract a trout and, if he doesn't strike promptly, he may gather the bait in as soon as you allow it to settle once more.

Always place swivels ahead of a sewn minnow, else your line will become hopelessly twisted.

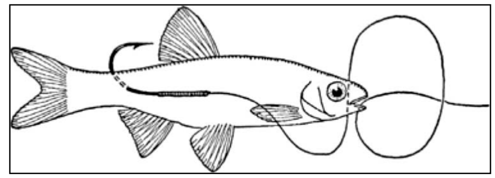
More Minnow Business

You won't always have minnows along with you on the stream, but here's a stunt which sometimes helps to compensate when you need them.

Examine the trout you catch and you'll find an occasional trout with a minnow in its mouth, or part way down its throat. What better proof do you want that here, indeed, is a good bait? Put that very minnow to use in the next few pools.This trick seldom fails to produce a strike, probably because minnows aren't found in trouts' mouths unless they are feeding on minnows at the time, that particular kind and size.

Tiny minnows, less than two inches long, are excellent bait. Hook these little fellows through both lips with a No. 10 hook and make them dart just under the surface by twitching them against the current. There'll be a swirling rise whenever they're taken.

Hook your chuckleheads—if you can get them—in the same manner, but try and work them deeper as they're strictly bottom-dwellers. A trout that turns down a chucklehead is just plain off his feed.



Correct method of sewing minnow bait

Fishing a minnow behind a spinner is good business, especially early in the season when cold water makes the trout somewhat sluggish. In this case it is best that the minnow swim naturally, so rig up two tandem hooks in the same way that you made your worm gang. Hook the forward hook through both lips of the minnow and bind the trailing hook to the minnow's body with thread or secure it with a tiny rubber band. Precede the bait with a No. 4 June Bug spinner, and you may hook something you'll remember for the rest of your days.

If whole minnows go untouched, cut one in half and fish the tail section as you would a bucktail or streamer. It sometimes makes the sun break through the dark clouds.

Cannibals

Did you ever catch a seven- or eight-inch trout with matching "crimp" marks on opposite sides of its body? Don't let such marks pass unnoticed, for they are the jaw marks of an old lunker and the trout which bears them is alive only by a miracle. You can be sure that the big meat-eater lives in a nearby pool, probably the largest, so don't fail to give him your best treatment.

The biggest brown trout I ever hooked—and I lost him—was just such a cannibal who reared up and struck just after I had caught a brookie wearing the indelible stamp of his jaws. Needles to say, minnows are the things to offer these big, fish-hungry babies.

Dark of the Moon

Do you have a burning desire to catch a really large trout? Instead of answering so foolish a question, go get a few four-inch minnows, some 2/0 hooks, heavy sinkers, some ten-pound test nylon, your usual fishing equipment . . . and a flashlight. Wait until evening and then set out for a stream known to hold big trout. Pick the most likely pool you know—if it is one from which you have never been able to take a fish, so much the better, for that's a good sign it's the domain of one or more old busters.

Tie three feet of the heavy nylon to your line and rig it with big hook and sinker. Pass the point of the hook through the mouth of a dead minnow and out a gill opening. Draw the hook clear and shove the point under the dorsal fin, making sure that the barb comes free. Now you're ready for business.

Disregard the head of the pool and concentrate on a quiet backwater or eddy. Under cover of darkness, the big boys feel safe to come out of hiding and cruise the quiet water for minnows. If you've never seen them, you'll just have to take my word for it.

Pick out a spot and cast your minnow well out into the pool. Prop your rod in a forked stick and strip plenty of loose line from the reel, coiling it on the ground under the rod. Now light your pipe and take it easy.

Have no fear that your minnow, lying stiff, stark, and motionless on the bottom, will fail to attract the attention of the first big trout to cruise nearby. He'll pick it up, but it may be some little time before he happens along. If you are inclined toward impatience, remember that the stakes are high.

With the first swish of line whipping through the guides, thrust down your rising excitement and pick up your rod, taking care to put no strain on the line. Let the fish move off as far as he likes; he'll stop presently to swallow the minnow. Give him ample time to get the bait down—at least a couple of minutes—then strip slack with the rod held low, until you can feel the fish with the tip. Make sure that the line is taut against the trout, then drive that big hook home as though you meant business.

What you do next is up to you . . . and the trout. If you've never played a heavy fish in pitch darkness, you're in for a brand new experience.

Check local laws to make sure that you are within legal fishing hours.

Wait Them Out

Minnow fishing is predominantly big-trout fishing, so work with extreme thoroughness and patience. A huge trout may resist capture for years and then fall to someone who was willing to work on him for just a little longer than anybody else cared to. Steel yourself against long, dull periods between strikes by remembering that your rewards will come in big hunks if you keep at it.

Á La Carte

I once surprised a large brookie chewing on a side of bacon which apparently had turned rancid and had been cast into the stream. On another occasion I watched with lifted hackles while a pair of tremendous rainbows tore the overripe body of a huge rat to bits and devoured it with obvious relish. I recommend neither rancid bacon nor defunct rats as bait, but these incidents point to surprising range in trout appetites and infinite bait possibilities.

For a variety of effective baits, there's no handier source than the shorelines of the streams you fish. Turn over rocks at the water's edge and you'll find them.

Salamanders

Not newts, which have little value as trout bait, but those lively, wriggling little chaps with bodies hardly larger than matchsticks. If you can catch one of these little wrigglers—you have to move fast—hook him through the lips without delay and drift him through the nearest pool before his wriggling subsides. He won't live long if there are trout around.

These little salamanders take first place on a trout's list of tidbits. In addition to being relished, they are relatively rare, which serves to make them doubly desirable.You don't often find one in a trout's stomach, but you'll seldom fail to get an enthusiastic strike when you use one as bait.

And Hellgrammites

Don't overlook these ugly larvae. In the cold water of trout streams they don't grow to be the big, leathery cusses generally used as bass bait, and are all the more attractive for their small size. Whenever you turn up one of these little trout-stream hellgrammites, hook it lightly under the collar and fish it as you would a worm. It's a good bait.

I remember one instance when a tiny specimen produced two successive rainbows in the pound-and-a-half class as quickly as I could place it in the water. How much longer *that* would have kept up I'll never know, for the second trout tore the hellgrammite loose and no amount of searching would turn up another.

And Just about Everything

You'll turn over hardly a rock without finding some sort of stream-side life. Nymphs of all kinds will cling to the bottom of each overturned stone, and one that you possibly can hold on a small hook is well worth trying.

Even the common earthworms found in this manner will have a freshness and flavor impossible to retain for any length of time in a bait box. Use them at once, for they probably will prove more attractive than those you have brought with you.

Be a rock-turner-upper. If anything moves, grab it and hang it on your hook!

Five, Six, Pick Up Sticks

"Stick worms"—larvae of the caddis fly—are common to trout streams and gain their name from their ability to sheathe themselves with bits of wood until they resemble sunken twigs resting on the bottom. Stripped of their cases, these larvae are looked on with high favor by trout.

Gather a supply of these caddis worms—you can pick them up almost anywhere along a stream—and drop them in your bait box. Rig up with tapered leader (3X is none too fine) a No. 14 hook of light wire and give your line a coating of grease to make it float. Draw one of the tiny worms from its case, thread it carefully on the hook, and fish it upstream, exactly as you would a dry fly.

Cast delicately to keep the worm on the hook, and drop it near the head of a pool. Strip slack as the line floats toward you and watch for a check which will signal a strike. Hit the fish gently out of respect for your fine terminal tackle.

Caddis worms are especially effective during those periods of low, clear water when bait fishing is bound to be difficult. Fish them downstream if the overhang won't permit casting, but have at it in the upstream direction whenever possible.

Buzz, Buzz

The next time a formation of June bugs dive-bombs your screen door or window, go out and collect a supply of these hard-shelled beetles. Cast one upstream on a No. 10 hook and it will come floating back like a tiny brown test to their effectiveness.

How about houseflies and the big bluebottles? Trout love them.They require a tiny hook and they won't stand much casting but you can float them downstream or dap them over the grass-hung banks of meadow streams.

Don't overlook the insects which hatch along the streams—the May flies or drakes.They are difficult to put on a hook and to handle, but they can be put to good use with a little ingenuity. Many times a favorable breeze can be utilized to carry them over a pool and dance them along the surface.They will be taken avidly.

Bees and hornets probably would work well, but that's where I draw the line.

Hippity Hop

Grasshoppers leap first and look afterward, and are forever plunking down in trout streams. During the late summer months trout gobble them by the thousands and are just begging to be tricked by a juicy hopper on a small hook.

As is to be expected, trout will rise with enthusiasm to a grasshopper fished on the surface. Oddly enough, they also produce well when fished deep, so try both methods to see which works the better.

Grasshoppers are difficult little cusses to control when carried alive. If you do as I do, you'll execute them as you catch them by nipping their heads between the nails of thumb and forefinger. Given this treatment, they'll stay put in the bait box and, as far as I can tell, will be every bit as attractive to the trout.

Crickets are on a par with grasshoppers, though more care must be taken to keep them on the hook. Lay in your supply in the early morning while the dew is still on the grass.They don't like moisture and will be found congregated under old boards and loose rocks where the ground is dry.

Those big locusts which flush ahead of you like timber-doodles are fine for trout, although they are difficult to catch. Place one on a small hook and give him a gentle toss with the rod. If you're lucky, he'll land in the water with wings beating. Don't waste time on a trout who refuses a fluttering locust; he's neurotic and at odds with the world.

In Short

There's little in the way of living tissue which trout won't accept in one form or another, so be as democratic in your offerings as they are in their tastes. Here's one more little dodge which may whet their appetites:

Rig up with a worm gang and bait the first hook with a cricket or grasshopper, the second with a small hellgrammite or worm and the tail hook with a minnow tail. What more can they ask—a printed menu?

Pond and Lake Fishing

This is a complete subject but I intend to penetrate it only to the depth of a few basic hints. Let's start with brook trout.

Ponds

Pond brookies can be taken early in the season by dangling a worm almost anywhere. Come warmer weather, and they retreat to the spring holes and become shy and selective to the point of exasperation. Locate these hangouts by exploring the deepest sections of the pond and any inlets which may bring cold water.

Nymphs and larvae such as the caddis worm, hellgrammite, dragonfly nymph, etc., are among the better baits and will generally outproduce worms. Fish them with a fine tapered leader, small hook, and *no sinker.* Make as long a cast as possible and let your bait settle to the bottom and remain undisturbed for several minutes. If it is not taken, start it along the bottom in tiny hitches by retrieving line with a very slow hand twist. Continue with your twist retrieve until the nymph reaches the very top of the water. Trout may follow it along the bottom without taking, and then grab it on the way to the surface.

If you take my advice, you'll leave the ponds alone after streams. If you're a stubborn cuss, use the finest possible tackle, effect a slow, natural motion of the bait, and feed them tidbits rather than full dinners.

Lakes and Lunkers

Trolling is a standard method for taking those big browns and rainbows—brookies too, if they are present. Troll near the surface in early season and deep when the water has warmed. A sewn minnow makes a good trolling lure, or you can run it behind a spinner arrangement. The latter can range from a single blade to the Dave Davis rig which consists of spinners in tandem to give off a maximum of flash and glitter.

Nightcrawlers trolled behind a spinner or spoon work well in lakes and here is a simple and effective rig for their use:

Remove the hooks from a large red and white casting spoon and replace them with a worm gang of No. 6 hooks whipped to a 15-inch snell. Drape a crawler on the gang and troll at a speed which will give the spoon a slow wobble.

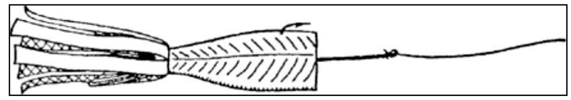
Such spoons are effective when used without bait and, for an interesting variation, try trolling a tiny red and white spoon a foot or so behind one of the large ones. Be sure to use swivels ahead of all trolling rigs.

Still fishing pays off if you have the patience to sweat them out. Nightcrawlers fished just off the bottom are always a good bet, as are live minnows. Dead minnows are sometimes better. Let these rest on the bottom but jig them frequently to attract attention.

Some fishing tricks fail to make sense on the face of them, yet come through with flying colors when you can bring yourself to put them to the test. Here's one of that type to try on those sly browns and rainbows that have grown fat and heavy by turning down all conventional baits.

Select one of your largest minnows and cut it in half. Take the tail-half and peel the skin back to the base of the tail. Slit the skin lengthwise several times so that it hangs from the body of the bait in narrow ribbons or streamers. Run your hook through the fleshy end and lower the bait close to the bottom.

Jig gently with the rod for several moments to make the shreds of skin flutter and wave. After a few minutes of jigging, drop the minnow tail to the



How to prepare a skinned minnow for lake fishing

bottom and let it lie there. If nothing takes it at the end of five minutes or so, start it up and jig some more.

You may have to work a long time for your fish, but, when he comes, he's likely to be an old lunker too wise to fool with a plain minnow!

As a day-in, day-out proposition, bait fishing for trout in lakes shapes up as a sit-and-wait deal that takes a little too much patience for most of us. Fish, when you hook them, are likely to run big indeed, but it can be a long time between bites—and generally is. There is, however, one way to lick this. Pay no attention to lakes except on those relatively few days when conditions are ripe for a killing.

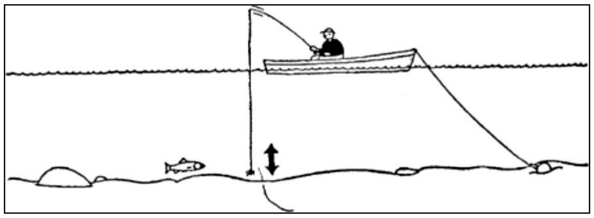
Pick only those days during or following a heavy rain. Rain, no matter how violent, has little effect on a lake of any size, but the tributaries—ah, a different matter entirely! Each swollen brook pours a steady stream of rain-washed food into the lake, and the trout gather at the mouth of each to feed. If you can contrive to be at one of these inlets when the stream is on the rise, you'll catch those usually stand-offish browns, rainbows, or squaretails with their guard down. Anchor where the roil mixes with the clear lake water, and lower a lively nightcrawler. Things should start happening in a matter of minutes!

Unclassified

Which means a few rag-tag observations. The first one is plain screwy.

Watch Out behind You

As a youngster I swam with my contemporaries in a pool below the remains of an ancient wooden dam. When we were through swimming, we would



Jigging

rush for our alder poles and catch trout, almost before the ripples had died away. It sounds crazy, but our thrashing around seemed somehow to stimulate the trout and prompt them to bite.

I honor this early experience by casting behind me frequently, and it pays off often enough to keep me at it. I remember one 14-inch brookie which snapped up my worm the instant it landed in my muddy wake. It was the only decent trout taken over an entire day by three fishermen.

By a Waterfall

You can pick up bonus fish cram-jam against the base of a falls too high for trout to ascend. If the water falls to a flat shelf and then drops into a pool, fish the pool, but don't fail to try the shelf, no matter how barren it looks. There will be one or two trout hugging the foot of the falls if there is water enough for them to swim.You might as well have them as the next fellow.

Change of Pace

Thinking back over a lot of trout fishing on a good many streams, one trick keeps popping up as a tide-turner—the quick shift.You're having better-than-average luck with a certain bait or lure. Then you come to a likely pool where you get nary a nudge, although common sense tells you should connect. Finally, as a last resort, you try something radically different. One cast—bango!

This is an altogether different matter from changing lures when the fish aren't hitting. It involves removing a lure that has been producing steadily in favor of something untried. Generally the temptation to move on to the next bit of water wins out and you don't go to the bother of changing. You may pass up the prize of the day, however.

This has happened to me too many times to count it as coincidence. The way they slam into that second lure on the first cast indicates a cause-and-effect answer, and here's how I have it doped:

First, you hit on something that produces, something that packs a lot of appeal on that particular day. Several fish take it greedily, then you come to a spot that holds a customer with a bit more will power. Like the others, he wants your offering—maybe comes within an ace of grabbing it—but his super sense of caution holds him back. Such a fish, nevertheless, already wavering on the brink of decision, is now a better prospect than when you first walked up on him. Maybe he can resist the appeal of that first lure indefinitely, but when temptation unexpectedly appears in a second form it may prove to be just too much to bear. Thus, he's likely to bang whatever else you toss at him—almost anything, just so it's different. It's really nothing more than the old one-two punch; you set him up with the first lure, then come up from the floor with the crusher.

The tough part about this trick is that it calls for changing lures when probably you have but to move to the next hole to take a trout with what you already have on. Remember, though, that the hard-to-tempt fish live longest, grow the biggest. A change at the right time often raises one of these lunkers!

That Swimmin' Hole Trout

Remember him? Here's the trick I'd use to show him where lightning struck the barn.

I'd get a fat nightcrawler, and I don't think I'd use a hook a bit bigger than a No. 14. I'd rig it with at least a six-foot leader, then I'd get real cagey and pinch on a couple of buckshot or a good-sized clamp-on sinker, *just below where the leader joined the line.* I'd flip this into the pool, let the sinker plunk to the bottom on a slack line, then barely tighten the line against the weight of the lead. In the meantime, the crawler would work downstream very slowly in the slight current until the leader was fully extended. It would then appear to lodge, which would be perfectly natural in a deep, quiet pool. The leader would lie along the bottom and have no apparent effect on the bait.

Once settled, I'd let the crawler lie there on the bottom and wriggle until the trout grabbed it. Bet he'd do it, too; maybe not right away, but eventually. The falling sinker and line would not disturb him as much as you might think—not enough to keep him from scooping up a worm that lay a good six feet from these objects and seemed in no way associated with them.

It boils down to the fact that in deep, quiet pools of glass-clear water, the only place to fish a worm is smack on the bottom. You can't make it look and behave as it should in any other way—line and leader always affect it seriously if you try to sink it slowly, and to let it dangle at some arbitrary depth is a worse giveaway. Get it right down on the gravel, and keep the sinker a full leader-length away from the worm!

Robinson Crusoe

He lived on an island, didn't he? This is about islands—the little islands in trout streams.

Ever notice that these little plots of high ground never split the stream equally in half? Which way to go? Follow the main current as other fishermen would? Aha! As other fishermen would, eh? Maybe the smaller branch hasn't been fished for a month.

Go around the "poor" sides of those little islands. You'll pick up more than one good trout doing just that.

Spotted Trout

Any fisherman worthy of the name is always on the watch for trout, whether he be fishing or less sensibly employed. Here's a trick which will help you to "spot" trout, and that should lead to taking them.

Pick up a thin piece of shale or slate the size of a dime and flick it into a quiet pool. Watch it twinkle and spin as it slants toward the bottom. Note how its progress can be followed far into the green depths. Note also, you lunkhead, that a two-pound trout has just made a pass at it! How long is it going to take you to get back there with a rod?

Another way to count noses is to inspect streams when the fall spawners (brookies and browns) are on their spawning beds. Look for the browns in the riffles of the main stream where bright areas of freshly turned gravel betray their presence. Search for spawning brook trout in the headwaters.

You may be astounded by what you see—especially in "fished-out" streams. Though your hands will be tied at the moment, the knowledge that those trout are there should provide that extra margin of strength and courage which you need to live through a long, dull winter.

Lake Trout and Salmon Fishing

Lake Trout seem to think that they can live only in water which is around 45 degrees Fahrenheit, and nobody can talk them out of this ridiculous idea. For all they know they might like a temperature of 60 degrees better, once they got used to it.

This finicky trait costs us a lot of good fishing, for lakers offer sport on light tackle only when they lie in shallow water. For a few short weeks in early spring and late fall they find the surface temperature to their liking and they then hang near the top.That's the time to hit them for the most fun.

Fly Fishing

You don't normally think in terms of fly fishing on days when ice forms in the guides and your hands turn blue, but you may have to put up with rugged weather if you want to take lake trout on flies. As soon as the lakes clear of ice, lakers come close to shore, hungry and ready to snap up anything which resembles a smelt or minnow. They won't stay there long, so you'd better brave the cold if you want some exciting streamer and bucktail fishing, with fish averaging may be four pounds and running to ten or better.

Use the rod and line which you ordinarily do for streamer fishing, but splice a generous amount of backing to the fly line, just in case. Your leader doesn't have to be tapered, and a length of nine feet is plenty. Going finer than four-pound test won't get you any more fish, and may lose some for you.

All streamer and bucktail patterns will take lakers, but you'll do well to stick with such proven numbers as the Gray Ghost, Black Ghost, Supervisor, and Dark Edson Tiger. Flies with two hooks in tandem are the surest hookers. No. 4 is a popular size for lakers.

Pick a rocky shoreline and let your fly sink into the deeper pockets, pinching on a split shot or two to help sink it if necessary. Remember that you're trying to imitate a smelt or minnow and that your fly will do that best if it runs well under the surface. Retrieve at moderate speed, working your rod to give the fly a darting, smeltlike action. Keep moving to cover as much water as possible. Lakers are hungry in the spring and don't require much teasing, so you'll only waste time by casting away in one spot.

On calm evenings you can sometimes spot lakers rolling at the surface, and cast directly to rising fish, but generally you have to go at it "blind." This makes slow work of it and you almost always can turn up more lakers if you troll your flies or, better yet, combine trolling and casting. We'll have more to say about fly trolling when we get to landlocked salmon; just remember that it is just as effective on lakers as it is on landlocks.

Bait Casting and Spinning

If bait casting or spinning's your game, you can get in your licks with spoons and wobblers while the lakers are near the top. Maybe you'll find that they have it over flies, for you can sink the metal lures deeper than you can the streamers and pick up fish when they're just a little too far down for flyfishing.

Good spoons for lakers are those of medium size which you can handle on either a bait casting rod or a fairly stiff spinning rod. Almost any metal wobbler will take lake trout, but if you have any doubts you can always snap on a Dardevle and know that you have picked a time-tested lure.

The way you fish counts for more than your choice of lure, just as it does in all kinds of fishing. Probably the worst mistake you can make is to get in the rut of retrieving in the same old way, cast after cast. Vary the action; run your lure close to the bottom by letting it sink after each cast, then reeling slowly. If this doesn't work, try reeling faster. This makes your lure angle toward the top, so pause every ten feet to let it flutter back down and regain depth. Try as many combinations of reeling and rod twitching as you can think of. Experiment until you get results, then feed them more of the same.

Deep Trolling

Trolling for lake trout after they have returned to deep water is looked on by many as the dullest occupation known to man, yet others find it fascinating. Probably those who like it are the ones who have taken the trouble to learn the business. It can be discouraging at the start and it's not at all surprising that so many lack the patience to see it through.

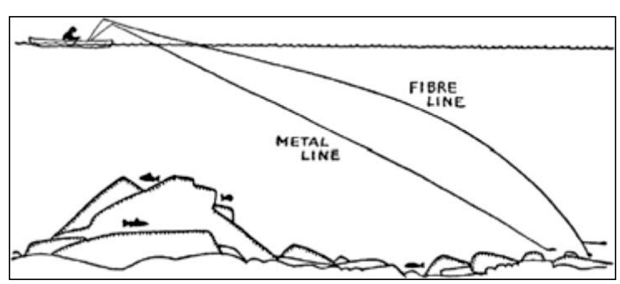
Since lakers stubbornly refuse to live in water much warmer than 45 degrees, and prefer it closer to 40, you're faced with the job of locating water this cool, even on the hottest summer days. If the surface temperature has gone no higher than 60 degrees you can generally hit your layer of trout water by going down 40 feet or so.That's not so bad, but when the surface warms to 70 or 80 degrees, as it does in many lakes by midsummer, you may have to go as deep as 80 or 100 feet, and sometimes even deeper!

With a "maximum-minimum" thermometer you can locate the water that holds the lakers, but that's only part of the job. It's one thing to know that the trout are 80 feet down, and another to get your lure down to them and hold it there while you troll.

A braided fiber line—silk, nylon, etc.—is not satisfactory for deep trolling. You must hang on an appalling amount of lead to hold the lure down where you want it, and, even then, the line develops such a belly that it makes the hooking of striking fish extremely uncertain. Metal lines, on the other hand, sink of their own accord and pass through the water with but slight friction resulting. They develop very little belly, and the hooks sink home when a fish strikes, due to the straight pull against the rod.

The depth at which you troll should determine the type of metal line you select. To fish moderately deep you can use a braided or twisted metal line and enjoy the greater ease with which these two types handle, for they do not tend to kink, coil, and spring as does a line of solid wire. Due to their lesser density, however, they do not sink as readily as a solid strand, and the latter makes a more suitable line when you must go down a hundred feet or more to take fish. You must use care in letting out, spooling, and handling these lines in general, for a "bird's nest" of this fine wire cuts deeply into a man's soul, then proceeds to rub salt in the wound. Sensible caution will spare you this pain, however, and the resulting advantages are cheaply bought for the relatively slight risk you run of a tangle.

Lines of Monel metal have by now won the nod of favor from the majority of deep-water fishermen, and Monel is especially preferred in the solid wire



Action of fiber and metal lines in deep trolling class. Monel wire is extremely strong for its diameter, and, by using a line that tests around 15 pounds, it is possible (and practical) to use an ordinary bait casting outfit to troll at great depths with those lures that do not place undue strain on the rod. Lines of greater strength—25- to 35-pound test—are also surprisingly fine and you need no greatly oversized reels to hold all you need for the deepest trolling—200 yards or so. Monel does not kink with disastrous results (as does copper) nor does it rust or otherwise deteriorate with use.

To those who object to deep trolling on the grounds that it requires tackle so heavy that it robs the game of sport, the fine-gauge Monel lines now available offer a possible solution. A fly reel will hold several hundred yards of the five-pound test, and this hair-fine line will take a streamer or bucktail down to the deepest levels without straining a four- or five-ounce fly rod in the least. Thus it is possible to take lakers from the depths on the lightest of tackle, although working a heavy fish to the surface from over 100 feet down may prove to be a long, drawn-out process.

A solid wire line has one characteristic which you should keep in mind when a fish is first hooked: it will not stretch. While this feature makes for sure hooking, it also gives a fish a good opportunity to tear free during that first wild flurry if you handle him with a heavy hand. Don't snub him short during those first few moments, especially if your rod is on the stiff and heavy side.

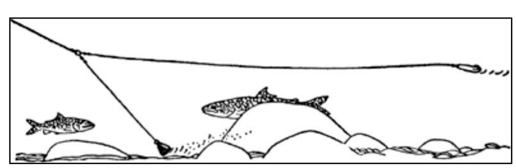
The closer to the bottom you troll your lure, the better, for that's where the lakers generally lie. Here's one way to do it:

Snap on a wobbler that rides with the single, fixed hook upward, such as the Pfleuger Record Spoon. Fish the spoon as is, or hang a thin fluttering tail of pork rind on to the hook. Slow down to trolling speed—just fast enough to "work" the spoon—and start paying out line (not too fast with that single-strand wire!). Eventually you'll feel the spoon bump bottom, for this will kill the throbbing action momentarily. As soon as the spoon touches, slip a glove on your right hand and grasp the line, laying the rod beside you or propping it between your knees. Reach straight behind you, then sweep your arm forward along the gunwale through an arc of nearly 180°, repeating the motion with a steady rhythm. The forward sweep picks the lure from close to bottom and makes it dart upward, then, when you bring your arm back, it slows and flutters downward. If you feel it brush bottom every few times, you're working it just right. The resulting action is of the sort likely to provoke strikes, and by sounding the depth constantly, you hold your lure at its most effective level.

You can work this stunt where the lake floor is relatively clean, but you soon come to grief if you attempt it over ledges or in other spots where your spoon will hang up. Neither can you bump lures with treble hooks along the bottom without snagging constantly or picking up debris from the bottom. Here's a way to keep your lure in the clear and feel out the bottom at the same time.

To the end of your wire line attach a barrel swivel and fit this in turn to a fairly large split ring. Take about 3 feet of bait casting line, tie a 6-ounce bell sinker to one end, a swivel to the other, and work this swivel into the split ring. Next you need a 10-foot length of 20-pound test nylon. Rig your lure to one end and swivel the other to the split ring.

Now you have a three-way rig—the nylon angles away from the metal line at the split ring, letting your lure run close to the bottom but never quite touching it. With this type of rig you maintain contact with the bottom through the lead sinker, but without fear of the lure snagging or fouling. To fish light lures, or those with a pronounced tendency to plane, as close to the bottom as possible, you may

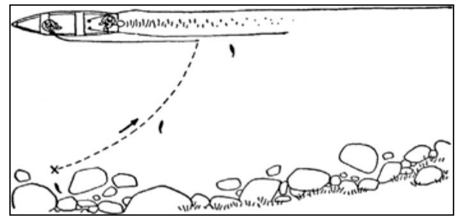


Method of fishing for landlocked salmon

need to shorten the sinker line and add length to your nylon leader. Heavy lures may require just the opposite to keep them from hanging up. Trial and error will soon point the way.

Practically all wobblers and spoons make good trolling lures, and a jointed plug will take its share of lakers. Floating plugs (divers, not surface plugs, of course) almost never snag bottom when properly adjusted behind a sinker, for they dip down only when under way, and rise when you slacken speed or stop for any reason.

A combination of bait and hardware is the favorite of many lake fishermen—a sewn minnow, a smelt, or a gob of crawlers behind a single spinner or the tandem blades of the Dave Davis rig. No matter what you hang on your line, however, get it down deep and keep it there, for that's 90 percent of the secret of taking lakers after they have left the surface.



Three-way rig for deep trolling

Landlocked Salmon

So many have sung the praises of landlocked salmon that it's a wonder that the lot of them haven't developed swelled heads. Beautiful to look at, and swift, slashing fighters, landlocks deserve everything good that's been said about them, but they're not quite so aristocratic as they're often made out. My first chance at landlocked salmon came when I was too young to hold them in any reverence. Fishing from shore with a battered telescope rod, I took them on nightcrawlers almost as easily as you'd catch perch. Since then, of course, I have learned better than to use such crude methods on so noble a fish. Besides, I rather doubt that worms would work as well now as they did years ago.

Fly Fishing

Landlocked salmon, like lake trout, come close to the surface only when the water is cold. Early in the spring, and again in the fall, they come into the shallows along the shorelines where they afford some of the most exciting light-tackle fishing you can get in fresh water. Far and away the most popular way to take them at that time is by fly-rod trolling.

The rig: A fly rod—better make it a stick of at least four ounces—a silk line that sinks readily, an eight- or nine-foot level leader of four- or six-pound test, a streamer for a tail fly, and another as a dropper about four feet up the leader.

Here's a suggestion on choosing your patterns: Popular theory has it that your flies should imitate smelt, but don't take this too literally. True enough, smeltlike flies like the Green Ghost and Nine-Three are salmon killers, but many times such patterns as the Dark Edson Tiger or Mickey Finn will bring you more strikes, although neither looks anything like a smelt. It's wise to offer salmon a choice; tie on a smeltlike pattern for a tail fly and a contrasting number as a dropper.

Another tip: Try trolling a red and white wobbler in the tiny fly-rod size. Very deadly! Do salmon take *this* for a smelt? If they do they should have their eyes examined!

A bang-up job of salmon trolling really calls for a two-man crew. Work it something like this:

Troll a long line and a short one. Strip 50 to 90 feet from one reel and 20 to 30 from the other. If a salmon resists the urge to nail the first flies, the next pair may win him over a few seconds later.

When you have both lines out, one of the crew should rig up a third rod and cast toward shore. Maybe he'll pick up a fish, maybe not; his big job is to keep shooting his fly close to shore to toll fish out of the pockets so they'll see your trolled flies and smack them. If he lifts his fly before it has swung directly astern and into the path of the oncoming streamers, he deserves a chewing out—see that he gets it!

The harder the wind blows, the more salmon fodder the waves pound up along shore, and the hotter the fishing. Salmon move right into the surf to feed, especially where large rocks or boulders give them partial protection from the tossing water. Give such shorelines your attention and pay particular heed to any point which sends out a reef or bar which the waves break over. Shame on you if you give a hot spot like that only one try. Bring your boat around—the pounding will help settle your breakfast—and drag through that rich pay dirt again, then swing back through at least once more before you move on.

Very important: Troll fast for landlocked salmonl! They're swift, powerful swimmers and wide-ranging cruisers who like an excuse to show their speed. To excite them, your flies must move!

More good business: Twiggle! Saw the line back and forth through the guides to make the flies dart ahead and fall back. A big help any time, but look on twiggling as a must when working a likely spot for all there is in it.

You pray for a good, heavy chop, so what do you get? A flat calm, of course, not so good for salmon fishing, but here are a few things to try when the water is glassy smooth:

Troll a very long line, going well into your backing before you stop stripping. If this doesn't pay off, shorten up until your flies hang in the wash of the motor! Won't the motor scare them? No! The propeller acts as an attractor, and that's the point of the trick.

If your partner hooks a fish, grab the extra rod and start casting. Nothing excites a salmon more than to see one of his mates dashing madly about with a fly stuck in his jaw. If the hooked fish has attracted another, he's likely to snap up your fly out of envy the moment he sees it. You risk a tangle, of course, but who wouldn't for a twin killing?

Spinners and Spoons

You can take landlocked salmon by casting spoons and wobblers as you do for lake trout. Lures of bait-casting weight will turn the trick, or you can spin-fish with the smaller lures and get good results. Tie on the same lures for trolling or run a minnow or smelt ahead of one of the standard spinner rigs.

But before you turn to hardware, give the fly rod and streamers a thorough try. Even though the metal lures may have a slight edge over flies—many will hotly deny that they do!—they call for stiff rods which cheat you of thrills once you have your salmon hooked. Sample this incomparable fighter and leaper on four or five ounces of fly rod, then see if you would have it any other way!

Deep Trolling

Hot weather drives the salmon into deep water where you can reach them only by resorting to the methods recommended for lake trout. They come mighty hard, once they leave the surface, and to take them requires the same patience and study that makes lake-trout trolling too much of a chore for many. All the lake-trout lures will do for salmon but probably the most popular lure is the Dave Davis spinner rig followed by a sewn minnow or smelt.

Atlantic Salmon

When the dreamed-of day comes and you shoot the works on your first trip to a salmon river, you'll have very little know-how that carries over to salmon fishing. Aside from the purely mechanical skills, it's actually best to forget all you've learned about fishing.

Forget about Trout!

If you don't, you'll size up the water in terms of trout from force of habit . . . and invariably come to the wrong conclusions!

You won't find salmon where you'd expect to find trout for two good reasons: Salmon in fresh water show little interest in food, and they seek no cover. Spots which attract trout on both counts hold no appeal for salmon. Unless you remember that, you may spend a good share of your time casting to all the wrong places.

And Rely on Your Guide!

He's the fellow who can keep you from pounding away where you'll do yourself no good. He knows his river—the pools which hold fish, and the precise spots in those pools where the fish lie. Added to this, he can see a salmon that you can't make out to save your life. Put your fly where he tells you to!

Fly Fishing, Period!

You have no choice but to fly-fish for Atlantic salmon, for no other method is legal in North American river. This makes a tough proposition tougher, for you're restricted to bits of feathers and fur in teasing strikes from fish who have sworn off eating! Most would applaud this restriction, however, even if it were not needed as a sound conservation measure. Held to a fly rod, you're bound to get your money's worth when you hook a salmon. And then some!

Wet-Fly Fishing

Salmon fishing has inspired fly tyers to their greatest efforts, resulting in such exquisitely beautiful patterns as the Jock Scott, Durham Ranger, and Silver Doctor. Though these.and equally colorful favorites, have won well-deserved reputations, one can't but wonder if their elaborate construction is an actual requirement.

Many fishermen have toyed with this idea, and some have had the courage to break with tradition and use simple patterns. Results seem to prove that ordinary bucktails, streamers, and wet flies will take as many salmon as the fancy creations. This doesn't knock the gaudy "standards" out of the running, but it shows that you'll do all right with a well-stocked book of trout flies.

As it does in most fly fishing, size of hooks seems to play a more important role than pattern. Flies tied on Nos. 4, 6, and 8 come in for the most use, but you should have some larger ones with you for possible high-water fishing. When rivers are low you need to swing to the opposite end of the scale, but there's a limit to how small you can go on hook size without killing your chances of landing such powerful fish. You can get around this obstacle by using low-water salmon flies—flies with bodies small enough to win over critical fish, but tied on hooks large enough to hold.

Why salmon rise to a fly at all is a mystery, for they leave their appetites behind them in salt water. They certainly must rise for a reason, though, so let's assume that the sight of your fly fans to life some lingering spark of the feeding instinct. This still leaves you the job of begging strikes from fish that aren't hungry, but we'll do our best to give you a little leverage with the following tips.

Hottest fishing comes with the rising water that follows a heavy rain. Fresh fish come into the river and those already there show more interest in flies. You can't order the rain, but you can be up bright and early the morning after any comes.

Keep your eyes peeled for rolling fish—not leapers, for leaping fish are poor bets, but "porpoising" salmon who break the surface with their backs.These are your hottest prospects, so work on any you see.

Locating a salmon, and then pegging away at him, is ever so much better than fishing blind. Blind casting will win you grilse—small salmon who come into the river after but a single year in the sea—but your best chance of hooking a mature salmon of ten pounds or better comes with finding your fish first, then going to work on him. Cast to him repeatedly; he may finally get the urge to rise, or he may take a crack at your fly out of sheer annoyance. If he shifts his position when your fly comes over him, you've got him interested and you should get set for a rise.

If he rises and misses—or you miss him!—get your fly back to him quickly to give him a second chance. If he refuses, change to a different pattern, one size smaller, and try him with that. Make sure that you have him relocated after a rise, for he may drop downstream when he settles back.

Before you give up on a fish, try this: Get directly upstream from him if you can, then let your fly hang in the current in front of him. Draw it ahead, let it fall back, make it shimmy; he may tear into it when you have his nerves worn thin.

Under ordinary circumstances, cast cross-stream and bring your fly back slowly and smoothly, holding it close to the top. Here again, you'll do well to forget about trout fishing, for a fly which swims evenly seems to bring more strikes than one fished with a darting "trout" action.

If you have no luck with the swimming retrieve, try drifting your fly. Cast cross-stream as before, but then keep your line as slack as possible by constant mending. This lets your fly drift sideways under no tension and sometimes brings up a salmon when a moving fly fails.

Remember the "riffling fly" trick mentioned in it takes trout, but its chief claim to fame is as a salmon persuader.Tie fly to leader with the usual Turle knot, thenhalf-hitch the leader just back of the head of the fly so it comes away from the under side of the shank at an angle. Riffle the fly by planing it smoothly along the surface on a short, taut line. If you can see a wake behind it, you're cutting the right caper. Paste a big, bright star opposite this stunt; it's a real fish-taker and you don't want to risk forgetting it.

Sometimes you wind up farther ahead if you "rest" a pool during the afternoon, then work it over during the last hour of fishing. Late afternoon is one of the best times to raise salmon, and they're all the more likely to strike if they haven't seen a fly for several hours.

Above all, heed the advice of your guide. Each salmon river has secrets and quirks known only to him and others like him who study the stream year after year. He'll put all his know-how to work for you, for he has a reputation to maintain and is as eager to see you fast to a salmon as you are to hook one. Treat what he says as the law!

Dry-Fly Fishing

Although wet-fly fishing is the most popular method, dry flies have an important place in salmon fishing. They are especially effective when the water is low and warm and the fish have been in the river for some time. Make sure you have a supply with you on any salmon-fishing trip, but particularly if you go late in the season.

The most popular patterns run to such bushy high-floaters as the bivisibles and hair-winged Wulffs, but some fishermen stick with their favorite trout patterns and take salmon on Quill Gordons, Cahills, and the like.The most effective size depends on water conditions and the whims of the fish. Salmon fresh from the sea may rise to a large dry fly—a No. 6, for example—while later on they may hold out for something tiny. Here again, you should trim larger flies, or use the low-water type, to avoid using hooks too small to hold your fish.

You can't comb the water with a dry fly as you can with a wet, so it's even more important to zero in on a particular fish when dry-fly fishing. Cast well above him to give him a good, long look at your fly before it reaches him.With plenty of time to make up his mind he may rise and take it, whereas he'll probably refuse it if you drop it on his nose and force him to a hurried decision.

If your best dragless floats come to naught, try twitching the fly along the surface. If you can get above your fish, float your fly down to him, skitter it back upstream a few feet, then let it drift down again. A little action may be all that's needed to draw a strike.

Hooking

Your trout-fishing habits will do you dirt at this critical point, too, if you don't watch yourself. Due to his bulk, a salmon makes a hair-raising boil as he comes for your fly. If you follow your natural inclination,you'll strike too soon and yank the fly away from him. Give him time to clamp the fly in his jaws, then set the hook as he takes it down. Compared to trout, salmon are slow in ejecting a fly, so you run little risk of striking too late. It takes a high order of self-control to hold fast while a great shape rolls up behind your fly, takes it in his mouth, and sinks back with it . . . but that's the way to hook salmon.

Playing

You can't possibly lick a salmon with anything as puny as a fly rod. The spring of the bamboo will wear down lesser fish, but to a fear-crazed salmon it is as nothing. All you can do is hang on while he licks himself!

You have your job cut out for you to stick with him while he burns up his tremendous energy in long runs and wild leaps. He'll show you such power as you'll see in no other fish in fresh water, and you have but to give him leverage for a fleeting instant to have him break free. Give him his head and let him rip; the longer and faster his runs, the sooner he'll tire to the point where you can at last control him with the rod and land him. Stand ready to follow him upstream or down; sometimes a quick sprint is the only way to keep him from cleaning you when he takes the bit in his teeth.

Try to remember this very important tip: Lower your rod quickly when your fish leaps or, even better, lean forward and flip as much slack at him as you can manage. If you let him jump on a tight line, he may snap the leader by a direct jerk against the reel, part it with a flirt of his powerful tail, or crash down on it with the same result. If you haul back and let him break away, don't say I didn't warn you.

You must, of course, play salmon directly from the reel. Most right-handed fly fishermen reel with their right hands, but it makes more sense to do the job with the left and leave the right hand free to handle the rod. Left-handed reeling becomes second nature with but a little practice, and you'll find it a big help in playing heavy fish on a fly rod.

Rods and Reels

The trend in salmon fishing is definitely toward lighter rods. Each year more and more salmon fishermen show up with trout rods and proceed to prove that a competent fisherman can tackle a salmon with a five-ounce, nine-foot rod and come off with a whole hide. If your fishing calls for exceptionally long casts,you may need a powerful 12-footer with double grip, but on all but the largest rivers you'll take more pleasure, and as many fish, with a shorter, lighter rod.

Unlike trout reels, which serve as little more than line-holders, a salmon reel plays an important part in landing fish, much depending on its ability to run smoothly under the salmon's long, fast dashes. This calls for expert design, machining, and fitting, and rules out the possibility of salmon reels which are both satisfactory and cheap.

Pick a reel—a single action—with a narrow spool but one deep enough to hold at least 100 yards of backing under your fly line. A hundred yards—300 feet! That should give you an idea of what to expect from an Atlantic salmon!

You never know what a taste of these big fish on a fly rod will do to a fellow. I knew one trout fisherman who swore off trout fishing for life as soon as he caught his first salmon. So far, he has stuck to it—claims he can no longer get a kick out of catching a mere trout.

In contrast, there's the fishing nut I know who recently spent two thrill-packed weeks on a salmon river. As nearly as any man can, he'd had it, but it took less than a week for the old itch to creep up on him again. The following Saturday, he was out after bluegills! Said he had just as much fun with them as he ever did.

The bug never really bit that first fellow—just nipped him a little. Like the chap who held that there was no such thing as poor liquor, the true fisherman never gets his fill. He'll fish for anything that grows fins—any time, any place!

Wild Fruits

BY DAVID SQUIRE

The strict botanic definition of fruits encompasses nuts as well as the soft and fleshy wayside fruits such as blackberries, cranberries and wild strawberries. However this chapter is devoted to the juicy succulent fruits and the next chapter deals with nuts.

These much-desired fruits are borne on a wide range of plants, from ground-hugging evergreen shrubs to brambles with long, thorny stems and trees providing fruits such as elderberries, hawthorns, and sloes.

Knowing where and when to search for country fruits is a major element in successful foraging, especially as many provide easy pickings for native animals and birds. For each of the fruits in this chapter the timing and where to find it are clearly indicated, since this is crucial to foraging success.

Do not expect to gather masses of these fruits at one time, since, within even a small area, fruits differ in their ripening and picking times. Most are picked and eaten as treats, but where foraging brings in several bowlfuls of the same type of fruit, then jams, jellies, sauces, and pies are possible.

After spending hours searching out and picking wayside fruits, the last thing you want to do is to knock over the container. Always pick fruits into flat-based boxes and regularly tip them into a larger container that has a lid. This way, even if you knock over the picking box you will not lose your complete harvest.

Thoroughly cleaned large plastic ice-cream containers are ideal when foraging as the lids can be snapped open and closed very easily. They can be labeled with a permanent marker if you are foraging for several different fruits at one time.

If you arrive home from foraging with no telltale signs on your fingers and lips of eating a few (or more) fruits along the way, then you will not have enjoyed yourself to the full!

Barberry (*Berberis vulgaris*)

Also known as: common barberry, jaundice berry, pipperidge, piprage

You might see this thorny, deciduous shrub in old and neglected gardens where it was once grown for its 5–7.5 cm. (2–3 in.) long pendulous clusters of yellow flowers, followed by red berries.

It is native to large parts of Europe, northern Africa and temperate Asia, as well as abundant and now naturalized in North America, where it was introduced by early settlers.

You'll find it: in old gardens it was traditionally used as a hedging plant, so do not be surprised if you find it around abandoned buildings and alongside roads. Also look for it on wasteland around old dwellings.
Fruits: red oblong berries, 12 mm. (½ in.) long, appear in late summer. These are high in vitamin C and are an important food for small birds. Barberry has also been used to treat liver complaints and jaundice in alternative medicine. However, its very sharp thorns make it quite difficult to pick the fruits in some locations.
Harvesting the fruits: berries are ripe enough to be picked in autumn when they turn a deep red. Use gloves as the prickly stems can damage your fingers and hands.
Using the fruits: although acidic, they can be eaten raw and are considered a delicacy in some cultures. However, they are more palatable when candied or preserved in sugar.

The fruits make good jams and jellies—use the recipe for hawthorn jelly as a template for making barberry jelly. In eastern Europe this jelly is traditionally used to accompany roast meats.

Iranian Delicacy

The dried fruit of barberry is widely used in Iranian cooking—Iran is the world's largest producer of dried barberry, known as *zereshk* in Persian. *Zereshk* is added to chicken dishes to give a tart flavor, and is also cooked in rice and made into jams, juices and fruit rolls. Try adding a few fresh or dried berries to rice during cooking to give a sharp note to the dish.

Bilberry (*Vaccinium myrtillus*)

Also known as: blaeberry, crowberry, whinberry, whortleberry

Few plants have such delicious fruits as this hardy, deciduous, spreading shrub. Native to large parts of central and northern Europe, its appearance belies its value as a foraging plant. Earlier it was widely planted in North America, where it is now established.

Growing 30–60 cm. (1–2 ft.) high, it is smothered in oval, slightly pointed and finely tooth-edged, bright green leaves. Drooping, greenish-pink rounded flowers are borne singly or in pairs in terminal and side clusters during late spring.

You'll find it: abundant on mountainsides, in open woodland and on acid heaths and moors.

Bilberry Tart

There are numerous recipes for Bilberry tart but the following one has proved to be popular.

- 1½ cups of large, washed bilberries
- 4 tbsp. confectioners sugar
- 20 cm. (8 in.) wide tart tin lined with sweet short-crust pastry. Bake blind to create a base for the berries.
- 4 egg yolks
- 4 tbsp. double cream
- 6 fresh bay leaves

Heat the oven to I80°C (350°F). Mix together the sugar and bilberries and tip into the prepared tart case. Beat together the egg yolks and cream, then pour the mixture over the sugared berries. Place bay leaves on top of the art and bake for 25 minutes or until set. Eat warm or at room temperature. A dollop of cream or vanilla ice cream are delicious companions to this tart!

In windswept areas you need to search carefully for this plant, as it grows lower than usual.

Fruits: round, juicy bluish-black and 6 mm. (¼ in.) across. They often cluster under leaves and unless searched out are not easily seen.

Harvesting the fruits: berries are ready for picking from mid-summer to early autumn

Using the fruits: wash before eating. Large fruits are superb with sugar and cream. They make tasty tarts and jams, and can be added to stewed fruits.The dried leaves can be infused in boiling water to make a tea substitute.

Blackberry (*Rubus fruticosus*)

Also known as: bramble, brier

Perhaps one of the best-known foraging plants, with lusciously sweet berries in late summer and autumn.The green, prickly, bramble-like leaves assume reddish-purple shades in autumn. During early and mid-summer, white or pink flowers, about 30 mm. (1 in.) wide,appear in clusters. Later, these are the source of the fruits.

Native to Europe (especially southern regions), Mediterranean regions and Macaronesia (islands in the North Atlantic ocean, including the Azores, Canary Islands, Cape Verde, and Madeira) but widely naturalized around the temperate regions.

You'll find it: widespread in hedges and woods, alongside roads and in old, neglected gardens and allotments, where it forms a tangle of near impenetrable, thorny, arching stems.

Fruits: color changes from green to red before finally turning rich purple when they are ready for picking.

Harvesting the fruits: place the fruits in shallow baskets and avoid squashing. Try not to collect more fruits than you can eat; leave some for the wildlife.

Using the fruits: most fruits are eaten fresh, sometimes with a dusting of sugar and cream, but such is the versatility of blackberries that they are used in a wide range of desserts and jams.They are particularly good with apples in a crumble, in blackberry tarts and pancakes, and of course, with vanilla ice cream.

Blackberry Sauce

This is an easy recepe and is excellent with duck, pork or turkey.

- 450 g. (1 lb.) blackberries
- 3 tbsp. confectioners sugar
- 1 tbsp. lemon juice

Mix the blackberries, sugar and lemon juice in a saucepan.

Cover and simmer gently for about ten minutes.

Remove from the heat, allow to cool slightly, and then blend in a food processer or blender.

Strain the mixture to remove seeds and label the jars when cool. The sauce can be kept in a refrigerator for two or three months, but is best used soon after making.

Blackcurrant (*Ribes nigrum*)

Also known as: european black currant, squinancy berry

Widely grown in gardens, it is native to much of Europe as well as north and central Asia to the Himalayas. This hardy clump-forming shrub, up to 1.5 m. (5 ft.) high, has large, matte green, three- or five-lobed leaves. It bears clusters of drooping, dull purplish-green flowers, followed by sprigs of round berries that ripen in the latter part of mid-summer.

You'll find it: in moisture-retentive soil in woods and alongside banks.
Fruits: distinctively black and glossy, but not in such large and dense clusters as cultivated blackcurrants.
Harvesting the fruits: pick entire sprigs (clusters) of the fruits, not individual berries. When you get them home, remove individual berries from stalks and place in a cool larder rather than the refrigerator since they lose some flavor if excessively chilled.
Using the fruits: apart from being used fresh with a dusting of sugar and cream, they are made into jams and put in flans and pies.They are also superb in muffins, fools, and as toppings for cheesecake and ice creams. Blackcurrants are very high in vitamin C.

Sore Throat Remedy

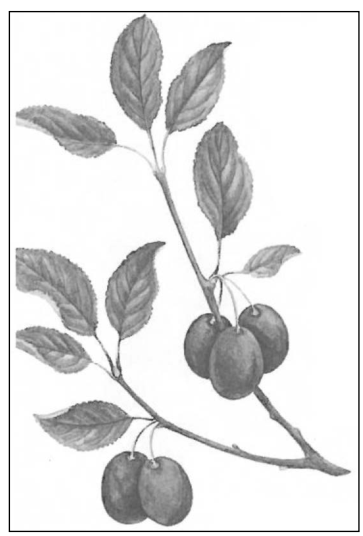
Blackcurrants have been gathered in the wild for many centuries before the plant began to be cultivated in gardens. The fruits were used in folk medicine to alleviate a sore throat, known as a qunsy. This led to the plant being called squinancy, an earlier but still relevant common name. Its effectiveness for easing sore throats was vindicated during the Second World War (1939–45) when commercially bottled blackcurrent syrup was given to children suffering from that complaint.

Tea Tricks

Transform a port of ordinary India tea, and give it the flavor of green tea from China by adding dried blackcurrant leaves to the infusion. When fresh, blackcurrant leaves have a heavy, aromatic aroma, especially when crushed.

Bullace (*Prunus domestica subsp. insititia*)

Also known as: bullace plum, bullums, bullison, damson plum, green damson



Closely related to damsons, the bullace is sometimes classified as *Prunus insititia.* It is deciduous, brown-barked and usually forms a densely twiggy and thorny shrub, although it can reach tree-like stature of 1.8-4.5 m. (6–15 ft.) high.

Its hairy surfaced leaves are long, dull grayish green and coarsely tooth-edged. It flowers during mid- and late spring, with pear-shaped, broad, pure white petals.

It is a natural hybrid and was widely cultivated in Europe and southwest Asia but later became neglected when improved plum varieties were developed. It was introduced into North America and became known as bullace plum and Ddamson plum.

You'll find it: usually near old and abandoned orchards, in hedges, old gardens and undisturbed corners. It is often found in areas quite remote from houses.
Fruits: round or shortly oval drooping fruits are usually blue-black, with a white bloom, or purple. They are 18–25 mm. (¾–in.) wide and larger than the fruits of sloes.The stone is bluntly angled, with the fruit's soft flesh clinging to it.
Harvesting the fruits: although more palatable than the fruits of sloes, their taste is so sharp that they are often left on the shrub or tree until mid- or late autumn.This enables early frosts to soften the flesh and decrease their acidity.
Using the fruits: the range of uses for bullaces is wide and certainly in earlier years it was an important culinary fruit in autumn. However, as new varieties of plums, damsons and gages were introduced, its importance faded. Nevertheless, as a foraging fruit it is worth seeking, with uses ranging from jams and sauces (especially to accompany wood pigeon) and to make bullace vodka (see page 81 and adapt the recipe for sloe gin using vodka or gin if you prefer).

Cherry Plum (*Prunus cerasifera*)

Also known as: myrobalan plum

This deciduous spreading tree can grow 8 m (26 ft) tall in the wild but it is mostly found as a scrambling hedgerow plant. It has finely toothed oval, alternate leaves and white flowers with five petals that open before the leaves in early spring. Since it is the first Prunus to flower, it is often confused with sloe (see page 81).

Native to a wide range of areas in Europe and Asia, it has been widely cultivated and has become naturalized in North America.

You'll find it: especially alongside hedgerows and thickets on all but the poorest soil. Since it has been widely cultivated, look for it in old and neglected gardens and old orchards. It has also been grown as a decorative shrub and tree.
Fruits: round 2–3 cm. (1–1 ¼ in.) across with a stone, the fruits can be either red or yellow. Some foragers claim the taste is a combination of cherry and plum. They can be eaten fresh but some are quite dry and may need to be transformed into preserves or jellies.
Harvesting the fruits: ripening from mid-summer to early autumn, try to harvest before the birds get to them. Cut them off and either eat immediately or store in shallow boxes in a well ventilated room. Use as soon as possible.
Using the fruits: they can be eaten immediately when ripe and on picking. To many tastes they are sharp, but make excellent jams, jellies and chutney. Try cherry plums in a summer fruit cobbler with other foraged fruits such as blackberries or raspberries.

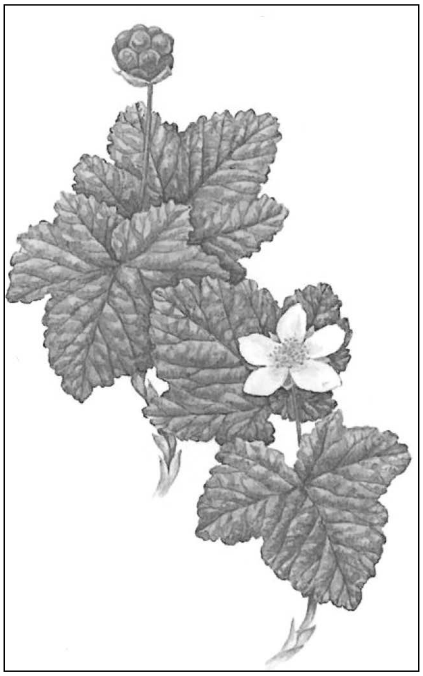
Cloudberry (*Rubus chomaemorus*)

Also known as: baked apple, baked apple berry, malka, salmonberry, yellow berry

Hardy low-growing herbaceous perennial, usually only 7.5–25 cm. (3–10 in.) high, depending on the barrenness of the area, with a creeping rootstock that enables it to survive cold regions.

Sometimes it has an annual nature and increases itself by seeds each year.

It is native to a wide area of the northern hemisphere, including North America, northern Europe, Scandinavia and Arctic Russia to central Russia and Germany. Plants flower from early to late summer, with five-petalled white flowers that are highly attractive to flies and bumble bees. Some plants are male, others female: each plant usually has just one flower, with only female plants producing berries.



You'll find It: on open moorland and mountains, and growing among other plants, including heather, cotton grass, and mosses.

Fruits: at first red and clustering in groups at the tops of stems, they become yellow or amber when ripe during late summer and early autumn.They are often described as small, orange globules packed in heads shaped like a raspberry.

Harvesting the fruits: this needs to be done as soon as the berries ripen, as insects find them tasty. It is a back-breaking task, searching the ground low down and this accounts for the high cost when buying them.

Using the fruits: they are especially tasty when eaten fresh with vanilla ice cream. Foragers new to these berries often find the seeds tough and therefore boil the entire fruits, adding sugar to make jam. This mixture can be reprocessed to make jellies and juices, blended with chocolate ice cream, or made into a refreshing and unique marmalade.

Cowberry (*Vaccinium vitis-idaea*)

Also known as: clusterberry, crowberry, foxberry, lingonberry, mountain cranberry, quaiiberry, red whortleberry

This hardy evergreen shrub with creeping roots is native to a wide area in the northern hemisphere, as well as to areas further south but at high altitudes. It is a popular native plant in North America where it is cultivated for its berries.

It rarely grows more than 20 cm (8 in) high, but in places where the weather is congenial it is slightly more vigorous—up to 30 cm. (12 in.). Its dark lustrous green leaves are oval to pear-shaped, tough with serrated edges. Pink or white bell-shaped flowers appear in terminal clusters during late spring and early summer.

You'll find it: on moors and in woods, where the soil is acidic. It is not easy to find, but often forms large, if sparse, colonies.

Fruits: acidic, globular red berries appear from late summer to mid-autumn.

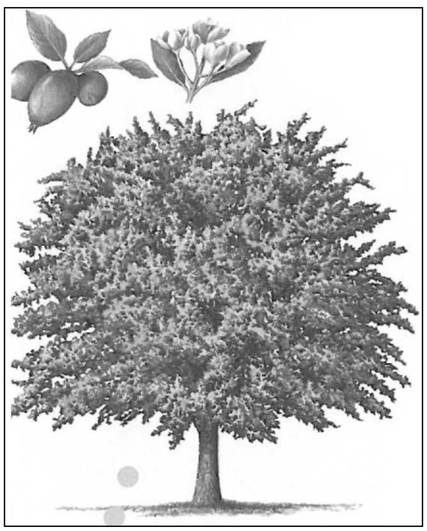
Harvesting the fruits: gather the berries as soon as they are red—not before. Take care not to squash them and get them home as soon as possible, before they become warm. Place in a cool, airy cupboard, where they can remain for several weeks.

Using the fruits: often scarcely edible when picked and therefore usually turned into jams and jellies. However, there are other ways to use cowberries: try them in muffins, baked with apples, or into buns. They can also be cooked with cabbage to give a sharp piquancy to a sometimes dull vegetable. Like cranberries, cowberry jelly is particularly good with turkey, game birds and venison.

Crab apple (*Malus sylvestris*)

Also known as: crab, wild crab apple, european apple, sour grabs

A native of Europe and southwest Asia and, when introduced into North America, a widespread escapee. It forms a small tree, up to 7.5 m. (25 ft.) high, with dull to mid-green leaves, smooth-surfaced, and with bluntly toothed edges. It should not be confused with seedlings from orchard apples, which can be distinguished from the wild crab apple by their downy stems and sweet fruits. During late spring it produces clusters of white flowers flushed with pink.



You'll find it: in hedges, woods and scrubland.
Fruits: the round, 18–25 mm. (¾–1 in.) wide fruits are hard and sour-tasting, greenish-yellow and when ripe, often speckled or flushed with red. Each fruit has a depression at both ends.
Harvesting the fruits: usually ready in late summer or early autumn, when they turn red, start to fall from the tree or their stalks are easily parted from the tree.

Crab Apple Jelly

- 900 g. (2 lb.) crab apples
- confectioners sugar
- 2 cloves

Chop the apples roughly and put into a preserving pan with cloves and enough water to cover.

Bring to the boil and simmer until soft and pulpy. Skim foam that arises. Put pulp in muslin layers or a jelly bag to drain overnight, catching the juices in a pan.

Discard the pulp and measure the juice. For every 600 ml. (1 pint) of juice add 450 g. (1 lb.) sugar. Return juice and sugar to the pan and dissolve sugar by heating gently, then boil rapidly for 20 minutes or until setting poin t is reached. Pour into warm sterilized seal while still warm.

Using the fruits: crab apple jelly is perhaps the best known way to use the fruits, but they are also used to make wine, chutney, apple butter and many jelly variations.Try adding two or three crab apples to ordinary apple tarts or crumbles to introduce a sharp note.

Cranberry (*Vaccinium oxycoccos*)

Also known as: bog berry, small cranberry

You might find this hardy, prostrate, evergreen shrub listed as *Oxycoccus palustris*. It is native to a large area from Europe to Scandinavia, central France, northern Italy, northern Asia to Japan, Greenland and many parts of North America.

It has wiry stems and small, oval and pointed, dark green leaves (whitish below); long stems often develop roots which help secure the plant in the ground. Pink flowers, with four spreading or turned-down petals, appear from early to late summer, with the fruits in autumn.

You'll find it: in bogs and wet heaths, but you may need to search for it under other shrubs.
Fruits: round or slightly oval red berries appear from late summer to mid-autumn. Sometimes, they have small, brown spots. The berries are borne individually at the ends of thin stems, which arise from leaf joints along main stems.
Harvesting the fruits: pick the berries individually when richly colored. Usually, you will not be able to find sufficient berries to make a pie; they are best used to make sauces.
Using the fruits: when picked they have a tart, acidic flavor and to many people's taste are almost inedible when uncooked. Cranberries are at their best when used to make traditional sauces to accompany turkey or venison.

North American Introduction

Known as the large cranberry or american cranberry, *Vaccinium macrocarpon* (earlier listed as *Oxycoccus mocrocorpos*), is native to North America as well as being introduced into other countries. It has been cultivated in its native countries and Europe for its large berries. It is now ideal for foraging in commercially abandoned areas, and the berries mix very well with smaller-berriel specios.

Dewberry (*Rubus caesius*)

Also known as: token berry, european dewberry

A popular wild bramble with slender, prickly, sprawling stems, and due to its low, deciduous nature is often unnoticed, especially as it does not produce many fruits during some seasons.This reluctance to bear fruits has encouraged its country name token berry. It rarely grows beyond 40 cm. (16 in.) high.The leaves have three green leaflets, and are slightly hairy on both sides.

Clusters of white, five-petalled flowers appear from early summer to early autumn and are followed by the distinctive fruits. Dewberry is common in many areas particularly along coastal regions in Europe from Scandinavia to Spain, Greece and Sicily, and also in Asia and Russia.

You'll find it: along roadsides, coastal regions, in scrub and dry grassland, and especially in chalky areas. It tends to grow well among blackberries.
Fruits: they are different from other bramble fruits in being formed of fewer but larger druplets (individually they form the characteristic clustered shape of fruits in the bramble family). When ripe they are bluish, with a distinctive whitish-bloom.

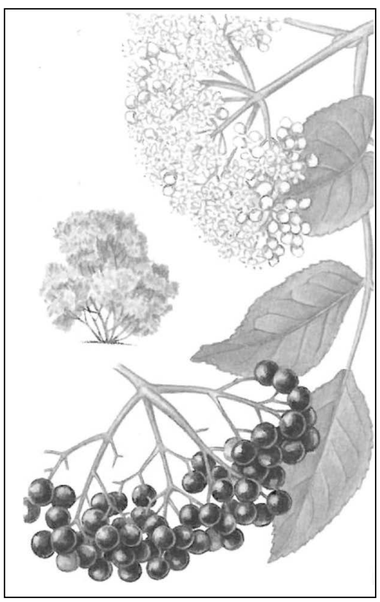
Dewberry plants often grow in the same areas as blackberries, but they flower earlier and the fruits can be readily identified by their shape and early appearance.

Harvesting the fruits: the fruits are ready for picking from mid-summer to autumn. At this stage they are soft, juicy and easily squashed. For this reason, cut them off in clusters, with a small stem intact and attached to them.
Using the fruits: there are never enough fruits to meet the demand so view dewberries as "treats". Eat as you pick, or if you manage to get them home, dip using their stems into bowls of cream and sugar.

Elderberry (*Sambucus nigra*)

Also known as: bour tree, common elder, european elder

This deciduous shrub or tree, up to 9 m. (30 ft.) high, is best known for its fragrant flowers and for the dark purplish-red fruits. Native to wide areas of Europe, southwest Asia and northern Africa, it often grows where little else thrives. It has been introduced to many temperate countries, including North America.



Sweet-smelling, creamy-white flowers appear in large, flat heads up to 20 cm. (8 in.) wide in early summer. The matte-green leaves, usually formed of five leaflets, have an acrid aroma when young.

You'll find it: abundant in woods, waste areas and hedgerows, especially where soil is fertile and moisture-retentive.
Fruits: round berries, first green, then purplish-black and 6 mm. (¼ in.) wide when ripe, appear in late summer and early autumn.

Elderflower Cordial

- 1.5 kg. (3 lb 5 oz.) sugar
- 1.2 liters (2 pts.) water
- 20 heads elderflowers
- 2 lemons
- 75 g (3 oz.) citric acid (available from chemists

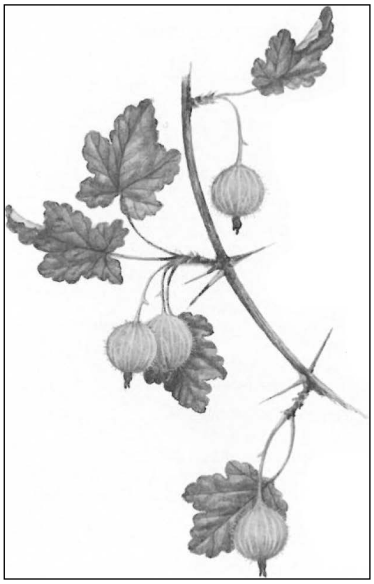
Dissolve the sugar and water in a pan and bring to the boil. Place the flowers in a large bowl. Pare the lemons in wide strips and slice the lemons. Add peel and slices to bowl. Pour over the boiling syrup, stir in the citric acid to dissolve, then cover and let stand overnight. Strain cordial through muslin cloth and place in sterilized screwtop jars or bottles.To use, dilute the cordial with either still or sparkling water.

Harvesting flowers and fruits: cut flowers off in clusters and before using the flowers, check that they are free from insects (shake but don't wash). When ripe, cut off berries in clusters, with a small piece of stem still attached.
Using the fruits and flowers: Elderberry wine can be made from the ripe fruits while the flowers yield elderflower cordial. The fresh flowerheads can also be dipped in a sweet batter and turned into fritters.

Gooseberry (*Ribes uva-crispa*)

Also known as: English gooseberry, European gooseberry, goosegog

Earlier known as *Ribes grossularia,* this deciduous, spiny, much-branched shrub is native to a wide area, from southern Europe to Scandinavia, and north Africa. It is also established in North America, where it has escaped from cultivation.



Bushes grow about I m. (3½ ft.) high, with three- or five-lobed, matte green leaves and clusters of small, green to pinkish-green flowers with purple tinges during late spring and early summer.

You'll find it: indigenous plants are most often seen in shaded, moisture-retentive areas alongside streams, but escapees from cultivation are found mainly alongside hedges and in woods, where they have been spread by birds eating the fruits and scattering seeds.
Fruits: usually hairy, round or oval, green, yellowish-green, or reddish-purple fruits in mid- and late summer borne in small, drooping clusters.
Harvesting the fruits: pick the berries individually as they ripen, leaving the short stalk intact with the fruit. Do not just tear them off the bush.Take care that thorns on the bush do not damage your fingers.
Using the fruits: unripe fruits are sometimes picked early and used with fennel in a sauce to accompany mackerel. Most fruits, however, are picked when ripe and eaten fresh with a dusting of sugar and cream.They are also ideal in preserves. As a dessert, gooseberry fool has few rivals and is very easy to make. Simply wash the fruits, then top and tail to remove ends and stems. Simmer 350 g. (12 oz.) gooseberries in a dash of water and about 85 g. (3 oz.) sugar (or to taste) for a short time until pulpy and hot. You can then puree the gooseberries in a food processor and sieve, or simply crush with a wooden spoon. Allow the puree to cool before folding it into 350 ml. (12 fl. oz.) cold custard or a mix of custard and whipped cream for a delightful summer treat. If you have more or less fruit to start with, then alter the quantities to fit your own situation.

Hawthorn (*Crataegus monogyna*)

Also known as: common hawthorn, English hawthorn, may-bush, may-tree, whitethorn, may

A widely seen, spiny-branched, deciduous shrub or small tree up to 6 m. (30 ft.) high with shiny dark green, deeply lobed leaves appearing in mid-spring.These are followed in late spring and early summer by white (sometimes pink), heavily scented flowers borne in dense, flattened clusters. Hawthorn is native to wide areas of Europe and the Mediterranean region to Afghanistan.

You'll find it: in woods and open land, on scrub land and in country hedges, where it has been planted for hundreds of years. Found on most soils, other than excessively wet land, fens and bogs.
Fruits: often known as haws, the deep red round fruits appear in autumn.
Harvesting the fruits: the fruits, when glossy and fully ripe, are best picked in a cluster, taking care to avoid the prickles. Remove individually from the group and wash and dry them.
Using the fruits and leaves: young leaves have a surprisingly nutty flavor and are sometimes added to early salads or sandwiches. When fully ripe the vitamin C–rich fruits are said to have a slight flavor

Hawthorn Jelly

Gather the ripe red haws before birds take them.

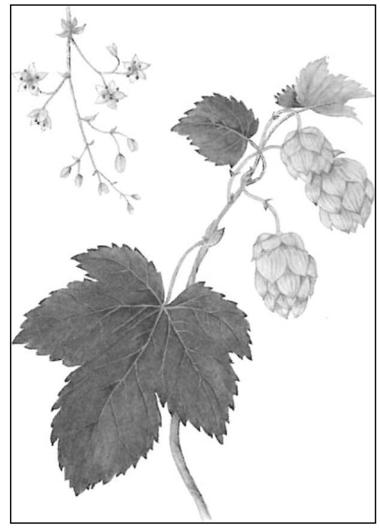
- Remove the haws, wash and dry and ensure the stalks have been taken off.
- Put the 700 g. (I lb. 9 oz.) haws in a heavy saucepan and add 430 ml. (15 fl. oz.) water.
- Bring to the boil and simmer for an hour. Mash the berries every twenty minutes with a potato masher.
- Put the mixture in a muslin bag and allow to drain over night. Do not squeeze the mixture.
- Place in a clean saucepan and for every 600 ml. (1 pt.) of the juice add 450 g. (1 lb.) of caster sugar. Also add the juice of a lemon.
- Slowly dissolve the sugar and boil for ten minutes.
- Remove surface foam, and once the setting point has been reached, pour into sterilized, warm jars with screw lids. Store in a cool dark place

of avocado pears and are often made into jellies to add piquancy to cheese and other savory dishes.

Hop (*Humulus lupulus*)

Also known as: bine, common hop, European hop

This distinctive perennial herbaceous climber sends up fresh shoots each year that spread 3–4.5 m. (10–15 ft.) over supports or nearby plants.Twining stems (known as bines) bear deeply cut, three- or five-lobed hairy leaves up to 15 cm. (6 in.) wide. Pale yellow-green cones (the female parts) are borne in groups of two or three from leaf joints during mid- and late summer, and sometimes slightly later. These cones have been used to brew beer for more than 500 years, providing flavor and stabilizing the brew. The small male flowers are much less distinctive and are normally borne on separate plants.



It is native to southern Europe and into western Asia, but widely distributed as an escapee from cultivation. It was introduced into North America and is widely seen growing wild.

You'll find it: in hedges and thickets, along the edges of farmland or escapees from hop gardens where it was raised abundantly for its part in making beer. It is prevalent in fertile, moisture-retentive soils.
Fruits: these are the hops, which look like inverted cones, about 18 mm. (¾ in.) long, sometimes more.
Harvesting the fruits: pick the hops individually, taking care not to crush them.
Using the young shoots: young shoots can be cut out in spring, chopped up and boiled as a vegetable. Alternatively, simmer in butter and add to omelets. A further variation is to cut a handful of young shoots, arrange the cut ends together, tie loosely, and immerse in salted water for about an hour. Then wash and plunge into boiling water until tender, usually only a few minutes. Serve drizzled with melted butter or olive oil as a side dish.

Hottentot Fig (*Carpobrotus edulus*)

Also known as: highway ice plant, sour fig

You might find this creeping, drought-resistant perennial from South Africa also listed as *Mesembryanthemum edule*. Such is its resilience and adaptability that it has escaped from its native country and is now established in coastal areas in many warm, temperate countries.

Trailing rooting underground stems produce mats of narrow, upwardly curved thick, triangular-shaped green moisture-retentive leaves up to 10 cm. (4 in.) long.The magenta or yellow flowers are about 5 cm. (2 in.) across and appear during early and midsummer. In warm countries, flowers often develop earlier and this brings forward the time when fruits appear.

You'll find it: in sandy ground, banks, loose sand dunes, and gravelly lime-rich gardens. Its coastal spread is partly due to gulls pulling up stems and later dropping them, where they develop roots and produce further colonies.

Fruits: in late summer fleshy, edible, reddish, fig-shaped fruits, about 36 mm. (1½ in.) in diameter and shaped like a spinning top.

Harvesting the fruits: cut off the fruits when they become fragrant and color is intense. If left, the fruit becomes tough, leathery and wrinkled.

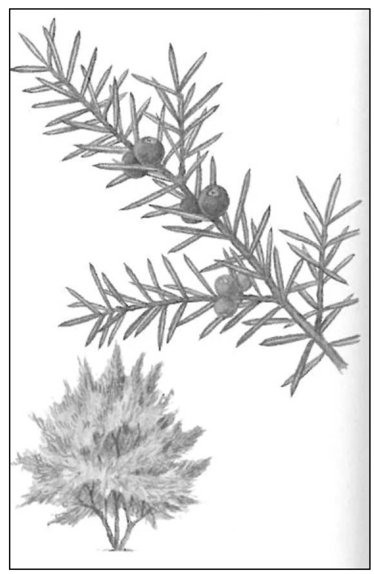
Using the fruits: can be eaten fresh but have a strongly sour taste. When able to ripen in full sun for several weeks the fruits are used to make a tart-tasting jam.

Ecology Warning

In coastal areas in some countries it has been used to stabilize sand dunes and gravelly soil, where it grows rapidly, stabilizes, and assumes command of large areas, to the detriment of indigenous plants. Additionally, where black rats are endemic, the Hottentot fig provides further food for them, with rats spreading the plant further through their feces.

Juniper (*Juniperus Communis*)

Also known as: bastard killer, common juniper, juniper berry, juniper fruit



This hardy evergreen shrub-like conifer, sometimes a tree 6 m. (20 ft.) or more high, has a prickly nature.The needle-like sharply pointed grayish leaves, each with a broad white band on its upper surface, have an apple-like fragrance when crushed.

It is found in wide areas, in northern temperate regions and northwards to the Arctic Circle, where it reveals itself as a dwarf species; also in the mountains of North Africa and the Himalayas, as well as in North America in northern California and Pennsylvania.

You'll find it: an abundant and widespread conifer, native to heaths, moors, pine woods and birch

Mother's Ruin

Gin, which contains juniper as a flavoring, has long had an unflattering association with women, and was known in the 18th and 19th centuries as mother's ruin. Earlier, berries were eaten to procure abortions (thus the country name bastard killer). Nowdays, pregnant women, those wishing to become pregnant and nursing mothers, should take care not to eat the berries or drink extracts from juniper.

woods, and especially dominant on chalk downs and limestone hills.

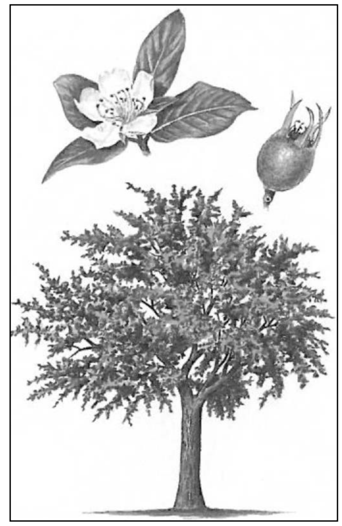
Fruits: the round or slightly oval female fruits, about 6 mm. (¼ in.) across, appear during early summer; in the first year they are green. In the latter part of their second year—usually during late summer and into autumn—they become black and covered with a blue bloom. Each fruit encloses two or three seeds in a resinous, mealy pulp.The small yellow cones are male and are borne on separate plants.

Harvesting the fruits: when gathering ripe berries, wear gloves to protect your hands from the prickly foliage.

Using the fruits: mostly associated with gin, juniper berries have several other culinary uses. Crushed juniper berries, whether fresh or dried, are ideal in marinades for meats, and they are excellent added to pork, goose and beef dishes. Wild game, especially venison, is another great partner to this useful flavoring.

Medlar (*Mespilus germanica*)

A deciduous tree, the medlar is densely twigged and often with a crooked appearance, thickly clad in thorns and usually under 6 m. (20 ft.) high. Distinctively, it forms a spreading canopy of dull green crinkled, finely toothed edged lance-like leaves up to 13 cm. (5 in.) long.



Five-petalled. 5 cm. (2 in.) wide, saucer-shaped flowers appear at the ends of short, young shoots in the latter part of mid-spring and until early summer, followed by apple-shaped fruits.

Native to Europe and southwest Asia, it is often seen as an escapee from cultivation in other countries. It has been established as a fruit tree in North America and can occasionally be seen as an escapee.

You'll find it: around old and neglected gardens and in orchards in warm areas. Also look for it in ancient hedges and among brambles.

Fruit: round green fruits that resemble very large rose-hips; each has a distinctive five-tailed calyx that partly encapsulates the fruit.

Medlar Jelly

Use soft ripened fruits to make jelly.

- Boil medlars in a small amount of water until pulpy, then strain through a jelly bag or muslin cloth.
- Simmer strained juice with sugar (500 g./1 lb. 2 oz. preserving sugar to each 500 ml./18 fl. oz. of fruit juice) and a squeeze or two of lemon juice until it reaches setting point.
- Place in sterilized jars once it has cooled, cover and store in a cool dark cupboard.

Harvesting the fruits: in warm countries, fruits can be eaten from the tree, but in cool climates fruits do not become palatable until half-rotten, sometimes known as "bletted." At this stage they become soft and brown. In temperate climates harvest when the weather is dry in late autumn. Place in slatted trays in a frost-proof shed or room until they are ripe (soft and brown) and ready for eating or making into preserves.
Using the fruits: scrape the brown interior flesh from the skin; eat with a dusting of sugar and cream. Medlar jelly is a popular accompaniment for lamb and game.The jelly is also good on scones or toast.

Mountain Ash (*Sorbus aucuparia*)

Also known as: common rowan, European mountain ash, quickbeam, rowan, rowan tree, wicken-tree

Mountain Ash is a slender and erect deciduous tree that develops a spreading nature with age, usually 6 m. (20 ft.) high. The 13–23 cm. (5–9 in.) mid-green leaves are formed of six or seven pairs of narrow leaflets. Clusters of white flowers in flattish heads appear during early and midsummer. It is native to many temperate parts of Europe and Asia, as well as Morocco. It was taken to North America, where it is now widespread.

You'll find it: in woods, scrubland and on mountainsides. It is more prevalent in areas with light or slightly acid soil. It can be found as an escapee in fields and hedges.

Mountain Ash and Crab Apple Jelly

- Remove stalks from the Rowan fruits and wash. Wash the crab apples and cut away bruised and pest-infested parts.
- Place in a heavy-based saucepan, cover with water and simmer until tender.
- Strain the mixture through a muslin bag but do not squeeze. Let all the moisture drain through naturally to avoid clouding the jelly.
- Warm the sugar before putting it into the liquid. For every 500 ml. (18 fl. oz.) of the liquid, measure 500 g. (1 lb. 2 oz.) preserving sugar into an ovenproof dish and place in a moderate oven for 10-15 minutes.
- Put the warmed sugar and strained juice into a saucepan, stir until dissolved, bring to the boil, then simmer until it reaches setting point.
- Skim the surface to remove the scum, and allow to cool slightly.
- While still warm, pour into sterilized jars.

Fruits: large clusters of round or slightly oval fruits ripen to a rich scarlet or bright red from early to late autumn.
Harvesting the fruits: pick entire clusters of fruits when ripe but before they become soft and mushy.
Using the fruits: the fruits are most commonly used in jelly to accompany game and lamb.They can also be used in combination with crab apples to make jelly (see left).

Oregon Grape (*Mahonia aquifolium*)

Also known as: blue barberry, holly barberry, holly *grape*, holly-leaved barberry, mountain grape

A distinctive, hardy, suckering evergreen shrub that grows up to 1.5 m. (5 ft.) high and

slowly spreads to form sprawling colonies. Its holly-like leaves are tough, leathery, glossy and dark green, up to 30 cm. (12 in.) long and each formed of five to nine leaflets.

During mid- and late spring it develops richly fragrant, golden-yellow flowers in clustered heads 7.5–13 cm. (3–5 in.) across.These are followed in early autumn by masses of berries.

Native to North America from British Columbia to northern California, it was widely planted in Europe and other countries to provide cover and food for pheasants. It has spread and become naturalized in many areas.

You'll find it: as an escapee around old and neglected gardens, alongside fields and on moors, especially where the soil is moisture-retentive.
Fruits: during early autumn, plants become covered in clusters of round black berries, slightly more than 6 mm. (¼ in.) across and with a violet bloom. They often appear like miniature grapes and this has encouraged some of its popular common names, such as Oregon grape, mountain grape and golly grape.
Harvesting the fruits: pick them in clusters, as soon as they are ripe and starting to soften.
Using the berries: high in vitamin C, they can be eaten fresh from the plant, although for some tastes they are tart and best eaten with a dusting of sugar and cream. Alternatively, the fruits can be made into a jelly to accompany meat, especially venison and pork. Berries can be crushed and fermented to produce a wine, but needs a high proportion of sugar to counteract the acidity of the brew.

Raspberry (*Rubus idaeus*)

Also known as: European raspberry, framboise, hindberry, red raspberry, wild raspberry

Raspberry bushes or canes have a suckering, scrambling and sprawling nature, with unbranched stems about 1.5 m. (5 ft.) long, armored with slender, straight prickles.The green leaves are formed of several oval, coarsely tooth-edged leaflets, 3.6–10 cm. (1½–4 in.) long.

Eton Mess

This simple combination of raspberries, broken meringues and whipped cream make the most of foraged summer fruits.

- Pick over a basket of foraged raspberries to remove leaves, stems, and the odd insect.
- Reserving a few raspberries for decoration, add a sprinkling of sugar to the rest of the raspberries, and crush with the back of a fork.
- Break up several meringues, then fold whipping cream, crushed berries and meringues together gently.
- Divide into serving dishes and top off with a few berries.

Clusters of small pinkish flowers appear in clusters at the ends of short twigs that arise on one-year-old stems from early to late summer. Later, these produce the succulent fruits.

It is native to wide areas, from southern Europe to Iceland, into Russia and abundant throughout Asia and much of North America.

You'll find it: in woods and hedgerows, on heaths and especially in hilly areas. It is also a bold escapee and becomes established in hedges, old gardens and allotments. It is spread by birds eating the fruits, so expect to find it over a wide area.
Fruits: ripen to red (only rarely to yellow) from mid-summer to early autumn. Each fruit is formed of several drupelets.
Harvesting fruits: pick as soon as fully red and readily part from the stem.Treat carefully as they squash easily, especially when overripe.
Using fruits: they are best eaten fresh but raspberries can be used in hundreds of ways—in cakes, summer puddings, with meringues, fools, and in sauces to accompany ice cream. Chocolate and raspberry is a favorite combination.

Redcurrant Sauce

To make redcurrant sauce you will need about 450 g. (I lb.) redcurrants, 300 g. (10 oz.) soft brown sugar, two pieces of orange peel, a finely chopped shallot, two sprigs of rosemary and a small wineglass of port.

- Place all the ingredients in a heavy-based saucepan or a preserving pan, and heat to a simmer for about twenty minutes, until it becomes sticky and resembles a slightly runny jam.
- Pick out the rosemary and pieces of orange peel and leave the mixture to cool slightly.
- Before cool, put in clean, sterilized jars and label. Store in a cool dark cupboard, and eat with lamb and other roasted meats.

Redcurrant (*Ribes rubrum*)

Also known as: northern redcurrant, wineberry

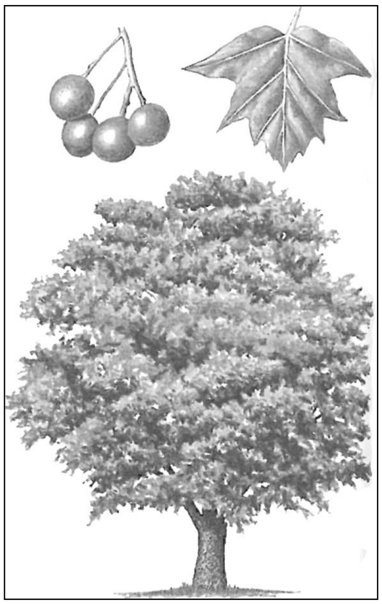
This spreading deciduous shrub, up to 1.5 m. (5 ft.) high, has three- or five-lobed green leaves, often with heart-shaped bases. Unlike blackcurrant, which is clump-forming and with many stems arising from ground level, redcurrant often has just one main stem, with branches growing from it.

During mid and late spring it develops clusters of saucer-shaped, drooping greenish flowers from leaf joints on the previous season's stems. It is from these flowers that the fruits develop.

Earlier known as *Ribes sativum,* it is native to western Europe and Asia, and spreading into Scandinavia and Russia. It is also found in North America and has become naturalized in many other countries.

You'll find it: in woods and along hedgerows, where the soil drains well but is moisture-retentive. It also grows in damp rocky places and mountain woods.
Fruits: although it does not fruit as heavily as blackcurrant, the red, juicy, sweet, and shining berries have few rivals in taste and eye-appeal. They ripen during mid-summer.

Harvesting: wait until the fruits are fully ripe, then snip them off in clusters.
Using: like many other types of currant, they are best eaten fresh, with a dusting of sugar. Tarts, jams, jellies, and syrups are other options, as well as making redcurrant sauce. Redcurrants are also a mainstay of summer pudding



Service Tree (*Sorbus torminalis*)

Also known as: wild service tree, chequers tree, checkers tree, chokers tree

A deciduous tree mostly found in ancient woodlands and hedgerows, it grows to 20 m. (65 ft.) high and can be 15 m. (50 ft.) wide, with dark brown to pale gray bark. Its leaves are dark green with three to five pairs of toothed, pointed lobes, much like a maple leaf. The white five-petalled flowers are borne in loose, branched clusters in late spring or early summer. It is native to Europe, northwestern Africa and Asia as well as growing in North America as an introduced plant.

You'll find it: in woods, particularly those with oak and ash and hedgerows. It prefers clay and lime-based soils.
Fruits: shaped like small apples or pears and 12–18 mm. (½–¾ in) long, greenish to russet or brown, and speckled with rusty lenticels.The are sometimes know as "chequers."
Harvesting the fruits: they can be hard, sour, and bitter if gathered too soon; wait until mid to late autumn, but still allow for a period of bletting so that the fruits become almost overripe. Once they reach this stage, they become edible and very sweet.
Using the fruits: Once bletted, the fruits are excellent both raw and cooked. When eaten raw, their taste has been likened to that of plum brandy with overtones of dried apricot.They can also be used in preserves and jellies. In earlier times, before the widespread availability of hops, they were used to flavor beer and to make an alcoholic beverage.

Sloe (Prunus spinosa)

Also known as: blackthorn, hedge picks, wild plum of western Europe

A well-known deciduous shrub or small tree, 4–4.5 m. (10–15 ft.) high, with rigid stems and a much branched nature, it often forms a dense thicket of shoots and spines. Dull green, oval leaves 42 mm. (¾ in.) long cluster at the ends of spine-clad stems, with small, pure white flowers appearing singly or in pairs in early or mid-spring on naked stems before the leaves develop.

Originally native across Europe, the Mediterranean regions to Persia, and Asia, it has been introduced in many places, including North America, and is established as an escapee.

You'll find it: in hedgerows, open woods and scrubland, often growing in poor soil, although it does demand plenty of sunshine.

Fruits: are round and about 12 mm. (½ in.) across, blue at first but

Sloe Gin

- Use a large, wide-necked (but sealable) sterilized jar or bottle.
- Wash the ripe sloes, dry and prick with a sharp knife or fork.
- Half fill the jar or bottle with fruits.Then add sugar (about one-quarter of the weight of the sloes is about right), and top up with gin.
- Add a drop or two of almond essence and a small cinnamon stick.
- Seal the jar then shake to mix the sugar and gin with the sloes; place in a cool, dark cupboard. Repeat the mixing daily for two or three weeks. Then allow to stand undisturbed for three or four months.
- Pour off the juice, which by now is a deep, ruby red and can be drunk in modest amounts. Place the sloe gin in a screw-capped bottle.
- The fruits will be soft, edible and steeped in gin, so take care! Try a few with ice cream.

when ripe, a beautiful shiny black, and often have a slight bloom.

Harvesting the fruits: pick when ripe in mid-autumn; pull-off, complete with their small stalks. At this stage they are tart and acidic. Place in trays and put in a cool place indoors.

Using the fruits: the fruit's main claim to fame is in delicious sloe gin, for which there are many recipes.

White beam (*Sorbus aria*)

Also known as: chess apple, hen apple, whitten, whittenbeam

This deciduous tree, occasionally a shrub, is usually 7.5–9 m. (25–30 ft.) high, sometimes more.

It forms a dense crown of branches that become smothered with oval, occasionally pear-shaped, green leaves up to 10 cm. (4 in.) long and coated on their undersides in a dense, white felt.

During late spring and early summer it develops 5–7.5 cm. (2–3 in.) wide clustered heads of dull-white flowers, each about 12 mm. (½ in.) wide.

It is native throughout central and southern Europe, including southern Spain, Italy and Corsica. It has been planted as a decorative tree in many countries, including North America.

You'll find it: in woods and scrubland on chalk and in limestone soils. It is spread by birds eating the fruits, so look for it on the fringes of woods as well as in more open sites, and especially in suburbs of towns where it has been planted as a street tree.

Fruits: the oval or round fruits, about 12 mm. (½ in.) long, appear in late summer and ripen to scarlet red in autumn.

Harvesting the fruits: cut them from the tree in bunched clusters when most of the fruits are richly ripe; place in trays in a cool room.

Using the fruits: like several other fruits, when newly harvested they are inedible and best left until bletted.To do this, store in trays in a cool, dry place until they are almost going rotten. It is only at this stage that they are edible and have acquired the flavor of luscious tropical fruits.They can be made into a jelly on their own, or mixed with rosehips. Additionally, when harvested fruits can be slowly dried in a slightly warm oven, then ground into a powder, and mixed with a cereal such as wheat.

Wild Cherry (*Prunus avium*)

Also known as: bird cherry, brandy mazzard, crab cherry, gean, massard, mazzard, sweet cherry

A lofty deciduous tree, the wild cherry grows up to 18 m. (60 ft.) high, open-branched with shiny, smooth, reddish-brown peeling bark.The oval, light dull-green leaves usually have a drawn-out point and are 7.5–13 cm. (3-5 in.) long. Pure white, five-petalled, slightly cup-shaped flowers are borne in clusters during mid- and late spring.

Native and widespread across Europe and western Asia, as well as in the mountains of northern Africa, it was introduced to North America, where it has become established and spread.

You'll find it: in woods and hedges, alongside orchards and farmland and especially where the soil is fertile.
Fruits: the sweet or tart, rich blackish-red, cherry-like fruits ripen in midsummer and hang in clusters from short spurs that previously produced the flowers. Birds are quickly attracted to them and this is the main way that the tree spreads.
Harvesting the fruits: pick the cherries as soon as they ripen, preferably with their stalks still attached.
Using the fruits: sweet cherries are best eaten fresh, as soon as they are picked.They are also delicious poached with a bit of sugar, and make an excellent pie filling or cobbler.Those with a bitter taste are better used to create cherry brandy.

Cherry Brandy

There are many recipes for making cherry brandy. This one is simple.

- Remove stalks from the cherries, then wash and allow them to dry. Prick each cherry several times to encourage the absorption of brandy.
- Fill a clean, wide-necked sterilized bottle that can be sealed with a lid to three-quarters full with cherries.
- Add a couple of tablespoons of sugar, depending on the sweetness the cherries.
- Fill the bottle to the top with cheap brandy, seal the bottle or jar and shake thoroughly.
- Leave in a cool, dark cupboard until Christmas, where a tasty and alcoholic treat awaits you.

Wild Rose (*Rosa canina*)

Also known as: briar rose, brier rose, dog berries, dog briar, dog brier, dog rose, wild dog rose

With its long arching stems, up to 3 m. (10 ft.) long and packed with curved or hooked prickles, the wild rose provides a formidable fortress for the

flowers and fruits.The dull green leaves are formed of 5–7 broadly oval leaflets, each up to 36 mm. (1½ in.) long. During early and midsummer, white or pinkish sweetly scented, five-petalled flowers are borne singly or in small clusters along the stems.

Widespread and common throughout Europe, it has been introduced to many other countries, including North America and the Antipodes.The wild rose has been used as rootstock for varieties of cultivated roses and from that role has spread and become naturalized in many areas.

You'll find it: in hedges, scrubland and woods, where it usually entangles itself with other plants and produces a wide clump of prickly stems.
Fruits: known as rosehips and occasionally pixie ears, dog berries and dog hips, the round or egg-shaped fruits ripen to a rich bright red.
Harvesting the fruits and flowers: gather the petals when one or two have dropped from the flowers and use soon after. Fruits, which are a good source of vitamin C, are gathered when richly colored in autumn, preferrably after the first frost.
Using the fruits and flowers: petals can be used in salads, jams, rose-petal jelly,Turkish delight, and rose vinegar, while the fruits are famed in preserves, syrups, and jellies.They are rich in vitamin C and, during times of hardship and scarcity of other fruits, have been made into rosehip syrup that was given to children to keep colds at bay.

Wild Strawberry (*Fragaria vesca*)

Also known as: sow-teat's atrawberry, woodland strawberry

A perennial plant with a thick, woody base producing long runners that develop roots at their leaf joints,

Cava and Wild Strawberry jellies

Make the most of a handful of delicious wild berries in this summery jelly.

- Soak four gelatine leaves in cold water for five minutes. Squeeze out excess water.
- In a small bowl over a pan of water, measure 100 ml. (4 oz.) of the cava, add the gelatine and I tablespoon sugar, and heat through.
- Remove from the heat and add 250 ml. (8 oz.) cold cava and stir.
- Place a few berries in the base of four wine glasses or other pretty dessert dishes
- Pour over the gelatine and cava mixture, then refrigerate until set.
- Garnish with a few more berries if you have any left.

its leaves are usually formed of three oval and coarsely serrated leaflets, bright green above and pale green beneath. White five-petalled flowers with deep yellow centers, up to 18 mm. (¾ in.) cross, appear on short stalks from mid-spring to mid-summer.

It is native to southern Europe, North America, Madeira and Azores, and much of Asia. It has also been planted in warm and temperate regions, from where it has escaped into the countryside.

You'll find it: in woods, grassland and scrubland, especially where the soil is fertile and slightly chalky.
Fruits: small, intensely flavored fruits, about 12 mm. (½ in.) across and usually red, they have a sublime flavor compared with commercial berries.
Harvesting the fruits: pick as soon as they are red, usually in late summer. If left on the plant too long they quickly deteriorate.
Using the fruits: best eaten fresh, either on their own or with cream. They are usually sweet enough not to require a dusting of sugar.

Wild Nuts

BY DAVID SQUIRE

Botanical definitions of nuts can be confusing, so here it is used in its popular sense for any seed or fruit enclosed in a hard or brittle shell. Trees are our main source of nuts, which are mainly harvested in autumn and range from acorns to walnuts. Rich in protein, fats and oils, nuts are a nutritious and healthy addition to a modern diet and certainly provided our forebears with valuable calories. For example, 450 g (1 lb) of walnuts provides about 3,000 calories, while Beech mast (nuts of the Beech tree) yields up to 20 percent of its volume in an oil rich in minerals, vitamins and proteins.

Nuts quickly provide foragers with large amounts of nutritious food, but these nuts are often an essential part of stored food for wild animals, enabling them to survive throughout winter; therefore, do not strip trees bare of nuts.

After harvesting nuts, keep dry as they decay quickly if damp and placed in a cupboard with little air circulation. When nuts are collected while still damp—perhaps after a few weeks of continuous rain—they need to be dried in slight warmth in a well-ventilated place before being stored for use in late autumn or winter:

For many early peoples throughout the world, long before wheat and barley were domesticated, nuts such as acorns were a major source of food. Apart from feeding early men and women, acorns were a central food for the animals they hunted, including deer, wild turkeys, squirrels, and wild fowl. In many areas the challenge to eat and survive was met by acorns—a simple and unprepossessing nut.

This chapter describes five sources of nuts for foragers in temperate climates, but there are many others in warm climates, including Australian native plants such as Queensland Nuts and Moreton Bay Chestnut. Brazil Nuts are native to South America, while Cashew Nuts are at home in tropical America. In Mediterranean regions, Pine Kernels are eaten like peanuts, either raw or roasted.

Beech (*Fagus sylvatica*)

Also known as: Common Beech, European Beech

This stately deciduous tree has few equals, often standing 30 m (100 ft) high and forming a canopy of vein-lined, oval and pointed, shiny-green leaves. In early autumn, the tree produces a mass of nuts that for centuries have been eaten as food as well as providing forage for pigs, deer and other animals. Native to wide areas of western and central Europe, including Corsica, Sicily, and Greece, it has been planted in many temperate regions in both hemispheres, from where it has spread into the wild.

You'll find it: in well-drained, open woodland, parks and grassland, especially where the soil is chalky.
Nuts: known as beech mast, each nut is triangular, 15 mm ($^5/_8$ in) long and borne in pairs. They are enclosed in a hard, woody, pear-shaped, four-lobed husk and covered in bristles. Beech trees bear nuts only once every three or four years, but when this happens their harvest is prodigious.

Harvesting beech mast (nuts): these ripen and fall in early to mid-autumn. Collect as soon as possible, before they are taken by squirrels, deer, badgers and dormice, then place in slatted boxes in a ventilated, gently warm room. Some may need to dry slightly if previously dampened by rain.
Using beech mast: highly nutritious, the nuts are eaten raw or roasted and salted. Additionally, freshly harvested nuts yield up to 20 percent of their volume in an oil rich in minerals, vitamins and proteins. Extracting the oil to use as a butter substitute as well as in general cooking involves cleaning the beech mast, removing the husks and placing in a liquidizer or fine mincing machine. Put the pulp-like material in a muslin bag and press to express the oil, then pour resulting oil into dry, sterilized, well-sealed jars. It needs to be used within a few months.

Hazel (*Corylus avellana*)

Also known as: Cob, Cobnut, European Filbert, European Hazelnut, Filbeard, Filbert, Nutall

The deciduous, shrub-like Hazel grows up to 6 m (20 ft) high and you will notice its pendulous, bright-yellow, male catkins in mid- and late-winter, long before its clusters of nuts are ready to be harvested in autumn. The female catkins are less apparent, being short and bud-like. Broadly oval, tooth-edged green leaves appear in spring and assume rich yellow shades in autumn.

Native to Europe, it has been planted in many temperate climates, including parts of North America.

You'll find it: growing in hedgerows and at shoulder-height or less, a result of being regularly cut back; also in woods and on scrubland.
Nuts: round to oval, each nut is 12–18 mm (½–¾ in) long and borne in clusters of up to four in autumn. Each has a hard brown shell partially enclosed in a thick, deeply lobed green husk.
Harvesting the nuts: they remain on the tree until ripe and fall off in the latter part of early autumn. At this stage, the husks (the protective outer parts) will have changed from green to brown. The nuts inside should be firm; if gathered too early they will be soft and tasteless and not store well. Remove the husks and store the nuts, still in their shells, in a warm, dry place, but do not allow them to dry out fully. When ripe, the shell naturally falls away from the nut.
Using nuts: highly nutritious and eaten raw, the nuts are chopped for adding to salads, or used as a substitute

for almonds. The ground nuts can be blended with milk or yogurt to make a nutritious smoothie using one part nuts to three of milk (add honey to taste). Hazel nuts are also delicious roasted, and are good added to cereals, breads, and cakes. The pressed nuts also yield a very good oil for salads and cooking.

Common Oak (*Quercus robur*)

Also known as: English Oak, Pedunculate Oak, Truffle Oak

This lofty, often 25 m (80 ft) high deciduous tree is better known for its timber than its ability to provide food. However, nearly 2000 years ago the Roman writer Pliny the Younger (61–112 AD) wrote of 13 varieties of oak tree with acorns that could be ground to produce a bread-making flour, and nearly 1000 years ago, the English *Domesday Book* described acorns being fed to hogs.

Native throughout Europe, western Asia, and North Africa, it has been planted in many regions of the world with temperate climates, including parts of North America.

You'll find it: in forests, but not where other trees tightly encroach upon it. You will also see it in open countryside and alongside hedgerows and paths. It grows best in warm temperate regions, as late spring frosts damage early developing shoots.

Acorn coffee

In times of privation, coffee-drinkers have turned to acorns as a coffee substitute. Many other plants, including dandelions, chicory, and grains of corn and rye, are also used to produce a coffee-type drink. Several ways are recommended to create nutty tasting acorn coffee, including:

Gather fallen acorns, remove their cupped bases, and place in boiling water until soft. Allow to cool slightly then remove the shells.

Cut them in half or quarters and put on low in a microwave until dry.

Then place on a baking tray (cookie sheet) in a warm oven and roast until brown.

Once cool place in a coffee grinder or kitchen blender and grind to the consistency of coffee grains.

To make a coffee drink, preferably use a cafetière in the same way as you would make ordinary coffee.

Acorns: a small rounded nut (botanically a fruit), the humble acorn is well known. Each acorn usually takes a couple of seasons to mature and is formed of a cup that holds the nut. Trees do not usually produce acorns until 20 years old and may not crop until about 40 years old.

Harvesting the nuts: trees shed their acorns (when ripe) in early autumn, usually slightly earlier than the fall of leaves. Some acorns will be green, most brown.

Using the nuts: for thousands of years preparing flour from acorns has been traditional among native people of many lands; in times of famine it became an essential food for many people. Today, it is regaining popularity, especially among back-to-nature enthusiasts. In North America, indigenous peoples are said to have mixed clay with acorn

Acorn flour

Gather fallen acorns, green or brown, immediatley as they are available; do not let them remain on the grass to become dirty and wet.

Place in a clean bucket; expect each container to produce half that amount of flour.

Arrange the acorns on a baking tray (cookie sheet) and roast for 20–30 minutes in an oven at 120°C (250°F). This will both dry them and kill any insects lurking inside. When cool, crack off the now-brittle shells to release the acorns.

Place the acorns in a muslin bag and immerse in water for two weeks, changing it two or three times each day. This removes most of the tannins, which if left impart a bitter taste to the flour.

Either sun-dry on a windowsill or place in a just warm oven until totally free from moisture. Store the acorns in clean, moisture-proof jars or immediately grind to a flour. If stored, use as soon as possible.

The flour can be used in place of wheat; it is ideal for making pancakes, muffins and, of course, acorn bread.

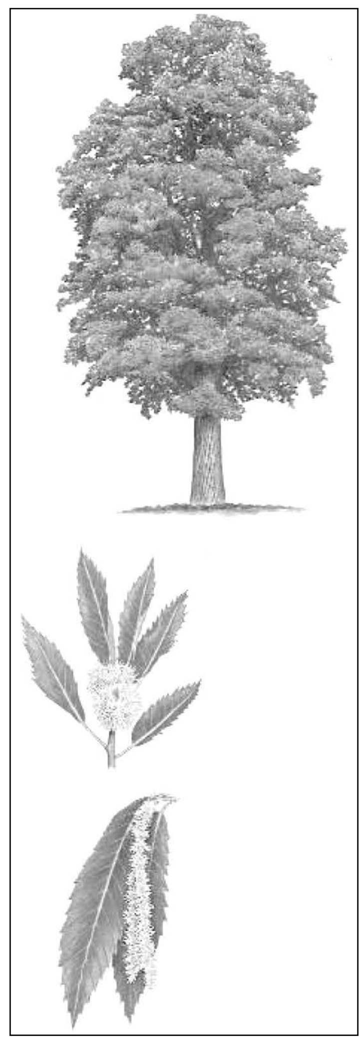
flour (at a ratio, by weight, of one of washed clay to twenty of flour). The resulting bread is claimed to be sweet and to rise as if yeast had been added.

Sweet Chestnut (*Castanea sativa*)

Also known as: Eurasian Chestnut, European Chestnut, Spanish Chestnut

A large deciduous tree, up to 30 m (100 ft) high, the Sweet Chestnut produces nuts in mid- to late autumn that can be eaten raw or roasted. Its distinctive, shiny, deep green, and narrowly oval leaves are edged in soft spines.Yellow, erect or spreading male catkins, up to 15 cm (6 in) long, appear in mid-summer, while the green female flowers (borne at the bases of male catkins) are sparse but by autumn will have developed into nuts. Native to Europe, North Africa, southern Turkey and western Iran, it has been planted and established in many temperate climates. It is well known in North America.

You'll find it: usually in woods surrounded by other trees, or in parks and open countryside. Sometimes it is coppiced every 10–15 years (cut down to near ground level in late winter) to produce young, straight stems used for fencing.
Nuts: triangular, bright red-brown nuts, borne in twos or threes and each 18–30 mm ¾–1¼ in) across, are enclosed in pale green husks. These husks, often known as burs, are covered with prickles.



Harvesting the nuts: trees start to shed their nuts in mid-autumn; you will not be able to reach most them but they can be knocked off by using a stick.They can be eaten raw if the husk (which is prickly) and bitter inner skin are removed. But they are more often roasted; slit the husks and either put them on a grate close to a fire, or in hot ash. As a guide to when they are ready, put an uncut

one next to them and when its outer parts burst (usually with a bang) the others are ready to eat.
Using the nuts: apart from eating the nuts raw or roasted, they can be ground or chopped and used in soup, as stuffing for turkey, in jams and cakes. Small nuts can be ground into a flour for making bread or pancakes.The nuts are roasted, then ground.The yellowish, slightly fragrant flour is ideal in cakes and breads but is usually reluctant to rise, therefore, add an equal amount of wheat flour.

Walnut (*Juglans regia*)

Also known as: English Walnut, Persian Walnut, Madeira Nut

Native to China, west and central Asia and southeastern Europe, this large, deciduous tree, up to 30 m (100 ft) high, is now widely naturalized in Europe. It has also been planted in other countries, where it has spread. However, in North America the native Black Walnut *(Juglans nigra)* is more popular and widespread.

The large, distinctive, shiny green leaves of seven to nine leaflets assume rich shades in autumn.

You'll find it: it is a warmth-loving tree; in cool temperate areas, established and earlier cultivated trees in old woodland and parks often produce self-sown seedlings. It also grows in warm, sheltered hedgerows.
Nuts: the outer casing of the nut, about 5 cm (2 in) across, is known as the hull. Inside it is the shell, which encloses the nut, the part that is eaten. Walnuts are one of the most popular nuts for eating and baking.
Harvesting the nuts: usually harvested when ripe in mid-autumn, having changed from green to brown. Wait until the nuts have fallen; many will have split hulls and an indication of ripeness is when the tissue between the hull and the shell turns brown. At this stage, fallen hulls can be gathered from the ground or low branches shaken to loosen them.
Using the nuts: completely remove the hulls, usually by pulling them apart, to leave shells with nuts inside. Discard nuts with cracked shells. Place intact nuts in the sun to dry fully, usually for a couple of weeks.They can then be stored in a cool, dry place for several months.

They are often used as late autumn and winter "treats" chopped in cakes and biscuits.Walnuts are delicious with pears and any blue cheese in a winter salad. Shelled nuts can be kept in the refrigerator for up to five months, and in the freezer for more than a year.

In addition to ripe walnuts, you can use young, green fruits, gathered before the nut-case hardens; these are sometimes pickled in vinegar for later use.

Wild Plants

BY DAVID SQUIRE

Wild Vegetables, Fruits, and Nuts

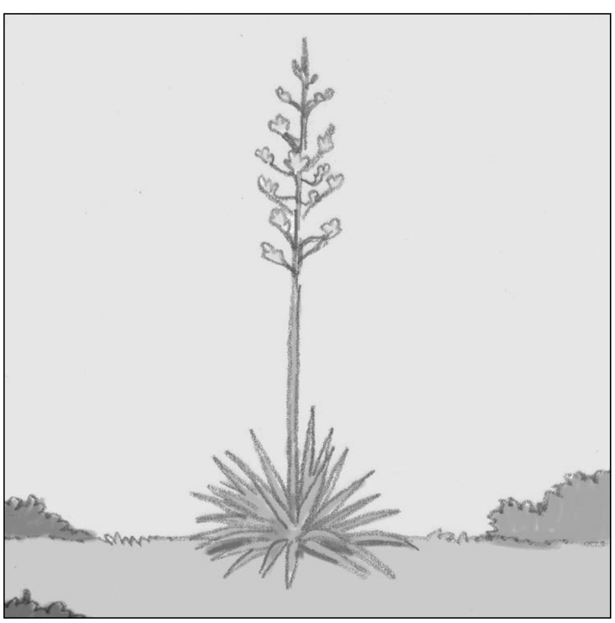
Agave

Description: Agave plants have large clusters of thick leaves that grow around one stalk. They grow close to the ground and only flower once before dying.

Location: Agave like dry, open areas and are found in the deserts of the American west.

Edible Parts and Preparing: Only agave flowers and buds are edible. Boil these before consuming. The juice can be collected from the flower stalk for drinking.

Other Uses: Most agave plants have thick needles on the tips of their leaves that can be used for sewing.

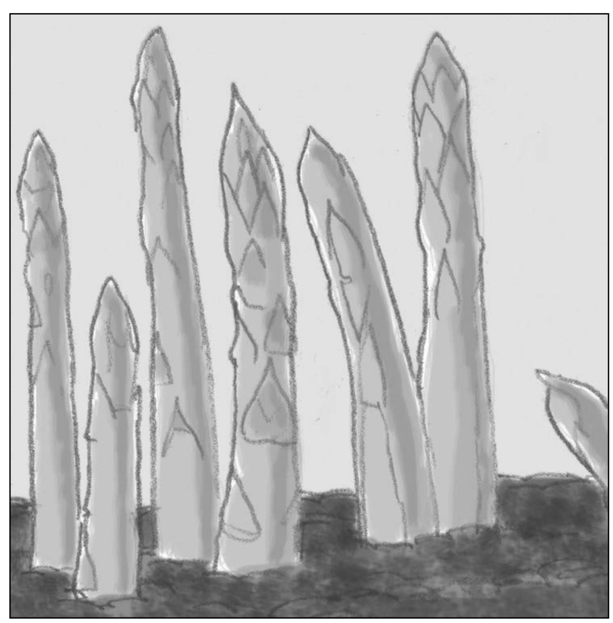


Asparagus

Description: When first growing, asparagus looks like a collection of green fingers. Once mature, the plant has fern-like foliage and red berries (which are toxic if eaten). The flowers are small and green and several species have sharp, thornlike projections.

Location: It can be found growing wild in fields and along fences. Asparagus is found in temperate areas in the United States.

Edible Parts and Preparing: It is best to eat the young stems, before any leaves grow. Steam or boil them for 10 to 15 minutes before consuming. The roots are a good source of starch, but don't eat any part of the plant raw, as it could cause nausea or diarrhea.

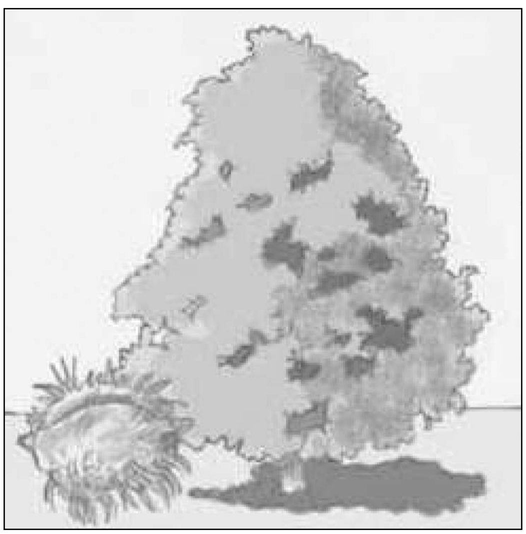


Beech

Description: Beech trees are large forest trees. They have smooth, light gray bark, very dark leaves, and clusters of prickly seedpods.

Location: Beech trees prefer to grow in moist, forested areas. These trees are found in the Temperate Zone in the eastern United States.

Edible Parts and preparing: Eat mature beechnuts by breaking the thin shells with your fingers and removing the sweet, white kernel found inside. These nuts can also be used as a substitute for coffee by roasting them until the kernel turns hard and golden brown. Mash up the kernel and boil or steep in hot water.



Blackberry and Raspberry

Description: These plants have prickly stems that grow upright and then arch back toward the ground. They have alternating leaves and grow red or black fruit.

Location: Blackberry and raspberry plants prefer to grow in wide, sunny areas near woods, lakes, and roads. They grow in temperate areas.

Edible Parts and Preparing: Both the fruits and peeled young shoots can be eaten. The leaves can be used to make tea.

Burdock

Description: Burdock has wavy-edged, arrow-shaped leaves. Its flowers grow in burrlike clusters and are purple or pink. The roots are large and fleshy.

Location: This plant prefers to grow in open waste areas during the spring and summer. It can be found in the Temperate Zone in the north.

Edible Parts and Preparing: The tender leaves growing on the stalks can be eaten raw or cooked. The roots can be boiled or baked.

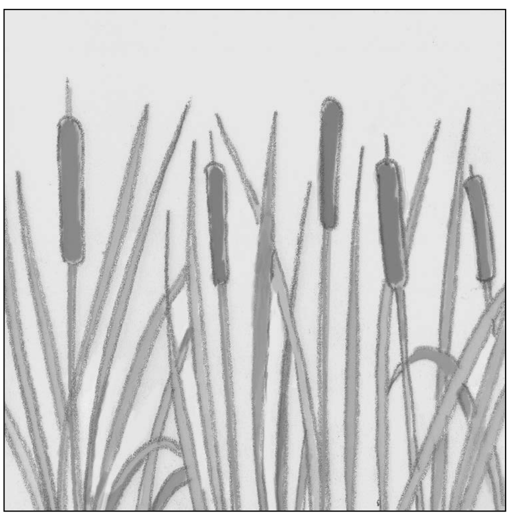
Cattail

Description: These plants are grasslike and have leaves shaped like straps. The male flowers above the female flowers, have abundant, bright yellow pollen, and die off quickly. The female flowers become the brown cattails.

Location: Cattails like to grow in full-sun areas near lakes, streams, rivers, and brackish water. They can be found all over the country.

Edible Parts and Preparing: The tender, young shoots can be eaten either raw or cooked. The rhizome (rootstalk) can be pounded and made into flour. When the cattail is immature, the female flower can be harvested, boiled, and eaten like corn on the cob.

Other Uses: The cottony seeds of the cattail plant are great for stuffing pillows. Burning dried cattails helps repel insects.



Chicory

Description: This is quite a tall plant, with clusters of leaves at the base of the stem and very few leaves on the stem itself. The flowers are sky blue in color and open only on sunny days. It produces a milky juice.

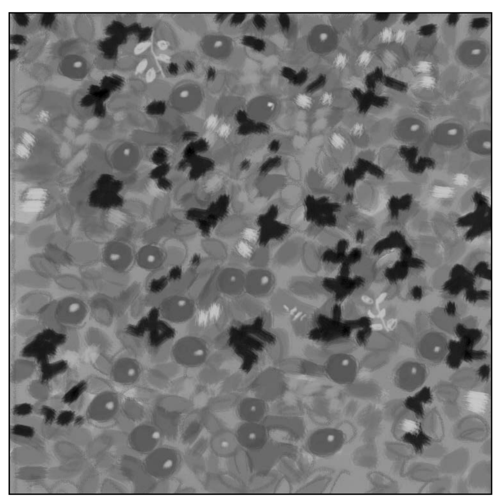
Location: Chicory grows in fields, waste areas, and alongside roads. It grows primarily as a weed all throughout the country.

Edible Parts and Preparing: The entire plant is edible. The young leaves can be eaten in a salad. The leaves and the roots may also be boiled as you would regular vegetables. Roast the roots until they are dark brown, mash them up, and use them as a substitute for coffee.

Cranberry

Description: The cranberry plant has tiny, alternating leaves. Its stems crawl along the ground and it produces red berry fruits.

Location: Cranberries only grow in open, sunny, wet areas. They thrive in the colder areas in the northern states.



Edible Parts and Preparing: The berries can be eaten raw, though they are best when cooked in a small amount of water, adding a little bit of sugar if desired.

Dandelion

Description: These plants have jagged leaves and grow close to the ground. They have bright yellow flowers.

Location: Dandelions grow in almost any open, sunny space in the United States.

Edible Parts and Preparing: All parts of this plant are edible. The leaves can be eaten raw or cooked

and the roots boiled. Roasted and ground roots can make a good substitute for coffee.

Other Uses: The white juice in the flower stem can be used as glue.

Elderberry

Description: This shrub has many stems containing opposite, compound leaves. Its flower is white, fragrant, and grows in large clusters. Its fruits are berry-shaped and are typically dark blue or black.

Location: Found in open, wet areas near rivers, ditches, and lakes, the elderberry grows mainly in the eastern states.

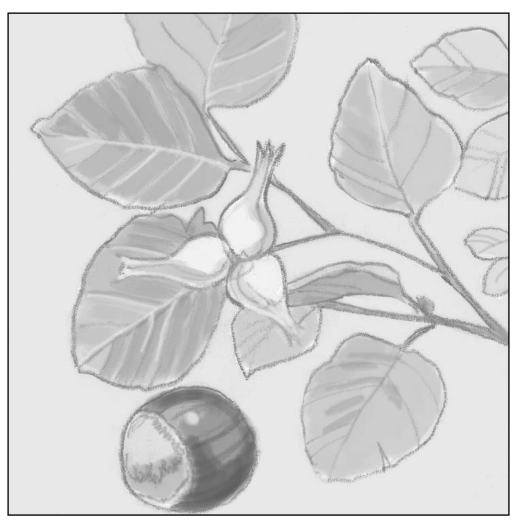
Edible Parts and Preparing: The flowers can be soaked in water for eight hours and then the liquid can be drunk. The fruit is also edible but don't eat any other parts of the plant—they are poisonous.

Hazelnut

Description: The nuts grow on bushes in very bristly husks.

Location: Hazelnut grows in dense thickets near streambeds and in open areas and can be found all over the United States.

Edible Parts and Preparing: In the autumn, the hazelnut ripens and can be cracked open and the kernel eaten. Eating dried nuts is also tasty.

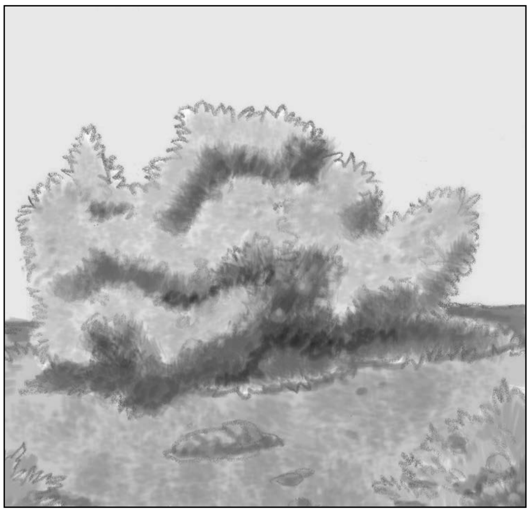


Juniper

Description: Also known as cedar, this shrub has very small, scaly leaves that are densely crowded on the branches.

Berrylike cones on the plant are usually blue and are covered with a whitish wax.

Location: They grow in open, dry, sunny places throughout the country.



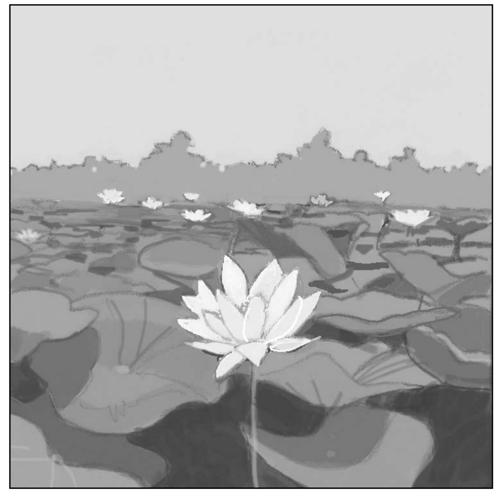
Edible Parts and Preparation: Both berries and twigs are edible. The berries can be consumed raw or the seeds may be roasted to make a substitute for coffee. Dried and crushed berries are good to season meat. Twigs can be made into tea.

Lotus

Description: This plant has large, yellow flowers and leaves that float on or above the surface of water. The lotus fruit has a distinct, flattened shape and possesses around 20 hard seeds.

Location: Found on fresh water in quite areas, the lotus plant is native to North America.

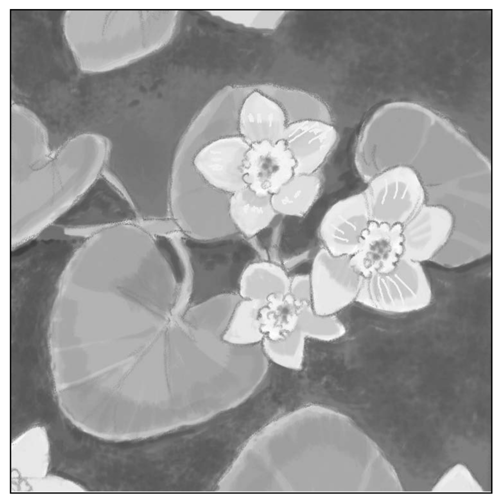
Edible Parts and Preparing: All parts of the lotus plant are edible, raw or cooked. Bake or boil the fleshy parts that grow underwater and boil young leaves. The seeds are quite nutritious and can be raw or they can be ground into flour.



Marsh Marigold

Description: Marsh marigold has round, dark green leaves and a short stem. It also has bright yellow flowers.

Location: The plant can be found in bogs and lakes in northeastern states.

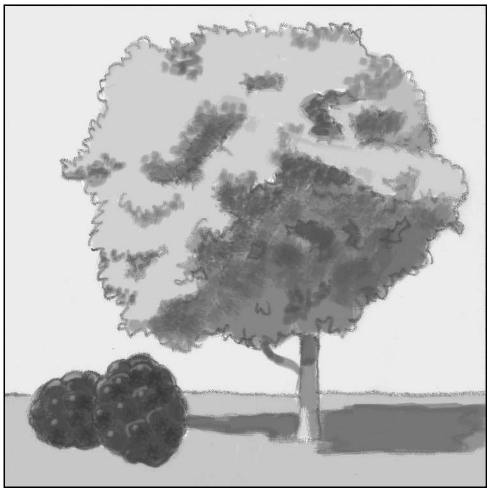


Edible Parts and Preparing: All parts can be boiled and eaten. Do not consume any portion raw.

Mulberry

Description: The mulberry tree has alternate, lobed leaves with rough surfaces and blue or black seeded fruits.

Location: These trees are found in forested areas and near roadsides in temperate and tropical regions of the United States.



Edible Parts and Preparation: The fruit can be consumed either raw or cooked and it can also be dried. Make sure the fruit is ripe or it can cause hallucinations and extreme nausea.

Nettle

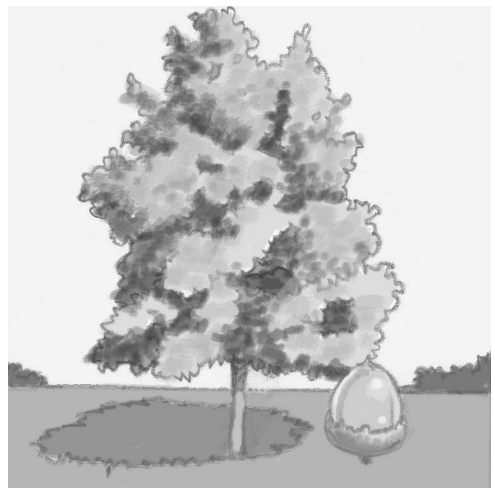
Description: Nettle plants grow several feet high and have small flowers. The stems, leafstalks, and undersides of the leaves all contain fine, hairlike bristles that cause a stinging sensation on the skin.

Location: This plant grows in moist areas near streams or on the edges of forests. It can be found throughout the United States.

Edible Parts and Preparing: The young shoots and leaves are edible. To eat, boil the plant for 10 to 15 minutes.

Oak

Description: These trees have alternating leaves and acorns. Red oaks have bristly leaves and smooth bark on the upper part of the tree and their acorns need two years to reach maturity. White oaks have leaves with no bristles and rough bark on the upper part of the tree. Their acorns only take one year to mature.



Location: Found in various locations and habitats throughout the country.

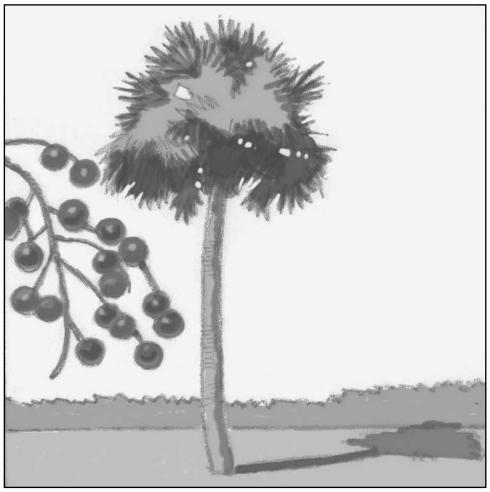
Edible Parts and Preparing: All parts of the tree are edible, but most are very bitter. Shell the acorns and soak them in water for one or two days to remove their tannic acid. Boil the acorns to eat or grind them into flour for baking.

Palmetto Palm

Description: This is a tall tree with no branches and has a continual leaf base on the trunk. The leaves are large, simple, and lobed and it has dark blue or black fruits that contain a hard seed.

Location: This tree is found throughout the southeastern coast.

Edible Parts and Preparing: The palmetto palm fruit can be eaten raw. The seeds can also be ground into flour, and the heart of the palm is a nutritious



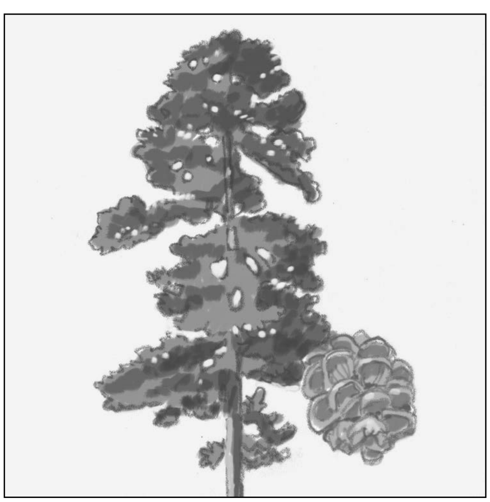
source of food, but the top of the tree must be cut down in order to reach it.

Pine

Description: Pine trees have needlelike leaves that are grouped into bundles of one to five needles. They have a very pungent, distinguishing odor.

Location: Pines grow best in sunny, open areas and are found all over the United States.

Edible Parts and Preparing: The seeds are completely edible and can be consumed either raw or cooked. Also, the young male cones can be boiled or baked and eaten. Peel the bark off of thin twigs and chew the juicy inner bark. The needles can be dried and brewed to make tea that's high in vitamin C.

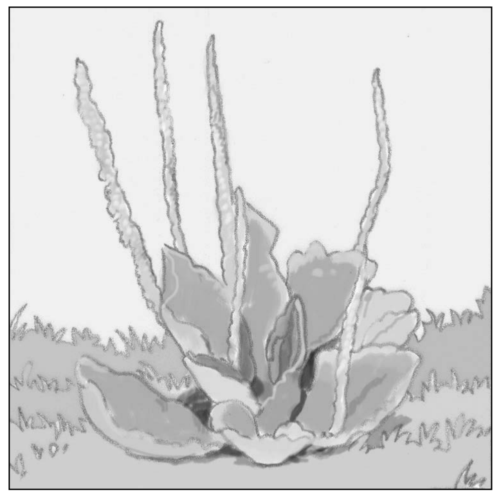


Other Use: Pine tree resin can be used to waterproof items. Collect the resin from the tree, put it in a container, heat it, and use it as glue or, when cool, rub it on items to waterproof them.

Plantain

Description: The broad-leafed plantain grows close to the ground and the flowers are suited on a spike that rises from the middle of the leaf cluster. The narrow-leaf species has leaves covered with hairs that form a rosette. The flowers are very small.

Location: Plantains grow in lawns and along the side of the road in the northern Temperate Zone.



Edible Parts and Preparing: Young, tender leaves can be eaten raw and older leaves should be cooked before consumption. The seeds may also be eaten either raw or roasted. Tea can also be made by boiling 1 ounce of the plant leaves in a few cups of water.

Pokeweed

Description: A rather tall plant, pokeweed has elliptical leaves and produces many large clusters of purple fruits in the late spring.

Location: Pokeweed grows in open and sunny areas in fields and along roadsides in the eastern United States.

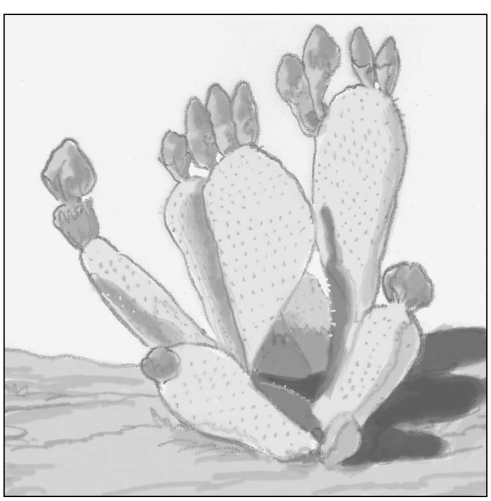
Edible Parts and Preparing: If cooked, the young leaves and stems are edible. Be sure to boil them twice and discard the water from the first boiling. The fruit is also edible if cooked. Never eat any part of this plant raw, as it is poisonous.

Prickly Pear Cactus

Description: This plant has flat, pad-like green stems and round, furry dots that contain sharp-pointed hairs.

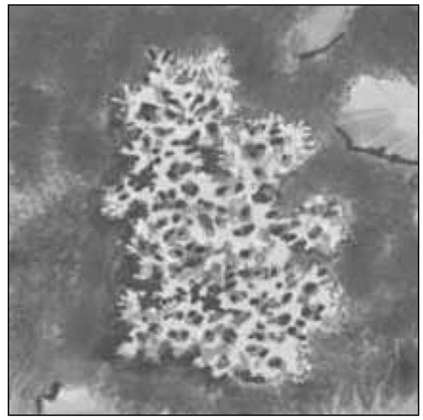
Location: Found in arid regions and in dry, sandy areas in wetter regions, it can be found throughout the United States.

Edible Parts and Preparing: All parts of this plant are edible. To eat the fruit, peel it or crush it to make a juice. The seeds can be roasted and ground into flour.



Reindeer Moss

Description: This is a low plant that does not flower. However, it does produce bright red structures used for reproduction.



Location: It grows in dry, open areas in much of the country.

Edible Parts and Preparation: While having a crunchy, brittle texture, the whole plant can be eaten. To remove some of the bitterness, soak it in water and then dry and crush it, adding it to milk or other foods.

Sassafras

Description: This shrub has different leaves—some have one lobe, others two lobes, and others have none at all. The flowers are small and yellow and appear in the early spring. The plant has dark blue fruit.

Location: Sassafras grows near roads and forest in sunny, open areas. It is common throughout the eastern states.

Edible Parts and Preparing: The young twigs and leaves can be eaten either fresh or dried—add them to soups. Dig out the underground portion of the shrub, peel off the bark, and dry it. Boil it in water to make tea.

Other Uses: Shredding the tender twigs will make a handy toothbrush.

Location: These plants prefer sunny, open spaces, are commonly planted, and appear in the northern Temperate Zone.

Edible Parts and Preparing: The fruit can be eaten raw, cooked, or dried. The plant leaves may also be eaten or dried to make tea.

Spatterdock

Description: The leaves of this plant are quite long and have a triangular notch at the base. Spatterdock has yellow flowers that become bottle-shaped fruits, which are green when ripe.

Location: Spatterdock is found in fresh, shallow water throughout the country.

Edible Parts and Preparing: All parts of the plant are edible and the fruits have brown seeds that can be roasted and ground into flour. The rootstock can be dug out of the mud, peeled, and boiled.

Strawberry

Description: This is a small plant with a three-leaved pattern. Small white flowers appear in the springtime and the fruit is red and very fleshy.

Thistle

Description: This plant may grow very high and has long-pointed, prickly leaves.

Location: Thistle grows in woods and fields all over the country.

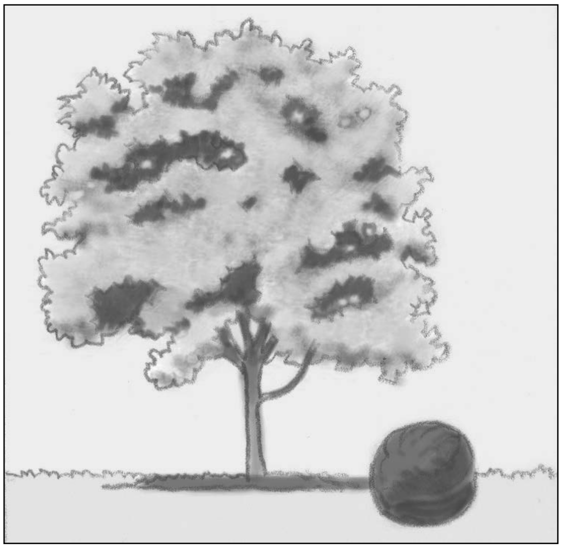
Edible Parts and Preparing: Peel the stalks, cut them into smaller sections, and boil them to consume. The root may be eaten raw or cooked.

Walnut

Description: Walnuts grow on large trees and have divided leaves. The walnut has a thick outer husk that needs to be removed before getting to the hard, inner shell.

Location: The black walnut tree is common in the eastern states.

Edible Parts and Preparing: Nut kernels become ripe in the fall and the meat can be cracking the shell.

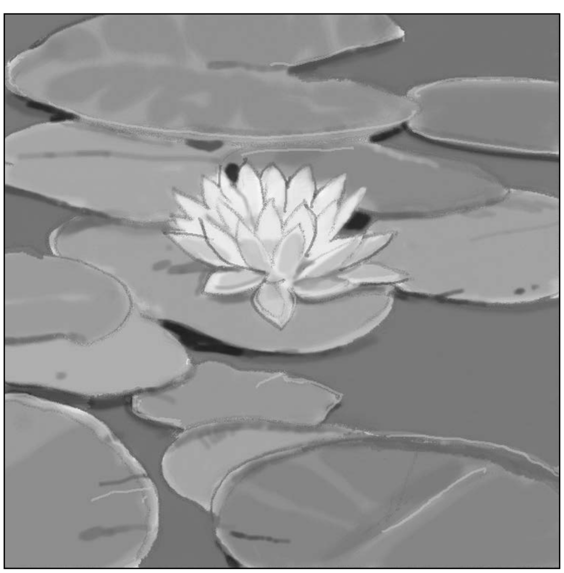


Water Lily

Description: With large, triangular leaves that float on water, these plants have fragrant flowers that are white or red. They also have thick rhizomes that grow in the mud.

Location: Water lilies are found in many temperate areas.

Edible Parts and Preparation: The flowers, seeds, and rhizomes can be eaten either raw or cooked. Peel the corky rind off of the rhizome and eat it raw or slice it thinly, dry it, and grind into flour. The seeds can also be made into flour after drying, parching, and grinding.



Wild Grapevine

Description: This vine will climb on tendrils, and most of these plants produce deeply lobed leaves. The grapes grow in pyramidal bunches and are black-blue, amber, or white when ripe.

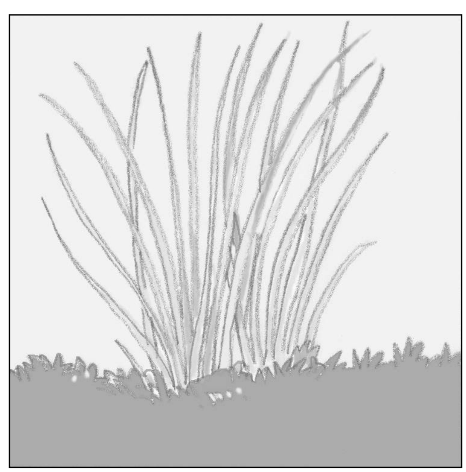
Location: Climbing over other vegetation on the edges of forested areas, they can be found in the eastern and south-western parts of the United States.

Edible Parts and Preparing: Only the ripe grape and the leaves can be eaten.

Wild Onion and Garlic

Description: These are recognized by their distinctive odors.

Location: They are found in open areas that get lots of sun throughout temperate areas.



Edible Parts and Preparing: The bulbs and young leaves are edible and can be consumed either raw or cooked.

Wild Rose

Description: This shrub has alternating leaves and sharp prickles. It has red, pink, or yellow flowers and fruit (rose hip) that remains on the shrub all year.

Location: These shrubs occur in dry fields throughout the country.

Edible Parts and Preparing: The flowers and buds are edible raw or boiled. Boil fresh, young leaves to make tea. The rose hips can be eaten once the flowers fall and they can be crushed once dried to make flour.

Violets

Violets can be candied and used to decorate cakes, cookies, or pastries. Pick the flowers with a tiny bit of stem, wash, and allow to dry thoroughly on a paper towel or a rack. Heat ½ cup water, 1 cup sugar, and ¼ teaspoon almond extract in a saucepan. Use tweezers to carefully dip each flower in the hot liquid. Set on wax paper and dust with sugar until every flower is thoroughly coated. If desired, snip off remaining stems with small scissors. Allow flowers to dry for a few hours in a warm, dry place.

Mushrooms

A walk through the woods will likely reveal several varieties of mushrooms, and chances are that some are the types that are edible. However, because some mushrooms are very poisonous, it is important never to try a mushroom of which you are unsure. Never eat a mushroom with gills, or, for that matter, a mushroom that you cannot positively identify as edible. Also, never eat mushrooms that appear wilted, damaged, or rotten.

Here are some common edible mushroom that you can easily identify and enjoy.

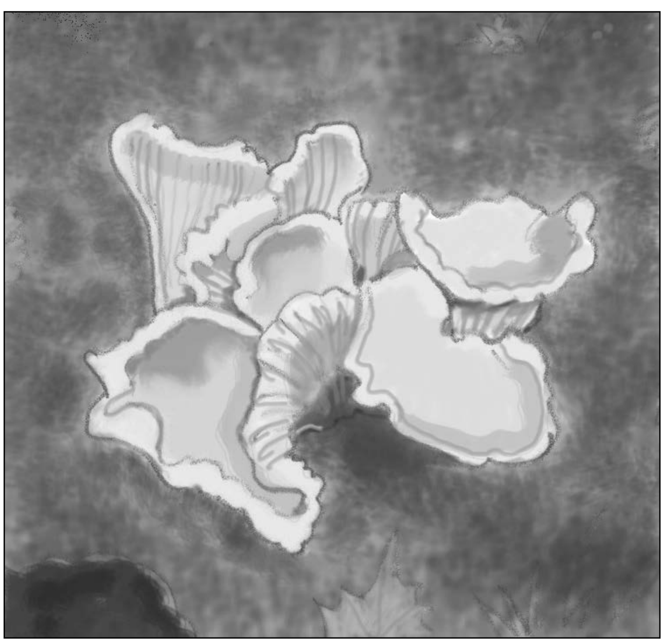
Chanterelles

These trumpet-shaped mushrooms have wavy edges and interconnected blunt-ridged gills under the caps. They are varied shades of yellow and have a fruity fragrance. They grow in summer and fall on the ground of hardwood forests. Because chanterelles tend to be tough, they are best when slowly sautéed or added to stews or soups.

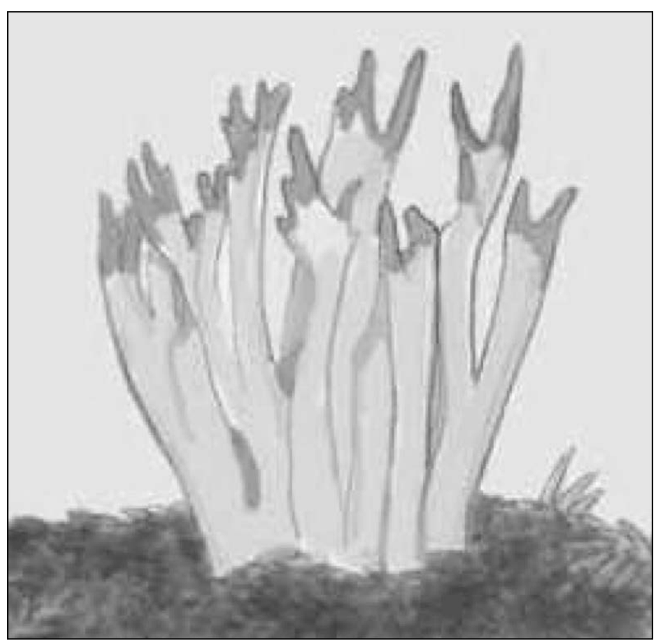
Notes: Beware of Jack O'Lantern mushrooms, which look and smell similarly to chanterelles. Jack O'Lanterns have sharp knifelike gills instead of the blunt gills of chanterelles, and generally grow in large clusters at the base of trees or on decaying wood.

Coral Fungi

These fungi are aptly named for their bunches of upward-facing branching stems, which look strikingly like coral. They are whitish, tan, yellowish,



Chanterelles



Coral fungi

Morel mushroom

or sometimes pinkish or purple. They may reach 8 inches in height. They grow in the summer and fall in shady, wooded areas.

Notes: Avoid coral fungi that are bitter, have soft, gelatinous bases, or turn brown when you poke or squeeze them. These may have a laxative effect, though are not life threatening.

Morels

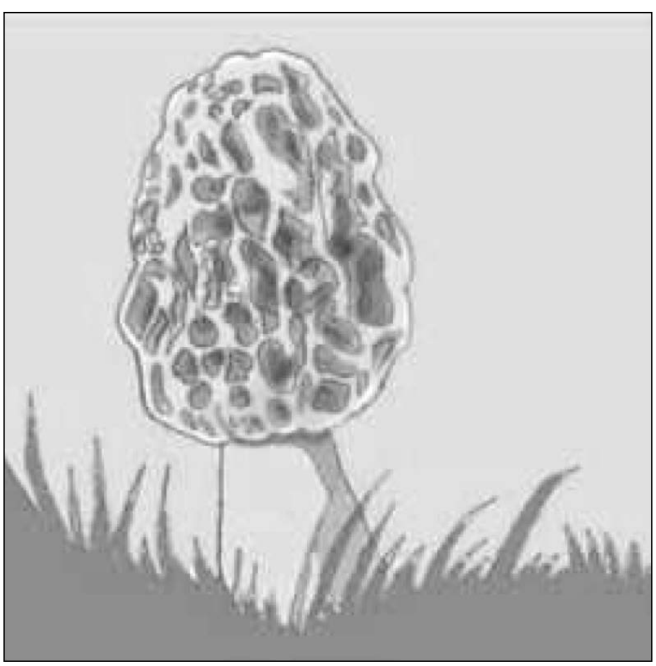
Morels are sometimes called sponge, pine cone, or honeycomb mushrooms because of the pattern of pits and ridges that appears on the caps. They can be anywhere from 2 to 12 inches tall. They may be yellow, brown, or black and grow in spring and early summer in wooded areas and on river bottoms. To cook, cut in half to check for insects, wash, and sauté, bake, or stew.

Notes: False morels can be poisonous and appear similar to morels because of their brainlike irregularly shaped caps. However, they can be distinguished from true morels because false morel caps bulge inward instead of outward. The caps have lobes, folds, flaps, or wrinkles, but not pits and ridges like a true morel.

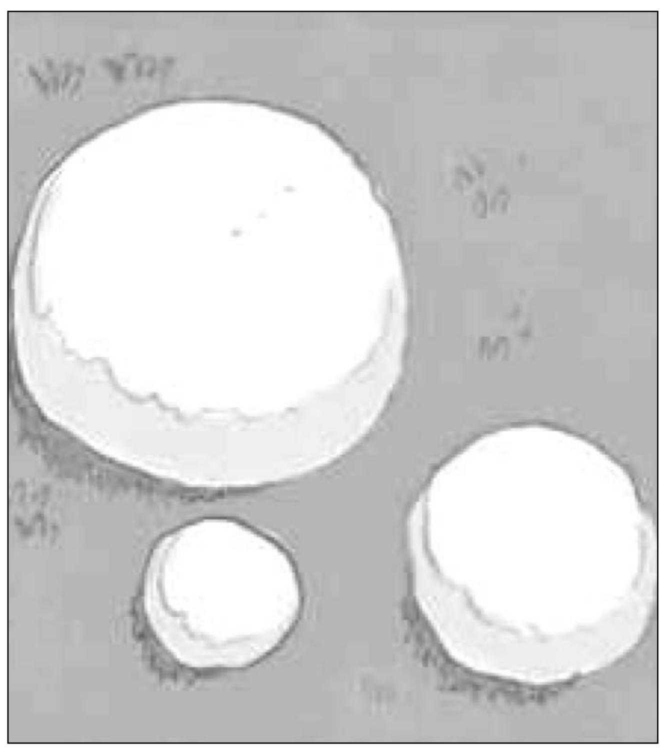
Puffballs

These round or pear-shaped mushrooms are often mistaken for golf balls or eggs. They are always whitish, tan, or gray and sometimes have a thick stem. Young puffballs tend to be white and older ones yellow or brown. Fully matured puffballs have dark spores scattered over the caps. Puffballs are generally found in later summer and fall on lawns, in the woods, or on old tree stumps. To eat, peel off the outer skin and eat raw or batter-fried.

Notes: Slice each puffballs open before eating to be sure it is completely white inside. If there is any yellow, brown, or black, or **if there is a developing mushroom inside with a stalk, gills, and cap, do not eat!** Amanitas, which are very poisonous, can appear similar to puffballs when they are young. Do not eat if the mushrooms gives off an unpleasant odor.



Morel



Puffball

Shaggy Mane Mushrooms

This mushrooms got its name from its cap, which is a white cylinder with shaggy, upturned, brownish scales. As the mushroom matures, the bottom outside circumference of the cap becomes black. Shaggy manes are generally 4 to 6 inches tall and grow in all the warm seasons in fields and on lawns.

Shaggy manes are tastiest eaten when young, but they're easiest to identify once the bottoms of the caps begin to turn black. They are delicious sautéed in butter or olive oil and lightly seasoned with salt, garlic, or nutmeg.

Shaggy mane mushroom

Cooking, Baking, Storing Foods

Preserving Meat and Fish

The Old Methods Survive Not Just for Practicality But for Unsurpassed Flavor

The problem of storing meat and fish for use the year round is as old as mankind. Most of the traditional methods involve processing with salt, smoke, and spices that not only preserve but add flavor as well. Although modern refrigeration has made food storage simpler, many of the old ways are still popular, primarily because they make meat and fish taste so good.

Curing and smoking were once the standard ways of preserving, and many popular products—Smithfield hams, corned beef, lox, pastrami—are still made by one or both of these techniques. Sausages, too, were and are popular. The recipes by which sausages are made vary according to climate. In warm areas traditional recipes call for cured meat laced with plenty of herbs and spices; the result is sausages that tend to be hard and dry. In colder climates, where storage is less of a problem, sausages are generally milder and are made from fresh, uncured meat.

Some old-time methods of preservation are now all but forgotten. Poultry, cooked and deboned, was stored for months beneath a covering of lard or butter. Roasts were kept fresh for up to a week by immersing them in cold running water—when the meat began to float, it was time for it to go into the oven. Charcoal, a strong antibacterial agent, was often ground and rubbed into the surface of meat; fish would be kept fresh by replacing the innards with a lump of charcoal. American Plains Indians perfected the art of drying, or jerking, meat and then grinding the jerky to make pemmican; modern outdoorsmen have rediscovered this ancient food, and today a small jerky-making industry flourishes, catering to the needs of hikers, campers, and skiers.

Short-Term Storage, Hanging, and Sanitation

Fresh meat (including poultry) deteriorates rapidly in temperatures above 40°F, so it is important to refrigerate it as soon as possible and to keep it under refrigeration until it is cooked or processed. In addition, a period of chilling, or hanging, can improve the flavor and texture of most meats by giving natural enzymes time to break down tough muscle fibers. The temperature range for hanging is 33°F to 40°F. Freshly killed poultry should be hung for 12 to 48 hours, depending on the size of the bird. Pork and veal should hang for one or two days; beef, mutton, and lamb for as long as a week. Game should be gutted first, and any scent glands should be removed. If you cannot maintain a temperature at or below 40°F, do not attempt to hang meat. Instead, cure it, freeze it, or otherwise process it for preservation immediately. Fish rots very quickly, so it should never be hung; process it immediately or else freeze it.

When handling meat and fish, make sure your hands are clean, as well as all your tools and utensils. Scrub or scrape wooden cutting boards, wash them with hot, soapy water, and scald them with boiling

Smoking meat, fish, and poultry is much easier than it might seem. This unique smoker is crafted to look like a bull, but really no specialized equipment is required beyond a firepit, where the hardwood smolders, and a ventilated smoke chamber (a wooden crate or even a cardboard box could serve). The smoke helps to preserve meat, partly by coating it with smoke-borne preservative chemicals. Thoroughly cured and smoked meats, such as the South's famous Smithfield hams, can be kept for years. (Smithfields have reputedly been stored for as long as 25 years—from a girl's christening until her wedding.) Nowadays, many people use smokers to add a delicious woodsy flavor to a piece of fresh meat or fish.

water before and after each use. You will probably need several different knives for preparing different cuts of meat. The knives should be not only clean but sharp. High carbon blades are the best; use a butcher's steel to give them a final edge after sharpening.

Special precautions are required when processing or preparing pork, since fresh pork may contain trichinae worms, which cause the disease trichinosis. These worms can be killed by heat or by cold. Always cook pork to a minimum of 137°F *throughout*. (To be safe, cook it to 145°F to 150°F.) For cuts of pork less than 6 inches thick the worms can also be destroyed by freezing at —10°F for 10 to 12 days or at 0°F for three to four weeks.

Freezing In Fresh Flavor

Since World War II freezing has become the most popular way to store meat and fish; it is quick and easy, and preserves both the nutritional value and flavor of the fresh food. The only drawback is that freezing is dependent on a consistent supply of electrical power. The best way to freeze meat and fish is to flash-freeze at −15°F, then store at 0°F. Most chest-style freezers have the capability of reaching −15°F, but some uprights may not. Set your freezer's control to its coldest setting several hours before using it as a flash-freezer. Shift the food that is already in the freezer to one side; try to leave about 1 cubic foot of freezer space for every 2 pounds of meat or fish to be flash-frozen.

Chill meat or fish before you freeze it to make it easier to cut and package and to decrease the chance of spoiling other food in the freezer. Wrap all pieces securely in individual moisture-proof packages to prevent freezer burn (caused by dehydration) and to avoid contaminating one meat with the odors of another. There are many brands of freezer wrap available that give durable protection for frozen goods. Label each package with the type and cut of meat or fish it contains and the date it was frozen. Then load the packages into the freezer. To protect the frozen food, be sure to keep the unfrozen packages from touching any of the already frozen food. When all the food is hard frozen, return the control to normal (0°F). In the event of freezer breakdown or power failure, do not open the freezer—it will maintain its temperature for several hours. During longer breakdowns keep the empty space in the freezer packed with dry ice. Once meat is thawed, it should not be refrozen.

All meats begin to deteriorate if they are left in the freezer too long. Cured meats, such as ham and bacon, and very fatty meats, such as sausage, do not keep well under refrigeration and should not be kept frozen for more than a month. Ground meat, stewing meat, pork chops, liver, and kidneys can generally be left frozen for up to three months. Steak, chops, fish, and roasts will last as long as six months. The best way to thaw frozen food when you are ready to use it is to place it in the refrigerator, still in its sealed package, and let it warm gradually. For quick thawing run cold water over the package. You can cook frozen meat without thawing by allowing extra cooking time.

Canning for Convenience

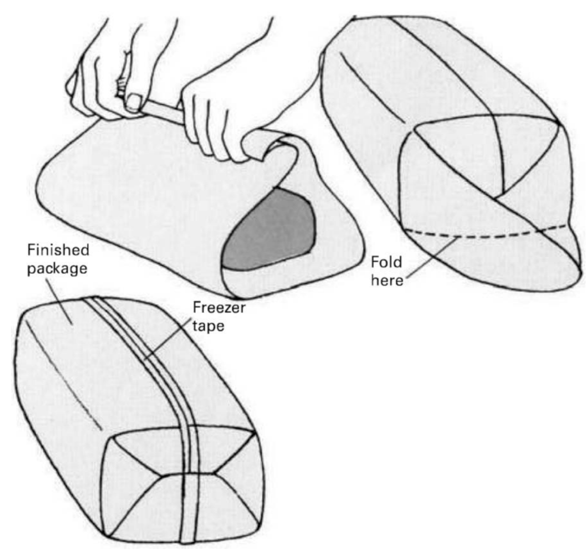
Canning is convenient and economical. Canned foods are not endangered by power failures, they are easy to transport, and they keep a long time. Both meat and fish can be safely preserved either in glass jars or in tin cans, but jars are generally recommended because they cost less, are more convenient, and do not require a mechanical sealing device.

The greatest danger in canning is botulism, a severe and often fatal form of food poisoning caused by bacteria that thrive in dark, airless conditions. To be sure of killing the bacteria, you must treat the food and containers for an extended time at 240°F. To reach this temperature requires a pressure canner with its control set for at least 10 pounds. (For instructions on pressure canning, canning terminology, and canning equipment,

Meat, fish, and poultry can be canned by either the raw-pack or hot-pack method. Raw-packed food is put into containers before it is cooked; hot-packed food is cooked first. In both cases the presence of fat on the rim of the jar may spoil the canning seal, so it is safest to trim off as much fat as possible before packing. For raw packing cut the food into pieces, pack it loosely in sterilized jars, and add ½ teaspoon of salt per pint but no liquid. Place the uncovered jars in an open saucepan of water, and heat gently until a thermometer inserted in the middle of the meat reads 170°F—the temperature at which air is driven out and all yeast and mold spores are killed. This process, known as exhausting, may take an hour or longer. Cap the jars immediately according to the manufacturer's directions; then process them in a pressure canner.

To hot pack, cook the food thoroughly in salted water, and pack it loosely into jars, leaving 1-inch headspace. Next, fill the jars to within 1 inch of the top with boiling water or cooking broth. Make sure the rims of the jars are clean and free of fat before putting the caps on, then carry out the standard pressure canning procedure.

After the jars have been pressure processed and allowed to cool, check for a perfect seal. Metal lids should be slightly concave and should give a clear metallic ring when you tap them. If one fails to



Freezer wrap is the best material for protecting frozen meat and fish from moisture loss. Place food in center of enough wrap to extend around it 1½ times. Join sides of wrapper at top, and fold over tightly against meat. Press out any air pockets, shape the ends into points, and fold back over meat. Seal with freezer tape.

A guide for canning

Meat	Preparation	Time at 240°F (sea level)
Chicken, duck, goose, rabbit, squab, turkey, and other poultry and small game	Bone in: remove meat from breast; break legs and wings into short pieces	1-pt. jars . . . . 65 min. 1-qt. jars . . . . .75 min. No. 2 cans . . . . 55 min. No. 2 ½ cans . . . . . . 75 min.
	Boneless: cut meat into chunks with skin attached	1-pt. jars . . . . .75 min. 1-qt. jars . . . . .90 min. No. 2 cans . . . . 65 min. No. 2 ½ cans . . . . . 90 min.
Beef, lamb, pork, and veal	Cut raw meat into strips or chunks, or grind and cook as patties	1-pt. jars . . . . .75 min. 1-qt. jars . . . . .90 min. No. 2 cans . . . . 100 min. No. 2 ½ cans . . . . . 135 min.
Mackerel, salmon, trout, and other fish	Fillet large fish, for saltwater fish add 1 tbsp. vegetable oil per pt,	½-pt. jars . . . . 90 min. 1-pt. jars . . . . .110 min. ½-lb. flat tins . . . . . 90 min. No. 2 cans . . . . 100 min.
Smoked salmon	Use C-enamel cans	½-pt. jars . . . . 95 min. ½-lb. flat tins . . . . 90 min. No. 2 cans . . . . 100 min.

do so, either discard it or open it and reprocess the contents from the beginning. After they are checked, label all jars with the contents and date. Store them in a cool, dry, dark location (direct light can discolor the contents).

If a lid bulges during storage, or if the contents spurt or show any sign of being under pressure when the jar is opened, do not use the food. Botulism is extremely virulent, yet affected food may not show the usual signs of spoilage. When disposing of the food, be sure it will not be eaten by an animal or other person.

Curing and Smoking for Lasting Flavor

Curing, the first step in the smoking process, is essential for good flavor. In the old days a strong brine cure was the rule—pioneer women judged that there was enough salt and other ingredients in the brine when a raw potato floated. Such a powerful mixture resulted in meat that had excellent keeping qualities but was extremely salty. Before the meat was eaten it was generally desalted by soaking in cold water. Modern refrigeration has opened the way for mild, sweet cures in which flavor is more important than long-term preservation.

Not only curing methods but smoking methods as well have changed over the years. In former times meat was kept for days or even weeks in chambers filled with cool, dense smoke (the temperature rarely topped 110°F). The result was strongly flavored meat that would keep for a very long period. Modern methods of hot smoking

Nitrites and Nitrates

Sodium and potassium nitrite, and to a lesser extent sodium and potassium nitrate (saltpeter)—ingredients that have been used for many centuries in curing meats—have recently come under suspicion as possible cancer-causing agents. These additives have several purposes: they preserve the red color of meat, they are partly responsible for the distinctive flavor of many smoked foods, and they reduce the risk of botulism and other types of food poisoning. Meat that is cured without the use of either nitrites or nitrates must either be kept under refrigeration like any nonsmoked product or else cured with enough salt so that the fluids in the meat contain at least 10 percent salt.

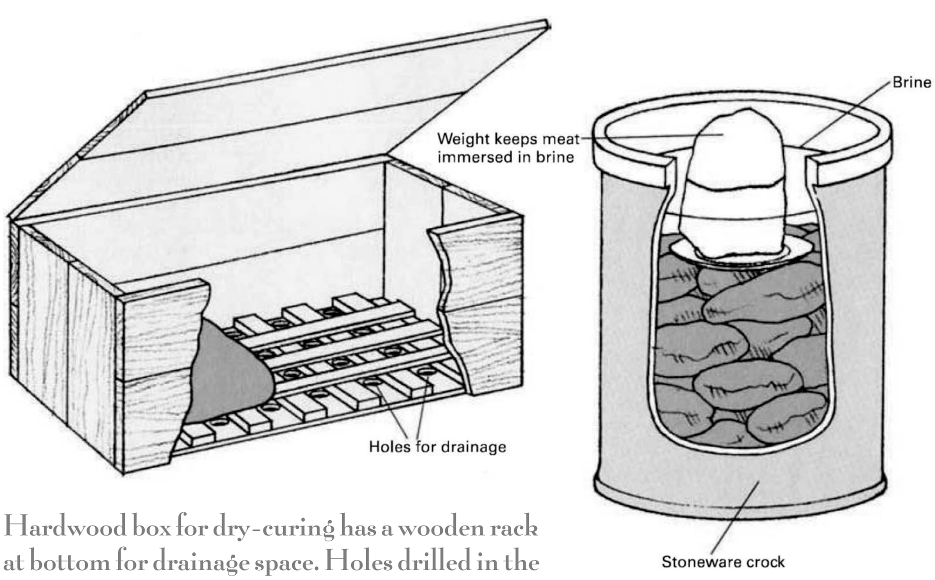
require temperatures of at least 170°F in the smoke chamber. In this heat the meat cooks as it smokes, and to prevent dehydration it must be removed from the smoke chamber after a relatively short time. The only purpose of hot smoking is to add flavor—hot-smoked meat does not keep significantly better than other cooked meat.

Hot smoking can be done all year round, but lengthy curing and cold smoking are best accomplished when the weather is cool enough to prevent the meat from spoiling but not so cold that the meat freezes. For these reasons the best time to start a cold-smoking project is in the autumn, when nighttime temperatures approach freezing and the days are consistently cool.

How to Cure: Two Methods

Salt is the only essential ingredient for curing. It retards spoilage by drawing water out of meat or fish while simultaneously killing decay-causing microorganisms. Meat cured with salt alone will store well but will be tough and dry. Sugar or honey is often added for flavor as well as to keep the meat moist and tender. Herbs and spices can be included in the curing mixture according to personal taste, but do so cautiously; some combinations give unsatisfactory results. Garlic and pepper, for example, can overpower the flavor of a cure.

There are two curing methods: brine-curing and dry-curing. Dry-curing is faster, but many



Hardwood box for dry-curing has a wooden rack at bottom for drainage space. Holes drilled in the bottom allow the escape of juices drawn from the meat or fish by the salt.

Traditional crock made out of stoneware is ideal for brine-curing, but any large container of pottery, plastic, or glass—even a sterile plastic garbage can–will serve the purpose. Do not use a metal container: salt water is highly corrosive, and the meat of fish can be contaminated. A seasoned hardwood barrel is also good for the job; avoid barrels made of softwood, such as pine, because the resins in the wood will leach into the brine and impart a bitter flavor to the meat or fish.

people prefer brine-curing because the results are more consistent and the flavor milder. In either case do not use ordinary table salt; the iodine it contains can discolor meat and fish. Pickling salt is the best type for curing. It has no additives, it is inexpensive, and since it is finely ground, it dissolves readily in brine cures and is quickly absorbed by the meat in dry cures. Other acceptable salts include rock salt, kosher salt, dairy salt, and canning salt.

Brine-curing. For a brine cure the curing mixture is dissolved in pure water. Boil questionable water first to kill bacteria and diminish chlorine, then let it cool. Lay larger pieces of meat or fish, skin side down, on the bottom of a watertight, nonmetal container, such as a stoneware crock, then pack smaller pieces on top. Fill the container with brine until the pieces start to shift. To keep the meat or fish submerged, cover it with a plate on which several weights have been placed; make sure no air pockets are trapped under the plate. Maintain the brine at 36°F to 40°F. After three to five days remove the meat from the brine, spoon off any scum, stir the brine up, and repack the crock. This procedure need be done only once for most cuts of meat; but if the pieces are large (a whole ham, for example), it should be repeated once a week until the cure is complete.

To check progress, cut off a small piece of meat, wash it, cook it thoroughly, and taste it. When the meat is cured to your taste, remove each piece from the crock and rinse it first in warm water, then in cold. Use a scrubbing brush to remove any encrustations of salt, and hang the pieces in a warm place to dry. When dry, red meats will generally have a glossy film of dissolved protein that helps to preserve them.

Dry-curing. In this process the meat or fish is packed directly in a mixture of salt and seasoning. Start by coating each piece; rub it in well and press extra mix into the crannies on the cut ends, especially around projecting bones. Cover the bottom of the curing box with a thick layer of curing mix and place the pieces of meat (or fish) on it. Pack more mix on and between the pieces, making sure each piece is well covered, especially where chunks touch, then put down another layer of meat. Continue until the final layer of meat is packed and covered. After three days remove the pieces of meat and recoat any surfaces that are not well coated. This process of checking and replenishing should be repeated every five days thereafter.

Making and Using a Smokehouse

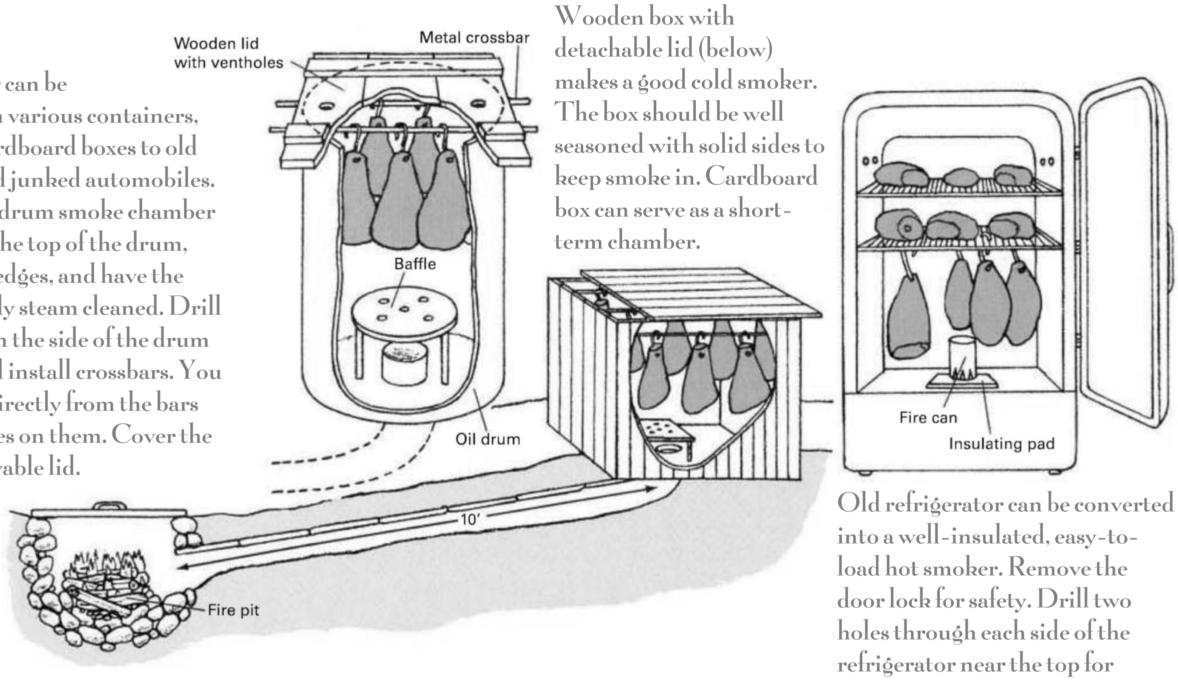
The difference between a smokehouse designed for hot smoking and one designed for cold smoking is largely a matter of the distance between the smoke chamber and the fire: the greater the distance, the cooler the smoke. Proper ventilation is important with either smoking method, since smoke that is trapped in the chamber too long becomes stale and gives food a bitter taste. Too much ventilation, however, dissipates the smoke. Your best guide is the temperature inside the chamber; install a thermometer that can be read from outside, then open or close the vents as needed.

Meats are cold smoked for flavor or for long-term preservation. When the aim is preservation, the temperature should be between 70°F and 90°F; the maximum is 110°F, although large hams are sometimes smoked at higher temperatures. Locate the fire pit about 10 feet from the smoke chamber on the side from which the prevailing winds blow. The top of the pit should be about a foot lower than the bottom of the chamber with a stovepipe or tile-lined tunnel between.

Hot smoking requires temperatures of 170°F to 210°F, so the smoke chamber should be insulated. Smoke is produced inside or directly beneath the chamber. If you use an electric burner to produce smoke and heat, the job of maintaining a proper temperature is made easier.

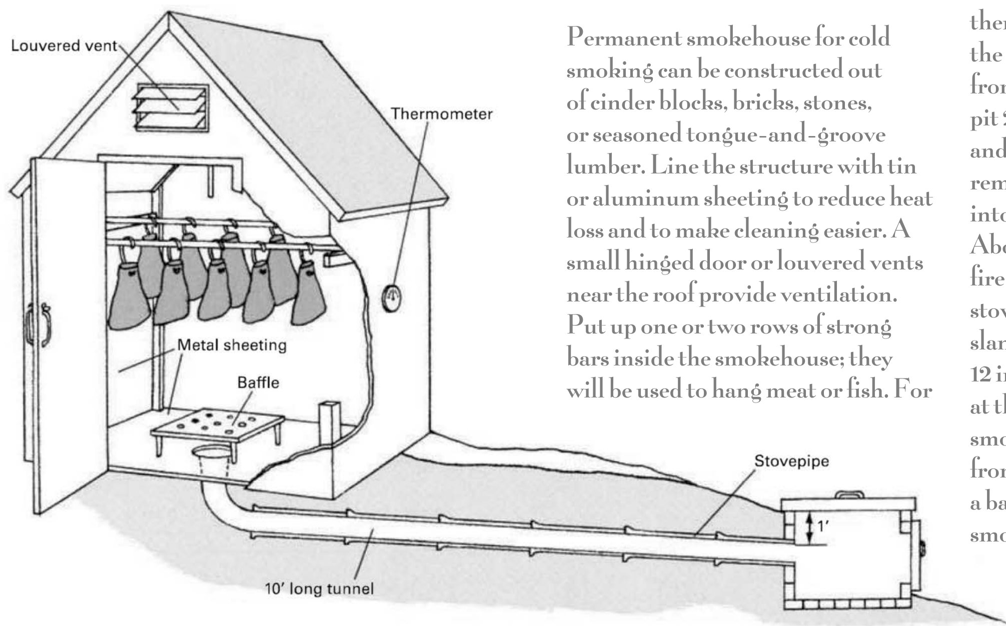
The flavor that smoke adds depends on the wood being burned. Softwoods should not be used—

Smoke chamber can be improvised from various containers, ranging from cardboard boxes to old refrigerators and junked automobiles. To make an oil-drum smoke chamber (right), remove the top of the drum, file down sharp edges, and have the inside thoroughly steam cleaned. Drill or punch holes in the side of the drum near the top, and install crossbars. You can hang meat directly from the bars or set wire shelves on them. Cover the drum witha movable lid.



Wooden box with detachable lid (below) makes a good cold smoker. The box should be well seasoned with solid sides to keep smoke in. Cardboard box can serve as a short-term chamber.

Old refrigerator can be converted into a well-insulated, easy-to-load hot smoker. Remove the door lock for safety. Drill two holes through each side of the refrigerator near the top for ventilation. Place fire can or electric burner on the bottom atop an insulating pad.



How to build a smokehouse

Permanent smokehouse for cold smoking can be constructed out of cinder blocks, bricks, stones, or seasoned tongue-and-groove lumber. Line the structure with tin or aluminum sheeting to reduce heat loss and to make cleaning easier. A small hinged door or louvered vents near the roof provide ventilation. Put up one or two rows of strong bars inside the smokehouse; they will be used to hang meat or fish. For easier temperature checks install a thermometer that can be read from the outside. About 10 ft. upwind from the smokehouse itself dig a fire pit 2 1/2 to 3 ft. deep and 2 ½ ft. wide, and line it with firebrick. Fit it with a removable cover, or, if it can be built into a hillside, with a metal side door. About a foot from the top of the fire pit install a fitting from a metal stovepipe. The stovepipe should slant upward slightly so that it is 6 to 12 in. higher at the smokehouse than at the fire pit. To help distribute the smoke and prevent meat drippings from falling into the pipe, place a baffle over the opening in the smokehouse floor.

their resins are ruinous to smoked food—but almost any hardwood is usable. The best smoke is produced from hickory, apple, or cherry. To use an electric burner, fill a 1-pound coffee can with damp shavings or chips, and place it on the top of a burner set to *low;* you will need to replenish the fuel about once an hour. Otherwise, start a fire with dry hardwood and let it burn to a bed of glowing coals before adding damp chips or shavings. Do not use a chemical fire starter—the odor will linger in the smoke.

When the chamber is filled with smoke and the temperature is right, load in the meat or fish. The best method is to hang the food from crossbars near the top. It can also be placed on mesh shelves of stainless steel or aluminum—not brass, copper, or galvanized steel. During smoking, continue to add damp fuel to maintain dense white smoke; should the smoke turn blue, it means the fuel supply is running low. If your smoke chamber is lined with metal, it is important to avoid the buildup of smoky deposits that will make new batches of smoked food bitter; clean and scrub the walls of the smoke chamber after every third or fourth use. Wooden walls are more difficult to clean, but they absorb much of the deposits and need not be scrubbed as often.

Recipes and Techniques for Curing Poultry, Pork, Beef, and Game

Curing and smoking are inexact arts, and any attempt at precise instruction concerning the strength and duration of the cure, or the time spent in the smokehouse, will be frustrated by variables. The type of meat and its weight, size, and quality are considerations. So are temperature and the density of the smoke, both of which vary with humidity and air pressure. The way the salt is ground makes a difference, as does the kind of wood burned for smoke. The greatest variables of all are the tastes and intentions of the person doing the smoking.

If your purpose in curing and smoking a piece of meat is to preserve it, use a strong, salty brine cure, and cold smoke for the full recommended time. If you are not interested in long-term storage but merely wish to add tenderness and flavor, soak the meat in a marinade, or dry-cure it briefly in seasoned salt before hot smoking. The length of time a piece of meat should be hot smoked varies with temerature. The best guide is reliable meat thermometer stuck deep into the meat.

Meat that has been cured and cold smoked for long-term preservation keeps best at 55°F to 60°F. It should be suspended to allow good air circulation, and pieces should not touch each other. Before storing smoked meat, clean the storage area thoroughly, and seal all cracks where dirt can collect or insects might breed.

The following basic curing recipes can be used with a variety of meats:

Sweet Pickle Brine
4 oz. pickling spices
2 ½ gal. water
2 ½ lb. salt
3 cloves crushed garlic
1 lb. sugar
Simmer spices in a cup of boiling water for 10 minutes, then mix with remaining water and other ingredients. Chill brine to 35°F, and add meat. Maintain temperature throughout curing.

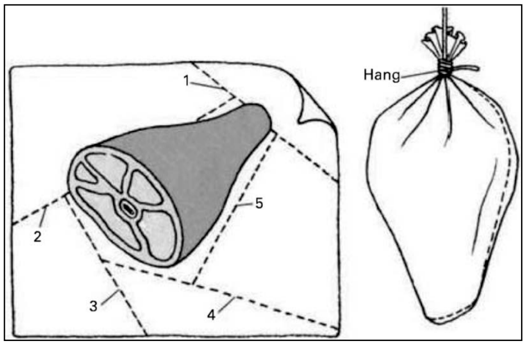
Spicy Seasoned Salt
1 cup salt
4 tbsp. sugar
4 tbsp. black pepper
4 tbsp. white pepper
1 tbsp. celery salt
2 tsp. onion powder
2 tsp. garlic powder
1 tsp. sage

Mix all ingredients and store for several days in an airtight jar to allow the flavors to blend before applying to meat.

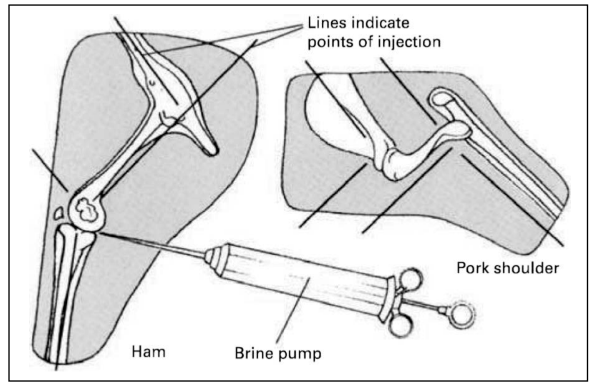
Country-Style Ham and Other Pork Cures

The majority of traditional curing recipes are designed for pork. One reason is that the meat's rich taste is ideally complemented by curing and smoking. Another is that pork was the staple meat among early settlers, and smoking was the most practical way to store hams, pork shoulders, sides of bacon, and other large cuts.

Protection from insects



Insect infestation is a major enemy of stored meat. To protect a ham after it has been cured and smoked, first wrap it in heavy brown paper according to the numbered sequence shown above. Place the wrapped ham in a fitted bag of strong sackcloth, tie the top with string or wire, and suspend the sack in a cool place. Inspect regularly for signs of insects, such as greasy spots or holes in the sackcloth. If the meat has been attacked, trim away all affected parts and use the remainder as soon as possible. Remove all meat from the storage area and spray room surfaces with a methoxychlor solution (½ lb. powder per gallon of water). When you replace the meat, do not allow it to contact sprayed surfaces.



Pumping a ham. To prevent rot at the heart of a large piece of pork, inject brine cure close to the bone. A brine pump to do the job can be bought at most agricultural supply stores. Sterilize the pump and fill it with 1 oz. of brine for each pound of meat. Thrust the needle deep into the meat; then press the plunger gently and steadily as you withdraw it. Pinch the opening closed to prevent brine from oozing out. Make four or five separate injections to distribute the cure evenly.

Long-term preservation of large pieces of pork calls for thorough curing and cold smoking. The process, known as hard-curing, can take from 10 to 90 days, depending on the size and cut of meat. The result is the familiar, rich flavor of country-style ham, pork shoulder, and bacon. Of the many old-time methods of preservation with all their regional variations, this is still the most popular. The chart at right gives curing and smoking times.

You can also cure and smoke pork for flavor alone rather than for preservation. Cut the meat into pieces of no more than 4 pounds. Dry-cure up to a week or brine-cure up to nine days, then rinse and scrub the pieces, and hang them to dry. Smoke for one to four hours at 110°Fto 120°F.

The cure recipes given at right can be used for either type of smoking. Always cook pork well before eating it.

Brine Cure for Pork

2 gal. water
3 lb. salt
1 lb. brown sugar
2 tbsp. black pepper
5 crushed cloves
1 tbsp. white pepper

Cut of Meat	Type of Cure	Quantity of Cure	Length of Cure	Smoking
Ham or shoulder	Dry	1 lb.for every 12 lb.	2 days per lb.	1–4 days at 100°F –120°F
	Brine	To cover meat	4 days per lb.; 28 days max.	
Bacon or loin	Dry	½ lb. for every 12 lb.	1 ½ days per lb.; 25 days min. for cuts over 2” thick	
	Brine	To cover meat	15–20 days	

Dry Cure for Pork

3 lb. salt
1 ½ lb. brown sugar
5 crushed cloves
2 tbsp. black pepper
3 crushed bay leaves
1 tbsp. cinnamon

Curing Beef

Any cut of beef can be cured and smoked for preservation, but only the cheaper cuts, such as rump, chuck, and brisket, are really improved by the process. To give a smoky flavor to steaks and other good cuts without losing too much moisture, cook them first, then cold smoke them for a short time to taste. In curing beef for preservation, avoid dry cures; use a brine cure that is rich in sugar or molasses.

Corned Beef

2 ½ lb. salt
10 lb. brisket of beef
1 gal. Water
1 lb. brown sugar
4 cloves garlic
4 tbsp. pickling spices

Rub 2 lb. of the salt into the meat, then place meat in a clean container for 24 hours. Boil water, and mix in sugar and remaining salt. Let cool, then pour brine over meat. Add garlic and spices, weight meat down, and cure for 30 days in refrigerator at 38°F to 40°F, turning meat every five days. Remove meat as needed; rinse in fresh water for a few hours before cooking. Keep remaining meat submerged in brine at 38°F to 40°F.

Pastrami

1 ½ gal. water
3 lb. salt
3 cups brown sugar
4 tbsp. pickling spices
8 crushed cloves
6 crushed garlic cloves
2 tsp. black pepper
1 tsp. onion powder
½ tsp. cayenne
Whole brisket of beef

Mix all ingredients except brisket. Submerge brisket in brine and cure three to four days for each pound. Rinse and dry. Cold smoke for four hours, then finish by cooking in slow oven until center of meat reaches 140°F. Store in refrigerator.

Curing Poultry

Large birds with a high fat content, such as ducks, geese, and capons, respond well to smoking. Turkeys and large chickens can also be smoked but tend to become dry and tough unless they are basted frequently either with cooking oil or with their own juices. Because dry cures tend to make the problem worse, they are seldom used with any poultry—and never with chicken or turkey. For flavor the bird can be rubbed with a basic seasoning mixture, such as the spicy seasoned salt on page 226. The more usual method is to brine-cure before smoking. Prepare the bird by cutting off its lower legs, head, and neck. Then remove the entrails and internal organs and wash the central cavity to remove all blood clots.

After brine-curing the bird, hot smoke it at 200°F to 225°F to taste, basting often to prevent drying. Alternatively, cold smoke until the skin turns a golden brown or deep reddish brown, then cook in oven. While cooking, keep the bird moist by wrapping it in tightly sealed aluminum foil along with a few tablespoons of water. Once the bird is smoked, use it immediately, since neither procedure contributes to preservation.

Brine Cure for Poultry

6 cloves
3 gal. water
3 lb. salt
3 ½ cups brown sugar
2 tbsp. dill salt
1 tbsp. onion powder
1 tbsp. sage
Ginger, nutmeg, paprika to taste (optional)

Crush the cloves, and mix the ingredients in a crock. Submerge the bird in the mixture, and let it cure at 38°F to 40°F for 24 to 36 hours per pound. Rinse and dry the bird.

Dressing and Curing Game

All wild game should be field dressed as soon as it is killed. Start by removing any musk glands from the legs. Next, open the body cavity from the base of the tail to breastbone, cutting around the anus to free it. Remove the entrails, cut around the diaphragm and through the windpipe and gullet, and remove the heart and lungs. Roll the animal facedown to let the blood drain, then clean the body cavity by rubbing it with grass, paper, or cloth—do not wash it, since moisture speeds spoilage. Keep the carcass chilled if possible.

Bear. Use the same recipes and smoking techniques for bear as for pork. Bear meat, like pork, must be thoroughly cooked as a precaution against trichinosis.

Deer, elk, moose. Venison is even less fatty than beef. Use the sweet brine cure given below before smoking large pieces, or cut the meat into strips for jerky.

Sweet Brine Cure

3 gal. water
5 ½ lb. salt
3 ½ cups brown sugar
6 crushed bay leaves
3 tbsp. black pepper

Small Game Marinade

1 cup wine
1 cup vinegar
½ cup olive oil or vegetable oil
1 medium onion, chopped
3 bay leaves
1 tbsp. oregano
1 tsp. nutmeg
2 cups water
3 tbsp. sugar (optional)

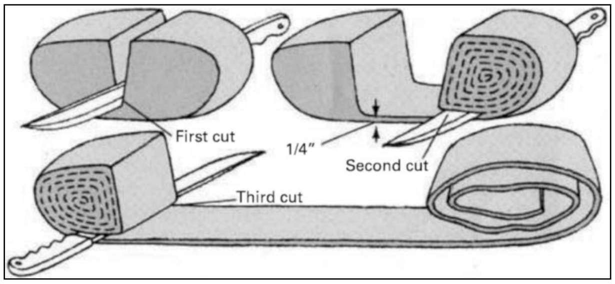
Small game animals, such as rabbits and squirrels, are too lean to smoke well, but their flavor is enhanced by soaking in this marinade before cooking.

The Ancient Art of Jerking

The word "jerky" is an Anglicized version of the Spanish *charqui,* which itself comes from the Peruvian *ch'arki,* meaning "dried meat." Jerky is a product that is so hard as to be nearly indestructible. It was a staple of American Indians as well as the Incas, and frontiersmen were quick to learn jerking for their own survival. Today, jerky and its derivative, pemmican, are popular among campers and backpackers. The meat is nutritious, lightweight, and compact, and will remain edible for months or even years if stored in containers that have a bit of ventilation. Any meat can be jerked, but lean beef and venison produce the best results.

Brine-cured jerky. Cut lean meat into long, wide slabs about 1 inch thick, and cure for three to six days in the sweet pickle brine described on the opposite page. Then rinse and dry in a cool place. Use a very sharp knife to slice the meat lengthwise into ¼-inch-wide slices (it will help to chill the meat to near freezing first). Hang the slices on racks and cold smoke at 75°F to 85°F for 12 to 36 hours. If

Jerking meat the American Indian way



Indian women could produce a sheet of meat ¼ in. thick by several yards long from a single chunk of lean meat. The technique was to cut down through the center to within ¼ in. of the bottom, then outward in one direction, unwrapping the meat as the cutting proceeded until half the chunk was sliced. The chunk was then reversed and the other half cut the same way.

the jerky snaps when it is bent rather than merely folding, it is ready.

Quick-cured jerky. Cut lean raw meat into very thin slices. Dip into a dry-curing mix (pure pickling salt will do) and suspend from racks. Smoke at 100°F to 120°F for two to four hours. Rinse off any encrustation of salt, and dry the meat between paper towels; then lay flat in baking trays and place in a cool oven (175° to 200°F) until meat is stiff and dry. Leave the oven door open to allow moisture to escape.

Pemmican. Pound some jerky into a powder or run it through a meat grinder. Add nuts, seeds, or dried fruit that have been finely chopped or ground. Bind the whole mixture together with melted beef fat and roll it into balls. Store in a lidded container in a cool, dry place.

Smoking and Drying Food from the Sea

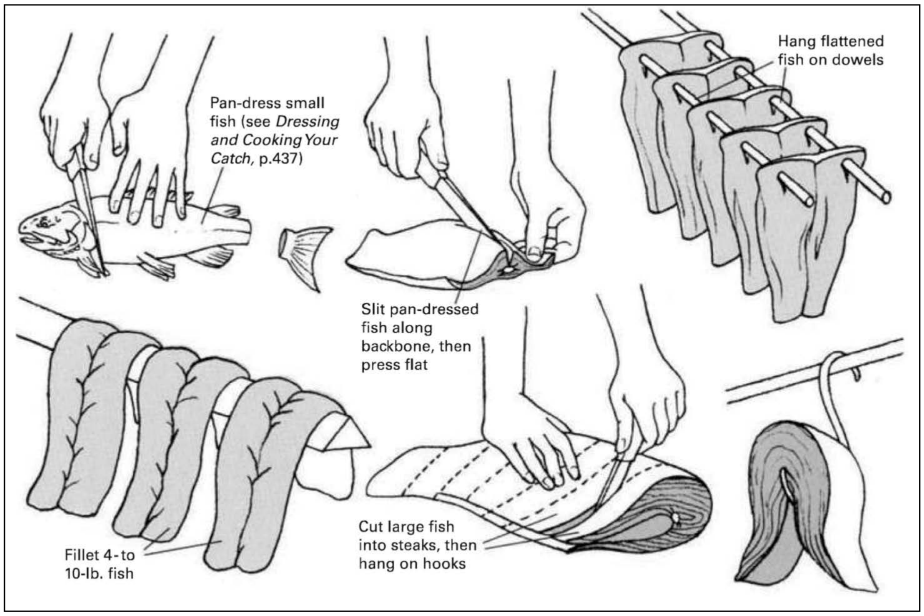
Almost every type of fish responds well to curing and smoking. The flavor of oilier fish, such as salmon and eel, is particularly enhanced by the process. Less juicy fish, such as pike, should be basted often while they are smoking to prevent them from becoming dried out.

Because fish rot quickly, they should be cleaned and dressed as soon as they are caught, then kept on ice until they are processed. The processes of curing and smoking are quicker and easier with fish than with most meats. Only a brief period in the cure followed by a few hours in the smokehouse is sufficient to add a delicious flavor; with slightly extended treatment you can achieve long-term preservation.

A fish that is to be cold smoked should first be cured to extract surplus moisture. Removing water firms the flesh and helps preserve the fish during smoking. First soak the dressed fish in a solution of 1 cup of salt per gallon of water for half an hour, then either dry-cure for up to 12 hours or else brine-cure for two to four hours. After curing, rinse the fish in fresh water, removing any lumps of salt with a stiff brush, then hang it to dry in a warm, shaded, well-ventilated place.

When the surface of the fish is absolutely dry, put it in the smokehouse. How long you smoke the fish depends on your personal taste and on how long you intend to store it. If you plan to eat the fish within a week, 24 hours of cold smoking should be sufficient. If you intend to keep it for several weeks, smoke the fish for up to five days, depending on its size and thickness: fillets will be ready the soonest, but steaks may require a few extra days. In either case expose the fish to light smoke by keeping the vent open for the first third of the total smoking period, then increase the density of the smoke, but keep the temperature in the chamber below 90°F.

Fish that is to be hot smoked need not be cured first; in fact, the combination of curing and smoke cooking will probably make it dry and tough. If you wish to add flavor, soak the fish briefly in a marinade or rub it with seasoned salt before moving it into the smoke chamber. Smoke it at a temperature of about 100°F for the first two to four hours, then gradually increase the temperature in the chamber to 140°F



Prepare small fish (up to 4 lb.) for smoking by splitting and pressing. Start by pan-dressing the fish; then carefully cut down the length of the backbone, and press the fish flat. Pierce the flattened body through the upper corners with dowels, and hang it for smoking.

Fillets and steaks. Fillet a 4- to 10-lb. fish, and hang the fillets over wooden bars in the smoke chamber. Cut larger fish into 1- to 2-in.-thick steaks. First, pan-dress; then use a sharp knife to slice the body crosswise. Hang on hooks or place on mesh grills as with red meat.

until the flesh is flaky. Eat the fish immediately, or let it cool, wrap it in wax paper, and refrigerate it.

Two Cures and a Marinade

The three recipes given below are good, basic formulas for curing almost any type of fish. For more tang you can add dried mustard, bay leaf, or other spices. The marinade only adds flavor but does not aid in preserving. After either cure, the fish should be left to dry until a glossy layer, called the pellicle, appears on its skin.

Dry Cure for Fish

1 lb. salt
1 lb. dark brown sugar
1 tbsp. garlic powder
2 tbsp. white pepper
1 tbsp. onion powder

Combine ingredients 24 hours before cure is needed, and store in airtight container to allow flavors to blend.

Fish Marinade

1 cup pineapple juice
8 tbsp. lemon juice
4 tsp. soy sauce
½ tsp. black pepper
1 crushed garlic clove

Brine Cure for Fish

5 qt. water
3 lb. salt
2 cups brown sugar
2 tbsp. onion powder
2 tbsp. oregano

Smoked Salmon

A salmon's large size and oily flesh make it a prime candidate for smoking, and there are nearly as many recipes for smoked salmon as there are for smoked ham. Lox, a traditional favorite, is thoroughly cured and cold smoked and eaten raw. Other recipes use hot smoking.

Dress the salmon by removing the strip of fat near the dorsal fin but not the rest of the skin. Clean the central cavity, then fillet the fish, or—if the salmon is large—cut it into thick steaks. The salmon can be dry-cured in the spicy mixture described below or brine-cured by submerging the fillets or steaks in a very salty brine for one to two hours, then letting them drain.

Spicy Dry Cure for Salmon

lb. salt
lb. sugar
2 oz. allspice
2 oz. crushed cloves
2 oz. mace
2 oz. white pepper
2 oz. crushed bay leaves

Mix ingredients thoroughly. Pack salmon fillets or steaks in mixture and cure for 8 to 12 hours. Rinse and dry fish. Smoke at 90°F for eight hours in light smoke, then increase density of smoke for 18 to 48 hours, depending on the flavor you like. (Or you can hot smoke the fish at 170°F until the flesh becomes flaky.) Store the salmon in a refrigerator.

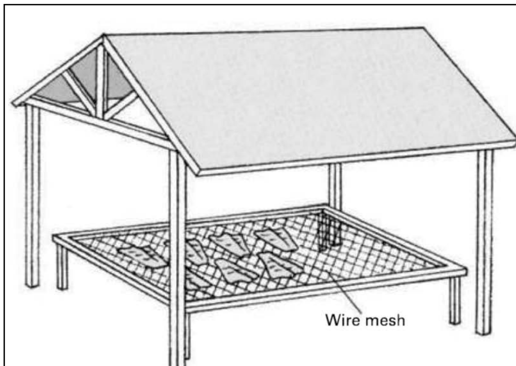
Drying Fish in the Open Air

In an area where warm sun and low humidity can be relied on for at least a week at a time, the flesh of lean fish can be preserved without smoking by air drying it. Properly dried, a fish will keep without refrigeration for a year or longer, provided it is protected from moisture. Drying is not practical for salmon, catfish, and other species whose oil content exceeds 5 percent.

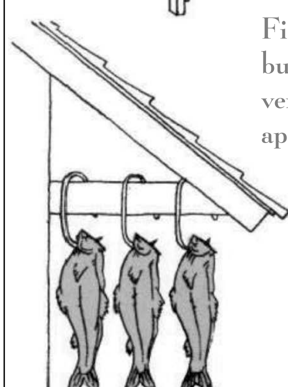
The only cure that is needed before drying is packing in salt. Finely ground pickling salt is best for the job. Clean and dress the fish as soon as it is caught; split and press fish that weigh less than 2 pounds and fillet larger fish; if the fish is large enough to require steaking, it is probably too fatty to be dried. Rinse the meat in a brine made from 1 cup of salt per gallon of water, towel it dry, then coat in salt, allowing about 1 pound of salt for every 4 pounds of dressed fish. Spread a layer of salt on the bottom of a dry-curing box and place a layer of fish, skin side down, on it. Cover with more salt, then add more layers of fish in the same manner. The last layer of fish should be placed skin side up. A small batch of fish may cure in 48 hours in warm weather; allow up to seven days for a large batch in cool temperatures.

When the weather is right—warm and dry but not too hot—take the fish from the curing box, rinse them, and clean off all salt, scrubbing with a stiff brush to remove any visible salt encrustations. Hang the fish or lay them on racks in a shady, well-ventilated place (direct sun will cause spoilage). Bring the fish inside every evening and stack them one atop another, head to tail, with the skin side down, except for the top fish, which should be placed skin side up. Then cover them, and press them with a weight about equal to the weight of the stacked fish.

Six warm days are usually required for thorough drying. To test for dryness, push on the flesh with your finger; if the impression remains, the fish is not yet dry. Should the weather turn before drying is complete, take the fish inside and wait for another good day. They can be kept for up to two weeks in a cool, dry place, provided that every second day you restack them, putting the bottom fish on top and putting a little salt on each layer.



Fish should be dried in open air but shaded from direct sun. Ensure ventilation by spacing fish well apart on racks of wire mesh.



Small fish can be hung to dry under the eaves of a house or barn. Suspend each fish on its own metal hook. Bring fish inside at night and stack in a location that is dry and well ventilated.

Smoked salmon is moist and full of rich flavor.

Bob McClement, Smoking Hobbyist

Smoking Meat for Fun, Producing Wood Chips for a Livelihood

Bob McClement, of Tacoma, Washington, runs a wood chip manufacturing operation for a firm that makes home smokers.

"There are an awful lot more people smoking food these days. I think they do it primarily for the flavor. You know, in the old days you could get charcoal in all different kinds of wood—oak, maple, hickory—and, of course, each one gave a different taste to what you were cooking. Now, with this homogenized charcoal, you don't get much taste at all, so people have gone in for smoking because they want to get that taste they remember from when they were kids.

"The smoking, you know, doesn't really preserve the meat. It's soaking the meat in the brine and drying it that does the preserving. Your basic brine can be salt, sugar, and water. Then you can add whatever spices you like, just like in a marinade. Your different flavors come from the brine and from the kind of wood chips you use. Fruitwood chips give a very different taste than hickory, for example. Applewood has a real nice flavor; and then there's cherrywood—that's got a very strong flavor so you would want to use that on deeper, redder meat.

"You've got to remember to keep the meat cold when it's in the brine. The meat isn't preserved at that stage and if you leave it out in the heat, it will just deteriorate. How long you smoke, of course, is a matter of taste, just the same as how long you boil an egg. For myself, with something like a turkey, what I do is keep it in the smoker for maybe four hours and then finish it off in the oven. That way it doesn't get too dry.

"How long you leave things in the smoker depends on the weight and thickness of the meat and also on the amount of area exposed—the more area exposed, the more flavor the meat or fish will retain. With a roast, because of the thickness, I usually wrap it and put it in the refrigerator for a few days after it comes out of the smoker to let the flavor sink all through the meat.

"Of course, you can save a lot of money— look at the price of smoked salmon in the market compared to what it costs to do it at home—but that's not the only reason people get into smoking. With fish, chicken, or turkey you don't save money by smoking, you just get more enjoyment and flavor out of what you're eating. Once people have made something that's really well smoked, they tend to go the whole gamut. They develop their own recipes for pride and pleasure as much as anything. I think out here in the Pacific Northwest if you asked 200 people how they smoked salmon, you'd get 198 different replies."

Preserving Fish in Brine

Oily fish that are not suitable for drying can be preserved without smoking by using their own juices to produce a strong brine. About 25 pounds of fish can be preserved in this manner in a 2-gallon stone crock.

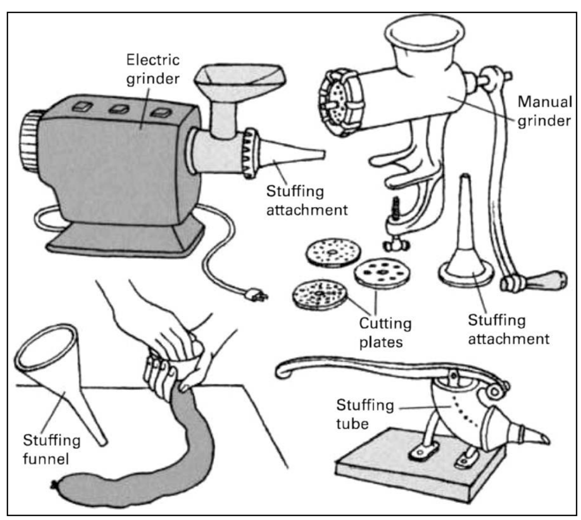
Dress the fish according to size and score the flesh so the salt will penetrate faster. Soak them for an hour or two in a mild brine (½ cup salt to 1 gallon water). After draining, coat the fish with dry salt (allow about 1 pound for every 3 pounds of fish). Next, sprinkle a layer of salt in the bottom of the crock and place a layer of fish on top of it. Cover with another layer of salt, then another layer of fish. Continue in this way until the container is full. Weight the fish down. Within 2 to 10 days, depending on the size of the cuts, the salt and fish juices will have combined to make a thick brine. At this point remove the fish, rinse and brush them. Scrub the crock and replace the fish; then cover with strong brine (2 ⅔ pounds of salt to 1 gallon of water). Store in a cool, dark place. Change the brine at least once every three months. If the weather is hot, change the brine more often.

Sausages and Scrapple: Delicious Techniques for Avoiding Waste

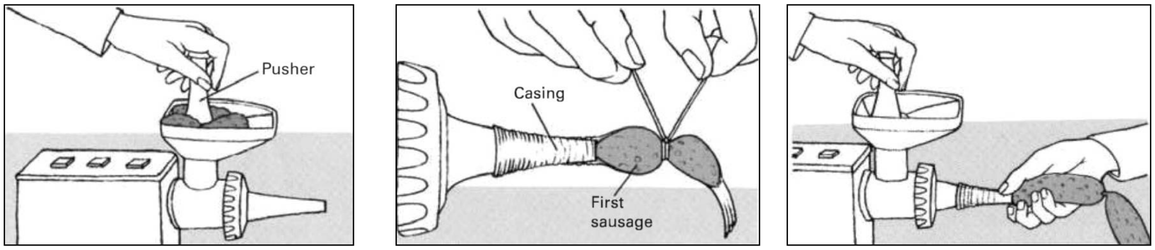
Autumn was the traditional time for slaughtering and putting up meat: the animals had been fattened during the summer, and cooler fall temperatures helped keep just-slaughtered meat fresh. Almost no part of a carcass was allowed to go to waste. Large joints of meat were carefully cured and smoked; organ meats were consumed immediately, and fat was rendered into lard for soap, candles, and shortening. Hides were fleshed and tanned, large bones used for broth, heads were boiled down to make headcheese, and the feet, or trotters, of pigs were stewed, jellied, or pickled. With all this accomplished, there were still many scraps of meat, fat, and innards that remained, waiting to be put to good use. Nowadays, such bits and pieces are discarded or ground up for pet food. In the old days, however, they were converted into sausage or scrapple with the intestine of a freshly slaughtered animal serving as casing.

Although sausages, scrapple, and headcheese are still produced commercially, traditional recipes and ingredients are seldom used. If you want to enjoy their special flavors, you will probably have to make them yourself—and when you make your own, you can include just the right blend of meats and spices to suit your own taste. The only special tool you will need is a meat grinder. Electric grinders do the job quickly and effortlessly but are expensive and, in general, designed for the processing of larger quantities of meat than you are likely to need. Food processors can be used to grind meat but have only limited value, since they will only produce a fine grind. Old-fashioned hand-cranked meat grinders call for a bit of elbow grease but are still best for home use; they will not overheat the meat while it is being ground, and they come with several cutter plates for finer or coarser grinds plus an attachment for stuffing sausages.

Plastic casings and other types of artificial casings are available in various sizes but are difficult to use. For the home sausagemaker the best casings are probably those made from the small intestine of a hog or sheep. They can usually be bought from a



Manual and electric grinders usually come with a stuffing attachment. A variety of other sausage-stuffing devices are available, including a stuffing tube with matching wooden plunger and a funnel through which the meat is pressed by hand.



1. Meat grinder ensures that the meat is cut into fine ribbons rather than pulped. Use pusher, not your fingers, to press meat into the grinder.

2. Rinse casing thoroughly. Place it over nozzle, stuff a small section, and tie off tightly in the middle in order to give an airtight seal to the first sausage.

3. Continue stuffing, supporting casing with free hand to prevent kinks and bends. Tie off or twist each link. Tie off end, leaving a little meat outside.

butcher who makes his own sausages. If you want to try making your own casings, you will need the intestine from a freshly slaughtered animal. Clean it thoroughly, scraping both sides to remove all traces of fat and mucus (this is a time-consuming job). Rinse the intestine in several changes of water, and store it in brine until it is needed. Hog casings can be used for sausages up to 1 ½ inches in diameter; larger casings are commonly made of light weight muslin.

Any kind of meat, poultry, or game can be used for sausage, from the cheapest to the most expensive. The lower the quality of the meat, however, the poorer the sausage is likely to be. Although pork and beef are commonly used, lamb, veal, and poultry will also serve the purpose—and venison sausage is a rare treat. No matter what type of meat is employed, it is important to strike a balance between fat and lean meat: about two parts lean meat to one part fat is satisfactory in most cases. Too little fat results in hard, dry sausages; too much fat results in greasy sausages that shrink when they are cooked. When stuffing the sausage casings, it is important to avoid air bubbles, since they can become pockets of spoilage; if any exist in the finished sausage, prick them with a needle. To give a soft texture and consistency to the meat so that it will fill the casings easily, it is a good idea to add a little water or wine.

Many types of sausage and scrapple must be eaten soon after they are prepared or else stored in a freezer. Other types, such as hard sausages, benefit from aging and will keep unrefrigerated for considerable periods of time. If you plan to preserve your sausages by freezing there are certain seasonings to avoid: garlic loses its flavor, sage produces an off flavor if it is kept frozen too long, and salt may cause a rancid taste after about a month of freezing.

Old-fashioned Pork Sausage

4 lb. lean pork
2 lb. pork fat
3 ½ tsp. salt
6 tsp. sage
3 tsp. pepper
1 ½ tsp. sugar
¾ tsp. ground clove
⅔ cup cold water

Thoroughly chill meat and fat and put them separately through grinder with ½-in. cutting plate. Chill meat again. Combine all seasonings and mix into meat, then put through grinder with ⅛-in. cutting plate. Mix meat and fat in a bowl and add just enough water to make a soft dough. Stuff into casings of muslin or hog intestine, taking care to avoid air bubbles. Hang sausages in a cool, dry place (or in the refrigerator) for one to two days.

These sausages gain from being cold smoked at about 80°F for 10 to 14 hours until they turn a deep, dark brown. Store under refrigeration. Cook before serving.

Traditional Recipes for Sausage, Scrapple, and Headcheese

The different regions of America developed sausage recipes tailored to local food resources and ethnic traditions. Another influence was weather: sausages that are stuffed with cured meat and then smoked afterward have superior keeping qualities in warm climates. Many sausages are made with uncooked pork; they must be thoroughly cooked before they are eaten.

Indiana Farm Sausage

This herb-flavored sausage is delicious fried for breakfast, especially with eggs or pancakes and syrup.

4 lb, lean pork
1 lb pork fat
2 cloves garlic, minced
2 tsp. black pepper
2 tsp. chili powder
2 tsp. cayenne
2 tsp. marjoram
2 tsp. thyme
2 tsp. basil
4 tsp. salt
2 tbsp.sage
2 tbsp. parsley
2 onions
6 tbsp. iced water

Cut meat and fat into chunks, add seasonings, and grind with medium cutting plate. Grind onions. Knead ground meat and onion in bowl and add iced water to give a soft dough consistency. Stuff into hog casings. Store in refrigerator.

Southwestern Sausage

Although well-flavored and spicy, this Spanish-Indian sausage is not quite as hot as the Mexican *chorizo*.

2 ¼ lb lean pork
¾ lb. kidney suet or fat
5 cloves garlic, minced
4-6 chili peppers, chopped
½ cup onion, finely chopped
¼ cup brandy
⅓ cup chili powder
1 tsp. black pepper
1 tsp. ground coriander
1 ½ tsp. cumin
Salt to taste
½ tsp. Tabasco
½ cup vinegar

Grind lean pork and fat together with coarse cutting plate. Combine garlic, peppers, onion, brandy, and seasonings. Mix into meat along with Tabasco and vinegar. Stuff into casings, lying off each link at 4 in. Hang in a warm, breezy, insect-free place to dry for 24 hours. Store in refrigerator.

Summer Sausage

Although the traditional recipe contains some pork, beef and beef fat can be used throughout.

6 lb.lean beef
Sweet Pickle Brine **(see p.226)**
4 tbsp.salt
4 tsp. garlic powder
3 tbsp. white pepper
2 lb. lean pork
2 lb. pork fat
8 whole black peppercorns
2 tbsp. coriander seed
Pinch mustard seed
2 ½ cups dry red wine

Cut the beef into 2-in. chunks and place in a crock. Cover with brine; use weight to keep meat submerged. Remove the meat and stir the brine every four days. After 8 to 12 days remove beef, rinse it, and place it in the refrigerator to drain for 24 hours; then cut it into smaller chunks, and mix with the salt, garlic powder, and white pepper. Grind the beef, pork, and pork fat twice through 3⁄16-in. plate, and mix. Mix in other seasonings and wine; let stand for 48 hours in refrigerator. Stuff into muslin casings. Cold smoke at 80°F for 12 to 14 hours until the skin turns dark brown (the sausage will dry and shrink by as much as one-third). Hang the sausage in a refrigerator or other cool place for at least two weeks. Use in salads and for snacks. Store in refrigerator.

For a faster recipe grind pork and beef through coarse cutting plate and mix in 14 oz. of Dry Cure for Pork. Regrind through same plate, knead meat in a glass or plastic bowl, and place in the refrigerator for 48 hours. Then mix in salt and other ingredients and continue as with brine-cure recipe.

Old-Style Frankfurters

Turn of the century cartoonist Tad Dorgan deserves credit for the name "hot dog;" his drawing of a frankfurter as a dachshund encased in a bun inspired the term. Store frankfurters under refrigeration.

1 ½ lb. pork loin or shoulder
1 lb. pork fat
2 tbsp. salt
1 tsp. white pepper
½ tsp. coriander
½ tsp. nutmeg
½ tsp. cinnamon

Cure the meat for three days in the Brine Cure for Pork; then grind it two times, along with the fat, through a coarse cutting plate. Mix in salt and seasonings, and grind again through a medium-fine cutting plate. Slowly add 1 cup of iced water and mix thoroughly. Stuff into hog casings about 18 in. long. Secure at both ends and twist in the middle to make two long, thin sausages from each length of casing. Hang to dry for 24 hours; then cold smoke for eight hours or until sausages turn deep brown. To cook, simmer in boiling water for 10 minutes.

Scrapple

This Pennsylvania Dutch delicacy, once popular in many parts of America, has slowly lost favor; a shame because it is tasty, economical, and easy to make.

5 lb. pork scraps, including bony meat, liver, kidneys, and heart
1 gal. Water
3 cups cornmeal
Freshly ground pepper, sage, thyme, and salt to taste

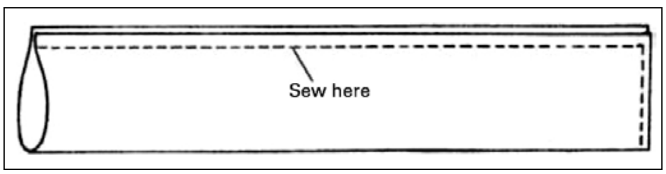
Boil liver, kidney, and heart in salted water until tender. Remove from pot and cut into small pieces. Mix with other meat and return to water. Boil until meat shreds when tested with two forks (there should now be about 3 qt. of broth). Remove any bones, then slowly add cornmeal to pot, stirring constantly until the mixture starts to thicken. Continue to cook until the scrapple has a thick, mushy consistency. Season with plenty of pepper plus sage, thyme, and salt. Pour into greased molds and allow to cool. To cook, cut into ¼ to ½-in. slabs, coat in flour, and fry in butter. Serve with eggs for breakfast or as a tasty trimming with roast game birds. Philadelphia scrapple is made the same way but only shoulder and neck meat is used. Store in refrigerator.

Headcheese

Sometimes called brawn, headcheese is the most popular way of preparing the various bits and pieces of meat from the head of a pig, calf, or lamb.

Head of a pig, calf, or lamb (for calf or lamb, use half the quantities of spices)
2 tbsp. salt
2 tbsp. black pepper
1 crushed bay leaf
½ tsp. hot pepper sauce
1 tbsp. ground mixed spices, such as garlic, onion powder, sage, mace, savory, and cloves

Split the head into halves or quarters (most butchers will do this for you). Remove the snout, eyes, brain, and any remaining bristles or extra fat. Soak in cold water for at least six hours to rinse out the blood. Then wash pieces under running water and put them in a heavy pot. Barely cover with water and bring to a boil; simmer until the meat slides off the bone. Separate meat from the bones and let it cool. Grind meat through ½-in. cutting plate. Add enough broth to the ground meat to make a soft batter consistency and discard the rest. Return mixture to pot and add seasonings. As soon as the mixture boils, pour it into molds of glass, china, or enamel. Cover with a cloth and plate, and put a few pounds of weight on top. Refrigerate until set. Remove from mold. Serve cold in thin slices. Headcheese can be kept in a refrigerator for two to three weeks.



To case extra-lage sausages (more than 4 in diameter), fold and saw a piece of muslin into a tubular shape, turn it inside out, and danpen with water just before stuffing.

Preserving Produce

One Harvest Can Provide a Year-Round Feast for Your Whole Family

In the not too distant past, drying, salting, and live storage were the only ways known for preserving produce. The Indians of North and South America depended on sun-dried foods. American settlers survived bitter winters by eating salt-cured produce or vegetables stored live in root cellars. Caesar's army carried pickled food with it, and the builders of the Great Wall of China dined on salt-cured vegetables.

Nowadays we can choose among a much larger variety of processes, including canning, freezing, and jellying. Besides being more convenient, these newer methods have helped to transform the job of preserving food from a mere necessity into a full-fledged culinary art.

A Survey of Ways to Preserve Fruits and Vegetables

Food spoils for two reasons: the action of external biological agents, such as bacteria and

Red peppers, like mushrooms, peas, corn, and many other vegetables, can be dried in the sun. A few long, hot days with low humidity should do the trick.

Choosing the Right Storage Method

Almost every fruit and vegetable can be stored by one of the common preserving methods: live storage (root cellars andsalt curing, jellying, and drying. The table givesthe methods that are considered most successful inpreserving flavorvarious produce.

Produce	Recommended storage methods
Apples	Live storage, canning, jams and jellies, drying
Apricots	Canning, jams and jellies, drying
Asparagus	Canning, freezing
Beans (green)	Canning, freezing, salt curing
Beans (lima)	Canning, freezing, drying
Beets	Live storage, canning, salt curing
Broccoli	Freezing
Cabbage	Live storage, salt curing
Carrots	Live storage, canning, freezing
Cauliflower	Freezing, salt curing
Celery	Live storage
Cherries	Canning, jams and jellies
Corn	Canning, freezing, salt curing
Cucumbers	Salt curing
Onions	Live storage
Parsnips	Live storage
Peaches	Canning, jams and jellies, drying
Pears	Live storage, canning, salt curing, jams and jellies, drying
Peas	Canning, freezing, drying
Peppers	Freezing, salt curing
Plums	Canning, jams and jellies, drying (prunes)
Potatoes	Live storage, canning
Pumpkin	Live storage, canning
Radishes	Live storage
Raspberries	Jams and jellies
Rutabagas	Live storage, salt curing
Spinach	Canning, freezing
Squash (summer)	Canning, freezing
Squash (winter)	Live storage, canning
Sweet potatoes	Live storage
Tomatoes	Canning, salt curing
Turnips	Live storage, salt curing

molds, and the digestive actions of naturally occurring enzymes. The art of "putting food by," as canning and other preserving methods were known in the old days, consists of slowing down or halting both types of spoilage while at the same time preserving nutritive values and creating food that tastes good. No system of preservation fully achieves all these goals, but no system fails to contribute something of its own—in taste, in food value, in convenience, in simplicity, in economy.

Live storage—either aboveground or belowground—preserves produce with minimum alteration in taste, color, and vitamin content. However, such storage requires certain temperature ranges: winters must be cold enough to slow down food deterioration, but food must not be allowed to freeze. In addition, only certain fruits and vegetables can be stored by this method, notably apples, pears, and root crops.

Canning involves heating to high temperatures, resulting in vitamin loss and changes in taste. Water soluble vitamins can be retained by conserving the cooking liquid, but some others are destroyed. If food is canned in jars, store it in a dark place to avoid loss of riboflavin by exposure to light. A cool area—below 65°F—also helps retain nutrients: at 80°F vitamin C will be reduced by 25 percent after one year, vitamin A by 10 percent, and thiamine by 20 percent.

Freezing, the most modern method of food preservation, has a minimum effect on flavor and food values if the food is properly prepared and carefully packaged. Only vitamin E and pyridoxine (B_6) are destroyed by the freezing process. For best results, frozen foods should be stored at 0°F or below. Vitamin C is easily oxidized and as much as half can be lost if food is kept at 15°F for six months. Length of storage time also affects nutrients. Even at 0°F, most of the vitamin C can be lost if produce is stored for a year.

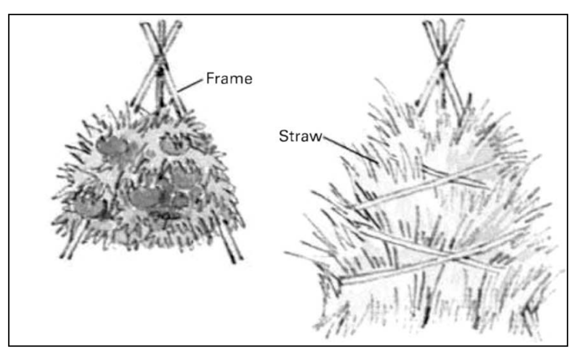
Salt curing alters the taste of the food (although in the case of pickling and fermenting, the results are delicious). If salt curing is done in a strong salt solution, nutritional value is greatly reduced because the food must be thoroughly washed before it can be eaten, a process that will rinse away vitamins and minerals. A weaker salt solution will preserve more nutrients, but there will be a greater risk of spoilage. Nor is salt curing reliable for truly long-term storage: pickles, sauerkraut, and relishes must be canned if they are to be stored for more than a few weeks after the three- to five-week salt-curing process is finished.

Jellying changes the taste of the food because of the large amounts of sugar, honey, or other sweetener that are needed in order to form a gel. In addition, some vitamins are lost during the heat processing required to sterilize fruit and make an airtight seal.

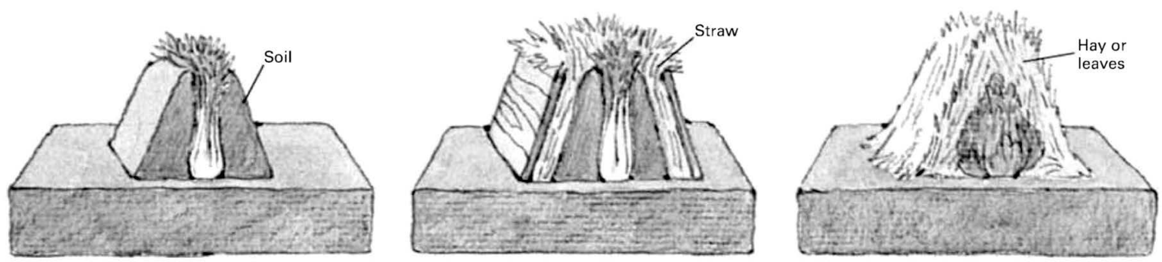
Drying retains a high percentage of most vitamins. But if dried foods are stored for long periods, considerable destruction of vitamins A, C, and E can result because of oxidation, especially if food has not been properly blanched. In addition, vitamins A and E and some B-complex vitamins are broken down by light; as a result, considerable food value can be lost by drying outdoors in direct sunlight.

Maintaining a Winter Garden

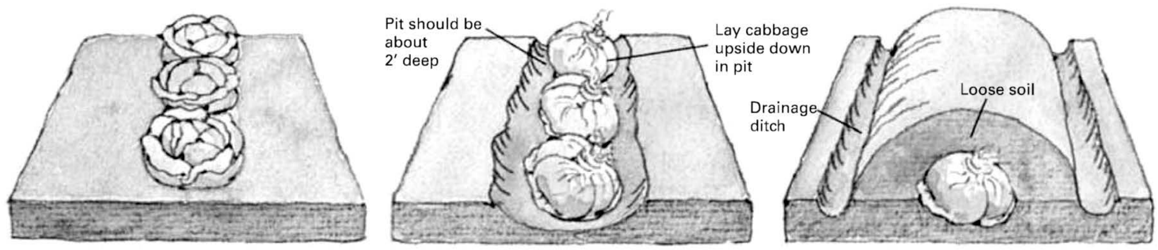
The simplest method of preserving garden produce is to leave it right where it is—in the garden. The technique is particularly suitable for root crops, such as radishes, beets, carrots, and parsnips, but even tomatoes can be kept beyond their normal season. With little more than a covering of earth and straw to help maintain a temperature of 30°F to 40°F, many vegetables can be safely left in the ground from the end of one growing season to the start of the next. The main requirement for successful in-garden preservation is wintertime temperatures that are near or just below freezing.



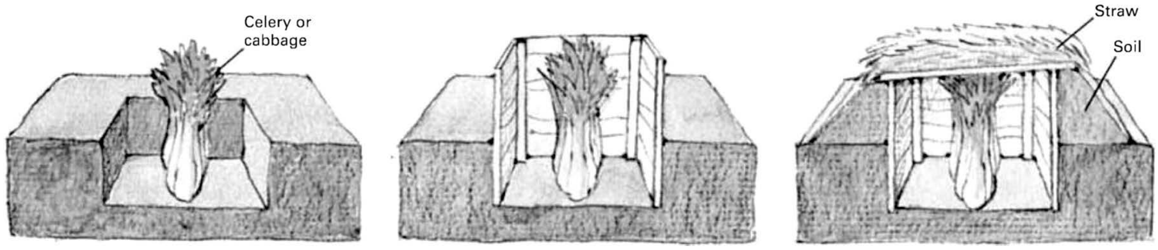
Prolong the tomato season with a tepeelike frame packed with straw and tied in place.



Bank soil around late celery (left). As temperature drops, cover plants completely. In near-freezing weather add straw held down by boards (center). Cover kale, collards, parsnips, and salsify with 2 in. of hay or leaf mulch (right).



Cabbages can be stored in a long pit dug in the garden as well as in a root cellar or conical mound. Dig storage pit about 2 ft. deep, pull cabbages out by the roots, set them upside, down, and cover them co pletelywith soil.



Trenching preserves both cabbages and celery. Dig shallow trench for cabbage, a deep one (2 ft.) for celery. Place plants, roots down, in trenches; then replace soil. Build frame high enough to cover plants, bank soil against it, and top with straw.

Keep Produce Fresh in Cold, Moist Air

If you live in an area where fall and winter temperatures remain near freezing and fluctuate very little, you can store root vegetables, apples, and pears in a wide variety of insulated structures and containers. These range from a simple mound in the garden to a full-fledged root cellar. In each case, the storage unit must maintain temperatures in the 30°F to 40°F range with humidity between 80 and 90 percent. The high moisture content of the air prevents shriveling due to loss of water by evaporation. An old-fashioned, unheated basement is an ideal spot for a root cellar, but a modern basement can be used if a northerly corner is available. Construction details are given below. Root cellars can also be built outside the house, either above the ground or embedded in earth.

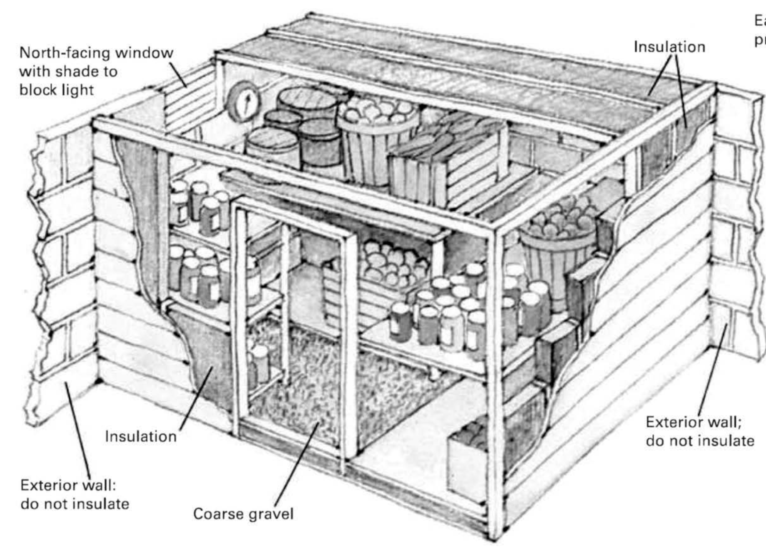
Different vegetables can be stored together in a single container, but fruits should never be stored with vegetables nor should different fruits be stored together. Be sure to check stored produce every week or two, and cull out any that is spoiling. The old saying One rotten apple spoils the barrel still holds true.

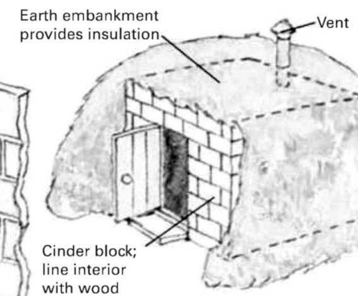
In addition to the basement, many warmer areas within the house can be utilized for preserving crops. Onions, pumpkins, and squash, for example, do best at temperatures between 50°F and 55°F with a humidity of 60 to 70 percent. An unheated attic or an upstairs room that is closed off for the winter months are excellent storage sites for these vegetables.

Onions and herbs can be strung and hung upside down above the hearth or in the kitchen for preservation. Tomatoes that have been picked green can be stored for several weeks by letting them ripen slowly. Set the tomatoes on a rack or shelf, spacing them 6 inches apart to allow for air circulation.

Setting Up a Simple Root Cellar

An 8-foot by 10-foot root cellar will accommodate 60 bushels of produce, more than enough for most families. Indoor root cellars are the most convenient to use and easiest to build. Try to use a northeast or northwest corner of your basement that has at least one outside wall and is as far as possible from your oil burner or other heat source. One north-facing window is desirable for ventilation. The interior walls of the root cellar should be constructed of wood, and if the basement is heated, they should be insulated. The precise amount of insulation needed depends on the average basement temperature, but standard 4-inch-thick fiberglass batting with a foil or plastic vapor barrier should be more than adequate. Install the insulation with the barrier against the wood. Add an insulated door and fit the window with shades to block out light. To keep humidity high, spread 3 inches of gravel on the floor and sprinkle it occasionally with water. You can also maintain humidity by storing the

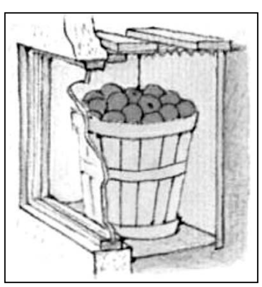




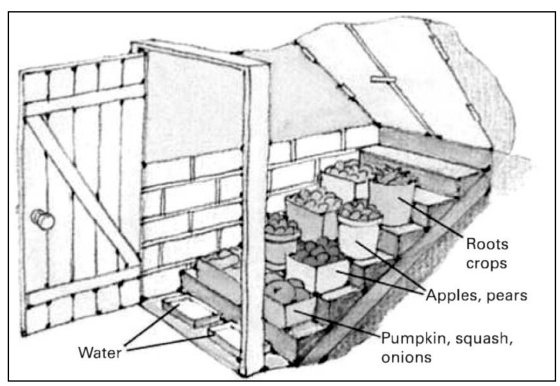
Root cellars can be part of the house, as shown at left, or completely separate. A small well-insulated shed or a concrete block structure (above) with soil banked along three walls are both time-tested designs. A wood-lined excavation drug in well-drained soil with a hatch to get in is simpler yet and still quite serviceable. Air vent should be provided for circulation; humidity control is the same as for indoor root cellar.

Basement root cellar is particularly convenient, since produce is near at hand.

Window wells and stairways



Basement window well can be used as a mini root cellar. Cover the well with screening and wood to keep in heat and keep out animals. When temperatures drop below freezing, open window so that heat from the house can warm the storage area. If outside temperatures rise into the 70s, open window to allow cool basement air to circulate in storage area.



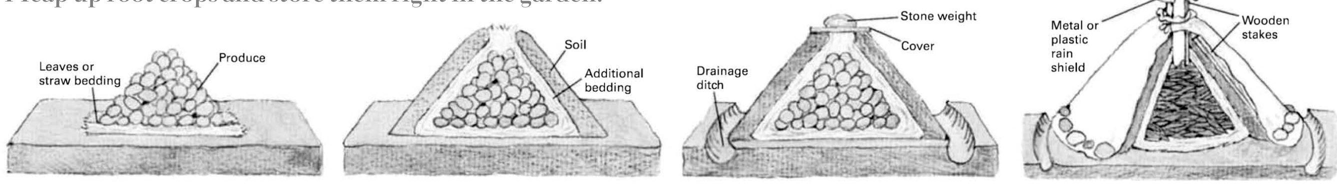
Outdoor basement entrance can make an excellent root cellar. Install a door at the bottom of the steps to block off house heat. The top steps near the outside door are coolest, the bottom steps are warmest. Store root crops, such as potatoes, on top steps; warmth-loving pumpkins, squash, and onions at bottom; apples and pears in between. Place pans of water at the bottom of the stairwell to provide necessary humidity.

produce in a closed container, such as a metal can lined with paper.

High-Heat Processing Eliminates Spoilage

Canning has been one of the most popular methods of preserving food since 1809, when the technique was first developed by the Frenchman Nicolas Appert. Today over 40 percent of families living in the United States do some home canning, and the percentage is increasing. The principle behind canning is simple: decay and spoilage are caused either by enzymes in the food itself or by bacteria and other microorganisms. During the canning process, food is heated to a high

Heap up root crops and store them right in the garden.



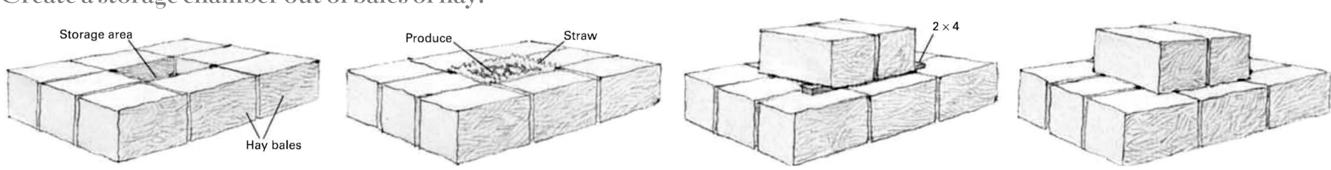
1. Spread several inches of leaves or straw as bedding. Stack produce in cone shape.

2. Cover produce with bedding and 4 in. of soil. Let bedding extend through soil for air.

3. Small drainage ditches and wood or metal cov ering protect cone from rainfall and runoff.

4. Cover large stacks with tarp; provide additional ventilation with wide central opening.

Create a storage chamber out of bales of hay.



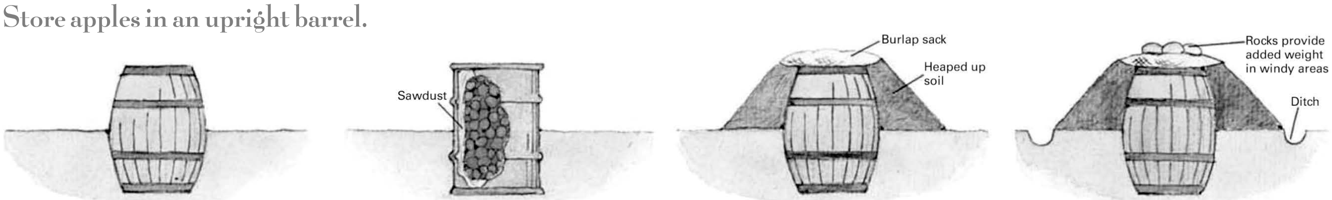
1. Form hay bales into rectangle. Central opening will be used as storage area.

2. Line opening with straw and stack produce. Spread hay over each item, then over stack.

3. Use additional bales as a lid over the opening. Raise bales on 2 x 4 for ventilation.

4. During periods of severe weather remove the 2 × 4 in order to seal opening.

Store apples in an upright barrel.



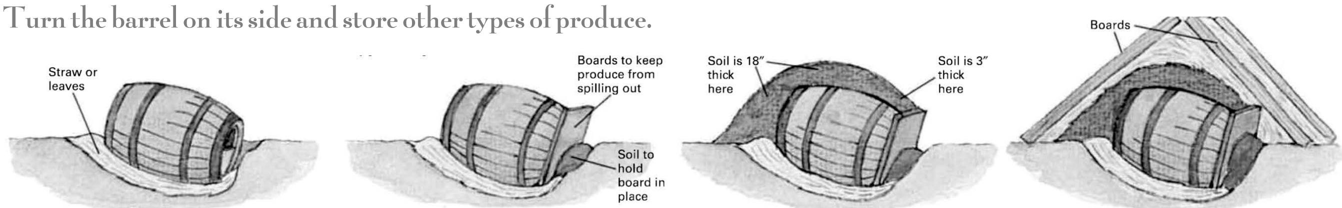
1. For apple storage, start by burying wooden barrel or metal drum halfway in ground.

2. If metal drum is used, line it with sawdust at bottom and between produce and sides.

3. Fill barrel or drum with apples. Cover with leaf-filled sack, then pile soil around sides.

4. Dig a 6-in. ditch around barrel for drainage; put rocks on sack to keep it in place.

Turn the barrel on its side and store other types of produce.



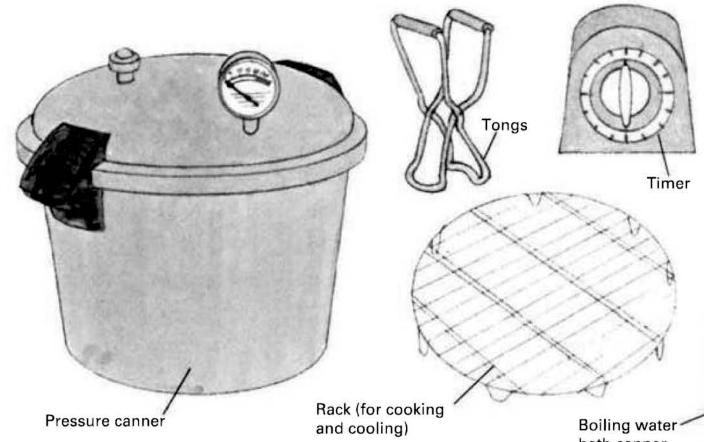
1. Dig space for barrel in well-drained area. Put bedding under barrel and fill with produce.

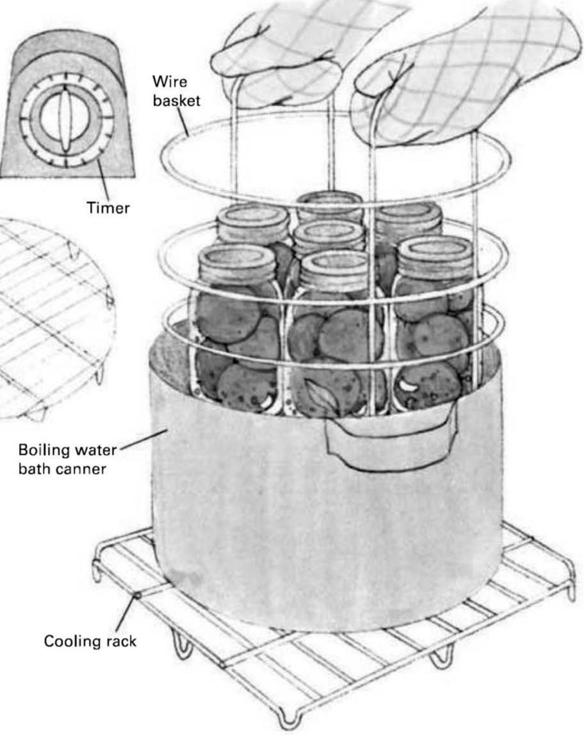
2. Slant open end down so any moisture will run out, then place board over the opening.

3. Cover sides and upper end of barrel with 18 in. of soil. Cover lower end with 3 in. of soil.

4. Cover everything with straw. Place boards on top to keep straw from blowing away.

Specialized canning utensils

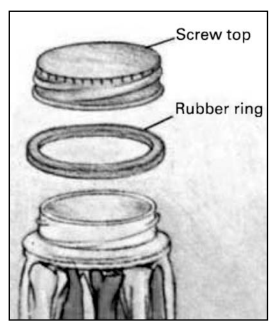




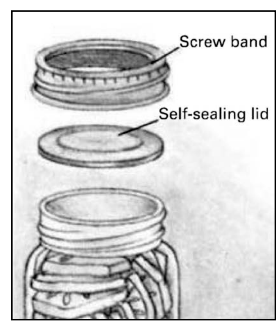
Some specialized utensils in addition to standard kitchen equipment are essential to successful canning. A water bath canner with a tight-fitting lid will be needed to process fruits, tomatoes, and pickled vegetables. Any large metal container can be used as long as it provides 4 in. or more of headroom above the jars. A pressure canner with an accurate dial or gauge is required for heat processing most vegetables. Other important accessories, in addition to the canning jars themselves, are a rack to hold the jars in the canner, tongs for lifting hot jars, a rack or several layers of towels on which to cool the jars, and an accurate timer.

temperature to stop the action of the enzymes and to kill all decay organisms. The food is then stored in sterile, airtight containers to prevent contamination.

Different foods require different processing temperatures. Low acid vegetables—and this includes every type other than tomatoes—can harbor heat-resistant bacteria and must be heated to at least 240°F, a temperature that can only be achieved by pressure canning. High acid foods, including tomatoes and most fruits, can be processed at the temperature of boiling water—212°F— since the only spoilage microorganisms present in them will be destroyed at this lower temperature. Pickled vegetables can also be processed in a boiling water bath.



Porcelain-lined cap consists of screw top and rubber ring. To seal, fit wet ring against shoulder of jar, screw on cap firmly, then back off a quarter turn. When jar is removed from canner, immediately screw cap tight.

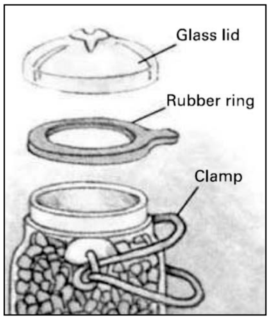


Self-sealing cap consists of lid with sealant around its rim and a screw-on band that holds lid against lip of jar. Tighten band firmly before processing and do not loosen again. Band can be reused but not the lid.

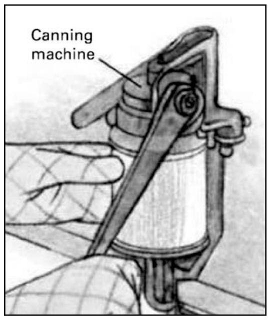
Cans and Jars

Home canners generally do their canning in glass jars rather than tin cans. Jars are easier to use, cost less, and allow you to see the contents. In addition, they can be reused many times and are chemically inert with respect to all types of food. The tin can's immunity to breakage is its only significant advantage. Two commonly used jar designs are shown at right, along with an old-fashioned clamp-type jar. Jars—and tins as well—come in a variety of sizes ranging from ½ pint (1 cup) to 1 gallon and larger.

If you plan to can in tins, you will need to purchase a sealing device. To check that the sealer



Bailed jar with glass lid and wire clamps is rarely sold now. Lid is held in place with long clamp during processing, then short clamp is snapped down for a tight seal. Decorative replicas should not be used for canning.



Tin cans are sealed by machine. Plain tin cans are safe for all foods, but to avoid discoloration of produce enamel-lined tins are used for corn, beets, berries, cherries, pumpkin, rhubarb, squash, and plums.

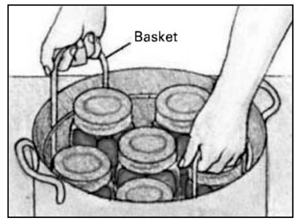
is properly adjusted, seal an empty can, then immerse the can in warm water for several minutes. No bubbles should rise from the can. When canning in tins, the food should be packed while it is hot (more than 170°F) or else heated to that temperature in the can. Seal the can immediately after heating, then process it by the appropriate method shown on the opposite page. Processing is similar to jar canning except that steam pressure can be reduced immediately after the heating period is completed.

The ABCs of Canning

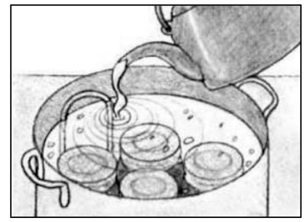
Vegetables and fruits must be pretreated before they are packed into jars for heat processing. Wash all produce, and cut vegetables into pieces. Berries and other kinds of small fruits can be left whole, but larger fruits, such as peaches, pears, and pineapples, should be pitted, if necessary, and sliced. Fruits are often dipped in ascorbic acid (vitamin C) and packed in sugar syrup to preserve their shape, color, texture, and flavor.

There are two ways to pack the produce into jars: raw (raw packed) or cooked (hot packed).

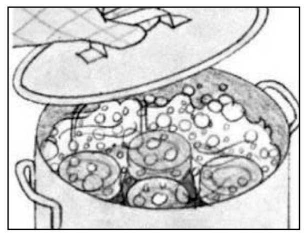
Boiling water bath canning



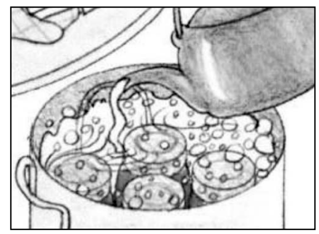
1. Fill canner halfway with hot water, load jars in basket, and put inside.



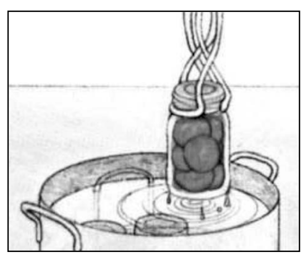
2. Add boiling water to 2 in. above jars. Do not pour directly on jars.



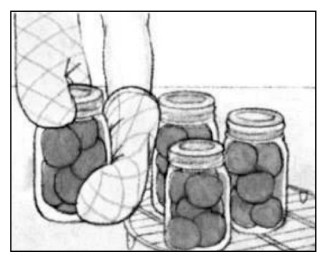
3. Cover canner. Bring water to rolling boil and start timing.



4. Reduce heat, but maintain rapid boil. Add boiling water if needed.



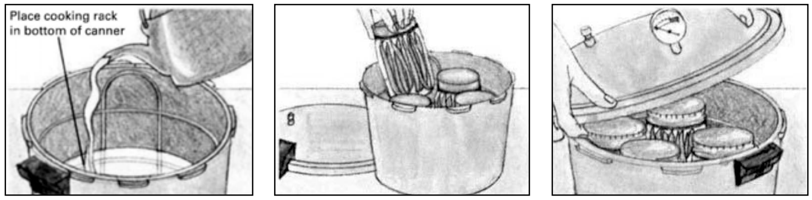
5. When processing time is up, remove jars immediately with tongs.



6. Tighten lids if needed. Set jars on rack, leaving space between them.

To hot pack most fruits or vegetables, steam them, or heat them to boiling in juice, water, or syrup; then immediately pack them into the containers. (Tomatoes and some fruits can be cooked in their own juices.) For raw packing, load clean produce tightly into containers and pour on boiling juice, water, or syrup. Wipe the rim and sealing ring to remove any particles of food, then close the jar and proceed with the canning process: boiling water bath for fruits and high acid vegetables, pressure canning

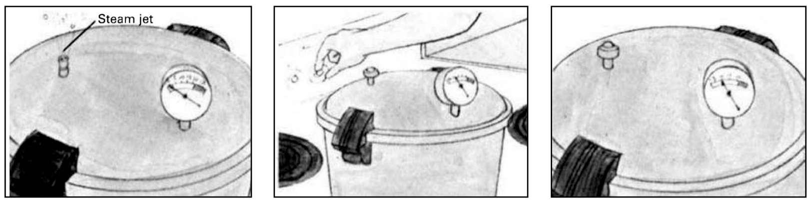
Pressure-cooker canning



1. Pour 2 to 3 in. of boiling water into bottom of pressure canner.

2. Place jars on rack set at bottom of canner. Jars must not touch.

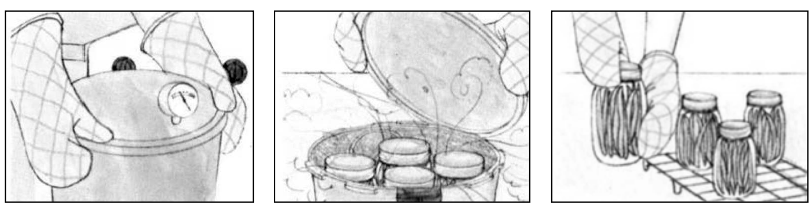
3. Fasten lid. Turn heat to maximum. Let steam exhaust 10 minutes.



4. When the first inch of the steam jet is nearly invisible, close the vent.

5. At 8-lb. pressure lower heat slightly. Let pressure rise to 10 lb.

6. At 10-lb. pressure start timing. Hold pressure for full canning period.



7. Remove canner from heat and let cool. Do not pour cold water on it.

8. When pressure is zero, open vent, then lid. Tilt lid as shown for safety.

9. Set jars on rack leaving spaces between jars. Tighten lids if necessary.

for low acid vegetables. After canning, store food in a dark place, since light can cause discoloration and loss of nutrients. Be sure to date and label all jars.

It Pays to Be Careful When Canning Food

Canning must be carried out with scrupulous care if bacterial contamination and spoilage are to be avoided. Most types of spoilage cause only minor illness at worst, but one type—botulism—is extremely dangerous and often fatal. This form of food poisoning is caused by toxins produced by germs that multiply rapidly in the low-oxygen, low-acid environment of canned vegetables. To prevent botulism as well as other food poisoning, it is essential that care be taken at every step of the way.

The first rule is to can only perfect produce. Overripe or damaged fruits and vegetables are prone to spoilage. Inspect jars, lids, and sealing rings to be sure they are in perfect condition, then wash and scald them before use. Wash all produce thoroughly, and pretreat it according to a reliable recipe and the principles described on. Be sure to use the correct time, temperature, and method of processing. (Because the spores that cause botulism are killed only at temperatures well above boiling, all vegetables except tomatoes must be pressure canned.) When canning with the boiling water bath method, use a lidded container and keep the jars totally immersed in rapidly boiling water. Before starting to pressure can, test the canner according to the manufacturer's instructions. After processing, check the seal on every jar: when you push down on a self-sealing lid, it should stay down. Test porcelain lids by turning jars upside down; if you see a steady stream of tiny air bubbles, the seal is not airtight.

There are further safety precautions to take after the processed food is on the shelf. Discard any jar whose contents appear foamy or discolored, whose lid bulges or is misshapen, or whose rim is leaking. Be sure that the canned produce is normal before you eat it; discoloration, odor, mold, and spurting liquid are all reasons to discard it. When disposing of suspect food, place it where animals or humans cannot accidentally eat it. Home-canned vegetables, except tomatoes, should be cooked before they are served. Bring the vegetables to a rolling boil, then boil an additional 20 minutes for corn or spinach, 10 minutes for other vegetables.

Vegetable	Time to Maintain Pressure for Pints	Time to Maintain Pressure for Quarts
Asparagus	25 min.	30 min.
Beets	30 min.	35 min.
Carrots	25 min.	30 min.
Corn	55 min.	–
Cowpeas	35 min.	40 min.
Lima beans	40 min.	50 min.
Potatoes	35 min.	40 min.
Pumpkin	55 min.	90 min.
Snap beans	20 min.	25 min.
Winter squash	55 min.	90 min.

Store canned goods in a cool, dark place—a root cellar is ideal. Jars let you see all the produce easily, but they must still be dated either on the lid or on a label. Also list such additives as salt, sugar, and spices.

Choose the Proper Canning Method and Follow Procedures Exactly

The specifics of canning vary from one fruit or vegetable to the next. For high-acid produce, use the boiling water bath method; start to time only when the bath reaches a rolling boil. For low-acid produce, use a pressure canner. Let steam vent for 10 minutes to expel all air from the canner, then close the vent to let pressure build. Start timing after pressure in

Fruit or Vegetable	Time in Boiling Water Bath for Pints		Time in boiling Water Bath for Quarts	
	Hot Pack	Raw Pack	Hot pack	Raw pack
Apples	15 min.	–	20 min.	–
Apricots	20 min.	25 min.	25 min.	30 min.
Berries	10 min.	10 min.	15 min.	15 min.
Cherries	10 min.	20 min.	15 min.	25 min.
Peaches	20 min.	25 min.	25 min.	30 min.
Pears	20 min.	25 min.	25 min.	30 min.
Plums	20 min.	20 min.	25 min.	25 min.
Rhubarb	10 min.	–	10 min.	–
Sauerkraut	15 min.	15 min.	20 min.	20 min.
Tomatoes	35 min.	40 min.	45 min.	50 min.
Tomato juice	35 min.	–	35 min.	–

Altitude above sea level	For boiling water bath:		For pressure canning, add
	of 20 min. or less, add	of 20 min. or more, add	
1,000'	1 min.	2 min.	½ lb.
2,000'	2 min.	4 min.	1 lb.
3,000'	3 min.	6 min.	1 ½ lb.
4,000'	4 min.	8 min.	2 lb.
5,000'	5 min.	10 min.	2 ½ lb.
6,000'	6 min.	12 min.	3 lb.
7,000'	7 min.	14 min.	3 ½ lb.
8,000'	8 min.	16 min.	4 lb
9,000'	9 min.	18 min.	4 ½lb.
10,000'	10 min.	20 min.	5 lb

the canner reaches 10 pounds. If pressure falls below 10 pounds at any time during processing, start timing over again. Processing times for both methods depend upon the size of the jar used.

Adjustments for High Altitudes

If you live in an area that is more than 1,000 feet above sea level, the reduced atmospheric pressure causes water to boil at temperatures lower than 212°F. To compensate, you must increase processing times for boiling water baths. You must also increase pressure settings for pressure canning to attain the required 240°F temperature. Add time or pressure according to the table.

Simple Recipes with a Delicious Flavor Difference

Try a variety of flavorings and combinations when canning fruits and vegetables. Sugar or salt can be added or deleted from any recipe without changing the processing requirements; so too can vinegar, lemon juice, or spices. Tomatoes can be flavored in a number of ways to make condiments and sauces. But be careful when adding any other vegetable, such as onions, peppers, and celery, to tomatoes: the mixture will be less acidic than tomatoes alone and *must* be pressure canned. In addition, changes in density can affect processing time, so do not try to mix a variety of vegetables unless you have a reliable recipe that includes canning instructions.

Fruit Puree

3 lb. fruit
Sugar to taste

Wash and cut up fruit, remove any pits. Simmer fruit pulp until soft (about 15 min.), adding water as necessary and stirring frequently to prevent sticking. Put pulp through food mill or strainer. Add sugar to pureed pulp. Simmer pulp for five minutes more. Pack hot puree into jars, allowing ½-in. headroom. Adjust lids. Process in boiling water bath for 10 minutes for either pint or quart jars. *Makes 1 quart.*

Pear Honey

8 cups ripe pears, peeled and chopped
5 cups sugar
1 lemon, juice of and rind cut into pieces

Put all ingredients into large heavy pot. Bring slowly to a boil and simmer until thick (about 45 minutes). Stir frequently to avoid burning. Pour boiling mixture into jars, leaving ½-in. headroom. Process in boiling water bath for 20 minutes for either quarts or pints. *Makes 1 quart.*

Applesauce

3 lb. apples, quartered and cored
¼ tsp. cinnamon sugar to taste

Place apples in a saucepan with ½ cup water. Bring slowly to a boil, then reduce heat and simmer until soft (about 10 minutes). Add cinnamon and sugar and stir. Pack hot applesauce into jars, allowing ½-in. headroom. Insert knife to pierce any air bubbles. Adjust lids. Process in boiling water bath for 10 minutes for either pint or quart jars. *Makes 1 quart.*

Brandied Pears

¼–½ cup sugar
1 tbsp. lemon juice
1 tbsp. lemon rind
2 cups brandy
2 cups water
2–3 lb. perfect pears, peeled, halved, and cored

Mix sugar, lemon juice, rind, brandy, and water, and bring to boil. Add pears a few at a time, and cook until tender (about 20 minutes). Pack pears in jars, leaving ½-in. headroom. After all the pears are cooked and packed into jars, return liquid to a boil. Pour liquid over pears, leaving ½-in. headroom. Adjust lids. Process in boiling water bath 20 minutes for pint jars, 25 minutes for quart jars. *Makes 1 quart.*

Cream-Style Corn

5 lb. fresh corn
1 tsp. salt

Husk and wash ears of corn. Cut kernels from cob, but cut far enough away from the cob that the knife blade slices through the center of the kernels. Scrape cobs with knife to extract juice and pulp from part of kernels still on cob. Add scraped pulp to cut kernels. Pack corn into pint jars, allowing 1 ½-in. headroom. Add ½ tsp. salt to each jar. Fill to ½ in. from top with boiling water. Adjust lids. Process jars in pressure canner at 10 lb. for 95 minutes. Do not use quart jars to process corn. *Makes 1 quart.*

Beans in Tomato Sauce

1 lb. dry kidney beans
1 qt. tomato juice
3 tbsp. sugar
2 tsp. salt
1 tbsp. chopped onion
¼ tsp. mixture of ground cloves, allspice, mace, and cayenne pepper

Rinse the beans, cover with boiling water, and boil for two minutes. Remove from heat and soak for one hour. Reheat beans to boiling just before you are ready to put them in jars. Mix together tomato juice, sugar, salt, chopped onion, and spices, and heat mixture to boiling. Fill jars three-quarters full of hot, drained beans. Pour in boiling sauce, allowing 1-in. headroom. Adjust lids. Processs in pressure canner at 10-lb. pressure for 65 minutes for pint jars, 75 minutes for quart jars. *Makes 2 quarts.*

Tomato Ketchup

½ bushel ripe tomatoes
⅓ cup salt
1 tbsp. whole cloves in spice bag
1 whole nutmeg, grated, or ½ tsp. ground nutmeg
½ tsp. cayenne pepper
1 qt. cider vinegar

Press the tomatoes through a sieve or food mill to remove seeds and skin. Cook the tomato pulp to boiling over low flame, stirring frequently to prevent scorching. Add salt, spices, and vinegar. Simmer over low heat, stirring often, until liquid is reduced by half (about ½ hour). Remove spice bag. Fill pint jars with tomato mixture, allowing ½-in. headroom. Adjust lids. Process in boiling water bath for 10 minutes. *Makes 3 quarts.*

Tomato Preserve

2 cups red tomatoes, peeled and chopped
2 cups sugar
1 small lemon, juice of and grated rind
1 stick cinnamon
¼ tsp. powdered ginger

Cover tomatoes with sugar. Let them stand for 12 hours. Drain juice and boil pulp until thick, stirring often to prevent scorching. Add lemon juice, grated rind, cinnamon, and ginger. Cook until thick. Pour into pint jar. Process in boiling water bath 15 minutes. *Makes 1 pint.*

Freezing Produce

Freezing is not only simple and reliable but also retains flavor and nutrients better than any other preservation method except live storage. It prevents deterioration by slowing enzyme action and halting bacterial growth. For best results, store foods in moisture-proof containers and cool the food quickly to 0°F or below. Rigid containers of glass, metal, and heavy plastic are impermeable to all moisture and vapor. Other products made especially for freezing are resistant enough to prevent deterioration. These include paper cartons lined with a heavy coat of wax, freezer paper, heavy plastic wraps, and heavy plastic bags. Waxed paper, cartons lined with only a thin layer of wax, and thin plastic containers, bags, or wraps should not be used.

For rapid freezing, pack produce that is already cool; work with small quantities, filling only a few packages at a time, and freeze the packages immediately. Place them against or as close as possible to the freezer coils, and allow ample air space around each package. Once the food is frozen, rearrange it to make the best use of freezer space. Put no more food into the freezer than will freeze within 24 hours.

Frozen produce will keep for as long as a year. Label and date all packages and make a list showing the kind of produce and the date frozen. Put the list near the freezer and cross off entries as food is used. Once frozen fruits and vegetables are thawed, they deteriorate rapidly; so use the thawed food immediately and do not try to refreeze it.

How to freeze fruits

1. To prevent discoloration, dip light-colored fruits in a solution of ascorbic acid (vitamin C) and water. Use 1 teaspoon per cup of water for peaches and apricots, 2 ¼ teaspoons per cup of water for apples.
2. For a dry pack, sprinkle fruit with ½ cup of sugar per pound of fruit. For a wet pack, make a light syrup by mixing 1 cup of sugar with 2 ½ cups of water.
3. Pack fruit into rigid containers or plastic bags. In a wet pack, cover fruit with liquid; leave 1-inch headroom in glass jars, ½ inch in plastic containers.
4. Label and date containers, and freeze at 0°F.

How to freeze vegetables

1. Blanch vegetables in boiling water or steam to destroy enzymes that break down vitamin C and convert starch into sugar.
2. Cool vegetables quickly by immersing them in cold water. Drain on absorbent toweling.
3. Pack and freeze as you would dry-pack fruit, but do not use any sugar.

Salt Enhances Flavor and Shelf Life Too

Salt was a treasured commodity in the ancient world not only for its flavor but also for its preservative properties. When produce is impregnated with salt, moisture is drawn out and the growth of spoilage-causing bacteria inhibited. There are four basic methods of salt curing: dry salting, brining, low-salt fermentation, and pickling.

Dry salting and brining require heavy concentrations of salt during processing. In general, the more salt used, the better the food is preserved, but the greater the loss in food value, particularly since heavily salted food must be soaked and rinsed to make it palatable—a process that further depletes vitamins.

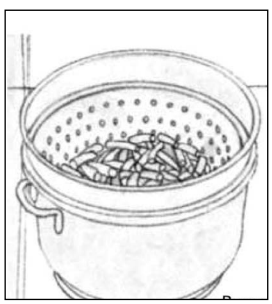
Modern cooks are more likely to choose a salt-curing method for its distinctive flavor than for its preservative properties. As a consequence, low-salt fermentation (the process used to make sauerkraut) and pickling remain popular today in spite of drawbacks as means of preservation. In both methods bacteria convert natural sugars in the produce into lactic acid, a substance that enhances flavor, improves preservation, and is said to promote health. The chief difference between low-salt fermentation and pickling is the use of vinegar, herbs, and spices in the pickling process. In either method salinity is low enough for the produce to be eaten without first being freshened (rinsed in water).

Almost any vegetable or fruit can be preserved by one or more of the salt-curing methods. Once cured, the produce will remain fit for consumption for periods of up to three weeks, provided it is kept at a temperature of about 38°F. If you want to keep the produce for longer periods or if the 38°F storage temperature is impossible to maintain, can the food by the boiling water bath method as soon as possible after it is thoroughly cured. For salt curing, choose vegetables and fruits that are firm, tender, and garden fresh without any trace of bruises or mold. Store-bought produce can be employed, but avoid vegetables

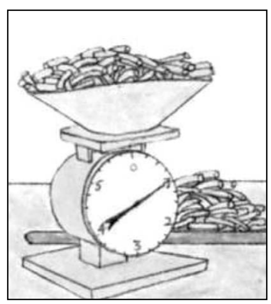
Pickling is an excellent way to preserve a small bumper crop and make it last for the first few months of the fall. If you want sharp, spicy pickles all winter, can them. Pickled foods are relatively easy to can because their acidity eliminates any chance of botulism growth. As a result, they can be processed by the boiling water bath method rather than the more complicated steam canning method required for unpickled vegetables.

Dry salting

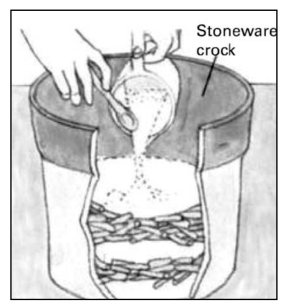
Severest method of salt curing is dry salting. Corn, beans, green vegetables, cabbage, and root crops are the foods most frequently dry salted. Use additive-free, finely granulated salt (coarse salt takes too long to dissolve) in the proportion of one part salt to four parts vegetables by weight. Produce must be "freshened" (thoroughly rinsed of salt) before it is eaten. To freshen, soak food for 10 to 12 hours in fresh water, changing the water every few hours.



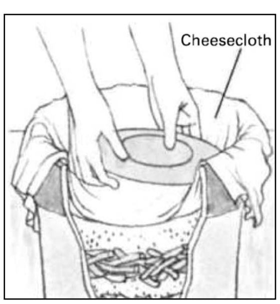
1. Blanch vegetables in steam over rapidly boiling water. Cool by plunging into cold water.



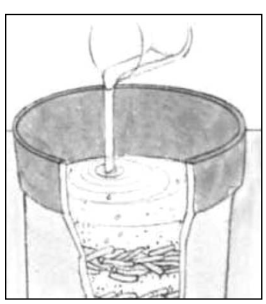
2. Weigh produce and divide into batches that will make 1-in. layers. Weigh out 1 lb. salt per 4 lb. produce.



3. Fill crock with alternate layers of salt and 1-in.-thick layers of produce. First and last layers should be salt.



4. Leave 4-in. headroom above final salt layer. Cover with cheesecloth weighted down with a plate or board.



5. After 24 hours juice should cover produce. If it does not, add a solution of 3 tbsp. salt mixed into 1 cup of water.

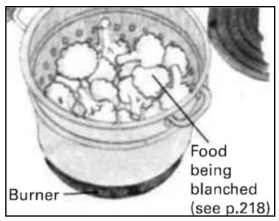
6. Store container in cool area (38°F). Change cloth when soiled. Use glass or china cup to dip out food.

7. Before eating salted produce, soak and drain it in several changes of fresh water until saltiness is gone.

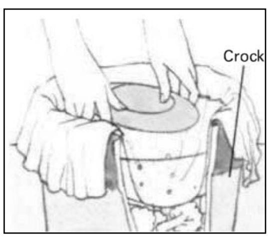
that have been waxed (cucumbers and rutabagas are frequently coated with paraffin), because the curing solution will not penetrate. Wash the produce thoroughly under running water, and scrub each fruit or vegetable individually. Curing containers should be enamelware, stoneware, or glass (avoid metal, since it may react with the brining solution). Do not cure with table salt—it contains additives that will discolor the food. Instead, use pickling or canning salt.

Brining

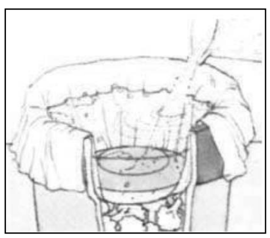
Salt solution is used to cure food by the brining method. Prepare the brine in advance by mixing 1 lb. salt per gallon of water. You will need 1 gal. of brine for each 2 gal. of produce. While the food is being brined, a process that will take four to eight weeks, keep it at room temperature (65°F to 70°F). Rinse food in several changes of cold water before eating it.



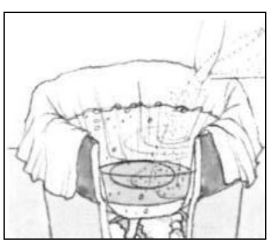
1. Weigh and blanch food, then place in crock and add brine to 4 in. of top.



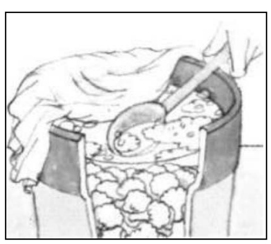
2. Cover produce with cheesecloth; weight with plate to keep submerged.



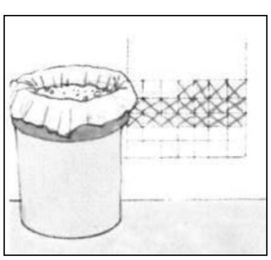
3. The next day, add salt on top of cloth—½ lb. for each 5 lb. of produce.



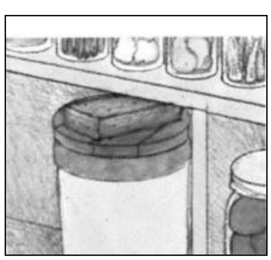
4. After one week add ⅛ lb. salt for every 5 lb. of produce. Repeat each week.



5. Check container every few days and remove any scum that appears on the surface.



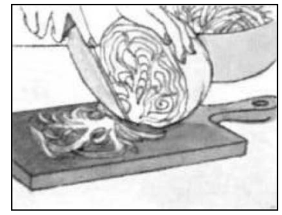
6. Maintain at room temperature until no bubbles rise (four to eight weeks).



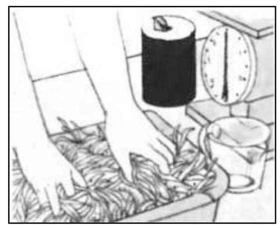
7. Store brined food in cool area (38°F) in container covered with tight lid.

Low-salt fermentation

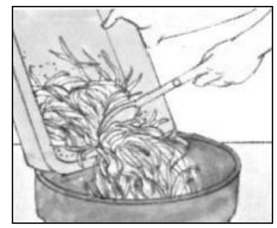
Do not blanch food when using the low-salt method, since fermentation organisms would be destroyed. Let the produce ferment at about 70°F, then store at 38°F in a tightly lidded container. For long-term storage, can by boiling water bath method (see p.207). Low-salt fermentation is particularly suitable for such vegetables as turnips and cabbage.



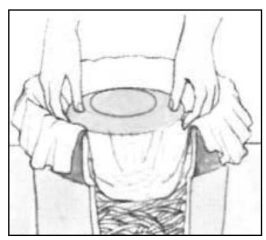
1. Wash and dry cabbage, then shred into small pieces so salt can penetrate.



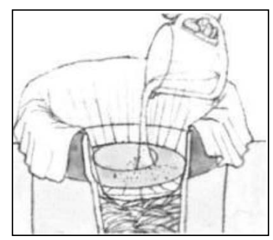
2. Weight out 1 oz. salt per 2 ½ lb. of cabbage. Thoroughly mix salt into cabbage.



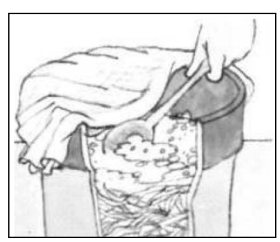
3. Pack salted cabbage into container. Press down firmly to help extract juices.



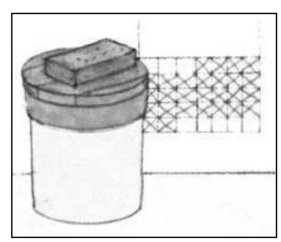
4. Cover with cheesecloth weighted down with plate. Check after 24 hours.



5. If brine does not cover cabbage, and solution of 1 tsp. salt per cup of water.



6. Check fermentation regularly. Remove scum and change cloth if dirty.



7. Keep at room temperature until no bubbles rise to surface (one to four weeks).

David Cavagnaro, Teacher and Farmer

His Garden Provides an Abundance of Pickles

David Cavagnaro is a Santa Rosa, California, writer, teacher, photographer, and homesteader. He and his family grow all the food they need and store enough in autumn to tide them through the winter and into spring.

"Pickling is really the easiest way for us to preserve summer vegetables to have year round. We pickle a whole bunch of things—cucumbers, beans, cauliflower, broccoli, mushrooms, peppers, and artichoke hearts, for example. We even pickle eggs—they have a sharp, vinegary taste, but otherwise they're just like any other hard-boiled eggs. We also do relishes ourselves and make our own pimentos. We make vinegar from our own apples and we grow garlic, mustard, dill, horseradish, coriander, and even grape leaves, which we use in some of the pickling mixtures. The only thing we don't make is our own olive oil.

"Pickling is really very simple, except for the chopping you do for relishes. There's one I do, Grandma Mabel's chili sauce, that's very time-consuming. Like a lot of pickling recipes, that one has been handed down in the family. But once you get into it, you start making up recipes of your own.

"The most important thing in pickling is the strength of the vinegar. You see, you're working with vegetables that don't have a very high acid content, and if you're not careful, there could be a danger of botulism. You need vinegar that has an acid strength of 5 percent, like most commercial brands. If you make your own, you really should check the acid concentration, and if it's less than 5 percent, you should increase the proportion of vinegar.

"I like all the things we pickle, but I'm very, very partial to honest-to-goodness crock pickles—just the cukes in a salt brine pot. You make them the same way you make sauerkraut. The salt brine ferments the cukes, and you get a pickle that's hard to describe. You could never get anything like it from a jar. But to tell you the truth, simple as it is, we've had some real failures with crock pickles. You have to remember to skim off the brine once or twice a day. It takes regular vigilance, and with a busy family, it's awful easy to forget. Let me tell you, we have gotten some of the muckiest-looking crocks of pickles you can ever imagine."

For Unbeatable Taste Add Vinegar and Spice

Pickling serves two purposes: it preserves and it adds delicious flavor. Choose firm, fresh vegetables and fruit for pickling—green tomatoes and underripe fruit can be used for greater firmness—but avoid vegetables that have been waxed. (Wax prevents the pickling solution from penetrating.) Use only pickling-type cucumbers.

There are two methods of pickling—fresh-pack pickling and fermentation pickling. Both rely on brine and vinegar as the primary preservatives; sugar, herbs, and spices are often added for additional flavor. The vinegar should have an acid content of 4 to 6 percent. Either cider vinegar or distilled white vinegar is acceptable; the latter has a sharper, more acid taste. Do not use homemade vinegar unless you are sure of its strength. For sweeteners, honey or granulated white or brown sugar is generally specified. Salt should be the pure granulated variety (often sold as "pickling salt") with no additives. Herbs and spices should be fresh and the water soft if possible. If the tap water in your area is hard, you can use rainwater or bottled soft water.

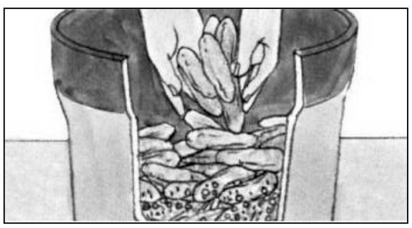
Pickled products should be heat treated (canned) unless they are to be consumed soon after pickling. The boiling water bath canning procedure can be used for all pickled products; processing times vary from recipe to recipe. The usual precautions should be followed during canning and afterward: the jars of pickles should be labeled, dated, and stored in a cool, dry location. If there is any sign of spoilage—a bulging lid, bad smell, poor pickle consistency, sliminess, discoloration—do not eat any of the food in the jar.

Making dills by fermentation pickling

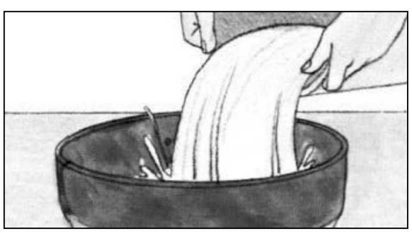
Cucumbers and green tomatoes are the vegetables most frequently treated by fermentation pickling. The method is similar to low-salt fermentation, but a stronger salt solution is employed, and vinegar and spices are generally added. After pickling is completed (a matter of one to three weeks), the pickles can be stored for up to three weeks in a refrigerator or cool (38°F) location. For long-term storage, can the pickles with the boiling water bath method. If the pickling brine is cloudy, make a fresh one to use in canning. You will need the following ingredients:

- 1/2 gal. water
- 1/3 cup salt
- 1/2 cup vinegar
- 4 lb. pickling cucumbers (4 to 5 in. each)
- 15 sprigs dill
- 30 peppercorns
- 15 cloves garlic (optional)

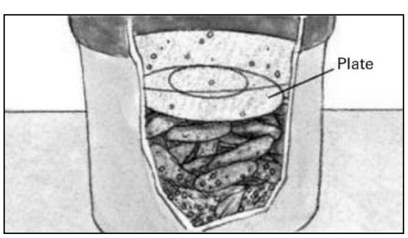
Prepare the brine by mixing water, salt, and vinegar. Clean and scrub cucumbers (especially the flower end) thoroughly, and be sure the crock and all other utensils are clean.



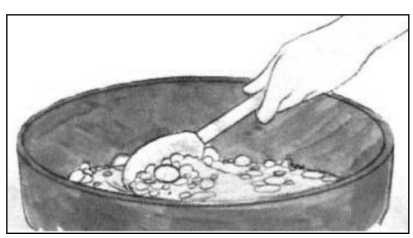
1. Line bottom of 1-gal. crock with half of dill and other spices, then add cucumbers.



2. Top cucumbers with the remaining dill and spices. Add brine to cover all ingredients.



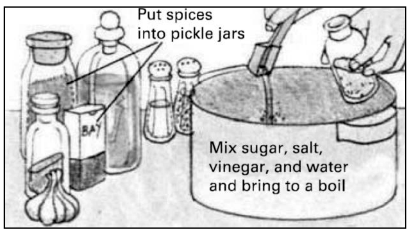
3. Keep produce submerged with a heavy plate so that it is under at least 2 in. of brine.



4. Remove scum daily. When bubbles and scum stop forming, fermentation is completed.

Making Dills by Fresh-Pack Pickling

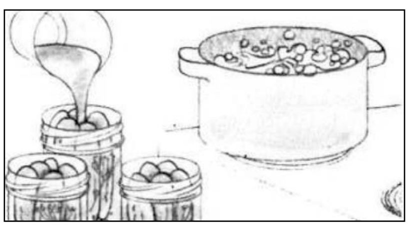
1. Soak cucumbers overnight in brine solution; then drain and pack into 1-qt. jars.



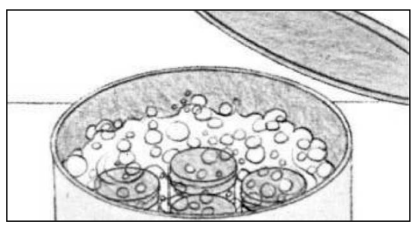
2. Divide spices among jars. Mix together vinegar, salt, sugar, and water, and bring to a boil.

Not only cucumbers but beets, cauliflower, green beans, pears, peaches, tomatoes, and watermelon rind are suitable for fresh-pack pickling. Each type of fruit or vegetable can be processed individually, or several can be combined to make a relish or chutney. Details of processing vary from recipe to recipe depending on the ingredients used. Vegetables are frequently marinated overnight in brine before being heat processed; fruits and relishes are often simmered in a syrup of sugar, vinegar, and spices before processing. The procedure shown here for making fresh-pack dills is typical. As for any pickle recipe, use only ripe, perfect produce, and wash it thoroughly. You will need the following ingredients:

4 lb. pickling cucumbers
½ gal. brine (⅓ cup salt in ½ gal. water)
4 cloves garlic (2 per qt.)
8 heads dill (4 per qt.)
4 tsp. mustard seed (2 per qt.)
1½ cups vinegar
3 tbsp. salt
1 tbsp. sugar
3 cups water



3. Pour boiling mixture over cucumbers to ½ in. from top of jars. Put lids on jars.



4. Process jars in boiling water for 20 minutes. Set jars several inches apart on rack to cool.

Pickling Recipes

There are pickling recipes to suit every taste. All kinds of fruits and vegetables can be combined, and vinegar, salt, sugar, and spices can be adjusted in an almost endless variety of ways. The results are piquant relishes, chutneys, and sauces—as well as pickles with sweet, sour, or sweet-and-sour taste combinations. Although pickling is of limited use as a means of preserving fruits and vegetables—it prolongs shelf life only a few weeks—it does simplify long-term storage, since pickled produce has a high enough acid content to be processed by the boiling water bath method (see pp.206-209). The recipes given below include processing times.

Tomato-Apple Chutney

6 lb. tomatoes, peeled and chopped
5 lb. apples, peeled, cored, and chopped
2 medium green peppers, seeded and chopped
4-5 medium onions, peeled and chopped
2 cups seedless white raisins
1 qt. white vinegar
4 tsp. salt
2 lb. brown sugar

1 tsp. ground ginger
¼ cup mixed whole pickling spices

Combine all ingredients except the mixed whole pickling spices. Put the spices in a spice bag and add to the mixture. Bring to boil and cook slowly, stirring frequently until mixture thickens (about one hour). Remove spice bag. Rack boiling mixture into sterile pint jars, leaving ½-in. headroom. Process in boiling water bath for 10 minutes. *Makes 7 pints.*

Pepper-Onion Relish

6–8 large onions, peeled and finely chopped
4–5 medium sweet red peppers, finely chopped
4–5 medium green peppers, finely chopped
1 cup sugar
1 qt. vinegar
4 tsp. salt

Combine all ingredients and bring to a boil. Simmer, stirring occasionally, until mixture begins to thicken (about 45 minutes). Pack into sterile half-pint jars, leaving ½-in. headroom. Process in boiling water bath for 10 minutes. *Makes 2 ½ pints.*

Sour Pickles

3 tbsp. mixed whole pickling spices
3 tbsp. pickling dill
40 well-scrubbed cucumbers
2 ¼ cups salt
3 cups white cider vinegar
3 gal. hot water
9 horseradish roots and leaves, or to taste
9 garlic cloves, or to taste
9 peppercorns, or to taste

Put half the mixed whole pickling spices in the bottom of a large stone crock and cover with half the dill. Add cucumbers. Put remaining pickling spices and dill on top of the cucumbers. Make a pickling brine by dissolving 1 ½ cups salt in mixture of 2 cups vinegar and 2 gal. hot water. Cool brine and pour it over the cucumbers. Cover with a plate weighted down to hold it beneath the brine. Keep crock at room temperature (68°F to 72°F) for two to four weeks. Remove scum daily.

When pickles are an even olive color without any white spots, they are ready for packing. Make a new brine of 1 gal. hot water, ¾ cup salt, 1 cup white cider vinegar, horseradish roots, and peeled garlic; bring to boil. Pierce each pickle on the ends and once in the middle with a sterilized ice pick or knitting needle. Divide pickles among quart jars and add at least one peppercorn and one horseradish leaf to each jar. Pour hot brine over pickles, cover, and process by the boiling water bath method for 15 minutes. *Makes 8 to 9 quarts.*

Pickled Green Beans

4 lb. green beans
1 ¾ tsp. crushed hot red pepper
3 ½ tsp. mustard seeds
3 ½ tsp. dill seeds
7 cloves garlic
5 cups water
5 cups vinegar
½ cup salt

Wash beans and remove ends. Cut beans into 2-in. pieces and divide among seven hot, sterile pint jars. Put ¼ tsp. red pepper, ½ tsp. mustard seeds, ½ tsp. dill seeds, and 1 clove garlic into each of the jars. Combine water, vinegar, and salt, and bring quickly to a boil. Pour boiling liquid over beans, leaving ½-in. headroom. Process jars in boiling water bath for 10 minutes. *Makes 7 pints.*

Watermelon Pickles

6 lb. watermelon rind with green rind and pink meat removed
¾ cup salt

3 ¾ qt. water
2 trays ice cubes
9 cups sugar
3 cups white vinegar
1 tbsp. whole cloves
6 1-in. cinnamon sticks
1 lemon, sliced thin

Cut rind into 1-in. squares (it makes about 3 qt.). Dissolve salt in 3 qt. water, add ice cubes, and pour over watermelon rind. Allow to stand five to six hours. Drain rind and rinse in cold water. Cover with cold water and cook until fork tender (about 10 minutes). Drain. Combine sugar, vinegar, and remaining 3 cups water; then add a spice bag filled with cloves and cinnamon sticks. Boil five minutes and pour over rind. Add lemon slices and marinate over night. Boil rind in syrup until rind is translucent (about 10 minutes). Pack boiling pickles into hot, sterilized pint jars. Remove cinnamon sticks from bag and divide among jars. Cover with oiling syrup, leaving ½-in. headroom. Process in boiling water bath for 10 minutes. *Makes 6 pints.*

Sauerkraut

5 lb. tender young cabbage, washed and thinly shredded
3 tbsp. salt

Mix cabbage and salt in a large pan and let stand 15 minutes. Pack mixture into clean nonmetal container, pressing it down firmly with wooden spoon. Juices must cover cabbage. Allow 4 to 6 in. of headroom above cabbage. Cover cabbage with clean white cheesecloth tucked down inside container. Weight down the cloth with a flat, tight-fitting lid that is heavy enough for the juice to rise up to but not over it. The cabbage should not be exposed to any air. Ferment at room temperature (68°F to 72°F) for five to six weeks. Skim off any scum that forms, and replace cloth and lid if they are scummy. When fermentation stops (bubbles will no longer rise to the surface), cover container with clean cloth and sterile lid, and move sauerkraut to a cold area (38°F), or process it in boiling water bath. To process, bring sauerkraut to a simmer (do not boil), and pack it into hot, sterile jars, leaving ½-in. headroom. Process in boiling water bath 15 minutes for pints, 20 minutes for quarts. *Makes 1 to 2 quarts.*

Sauerruben

5 lb. white turnips, peeled and shredded
3 tbsp. salt

Mix turnips and salt, pack into clean nonmetal container, and tamp down. Cover and weight down as for sauerkraut. Ferment at room temperature for four to six weeks. Process in boiling water bath as for sauerkraut. *Makes 1 to 2 quarts.*

Homemade Horseradish Sauce

2–4 horseradish roots, washed peeled, and grated
½ cup white vinegar
½ tsp. salt

Mix ingredients, pack into a clean jar, and seal tightly. The horseradish sauce can be used immediately, or it can be stored in refrigerator for up to four weeks. (Heat processing destroys the sharp bite of homemade horseradish.) *Makes 1 cup.*

Spiced Peaches

2 cups water
5 cups sugar
3 cups apple cider vinegar
1 tbsp. whole cloves
1 tbsp. whole allspice
2 sticks cinnamon
1 piece gingerroot
6–8 lb. peaches, peeled and pitted

Combine water, 2 cups sugar, and vinegar. Put spices into a spice bag, add to liquid, and bring to boil. Cook peaches a few at a time until barely tender (about 5 minutes). When the last batch has been removed, add 2 more cups sugar to syrup, and return to boil. Pour syrup over peaches and let stand 12 hours. Reheat peaches and syrup, then pack peaches into quart jars. Add final cup of sugar to syrup, bring to boil, and pour over peaches. Process in boiling water bath for 20 minutes. *Makes 6 quarts.*

Spiced Pears

8 cups sugar
4 cups white vinegar
2 cups water
8 2-in. cinnamon sticks
2 tbsp. whole cloves
2 tbsp. whole allspice
8 lb. pears, peeled

Mix sugar, vinegar, water, cinnamon sticks, spice bag filled with cloves and allspice. Simmer 30 minutes. Add pears. Simmer 20 minutes more. Divide pears and cinnamon sticks among pint jars, and cover with boiling liquid, leaving ½-in. headroom. Process in boiling water bath for 20 minutes. *Makes 8 pints.*

Sweet and Savory Ways to Store Your Fruits

Homemade jams, jellies, and preserves, cooked from fresh fruit sweetened just to your liking, are a treat for just about everybody. For exotic flavors add herbs, spices, or wines to the fruit or combine several different types of fruit.

Just as salt and vinegar preserve vegetables and fruits through pickling, so sugar acts as the preserving agent in jellies, jams, conserves, marmalades, preserves, and fruit butters. Since most fruits are high in sugar to begin with, they are natural candidates for preservation in one of these forms.

In order to achieve proper gelling of a sugar-preserved product, three key ingredients must be present in correct proportion: sugar, pectin (the gelling agent), and acid. The best way to ensure good results is to follow a recipe and measure all ingredients carefully. All fruits need added refined white sugar or other mild-tasting sweetener, such as light corn syrup or honey. Very few recipes use brown sugar, molasses, or maple syrup because the flavors of these sweeteners are too strong and will overpower the taste of the fruit.

Many fruits contain sufficient natural pectin and acid for gelling, but others require extra amounts of one or the other. Some fruits have enough pectin or acid if they are sour or just barely ripe but not when they are fully ripe or overripe. To test for pectin, mix 1 teaspoon of cooked fruit with 1 tablespoon of rubbing alcohol. If the mixture coagulates into a single clump, there is sufficient pectin. (Do not taste the mixture, since rubbing alcohol is poisonous.) To check a fruit for acid, compare its taste to that of a mixture consisting of 3 tablespoons of water, 1 teaspoon of lemon juice, and ½ teaspoon of sugar. If the fruit is less tart than the lemon juice mixture, it needs more acid.

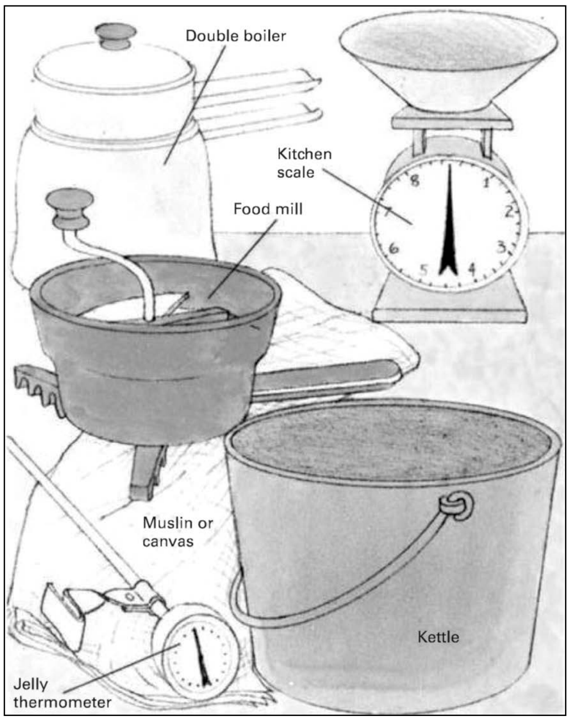
Pectin can be purchased in either liquid or powdered form, or you can make your own from

Gelling properties of common fruits

Fruits with sufficient acid and pectin to gel	
Apples (sour)	Gooseberries
Blackberries (sour)	Grapes
Lemons	Loganberries
Crabapples	Plums
Cranberries	Quinces
Currants	

Fruits that may need added acid or pectin	
Apples (ripe)	Grapefruit
Blackberries (ripe)	Grapes (California)
Cherries (sour)	Loquats
Chokecherries	Oranges
Elderberries	

Fruits that always need additional acid or pectin	
Apricots	Pears
Figs	Prunes
Grapes (Western Concord)	Raspberries
Guavas	Strawberries
Peaches	



Equipment required for making jams and jellies includes all the standard canning supplies plus a few others. Buy a jelly thermometer, double boiler, and strainer. You will also need ½ yd. of a strong fabric, such as unbleached muslin or canvas, to make into a bag for straining jelly. A heavy kettle (less likely to let fruit scorch than a thin one), a food mill for pureeing, and a kitchen scale for precise measurement are also helpful.

Making and Using Pectin

To manufacture your own pectin, wash 10 lb. of tart apples, remove stems quarter the fruits (but do not core), and place in a kettle. Cover apples with cold water and bring to a boil over moderate flame. Then cover kettle and simmer until the fruit is soft (about 30 minutes). Drain fruit in jelly bag overnight and collect juice (there should be about 3 qt.). Boil down juice to make 1 ½ to 2 cups pectin.

Adding liquid pectin to fruit. Cook fruit until it is soft, add sugar, bring to a full boil, then boil fruit and sugar together for one full minute. Add the pectin. No additional cooking is required.

Adding powdered pectin to fruit. Stir pectin into softened, cooked fruit, bring fruit and pectin mixture to a boil, and add sugar. Return mixture to a boil, then boil one minute. Jelly will then be ready.

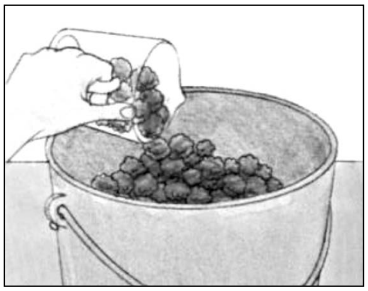
apples (below right). A pectin substitute, low-methoxyl pectin, forms a gel when combined with calcium salts or bonemeal and lemon juice. It can be used to make jelly without any added sweeteners. If fruits lack sufficient acid, add lemon juice or citric acid when you add sugar.

Making Jelly without Added Pectin

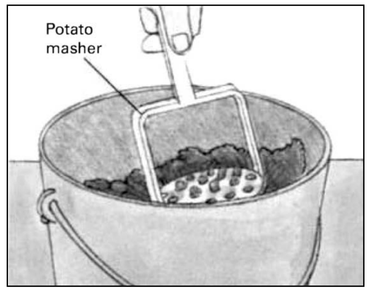
While any sugar-preserved product needs a good recipe, accurate measuring, and precise timing, nowhere is care more important than in the preparation of jelly without added pectin. The first requirement is that the fruit has enough natural pectin for gelling; either select a high-pectin fruit from the list or test for pectin content as described on the same page.

To collect juice for jellymaking, cook the fruit, then hang it in a jelly bag made of muslin or several layers of cheesecloth. Squeezing the bag or pressing it with a spoon hastens the flow of juice but can cause cloudy jelly—it is better to let the juice drip naturally. If you do squeeze the jelly bag to collect extra juice, strain the juice a second time through a clean cloth.

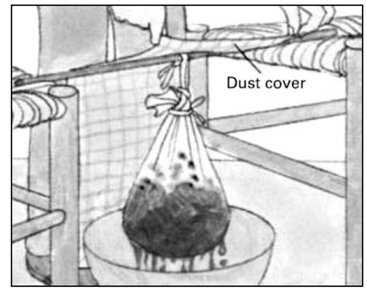
Blackberry Jelly Step-by-Step



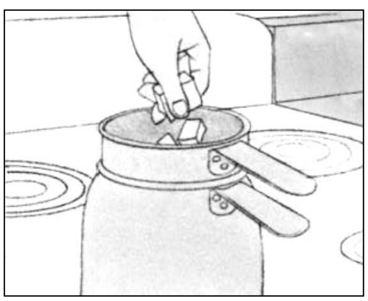
1. You will need 5 qt. of berries (about one-fourth should be underripe) to make 2 qt. of juice. Remove stems, wash fruit, and place in heavy kettle.



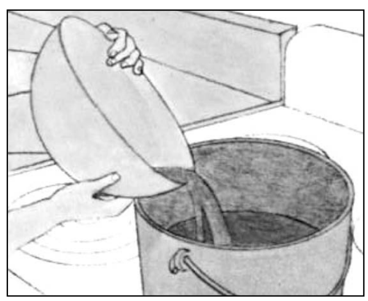
2. Crush berries with potato masher, add 1½ cups water, cover, and bring to boil. Reduce heat and simmer, stirring occasionally, until tender (five minutes).



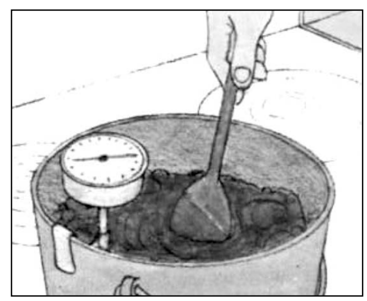
3. Pour mixture into dampened jelly bag, suspend bag over bowl or pan, and let juice strain overnight. Cover bag and bowl with cloth to protect from dust.



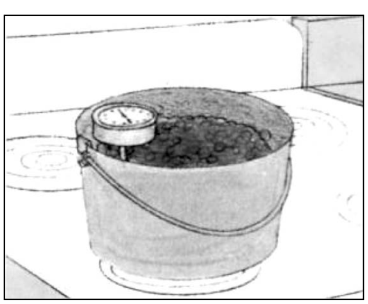
4. If you are going to seal with paraffin, cut fresh paraffin into chunks, and add a few at a time to double boiler until all are melted. Hold until jelly is done.



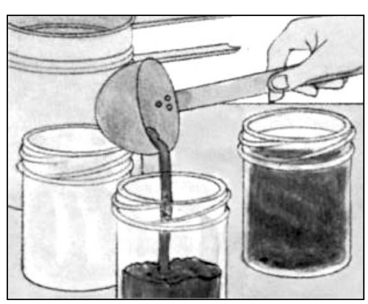
5. Pour 2 qt. of juice into heavy kettle and add 6 cups of sugar. Place kettle over a high flame and heat the liquid to a full rolling boil that cannot be stirred down.



6. Stir juice, insert thermometer so that bulb is covered but does not touch pan, and note temperature at which juice reaches full rolling boil.



7. Continue heating until temperature reaches 8°F to 10°F above initial boiling point. At this temperature sugar is concentrated enough for product to gel.



8. Pour jelly into hot, sterile jars, leaving ½-in. headroom. Process by boiling water bath method, or cover with ⅛ in. of paraffin, using pin to break bubbles.

9. Let jars stand undisturbed on rack overnight. Then put on lids over paraffin seal; label with name, date, and batch number; and store in a cool, dark place.

Prolonged cooking turns the sweetened fruit juice into jelly by boiling away water until the sugar reaches just the right concentration. Timing is critical: overcooking leads to jelly that is stiff or full of sugary crystals; undercooking will produce thin, runny jelly. Because of the precision required in the process, work with the exact amounts specified in recipes: do not double a batch for extra jelly, make two separate batches instead.

An accurate thermometer provides the simplest and safest way to tell when the sugar has reached the proper concentration. Start by measuring the exact temperature at which the mixture first boils (it will vary depending on weather as well as altitude, so take a new reading each time you make a batch of jelly). As cooking progresses and water boils away, the sugar concentration will rise and the temperature go up. When the thermometer registers 8°F to 10°F above the initial boiling point, the jelly is done. As an additional test, dip a cold metal spoon into the mixture and hold the spoon away from the heat. If the jelly runs off in a sheet rather than individual drops, it is ready. A third test is to put a spoonful of jelly on a plate and put it in a freezer. If the sample becomes firm after one or two minutes, the jelly is ready. The freezer test can also be used for jams and preserves, the sheet test cannot.

The traditional way to seal jelly is with paraffin. Melt clean paraffin in a double boiler or small pan set in a larger wide-bottomed pan filled with water. (Do not melt paraffin directly over a flame or it may catch fire.) Prepare the paraffin in advance so that you can use it as soon as the jelly is done. Once the sealed jars are cool, put on lids to protect the paraffin from being accidently broken. For surer long-term storage, use canning jars and lids, and process the jars of jelly for 5 to 10 minutes in a boiling water bath. For best retention of color and consistency, store the sealed jelly in a cool, dark place and use it within three months.

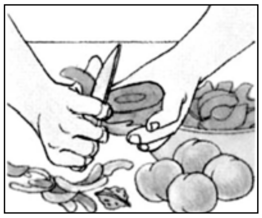
A Variety of Confections to Please Every Taste

Unlike jelly, which is made from fruit juice, other sugar-preserved foods contain parts of the whole fruit. Fruit butter is mashed pulp simmered with sugar until the pulp is thick; in the other fruit products pieces of fruit float in a light gel. Jam consists of gelled, mashed pulp; preserves are made of fruit pieces in a thin gel; and marmalade contains bits of fruit and citrus rind in a stiff, clear gel. Conserves contain a high proportion of mixed, chopped fruits in a small amount of gelled juice; nuts are often stirred into the gel just before it starts to set.

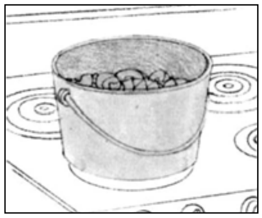
In all these products, with the exception of the fruit butters, the concentration of pectin, acid, and sugar are critical to proper setting, particularly if extra pectin is not being added. As in making jelly, best results are achieved by following a recipe carefully—do not double or triple ingredient measures to make a bigger batch. Instead, make several small batches. Be sure pectin and acid content are high enough by using plenty of underripe high-pectin fruit or by testing for pectin and acid as described on. You can tell if the sugar concentration is correct by measuring the temperature of the sugar-fruit mixture as it cooks. First, find the temperature at which water boils. Then cook the fruit and sugar until it reaches 8°F to 10°F above the boiling point of water. If you do not have a thermometer, use the freezer test described on. When making jams or other fruit products with added pectin, you need not cook down the fruit mixture to make it gel, but precise measurements and accurate timing are still important.

Jams, marmalades, preserves, conserves, and butters must undergo further processing to eliminate spoilage-causing organisms if the product is to be stored for more than two or three weeks. Certain recipes specify freezing; all others require canning by the boiling water bath technique described on. Use hot, sterile canning jars, and leave a ½-inch space above the fruit.

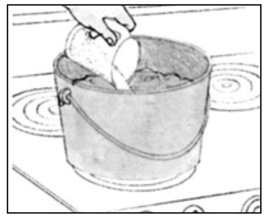
Jams, marmalades, preserves, and conserves without added pectin



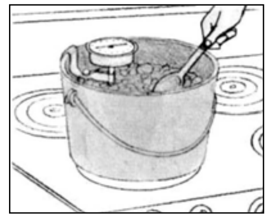
1. Wash fruit, remove pits, and peel if called for in recipe. Cut up large fruits, such as peaches. Measure exact boiling point of water.



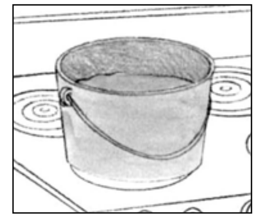
2. Put fruit into kettle, first crushing bottom layer. (Add water if fruit has little natural juice.) Cook according to recipe instructions.



3. Add sugar (and lemon juice if acid content is low). Insert thermometer. Return mixture to boiling, stirring constantly to prevent scorching.

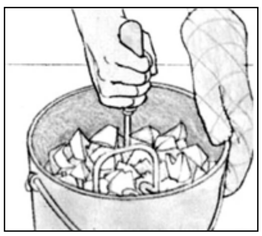


4. Boil rapidly, stirring constantly, until temperature reaches 8°F to 10°F above boiling point of water. Remove from heat immediately.

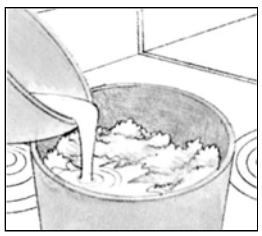


5. To prevent fruit from floating in finished product, let mixture cool for about five minutes and stir several times during cooling.

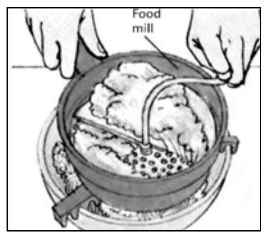
Making fruit butters



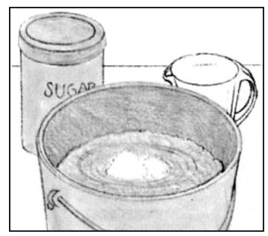
1. Wash and cut up fruit, remove pits, and crush fruit into a pulp with potato masher. Measure pulp and put into a heavy kettle.



2. Add half as much water by volume as there is fruit pulp. Cook over low heat, stirring almost constantly to prevent scorching, until pulp is soft.



3. Press fruit pulp through a colander or strainer to get rid of all pits and skin. Then put it through a food mill or blender to make a smooth puree.



4. With kettle removed from heat, pour pureed pulp back in, and stir in ½ cup of sugar per cup of fruit pulp. Return kettle to low heat.

5. Cook mixture over low heat, stirring constantly and watching carefully to prevent scorching. Simmer until fruit is thick and glossy.

Apple Jelly

2 ¼ lb. just-ripe tart apples
¾ lb. underripe tart apples
3 cups sugar
2 tbsp. lemon juice (if apples are not sufficiently tart)

Wash apples and cut into small pieces without paring or coring. Put apples and water into heavy kettle, cover, bring quickly to a boil. Reduce heat and simmer until apples are soft (about 20 minutes). Pour cooked apples into jelly bag and collect juice as it drips. Return 4 cups juice to heavy kettle, add sugar and lemon juice. Place over high heat, and boil rapidly until temperature rises to 8°F to 10°F above boiling point of water. Remove from heat immediately, skim, and pour into hot, sterile jelly jars. Seal. *Makes four to five ½-pt.jars.*

Grape Jelly

3 ½ lb. underripe Concord grapes
1 tart apple, cut into eighths but not peeled or cored
½ cup water
3 cups sugar

Wash grapes and remove stems. Put grapes into heavy kettle and crush. Add apple sections and water, cover, and bring quickly to a boil. Reduce heat and simmer until grapes are soft (about 10 minutes).

Pour grapes into a jelly bag and collect juice as it drips. Let collected juice stand in a refrigerator or other cool place for 8 to 10 hours, then strain juice through two layers of cheesecloth to remove any crystals.

Return 4 cups juice to heavy kettle, and add sugar. Place over high heat, bring to a full boil, and continue rapid boiling until temperature rises to 8°F to 10°F above boiling point of water. Remove from heat immediately, skim, and pour into hot, sterile jelly jars. Seal. *Makes three to four ½-pt jars.*

Mint Jelly

1 cup tightly packed mint leaves
1 cup water
½ cup cider vinegar
3 ½ cups sugar
5 drops green food coloring
3 oz. liquid pectin

Wash mint, remove stems, and coarsely chop leaves. Put mint leaves, water, vinegar, and sugar into heavy kettle, and bring quickly to a full boil, stirring constantly. Remove kettle from heat, add food coloring and pectin, return liquid to a full boil, then boil 30 seconds. Remove immediately from heat, skim, strain through two layers of damp cheesecloth, and pour into hot, sterile jelly jars. Seal. *Makes three to four ½-pt. jars.*

Apple Butter

8 cups applesauce
½ tsp. cloves
½ tsp. allspice
2 cups brown sugar
½ tsp. cinnamon
Grated rind of one lemon

Mix all ingredients and spread in shallow baking pan. Bake at 275°F, stirring occasionally, until thick (about four hours). Pack into hot, sterile canning jars. For long-term storage, process in boiling water bath for 10 minutes. *Makes two ½-pt.jars.*

Peach Jam with Powdered Pectin

3 lb. peaches
¼ cup lemon juice
1 ¾ oz. powdered pectin
5 cups sugar

Wash, peel, pit, and crush peaches; there should be 3 ¾ cups. In a heavy kettle mix fruit, lemon juice, and pectin. Bring quickly to a full boil, stirring constantly. Add sugar. Return mixture to boil, then boil rapidly, stirring constantly, for one minute. Remove immediately from heat, skim, and pour into hot, sterile canning jars. For long-term storage, process 10 minutes in boiling water bath. *Makes six ½-pt jars.*

Blueberry Peach Jam

4 lb. fully ripe peaches
1 qt. firm blueberries
2 tbsp. lemon juice
½ cup water
1 stick cinnamon
½ tbsp. whole cloves
¼ tsp. whole allspice
5 ½ cups sugar
½ tsp. salt

Wash, peel, pit, and chop peaches; there should be 1 qt. Wash and sort blueberries. In a heavy kettle mix fruit, lemon juice, and water; then simmer, covered, until fruit is soft (about 10 minutes). Tie cinnamon, cloves, and allspice in a cheesecloth bag, and add bag, along with sugar and salt, to fruit. Bring mixture quickly to a full boil, and boil rapidly, stirring constantly, until mixture reaches 8°F to 10°F above the boiling point of water. Remove immediately from heat, skim, and remove spices. Pour jam into hot, sterile canning jars. For long-term storage, process in boiling water bath for 10 minutes. *Makes six ½-pt. jars.*

Uncooked Berry Jam

1 qt. fully ripe berries
4 cups sugar
1 ¾ oz. powdered pectin
1 cup water

Wash berries and remove stems. Place fruit in bowl and crush; there should be 2 cups. Add sugar, and let stand for 20 minutes, stirring occasionally. Meanwhile, mix pectin and water, bring to a full boil, then boil one minute. Pour pectin solution into berries, and stir for two minutes. Pour into sterile jars or freezer containers. Store in refrigerator for up to three weeks or in freezer for up to one year. *Makes five ½-pt. jars.*

Strawberry Preserves

2 qt. firm, tart strawberries
4 ½ cups sugar

Wash berries and remove stems and leaves. Arrange alternate layers of whole berries and sugar in a large bowl, and let stand in refrigerator or other cool place for 8 to 10 hours to bring out juice. When juice has accumulated, place fruit-sugar mixture in heavy kettle over medium-high heat. Bring quickly to a boil, stirring gently so as not to break berries. Boil mixture rapidly; stir frequently to prevent scorching until temperature reaches 8°F to 10°F above the boiling point of water. Remove fruit mixture immediately from heat, skim, and pour into hot, sterile canning jars. For long-term storage, process 10 minutes in boiling water bath. *Makes four ½-pt. jars.*

Orange Marmalade

1 ½ cups orange peel, cut into thin strips
⅓ cup lemon juice into thin strips
6 oranges
⅓ cup lemon peel, cut
3 cups sugar

Cover orange and lemon peel with 1 qt. cold water and simmer, covered, until tender (30 minutes). Drain. Section oranges, remove filaments and seeds, and cut into small pieces. In a heavy kettle mix oranges, lemon juice, drained peel, sugar, and 2 cups boiling water. Bring quickly to a full boil, then boil rapidly, stirring often, until temperature reaches 8°F to 10°F above the boiling point of water. Remove immediately from heat, skim, and pour into hot, sterile jars. For long-term storage, process in boiling water bath for 10 minutes. *Makes three ½-pt. jars.*

Tomato Marmalade

5 ½ lb. tomatoes
3 oranges, thinly sliced
2 lemons, thinly sliced
6 cups sugar
1 tsp. salt
4 sticks cinnamon
1 tbsp. whole cloves

Peel, chop, and drain tomatoes. Cut fruit slices into quarters. Mix tomatoes, fruit, sugar, and salt in a heavy kettle. Tie spices in a cheesecloth bag and add. Bring mixture quickly to a full boil, and boil rapidly, stirring constantly, until thick (about 50 minutes). Remove from heat, skim, remove spices, and pour marmalade into hot, sterile canning jars. For long-term storage, process in boiling water bath for 10 minutes. *Makes nine ½-pt. jars.*

Apple Marmalade

3 lb. tart apples
1 orange
1 ½ cups water
5 tbsp.sugar
2 tbsp. lemon juice

Pare, core, and slice apples. Quarter and slice oranges. In a heavy kettle heat water and sugar until sugar dissolves. Add fruit and lemon juice. Bring quickly to a full boil and boil rapidly, stirring constantly, until mixture reaches 8°F to 10°F above boiling point of water. Remove immediately from heat, skim, and pour into hot, sterile jars. For long-term storage, process 10 minutes in boiling water bath. *Makes six ½-pt.jars.*

Apple Raisin Conserves

3 lb. tart red apples
½ cup raisins
½ cup water
¼ cup lemon juice
1 ¾ oz. powdered pectin
5 ½ cups sugar
½ cup nuts, chopped

Wash, core, and chop apples fine; there should be 4 ½ cups. In a heavy kettle mix apples, raisins, water, lemon juice, and pectin. Bring quickly to a full boil, stirring constantly. Add sugar. Return mixture to a full boil, then boil rapidly, stirring constantly, for one minute. Remove from heat, skim, and add nuts. Pour into hot, sterile canning jars. For long-term storage, process in boiling water bath for 10 minutes. *Makes six ½-pt.jars.*

Let Sun and Air Preserve for You

When 80 to 90 percent of the moisture in food is removed, the growth of spoilage bacteria is halted and the food can be stored for long periods of time. By exposing your produce to a flow of hot, dry air, you will not only remove moisture quickly but also concentrate natural sugars for a delicious, sweet flavor while reducing volume for easy storage. In addition, proper drying can preserve many of the natural nutrients in foods.

Careful preliminary treatment is an important contributor to high vitamin retention, good flavor, and attractive appearance. To fix the natural color in sliced fruits, dip the pieces of fruit in pure lemon juice or a solution of ascorbic acid (vitamin C) as soon as they are cut. You will need about a cup of lemon juice to process 5 quarts of cut fruit; or mix 3 teaspoons of pure ascorbic acid with 1 cup of water. Vitamin C tablets in the proportion of 9,000 milligrams per cup of water can also be used to prepare the dipping solution, but the tablets are expensive and difficult to dissolve.

Sulfuring and blanching are the most common ways of preserving vitamin content and preventing loss of flavor in produce that is to be dried. Of the two techniques blanching is preferable, since sulfuring destroys thiamine (vitamin B_1). In addition, sulfuring may impart a sour taste to food. In general, the sulfur method is best for fruits, where the tartness may be an asset to flavor.

High vitamin retention also depends upon striking the right balance between the relatively fast drying made possible by exposure to heat and slower drying at lower temperatures. Generally, the faster the food is dried, the higher will be its vitamin content and the less its chance of contamination by mold and bacteria. Excessively high temperatures, however, break down many vitamins. Most experts recommend drying temperatures in the range between 95°F and 145°F; 140°F is the optimum suggested by the US Department of Agriculture. Exposure to bright sun also speeds up drying, but sunlight is known to destroy some vitamins.

Blanching

Blanching—brief heat treatment in either steam or boiling water—helps preserve both color and vitamin content by deactivating plant enzymes. It also speeds the drying process by removing any wax or other surface coating on the produce and makes peeling easier by loosening the skins. Blanching in boiling water is recommended for fruits whose skins are to be peeled. Steam blanching is recommended for most other fruits and vegetables. Onions, garlic, leeks, and mushrooms should be dried without blanching.

Boiling-water blanching. Immerse produce in boiling water for the time listed on the chart. Use your largest pot and add fruit a little at a time so that the water will return to a boil quickly. After blanching, immediately dip the produce in cold water to cool it, then either peel the skin or crack it by nicking with a knife in order to aid in evaporation during drying.

Steam blanching. Place a 2 ½-inch layer of cut vegetables in a strainer or colander. Bring 2 inches of water to a boil in a large kettle. Set the strainer on a rack above the water, cover the kettle tightly, and process for the time specified on the chart.

Sun-dried tomatoes are delicious in pasta, salads, or on pizza

Outdoor Drying

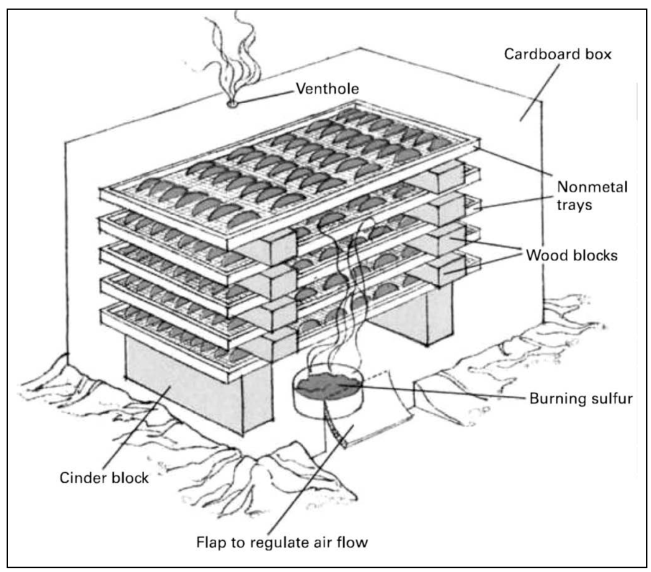
If you live in an area with clean air, a dry climate, and consistently sunny weather, the simplest way to dry produce is to do it right in the garden. Peas and beans can be left to dry on the vine if the growing season is long enough. Store vine-dried peas in mesh bags in an airy spot. When you are ready to eat them, whack the bag with a stick to remove the shells. Vine-dried green and wax beans must be blanched and then oven cured by baking them for 10 to 15 minutes at 175°F before storing. Oven curing

Sulfuring protects vitamins and bright colors

Sulfuring should be done outdoors—the fumes are not only unpleasant but also dangerous. You will need a heavy cardboard box large enough to allow 6 to 12 in. of space on all sides of a stack of drying trays. Cut a flap at the bottom of one side of the box to aid in air circulation.

To prepare fruit for sulfuring, cut it up, weigh it, and spread it in single layers—with cut sides up and no pieces touching—in nonmetal trays (sulfur fumes will corrode most metals). Stack the trays 1½ in. apart (set pieces of wood at the corners to keep trays separated), and support the stack on cinder blocks or bricks.

You will need about 2 tsp. of sulfur per pound of fresh fruit. Sulfur is sold at most pharmacies; a standard 2-oz. box contains about 16 tsp. Heap the sulfur about 2 in. deep in a clean, disposable container, such as a tuna fish can, and set it next to the stack of trays. Place the cardboard box over the trays and sulfur, then pile dirt around the box's edges to seal them. Light the sulfur through the flap and check frequently to make sure that it keeps burning. (If the sulfur will not stay lit, poke a venthole in the box at the top of the side opposite the flap.) When the sulfur is entirely consumed, seal both the flap and the vent and let the fruit sit in the fumes until it is bright and shiny. Dry the fruit immediately after sulfuring is completed.



Fruit	Time
Apples	45 min.
Apricots	2 hr.
Nectarines	8 min.
Peaches	8 min.
Pears	5 hr.
Prunes	1 hr.

Blanching: Preparation and Timing

Produce	Preparation	Steam	Boil
Apples	Peel, core, slice ⅛' thick	4 min.	2 min.
Apricots	Leave whole to boil; otherwise halve and pit	3–4 min.	4–5 min.
Beans	Cut into 1' pieces	2 ½ min.	2 min.
Broccoli	Cut into flowerettes	3–3 ½ min.	2min.
Brussels sprouts	Halve lengthwise	6–7 min.	4 ½–5 ½ min.
Cabbage	Core, Slice ⅛' thick	2 ½-3 min.	1 ½–2 min.
Carrots	Peel, slice ⅛' thick	3–3 ½ min.	3½ min.
Cauliflower	Cut into flowerettes	4 min.	3–4 min.
Celery	Remove leaves, slice stalks	2 min.	2min.
Corn	Remove husks	2–2 ½ min.	1 ½ min.
Grapes (seedless)	Remove stems	No blanching necessary	
Nectarines, peaches	Leave whole; halve and pit after blanching	8 min.	8 min.
Pears	Peel, halve, core	6 min.	–
Spinach	Trim, wash leaves	2–2 ½ min.	1 ½ min.
Summer squash	Trim, slice ¼' thick	2 ½–3 min.	1 ½ min.
Tomatoes	Peel, section or slice	3 min.	1 min.

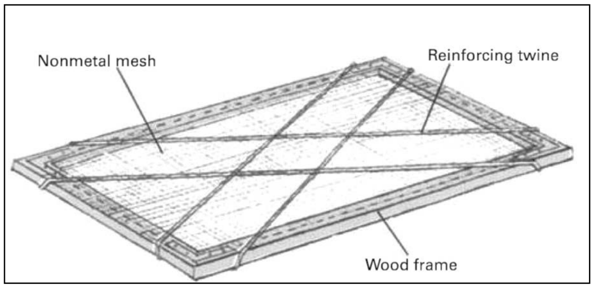
will kill any insect eggs and ensure thorough drying. For long-term storage, string the beans together and hang them in a dry place, such as the attic. Onions can also be allowed to dry in the garden. Pull them up and let them lie on the ground in the sun for four to six days. When the tops turn stiff and strawlike, braid them together with a length of strong twine.

While outdoor drying is convenient, there are some drawbacks. The longer the fruits and vegetables are exposed to air and sunlight, the more vitamins they lose. Moreover, even mild air pollution can contaminate food—in rural areas the fumes from trucks and automobiles can be a serious problem.

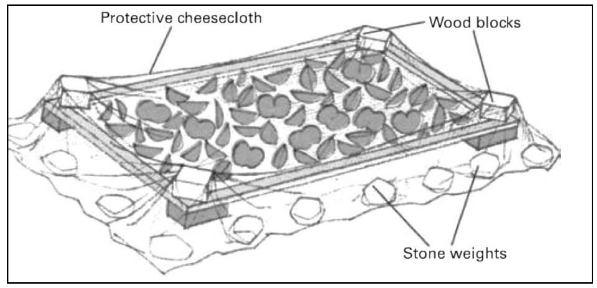
Drying on Trays

Produce that is not suited to garden drying can still be dried outdoors on trays made from parallel wooden slats or from nonmetallic screening. (Metal screening should not be used, since some metals are poisonous while others destroy vitamins.) The mesh should be tacked or stapled to wooden frames. Old metal window screens covered with brown paper are sometimes used for drying, but they are not recommended because the metal may still contaminate despite the paper.

When your food is ready for drying, spread it on trays in single layers so that the pieces do not touch one another. Choose a warm drying spot, such as a heat-reflecting driveway or a rooftop, and set the trays out, raising them on blocks to 6 inches above the ground for better air circulation. For even more heat tilt the trays so that they face the sun. To protect against insects, shield the food with cheesecloth placed above the tray. Drape the cloth over wooden blocks to keep it from touching the food, and weight its edges down with stones. Put out the trays as soon as the morning dew has evaporated. At dusk either bring the trays indoors or cover them with canvas or plastic.



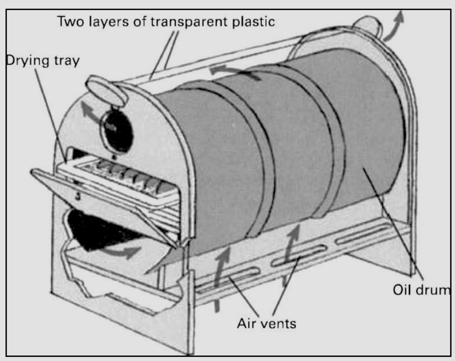
Make a drying tray from wooden slats orby stretching nonmetal mesh on a wooden frame. Reinforce bottom with twine.



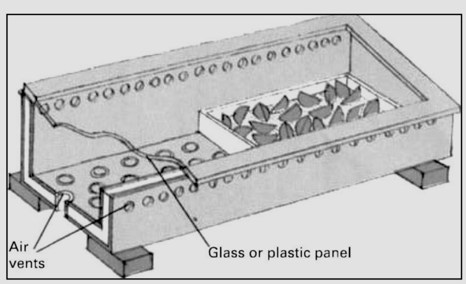
Cover trays with cheesecloth to allow maximum air and heat circulation while protecting against insects and birds.

Solar Driers

Solar driers collect heat from the sun and use it to speed up air circulation and reduce the moisture content of the air. They are especially useful in areas, such as the Southeast, where there is plenty of sunlight but the humidity is relatively high. The simplest design has glass or plastic panels that trap sunlight to warm a box. A more elaborate drier, made from on oil drum, circulates sun-heated air around stacks of drying trays. The key to successful solar drying is to check the apparatus frequently. If sunlight is blocked even partially, the air inside the drier will cool, fail to circulate, and become damp. The result is increased risk of deterioration of food.



Ingenious drier designed by New Hampshire sun enthusiast Leandre Poisson uses curved layers of plastic as solar collectors. Heated air travels by natural convection into the oil drum, where food is spree on trays. Electric light bulb and small fan increase reliability by maintaining the temperature and a balanced flow of air if sun dims.



Simplest solar drier is like a cold frame with glass panels tilted toward sun. Specially placed vents maximize air circulation.

Drying Indoors Is Most Efficient

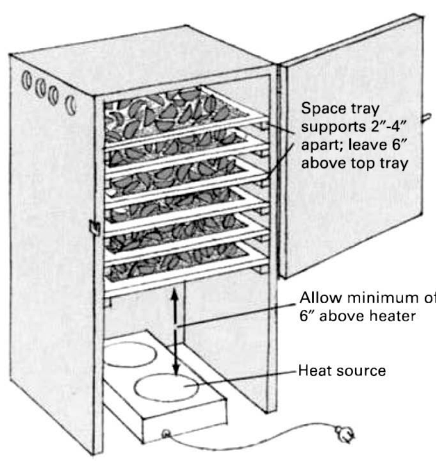
In many parts of the country indoor drying is the most convenient and practical way to remove moisture from food. Not only is indoor drying independent of the weather, but it is faster than open-air drying because it continues day and night. As a result, vitamins are conserved and there is less chance of spoilage.

The simplest way to dry food indoors is in an oven. Start by preparing the food, including blanching or sulfuring. Next, preheat the oven to 145°F. (Buy an accurate thermometer to check the oven temperature.) Spread the pieces of fruit and vegetable in single layers on cookie sheets, making sure that the pieces do not touch one another. Place the sheets on racks inside the oven, leaving at least 4 inches above and below the trays for air circulation. With the oven door slightly ajar for ventilation, turn the temperature down to 120°F, then gradually increase it to 140°F. Be sure that the food is exposed to 140°F temperatures for at least half the full drying

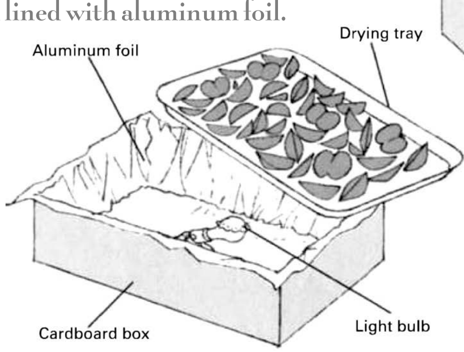
Dried fruit or vegetables will be dramatically reduced in size and weight after drying but will maintain most of the flavor and color.

Easy-to-make indoor driers

Wooden box in which several trays can be stacked makes an easy-to-construct home drier. Some models are raised on legs to accommodate the heating unit underneath; in others the heater is held within the box itself. Hot plates, electric heaters in which the heating element faces upward—even ordinary light bulbs—are all possible sources of heat. (Long-life bulbs screwed into porcelain sockets are recommended for safety.) Devices that burn coal or oil should be avoided because their fumes are dangerous when concentrated in a small enclosed space. The simplest of all driers is a cardboard box lined with aluminum foil.



Home dehydrator (above) holds trays 2 to 4 in. apart and leaves 6 in. above top tray for circulation of heated air.



For simple drier (left) line box with foil and place light bulb inside box, but not touching the box. Blacken bottom of tray and set on top of box. Spread food on tray.

time. From time to time rearrange the trays and shift the food to ensure even drying A number of com mercial devices are available for drying food in the home, or can make one of the simple driers shown on this page. Such driers generally do the job more slowly than an oven but have the advantage of using less energy. In addition, they free the oven for more routine tasks, such as cooking dinner or baking bread.

Storage and Rehydration

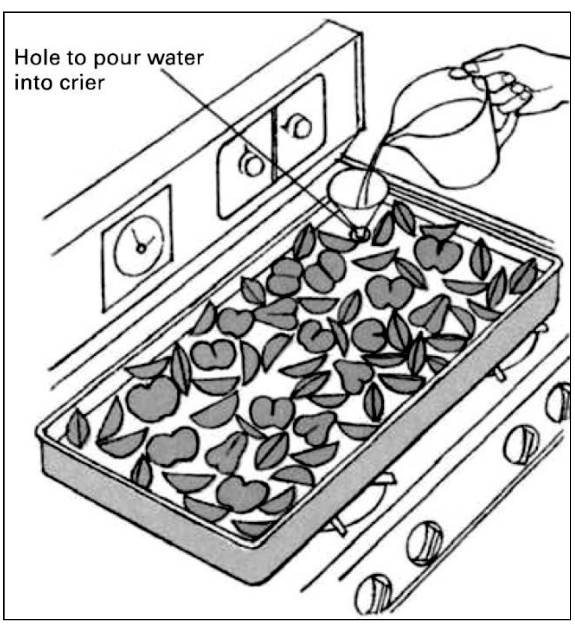
After food has been dried it should be pasteurized in an oven to be sure no insect eggs or spoilage microorganisms are present. Final pasteurization also helps ensure thorough drying. To pasteurize, preheat the oven to 175°F. Spread food 1 inch deep on trays, and put the trays in the oven for 10 to 15 minutes.

Even though a batch of fruit or vegetables may have been meticulously dried and pasteurized, small pockets of residual moisture always remain trapped. Additional conditioning helps spread this moisture evenly throughout the produce. The conditioning is accomplished by placing the cooled, dried produce in open enamel, glass, or ceramic containers, such as mason jars. The food is then stirred thoroughly twice a day to distribute any remaining moisture. If the food seems moist at the end of five days, return it to the drier.

After the fruits and vegetables have been conditioned, they are ready for long-term storage.

Drying on top of the stove

Stove-top driers designed for wood-burning stoves can be used on gas and electric stoves as well. In this type of drier the drying tray is separated from the direct heat of the burner by a 3-in.-deep reservoir of water. All burners are lit, but they are turned very low. As in other drying techniques, food must be spread in a single layer with space between pieces.



Keep a watchful eye and add water to the reservoir as needed to prevent burning of food.

Tests for Dryness

Drying times vary considerably depending on weather as well as size and moisture content of produce. Fruit is dry if it appears leathery and tough and no moisture can be squeezed from it. Vegetables should be so brittle and crisp that they rattle on the tray. Check weight too. If food has lost half its weight, it is two-thirds dry. The table gives approximate drying times.

Produce	Time in Drier
Apples	6–12 hr.
Apricots	24–36 hr.
Beans	8–18 hr.
Broccoli	12–15 hr.
Brussel sprouts	12–18 hr.
Cabbage	10–12 hr.
Carrots	10–12 hr.
Cauliflower	12–15 hr.
Celery	10–16 hr.
Corn	12–15 hr.
Grapes (seedless)	12–20 hr.
Nectarines	36–38 hr.
Peaches	36–48 hr.
Pears	25–36 hr.
Spinach	8–10 hr.
Summer squash	10–12 hr.
Tomatoes	10–18 hr.

Dried food is best kept in sterilized glass jars or plastic bags. Metal containers can be used, provided they are lined with brown paper—dried food should never be allowed to come in direct contact with metal. A perfect seal of the sort required in canning is not necessary, but the containers should have secure, tight-fitting lids to keep out dirt, dust, and insects. For best results, store dried food in a dark place where the temperature is below 60°F. Produce will sweat if stored in a warmer area, so refrigerate it during warm periods. Check periodically for condensation (it encourages mold), and return the food to the drier if any moisture is present.

Dried fruits may be eaten without reconstitution for snacks or in cereals, desserts, and salads. Vegetables, however, should be rehydrated by infusing them with enough water to replace the moisture removed during the drying process. Most fruits and vegetables can be rehydrated by pouring boiling water over them in the ratio of 1 ½ cups of water to 1 cup of dried food and letting the food soak until all the water has been absorbed. Vegetables generally rehydrate in about two hours, but dried beans and fruits require overnight soaking. If all the water is absorbed but the food still appears shriveled, add more water a little at a time. Avoid adding excess liquid, however, since it will dissolve nutrients and waste them.

Rehydrated fruits need not be cooked, but vegetables must be. Cover the vegetables with any water left over from soaking and add fresh water if necessary to prevent scorching. Bring the water to a boil, reduce the heat, and simmer until the vegetables are tender. Reconstituted fruits and vegetables can be eaten plain or combined with other foods and flavorings.

Recipes

Substitute reconstituted dried food for fresh in almost any recipe (generally the volume of soaked food will be four times that of dried), or take advantage of the concentrated flavor of tomato paste and vegetable powder to enrich soups and stews.

Apple Leather

4 qt. apples, peeled, cored, and cut in pieces
1-1 ½ cups apple cider
Honey to taste
Cinnamon, cloves, and nutmeg to taste
Cornstarch or arrowroot powder

Crush apples in a blender or food mill. Catch the juice and return it to mixture. Put ground apple mixture in a heavy kettle and add enough apple cider to prevent scorching. Bring mixture to a boil over low flame. Add honey and spices to taste. When mixture is as thick as apple butter, spread it in a ¼-in.-thick layer on oiled cookie sheets or cookie sheets covered with freezer paper. Cover sheets with cheesecloth and place in a warm, dry area until dry (one to two weeks) or in a 120°F oven or a food drier. When fruit leather is dry enough to be lifted from sheets, lay it on cake rack so both sides can be dried at once. When leather is no longer sticky, dust with cornstarch or arrowroot. Wrap each sheet in freezer paper, wax paper, or aluminum foil, stack sheets, and cover with more paper. Store in a cool, dark place.

Apple Pie

¼ lb. dried apple slices (3 ½ cups)
2 cups water
⅓-½ cup sugar
½ tsp. cinnamon
One 9-in. unbaked pie shell

Cook apples in water until soft (one hour). Add sugar and cinnamon. Pour into pie shell. Bake at 350°F for one hour.

Sun-Cooked Preserves

4 cups mixed fruit, such as peaches, pears, and berries
1 cup honey

Wash fruit and cut large types into ½-in. chunks. Place fruit in saucepan, add honey, and bring to a boil, stirring constantly. Spread boiled mixture ½ in. deep in cookie sheets, making sure fruit is spread in a single layer. Cover trays with cheesecloth stretched taut, and put them in direct sun or drier for two to seven days to dry. When preserves are thick, pack into sterilized jars and refrigerate or freeze.

Vegetable Powder

Use any thoroughly dried vegetable for this recipe. Grind vegetables in blender and store. Add dried powder to boiling water to make instant vegetable soup, or add to stews and casseroles to enhance flavor.

Tomato Paste

Italian plum type tomatoes, which have less juice, are best for this recipe, but any type of tomato may be used. Put tomatoes into heavy kettle and crush to bring out juice. Cook until very soft (about one hour), then put through blender or food mill to puree. Return puree to kettle and simmer, stirring often, over very low heat until reduced by half (two to four hours). Spread puree ½ in. thick on cookie sheets and place in sun or drier until no longer sticky (about two days). Roll dried paste into 1-in. balls and let dry at room temperature for another one to two days. Store in airtight jars. Add balls of tomato paste to soups, stews, sauces, and gravies to enhance flavor, or add to cooked tomatoes to make tomato sauce. For variety add such herbs as basil and parsley when making tomato paste.

Canning

Canning began in France, at the turn of the nineteenth century, when Napoleon Bonaparte was desperate for a way to keep his troops well fed while on the march. In 1800 he decided to hold a contest, offering 12,000 francs to anyone who could devise a suitable method of food preservation. Nicolas François Appert, a French confectioner, rose to the challenge, considering that if wine could be preserved in bottles, perhaps food could be as well. He experimented until he was able to prove that heating food to boiling after it had been sealed in airtight glass bottles prevented the food from deteriorating. Interestingly, this all took place about 100 years before Louis Pasteur found that heat could destroy bacteria. Nearly ten years after the contest began, Napoleon personally presented Nicolas with the cash reward.

Canning practices have evolved over the last two centuries, but the principles remain the same. In fact, the way we can foods today is basically the same way our grandparents and great grandparents preserved their harvests for the winter months.

On the next few pages you will find descriptions of proper canning methods, with details on how canning works and why it is both safe and economical. Much of the information here is from the USDA, which has done extensive research on home canning and preserving. If you are new to home canning, read this section carefully as it will help to ensure success with the recipes that follow.

Whether you are a seasoned home canner or this is your first foray into food preservation, it is important to follow directions carefully. With some recipes it is okay to experiment with varied proportions or added ingredients, and with others it is important to stick to what's written. In many instances it is noted whether or not creative liberty is a good idea for a particular recipe, but if you are not sure, play it safe—otherwise you may end up with a jam that is too runny, a vegetable that is mushy, or a product that is spoiled. Take time to read the directions and prepare your foods and equipment adequately and you will find that home canning is safe, economical, tremendously satisfying, and a great deal of fun!

The Benefits of Canning

Canning is fun, economical, and a good way to preserve your precious produce. As more and more farmers' markets make their way into urban centers, city dwellers are also discovering how rewarding it is to make seasonal treats last all year round. Besides the value of your labor, canning home-grown or locally grown food may save you half the cost of buying commercially canned food. Freezing food may be simpler, but most people have limited freezer space, whereas cans of food can be stored almost anywhere. And what makes a nicer, more thoughtful gift than a jar of homemade jam, tailored to match the recipients favorite fruits and flavors?

The nutritional value of home canning is an added benefit. Many vegetables begin to lose their vitamins as soon as they are harvested. Nearly half the vitamins may be lost within a few days unless

the fresh produce is kept cool or preserved. Within one to two weeks, even refrigerated produce loses half or more of certain vitamins. The heating process during canning destroys from one-third to one-half of vitamins A and C, thiamin, and riboflavin. Once canned, foods may lose from 5 percent to 20 percent of these sensitive vitamins each year. The amounts of other vitamins, however, are only slightly lower in canned compared with fresh food. If vegetables are handled properly and canned promptly after harvest, they can be more nutritious than fresh produce sold in local stores.

The advantages of home canning are lost when you start with poor quality foods, when jars fail to seal properly, when food spoils, and when flavors, texture, color, and nutrients deteriorate during prolonged storage. The tips that follow explain many of these problems and recommend ways to minimize them.

How Canning Preserves Foods

The high percentage of water in most fresh foods makes them very perishable. They spoil or lose their quality for several reasons:

- Growth of undesirable microorganisms—bacteria, molds, and yeasts
- Activity of food enzymes
- Reactions with oxygen
- Moisture loss

Microorganisms live and multiply quickly on the surfaces of fresh food and on the inside of bruised, insect-damaged, and diseased food. Oxygen and enzymes are present throughout fresh food tissues.

Proper canning practices include:

- Carefully selecting and washing fresh food
- Peeling some fresh foods
- Hot packing many foods
- Adding acids (lemon juice, citric acid, or vinegar) to some foods
- Using acceptable jars and self-sealing lids
- Processing jars in a boiling-water or pressure canner for the correct amount of time

Collectively, these practices remove oxygen; destroy enzymes; prevent the growth of undesirable bacteria, yeasts, and molds; and help form a high vacuum in jars. High vacuums form tight seals, which keep liquid in and air and microorganisms out.

Canning Glossary

Acid foods—Foods that contain enough acid to result in a pH of 4.6 or lower. Includes most tomatoes; fermented and pickled vegetables; relishes; jams, jellies, and marmalades; and all fruits except figs. Acid foods may be processed in boiling water.

Tip

A large stockpot with a lid can be used in place of a boiling-water canner for high-acid foods like tomatoes, pickles, apples, peaches, and jams. Simply place a rack inside the pot so that the jars do not rest directly on the bottom of the pot.

Fermenting

Fermenting is the process of preserving certain food products using either bacteria or yeast and keeping exposure to air at a minimum. Fermentation is used to help preserve certain foods and to create new flavors. This process is used to create products such as kefir, sauerkraut, and kombucha.

Kefir

Kefir is slightly fermented milk. It is similar to yogurt, except it is milder in flavor and of a thinner consistency.

To make kefir you will need to obtain kefir "grains"—these are made up of yeast and bacteria. These can be purchased online, or at select health-food stores (you may have to look hard, as they are not common). The grains will vary in size, anywhere from rice to walnut size. They resemble pieces of cauliflower.

Rinse the grains. Add about ½ cup grains to one quart of milk. The milk should be cold, preferably directly from the fridge. The milk can be store-bought, and skim or low-fat milk works best. Cover the milk, but do not seal it tightly, and leave it to sit at room temperature for 24–48 hours. Stir the milk once a day. Test the milk occasionally after the 24 hour period- finished kefir should have a mildly acidic taste and be slightly carbonated. Strain the grains from the kefir and refrigerate it. Rinse the grains.

The grains will continue to grow and multiply as they are used. Occasionally some grains will have to be removed from the milk mixture to ensure it does not become too thick. Remove the extra grains, wash them in cold water and allow them to dry completely between two pieces of cheesecloth.

To revive either dried or new grains place them in one cup of milk for 24 hours. Drain out the grains, rinse them and add them back to the milk, with another cup of fresh milk added. After two days you can add enough milk to make one quart and create kefir using the normal process.

Freezing

Many foods preserve well in the freezer and can make preparing meals easy when you are short on time. If you make a big pot of soup, serve it for dinner, put a small container in the refrigerator for lunch the next day, and then stick the rest in the freezer. A few weeks later you'll be ready to eat it again and it will only take a few minutes to thaw out and serve. Many fruits also freeze well and are perfect for use in smoothies and desserts, or served with yogurt for breakfast or dessert. Vegetables frozen shortly after harvesting keep many of the nutrients found in fresh vegetables and will taste delicious when cooked.

Containers for Freezing

The best packaging materials for freezing include rigid containers such as jars, bottles, or Tupperware, and freezer bags or aluminum foil. Sturdy containers with rigid sides are especially good for liquids such as soup or juice because they make the frozen contents much easier to get out. They are also generally reusable and make it easier to stack foods in the refrigerator. When using rigid containers, be sure to leave headspace so that the container won't explode when the contents expand with freezing. Covers for rigid containers should fit tightly. If they do not, reinforce the seal with freezer tape. Freezer tape is specially designed to stick at freezing temperatures. Freezer bags or aluminum foil are good for meats, breads and baked goods, or fruits and vegetables that don't contain much liquid. Be sure to remove as much air as possible from bags before closing.

Headspace to Allow Between Packed Food and Closure

Headspace is the amount of empty air left between the food and the lid. Headspace is necessary because foods expand when frozen.

Effect of Freezing on Spices and Seasonings

- Pepper, cloves, garlic, green pepper, imitation vanilla and some herbs tend to get strong and bitter.
- Onion and paprika change flavor during freezing.

Type of Pack	Container with Wide Opening		Container with Narrow Opening	
	Pint	Quart	Pint	Quart
Liquid pack*	½ inch	1 inch	¾ inch	1 ½ inch
Dry Pack**	½ inch	½ inch	½ inch	½ inch
Juices	½ inch	1 inch	1 ½ inch	1 ½ inch

*Fruit packed in juice, sugar syrup, or water; crushed or puréed fruit.
**Fruit or vegetable packed without added sugar or liquid.

Foods that do Not freeze well

Food	Usual Use	Condition After Thawing
Cabbage*, celery, cress, cucumbers*, endive, lettuce, parsley, radishes	As raw salad	Limp, waterlogged; quickly develops oxidized color, aroma, and flavor
Irish potatoes, baked or boiled	In soups, salads, sauces or with butter	Soft, crumbly, waterlogged, mealy
Cooked macaroni, spaghetti, or rice	When frozen alone for later use	Mushy, tastes warmed over
Egg whites, cooked	In salads, creamed foods, sandwiches, sauces, gravy or desserts	Soft, tough, rubbery, spongy
Meringue	In desserts	Soft, tough, rubbery, spongy
Icings made from egg whites	Cakes, cookies	Frothy, weeps
Cream or custard fillings	Pies, baked goods	Separates, watery, lumpy
Milk sauces	For casseroles or gravies	May curdle or separate
Sour cream	As topping, in salads	Separates, watery
Cheese or crumb toppings	On casseroles	Soggy
Mayonnaise or salad dressing	On sandwiches (not in salads)	Separates
Gelatin	In salads or desserts	Weeps
Fruit jelly	Sandwiches	May soak bread
Fried foods	All except French fried potatoes and onion rings	Lose crispness, become soggy

* Cucumbers and cabbage can be frozen as marinated products such as "freezer slaw" or "freezer pickles." These do not have the same texture as regular slaw or pickles.

- Celery seasonings become stronger.
- Curry develops a musty off-flavor.
- Salt loses flavor and has the tendency to increase rancidity of any item containing fat.
- When using seasonings and spices, season lightly before freezing, and add additional seasonings when reheating or serving.

How to Freeze Vegetables

Because many vegetables contain enzymes that will cause them to lose color when frozen, you may want to blanche your vegetables before putting them in the freezer. To do this, first wash the vegetables thoroughly, peel if desired, and chop them into bite-size pieces. Then pour them into boiling water for a couple of minutes (or cook longer for very dense vegetables, such as beets), drain, and immediately dunk the vegetables in ice water to stop them from cooking further. Use a paper towel or cloth to absorb excess water from the vegetables, and then pack in resealable airtight bags or plastic containers.

Blanching Times for Vegetables

Artichokes	3–6 minutes
Asparagus	2–3 minutes
Beans	2–3 minutes
Beets	30–40 minutes
Broccoli	3 minutes

(*continued*)

Frozen berries are perfect for smoothies and milkshakes.

Brussels sprouts	4–5 minutes
Cabbage	3–4 minutes
Carrots	2–5 minutes
Cauliflower	6 minutes
Celery	3 minutes
Corn (off the cob)	2–3 minutes
Eggplant	4 minutes
Okra	3–4 minutes
Peas	1–2 minutes
Peppers	2–3 minutes
Squash	2–3 minutes
Turnips or Parsnips	2 minutes

How to Freeze Fruits

Many fruits freeze easily and are perfect for use in baking, smoothies, or sauces. Wash, peel, and core fruit before freezing. To easily peel peaches, nectarines, or apricots, dip them in boiling water for 15 to 20 seconds to loosen the skins. Then chill and remove the skins and stones.

Berries should be frozen immediately after harvesting and can be frozen in a single layer on a paper towel-lined tray or cookie sheet to keep them from clumping together. Allow them to freeze until hard (about 3 hours) and then pour them into a resealable plastic bag for long-term storage.

Some fruits have a tendency to turn brown when frozen. To prevent this, you can add ascorbic acid (crush a vitamin C in a little water), citrus juice, plain sugar, or a sweet syrup (1 part sugar and 2 parts water) to the fruit before freezing. Apples, pears, and bananas are best frozen with ascorbic acid or citrus juice, while berries, peaches, nectarines, apricots, pineapple, melons, and berries are better frozen with a sugary syrup.

How to Freeze Meat

Be sure your meat is fresh before freezing. Trim off excess fats and remove bones, if desired. Separate the meat into portions that will be easy to use when preparing meals and wrap in foil or place in resealable plastic bags or plastic containers. Refer to the chart to determine how long your meat will last at best quality in your freezer.

Meat	Months
Bacon and sausage	1 to 2
Ham, hotdogs, and lunchmeats	1 to 2
Meat, uncooked roasts	4 to 12
Meat, uncooked steaks or chops	4 to 12
Meat, uncooked ground	3 to 4
Meat, cooked	2 to 3
Poultry, uncooked whole	12
Poultry, uncooked parts	9
Poultry, uncooked giblets	3 to 4
Poultry, cooked	4
Wild game, uncooked	8 to 12

General Observations on Food Dehydrating

BY JAY AND SHIRLEY BILLS

Types of Food Storage

There are a number of types of food storage available to the average family. Each has a place and should be utilized in providing for family nutritional needs. The following are methods that can be used:

1. Dehydrating or Drying
2. Canning
3. Freezing
4. Salting or Brining
5. Root Cellars
6. Jams and Jellies
7. Smoking
8. Sprouting of Stored Seeds

If a family uses all of the above methods, they will have a varied and well-balanced diet from their own cupboard.

The scope of this book, however, will be limited to the discussion of the most widely-used method throughout the world: dehydrating (or drying) fruits, vegetables, herbs, and meats.

Dehydrating: An Ancient Process

"Drying is a method of preserving food products in which so much of the product's natural moisture is removed that spoilage micro-organisms (yeasts, molds, and bacteria), even though present in a living condition, are unable to grow or multiply.

"The process is not new, but the method is; the process is as old as the bees. The bees collect nectar from flowers and store it in small cells where the drones, or the workers, keep up a flow of warm air over them. The warm air takes away the moisture leaving concentrated honey.

Timucua Indians smoking game in Florida circa 1562. Drawings by Jacques le Moyne.

"Since the beginning of time, man has cured (dried) hay and grass, corn, herbs, and meat for animal and human consumption by the heat of the sun. In food preservation today, we accomplish this curing or drying by evaporating the moisture or water in food products from a liquid to a vapor. Heat and air are required to accomplish this, but the heat must be held at a temperature that will not aflect the texture, color, flavor, or nutritional value of the product.

"Heat evaporates the water from the product, and air circulating around it absorbs the vapor. Drying changes the appearance of products, but if properly dried and stored, very few of the original food nutrients are lost.

"Drying has the great advantage of minimizing storage problems. The dried product's weight is from one-fourth to one-tenth, or in some cases even less, compared to the fresh product. Then, too, it can be

kept almost indefinitely, if stored under the proper condition."

Dehydrating Retains Nutritional Values

Fresh fruits and vegetables are the richest sources of vitamins, minerals, sugars, proteins, and other nutritive substances essential to good health. How necessary it is then, that we do our utmost to conserve these nutrients. Even though harvested or gathered, fruits and vegetables remain living materials capable of carrying on their own life's processes. After the product is removed from its life source, these processes, if left unchecked, destroy quality because they include the oxidation of valuable materials within the product.

"The chemical changes that impair product quality, as well as attacks by organisms of decay, can be retarded by storing products in the refrigerator until processed, but this storage must be as short a time as possible; two days should be the maximum length of time.

"Only products in prime condition should be dried, and that means they are at their best for drying when they have reached maturity and are garden or orchard fresh."

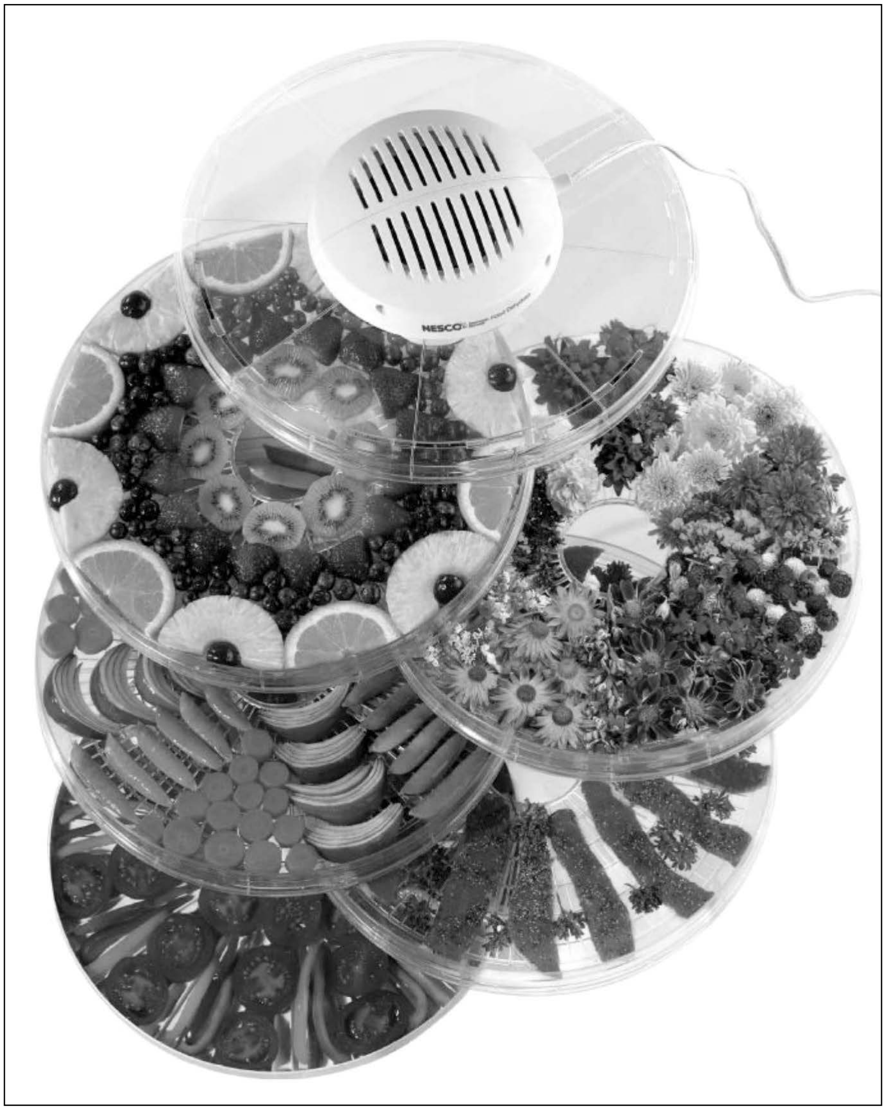
Dehydrated fruits and vegetables which have been reconstituted and cooked provide approximately the same amount of carbohydrates, fats, proteins, minerals, and bulk as the original fresh material similarly prepared. The proteins and minerals in dehydrated foods after reconstituting are no different from those of the original foods if dehydrated at the recommended proper temperature. Since steaming vegetables helps to retain more of the nutrients than scalding does, we recommend following the directions in the section on dehydrating vegetables.

"Fruits and vegetables not only provide important dietary nutrients, but make other contributions to the normal functioning of the body. Fruits, with exception of cranberries, plums, and prunes; vegetables, with the exception of rhubarb, spinach, and chard, exert an alkaline effect when oxidized in the body. The free acids and acid salts of fruits and vegetables are oxidized to carbonic acid which is eliminated by breathing. Vegetables provide salts of the metals calcium, magnesium, potassium and sodium, which are available for the purpose of neutralizing acid by products resulting from the metabolism of meat, egg, milk, and cereal proteins. This is but one of several reasons why a diet should include fruits and vegetables."

Fruits are an excellent source of Vitamins A and C but are not very rich in Vitamin B-l (Thiamin). While sulfuring destroys Vitamin B-l in fruits, it tends to retain the potency of Vitamins A and C. It is always better to preserve the greater amount of vitamins.

"Thiamin is well retained in vegetables that have been steamed, and steaming will aid in preserving some of the Vitamin C of vegetables, which, unfortunately, is easily destroyed. Vitamin B-2 (Riboflavin) occurring in a few fruits and many vegetables, is resistant to oxidation, heat, and sulfur fumes, but is affected by light. Niacin. occurs in few vegetables. It is not destroyed by oxidation or by heating to the temperature of boiling, so there should be little loss of Niacin in the process of dehydration."

It is clear that dehydrated fruits and vegetables retain almost all the nutritional values possessed by the foods when they are fresh.



Nesco FD-39 Food Dehydrator.
© *The Metal Ware Corporation*

Metabolic Considerations Related to Dehydrated Foods

(The material in this section has been prepared by Dr. R.N. Malouf, MD)

Dehydrated foods are now of special interest to the general public and may have significant clinical application to those who have blood sugar symptoms. Medical sciences have established the fact that all cells in the body require a proper balance of oxygen and various nutrients in order to facilitate the vital process of physiological combustion which in turn provides needed energy and metabolic essentials which are necessary to maintain good health.

The gasoline engine is a dramatic example of the principle in point: It is a well-known fact that too much fuel causes the engine to "choke" and too little will cause the engine to "starve." The blood sugar in the body is comparable to the gasoline for the engine and is the digested simplified sugar which is directly available to the cells for combustion. If the blood sugar level is too high, then proper combustion does not take place and a *hyperglycemic* or diabetic condition may prevail. If too low, a *hypoglycemic* condition or so-called “low blood sugar” may occur and cause undesirable clinical symptoms. Therefore, it is vital to good health that there be a proper ratio between oxygen and the available blood sugar in order to provide the ideal circumstances for the all-important physiological combustion.

When natural foods are eaten and subjected to the normal digestive processes, the blood sugar rises gradually, maintains a longer effective peak level, and then gradually declines to a level which signals the need for additional nourishment. In contrast to this, the more highly concentrated sweeter foods tend to send the blood sugar up much faster, the peak level time is shorter, and the let-down is usually much quicker and may be followed by undesirable clinical symptoms.

The type of diet that people eat plays a very important role in proper body metabolism. Ideally, the more natural foods provide the best sources for energy and tissue-building nutrients. Super-sweet and highly concentrated foods oftentimes cause undesirable physiological problems. Dehydrated foods provide an excellent source of natural nutrition and should be considered in any realistic dietary regime.

When prepared in the right manner, these foods are highly palatable, very flavorful, and provide excellent nutritional values without the undue stress of overeating. It has been noted by many people that eating very small servings of dehydrated foods satisfies the feeling of hunger and yields high energy returns. Another attractive feature is the fact that when prepared as directed, these foods can be stored in a comparatively small space at room temperature thereby offering a definite storage advantage.

In conclusion, it can be empirically stated that the intake, digestion, metabolism, and subsequent physiological functions of the body are much better with more natural foods. Thus, dehydrated foods offer some very definite and desirable advantages and may well take a distinct place in the medical world of good nutrition.

Methods of Dehydrating

A number of different methods have been used to dehydrate fruits and vegetables. Each has its advantages and disadvantages, and you should carefully study each to decide which method will best suit the needs of your family. The needs of a family who will dehydrate a few items in small quantities during the year are obviously different from that of a large family who will dehydrate bushels of a number of different kinds of fruits, vegetables, and meats.

Method 1: Sun Drying

"This method is perhaps the oldest known method of food preservation. It is the evaporation of water from products by solar or sun heat, assisted by movements of surrounding air. Products are spread on containers of one kind or another (such as window screen) that are tilted toward the south to receive the full effect of direct sunlight.

"Sun drying is not the most satisfactory method. To be successful, it demands a rainless season of bright sunshine and high temperature, coinciding with a period of vegetable and fruit maturity. Sun drying requires considerable care. The products must be protected from insects with screen or netting, and must be carried into a shelter when the dust blows or rain falls and before the dew falls in the evening. If there is not a succession of sunny days, there is danger of spoilage. This method is

Slices of meat being sun dried

An example of tomatoes being sun dried

slow at best because the sun does not cause rapid evaporation of moisture.

"Before storing, sun-dried products should be placed in an artificial heat dryer for 20–30 minutes. This will complete the drying and destroy any bacteria that may have collected during the drying process."

Artificial heat in drying, such as is found in a well-designed dehydrator, has many advantages over sun drying: it can be used independently of weather conditions, it is ready to operate whenever the product is mature, it can be controlled, it can be continuous, it is a faster process, the products better retain their natural color, and flavor and nutrients are preserved to a much greater degree.

Method 2: Use of a Net Bag

Food can be prepared and placed in a net bag and hung on the clothesline. Again, the advantage of this method is that it requires very little investment and keeps the insects and birds out. However, the bag must be brought in each night and any time it rains, and the bag should be shaken regularly to redistribute food so it will dry thoroughly and evenly. It will work—but is an obviously limited method and leaves much to be desired.

Method 3: Oven Drying

Fruits and vegetables can be dried in the oven. The kitchen should be well ventilated and care must be taken to keep the heat low. Set the regulator at 140–145°F and preheat the oven. When the product is first placed in the oven, the temperature will drop, but it will soon build up. Do not let the temperature rise above 145°F.

When drying either fruits or vegetables in an electric oven, leave the door open two inches. When using a gas oven, the door must be open eight inches. This helps to control temperature, but is also necessary to allow the escape of moisture through air circulation.

"If an oven with a regulator is not available, a portable oven thermometer is a great convenience although you can learn to tell by the 'feel' of the product whether or not it is drying satisfactorily. It should feel moist and slightly cooler than the air flowing over it. If it does not, it is drying too fast."

The food may be placed in pans or trays; trays made of open mesh material speed the drying process. Tray frames may be made of inch or inch-and-a-half lumber.

The frames should be small enough to fit on the oven racks. Cover the frames with any open mesh material, such as curtain netting, cheese cloth, muslin, or strong, washable nylon netting. If necessary, reinforce the covering by stretching strings diagonally across the frame underneath. This will keep the cloth from sagging. Spread the prepared product on the trays one layer deep and place the trays on the oven racks. Stir the product and rotate the trays occasionally to insure even drying.

L'Equip/Filter Pro Food Dehydrator
© *Pleasant Hill Grain.*

Nesco/1020 Food Dehydrator
© *The Metal Ware Corporation.*

The disadvantages of oven drying are many: It is difficult to get sufficient air movement, it can be difficult to get a low enough temperature in your oven to preserve nutrients and color, two racks are not efficient when dehydrating large amounts, and the oven is now not available for any other use.

Method 4: Dehydrators

Home-Built:

Constructing a home-built dehydrator that will produce the highest quality end-product is a very difficult task for the home handyman to attempt.

1. *Wooden Frame Box*
   A dehydrator can be constructed from a wooden box into which an electric heating element or a gas burner and a fan have been installed. This gives better control over temperature and air movement, but it becomes difficult to clean and may absorb food odors. Considerable experimentation is required to get the right air movement and temperature in home-built units in order to achieve optimum drying conditions.

2. *Refrigerator*
   An old refrigerator can be used to make a dehydrator by adding a fan, shelf supports, and a heating element. This provides more control and is easier to clean, but it does require some skill with sheet metal work and takes experimenting to get the right temperature and air movement. It is also very bulky for the space used and is difficult to store or move.

Commercially-Built Units:

1. *Speed*: "Whatever the method of drying, by sunshine or by controlled heat, speed is the word to keep in mind, both when preparing fresh foods for the drying and when starting the drying process. The faster you work the higher will be the vitamin value of the dried food, and the better the color, flavor, and cooking quality."
2. *Temperature*: Authorities recommend a maintained temperature of 140-145°F in cabinet-type dryers. If the temperature is too low, food may sour and spoil.

   Dr. D.K. Salunkhe of Utah State University states that food dehydrated at 160°F will lose three times as many vitamins as food dehydrated at 140–145°F.

   Surface drying and souring is prevented by controlling temperature and air flow. The proper temperature is, of course, obtained by increasing or decreasing the heat source. When controlled by a thermostatically-operated heat source, the temperature should remain fairly constant in the loaded operating cabinet. When products first start to dry, there is little danger of scorching, but when nearly dry, they scorch easily (and scorching destroys flavor as well as nutritive value).
3. *Circulation of Air*: When still air has absorbed all the moisture it can hold, then nofurther evaporation can take place from a moist object. Therefore, provision must be made to remove the moist air and replace it with dry air so that evaporation can continue. "If, however, the surface moisture is evaporated more quickly than the inner tissues are diffusing it to the surface, then the surface hardens, the inner mois ture cannot get through and the drying is retarded. This surface drying is called 'case hardening.'" In the well-designed dehydrator, proper air circulation is accomplished by an air-cooled fan.

   "Drying is best accomplished when the process is a continuous one because growth of micro-organisms is held to a minimum, whereas when heat is applied intermittently, temperatures conducive to bacterial growth can develop."
4. *Convenience*: The several racks provide increased drying capacity. Dehydrating can be accomplished during the night. The unit does not need to be placed in an area that needs ventilating. We have dehydrated our food in our basement, for instance, with no appreciable difference in humidity.

   Root vegetables, such as carrots, potatoes, onions, and cabbage, can be stored in a root cellar until the winter season and can then be dehydrated at your convenience. However, when vegetables such as carrots and potatoes are stored for an extended period of time, the starch in the vegetables converts to sugar, and this condition extends the dehydrating time by an appreciable amount.

Basic Dehydrating Techniques

Most fruits and vegetables can be dehydrated. However, since personal tastes differ, it becomes a personal matter as to which fruits and vegetables are to be preserved. In this book, we have tried to present basic guidelines on work we have done, but do not intend to imply these are the only products that can be dehydrated.

Fruits and vegetables selected for dehydrating should be in prime condition. Fruits should be firm; if poor quality fruit is used, the dried product will also be of poor quality. The same rule applies to vegetables and herbs.

The two essentials in dehydrating fruits and vegetables are proper temperature and proper air flow; this information is fully discussed in the previous chapter.

Experiments have been made with several different materials to support fruit during the dehydrating process. It has been found that high sugar-content fruits such as bananas will stick to

Snackmaster/FD-35 Entree-5 Tray
© *The Metal Ware Corporation.*

the shelves and become very difficult to remove. This sticking tendency may be prevented by using nylon netting. The hole size of the netting should be large enough to permit adequate air flow, but small enough so that items such as peas and corn will not fall through.

However, do not wash the netting in an automatic washer: If it runs through the spin cycle, the wrinkles will be set and cannot be removed. Wash in sudsy water, rinse, and pat dry. With proper care, this heavy nylon netting can be used indefinitely.

Nesco/American Harvest FD-39 Food Dehydrator
© *The Metal Ware Corporation.*

Both fruits and vegetables must be prepared in such a way that the moisture can get out. This can be accomplished either by peeling or slicing. If the skin is left intact, the moisture cannot escape as readily and the dehydrating time will be exceptionally long. Avoid the disappointment of a friend who loaded a dehydrator with whole prunes and after three days accepted the fact they were not going to dehydrate in a reasonable length of time.

Accessory Equipment Needed for Dehydrating

Keep the equipment you use for dehydrating simple, but effective. Items you will need are:

1. Deep pan with a close-fitting lid (used for blanching)
2. Perforated rack, wire basket, or colander to fit into pan to hold products (used for blanching)
3. Stainless steel knives (carbon steel will discolor fruit)
4. Large pan to hold Erythorbic Acid or Ascorbic Acid solution
5. Kitchen timer
6. Sulfur cabinet with wooden racks (if using an intermittent heat source, such as the sun)
7. Dehydrating unit (i.e., wooden box, oven, or commercially built unit)
8. Nylon netting to place on shelves
9. Container for dried products; jars or cans with tight-fitting lids or heavy plastic bags that can be heat-sealed.

Using Preservatives

Preservatives

Many people do not wish to use preservatives of any kind. If you are going to dehydrate fruit for a short storage life (i.e., six to nine months), no preservatives are needed. However, if you plan to store fruits for a longer period of time, you should use some type of preservative. This preserves color and decreases the loss of vitamins and therefore preserves the nutritional value of food.

The method of preserving vegetables through blanching is discussed in the section on dehydrating vegetables.

One method of preserving natural fruit color and flavor is to dip the fruit in one of the following solutions:

Erythorbic Acid or Ascorbic Acid: Dip fruit for two minutes only in a solution of one tablespoon Erythorbic Acid or Ascorbic Acid dissolved in one gallon of water. This preparation retards oxidation and prevents darkening of light-colored fruits during the dehydrating process.

Sodium Bisulfite Solution: Dip fruit for two minutes only in a solution of one tablespoon sodium bisulfite to one gallon water. Sodium bisulfite helps to keep fruit from darkening during the storage period. Drain thoroughly.

Combination of Sodium Bisulfite and Ascorbic or Erythorbic Acid: Another method is to use a combination of one tablespoon sodium bisulfite and one tablespoon Erythorbic Acid or Ascorbic Acid dissolved in one gallon of water. This method preserves the quality and color during the dehydrating process and during the storage period. If you plan to dry your fruit in the sun, it should definitely be sulfured because the heat source is not controlled and constant. However, if the fruit is dried in a well-designed dehydrator where this heat source is controlled and constant, less oxidation occurs and the fruit retains more of its color.

For those who are concerned with the intake of sulfur into the human body, Dr. D. K. Salunkhe at Utah State University states: "The body needs sulfur, which is part of a certain type of protein." Moderate exposure of fruits to sulfur fumes (as outlined below) is definitely beneficial to the product when using an intermittent heat source, and is not toxic to the health of the consumer. The heat of drying and subsequent cooking dissipates practically all of the sulfur.

Sulfuring

Another method of preserving natural fruit color and flavor in fruit is sulfuring with a compartment. "It may be a box, provided it is large enough to cover the trays and a sulfur pan. The sulfur pan may be any shallow pan or metal lid, such as a baking powder can lid. A packing box may be covered with roofing paper or tarpaulin, or a compartment may be built out of wallboard or a cardboard box. A small opening must be provided near the bottom of the container for ventilation. Sulfur will not burn without it. All sulfuring should be performed out of doors. The opening should be closed after the sulfur has all burned so as to retain the fumes long enough to "cure" the product.

TRAY wooden ones are needed for the product as sulfur corrodes metal.

BLOCKS of wood or brick placed on the ground may be used to support the trays.

STACK them one upon the other with something between each one to provide circulation. The lowest tray should be six to eight inches from the ground.

PLACE the sulfur pan in front of the trays.

MEASURE one level teaspoonful of sulfur for each pound of prepared fruit. (A sulfur candle is also available for this use.)

WRAP the sulfur in paper and place it on the ground.

SPREAD the prepared product on the trays. Spread pitted fruit pit side up.

STACK the trays and then light the paper around the sulfur. (Do not leave the match on the sulfur pan. It may prevent sulfur from burning to completion.)

PLACE the covering compartment over trays and sulfur pan.

KEEP product in sulfur fumes for time designated on the following chart.

REMOVE from sulfur compartment.

TRANSFER product to drying racks and dehytrate.

Chart Number 2:
Time Requirements for Sulfuring Fruits Out of Doors

Fruit	Time in Minutes
Apples	60
Apricots	60, sliced
	120, quartered
Cherries (White)	10–15
Peaches	60, sliced
	120, quartered
Pears	60, sliced
	120, quartered
Plums, large	60, sliced
	120, quartered
Prunes	60, sliced
	120, quartered
Nectarines	60, sliced
	120, quartered

Sliced oranges ready to be dehydrated

Banana slices that have been dehydrated

Chart Number 3: Conversion Chart
Fresh, Dehydrated, and Reconstituted Relationships: Fruits

The following chart is provided as an aid in learning how to convert fresh fruit to dehydrated and to reconstitute and then use the dehydrated fruit in recipes calling for either fresh or canned fruit.

	THIS AMOUNT FRESH	YIELDS APPROXIMATELY THIS MOUNT DEHYDRATED	THIS AMOUNT DEHYDRATED		PLUS THIS AMOUNT WATER	YIELDS APROXIMATELY THIS AMOUNT RECONSTITUTED		PLUS THIS MUCH LIQUID
PRODUCT	WEIGHT[1] POUNDS	WEIGHT POUNDS	CUPS	Wt. Oz.	CUPS	CUPS	Wt.[2] Oz.	CUPS
APPLES	25	4	1	0.8	2	1 1/4	4.2	1 1/2
APRICOTS	25	5	1	2.2	2	1	6.7	1 1/3
BANANAS	25	5	1	2.6	2	1	74.2	1 1/4
CHERRIES, pie	25	5	1	3.4	2	1 1/4	5.8	1 2/3
CHERRIES, Bing	25	5	1	3.4	2	1 14	6.2	1 1/2
GRAPES	25	5.5	1	3.5	2	1 1/3	7.5	1 1/2
PEACHES	25	5	1	1.9	2	1 1/4	6.6	1 1/4
PEARS	25	5	1	2.4	2	1	7.8	1 1/4
PLUMS	25	5	1	2.5	2	7/8	6.1	1 1/3
PRUNES	25	5	1	3.9	2	1 1/4	7.6	1 1/3
RHUBARB	25		1	2	2	2	8.7	1 1/8
RASBERRIES	25		1	0.9	2	2/3	2.7	1 2/3
STRAWBERRIES	25		1	2.2	2	1	6.3	1 1/3

1 Ready to dehydrate (peeled, etc).

2 Soaked for 3–3 1/2 hours.

Storage Pantries

Planning Your Long-Term Storage Pantry

BY KATE AND JIM ROWINSKI

Why Do You Need a Food Pantry?

In this uncertain day and age, it seems that potential disasters lurk around every corner—wild weather, the threat of terrorism, economic concerns—it is easy to feel that you and your family could fall victim at any moment. Ask yourself these questions: What if we lose power or the water is shut off? What if I lose my income? Could I feed my family for a day, a week, even a month? What if access to grocery stores was unavailable? Do I have a way to store and cook food in my home?

With fast food and easy access to almost anything, it may be hard to imagine a world of scarcity. But the reality is that scarcity can happen in an instant. A large tree falling on a road may keep you from the store for a day. A power outage may keep the stores closed for a week. Job loss may prevent you from shopping for three months or more.

You don't have to be a doomsday believer or a radical survivalist to consider creating your own emergency food pantry. In fact, the idea of not having a back-up supply of food should be as nonsensical to you as not having a tank of gas or extra batteries.

Rather than allowing the specter of disaster to loom in the back of your mind, there are simple steps you can take to make sure that your family's basic needs can be taken care of in the event of an emergency. Establishing a food plan gives you the following benefits:

A Powerful Insurance Policy

Food storage is the most powerful of all bank accounts, allowing you to get through any lean times without desperation or handouts. Knowing that you have what you need no matter what happens can give you peace of mind that no homeowner's policy could ever provide.

A Sense of Self-Sufficiency

Knowing that you can take care of yourself and your family has a powerful effect on your psychological state. Taken even further, understanding how to grow and preserve your own food will give your family greater appreciation for where their food comes from and a sense of gratitude for what they have.

Helping Others

Did you know the average family has less than a week's worth of food in their kitchen right now? And worse yet, if there was no power, many people wouldn't even know how to cook it! Your food pantry and cooking plan will not only help keep your family safe, but may allow you to help others as well.

Not long ago, a hurricane knocked out power to our area, taking down trees that prevented us from getting out for a few days. We were astonished to learn that most of our neighbors were not prepared to do something as simple as heating a can of beans. They could have gotten by on cereal or cheese and crackers for a couple of days, but many relied entirely on electric ranges and some had outdoor grills that were out of propane. Worst of all, many had no emergency water stored. It's not that they were completely without resources; they just didn't have a plan.

But what could have been a very uncomfortable situation turned into a party. People contributed food out of their now-useless freezers, and our emergency cooking plan fed the whole neighborhood for three days. We distributed gallons of drinking water and a neighbor with a swimming pool supplied water for toilets.

So how do you plan for unexpected events?

Establish Your Goals

Creating a food pantry may seem like a daunting task. Dedicated space is needed, time is required, both to gather supplies and to maintain them, and you have to be able to afford the necessary supplies to get started. So first take the time to determine what you want to accomplish.

Establish how much money and space can be allocated to your food storage project. It is important to take stock before rushing out and buying supplies willy-nilly. It is not necessary to create a millennial plan in order to begin, but it isn't enough to just run out and buy extra food. If you aren't ready for a big commitment, just start out with a carefully planned three-day supply of food and water. Even this small step will put you ahead of most of your neighbors. You will find that a lot of the components that go into being self-sufficient for three days are the same things that you need for longer term planning. So go slowly and get it right in the beginning. You will end up with a better plan all around.

As you grow comfortable with the planning process, it will be time to expand your pantry to include long-term storage. Again, think about your goal. Consider the degree of self-sufficiency you are seeking. Even if you think you want a one-year supply of food, start by working on your three-month plan first. Remember, a large supply of food requires care and rotation; it's not enough to just go out and buy a lot of food.

Once you have committed to the size and scope of your pantry, you are ready to get into the details. Will take you through the process of planning and execution.

Assess Your Resources

How much space is available for food storage? There is no point in making a one-year plan if your storage is going to be limited to a spare closet. Look

One Step at a Time

Emergency food planning is not an all-or-nothing proposition. As soon as you start to think ahead, you will quickly find that every step you take, no matter how small, gives you more control over your situation than you had before.

Begin by stocking a three-day supply of food for your family. Make sure you include nutritious items that don't require refrigeration or cooking.

Store water! Have at least three gallons on hand for each member of the family.

Slowly build your supply of staples and family favorites so that you could comfortably get by for two weeks.

around your home and think creatively, keeping in mind that the location you choose should be dry with a reasonably consistent temperature. Damp basements, freezing garages, or hot attics are not good choices.

What are your cooking arrangements if energy sources are limited? Take stock of your home. Is there a fireplace or wood stove that could be pressed into service? If not, do you have outdoor space for propane or charcoal cooking? What kinds of food would you need if no cooking was possible?

Next, think about how you will provide food for your family. Will your pantry satisfy all your needs, or will your plan include bartering or growing your own food and learning to preserve it? Again, assess your resources. Do you have a sunny location for growing vegetables? You don't need a large yard to grow your own food, and even a patio can provide fresh greens or herbs. There are great small-space options that produce high yields.

Take Action!

Your goals are set, your storage location is chosen, and you have some ideas on alternative cooking sources. Now is the time to act!

You don't have to wait until you have a lot of extra money to get started creating your storage pantry. If you set aside as little as $10 a week from your grocery bill to devote to your pantry, you will see great dividends in short order. I am a big fan of the weekly specials at my local store, where I can load up on beans and canned tomatoes, as well as boxed macaroni and cheese, and other family favorites.

Of course, if you are a coupon clipper, you can find great deals. Just make sure to stick to your list! You don't want to suddenly find yourself with a five-year supply of something that was on sale but may be impractical for long-term storage!

Bread Making–Basic Techniques

BY KATHRYN HAWKINS

It's time to move on to one of the most important parts of the book—how to get started.There are a few techniques involved in making bread, none of which is complicated, but they are vital nonetheless if you want to get a good result. I've broken down the process into ten simple stages described as if you were following a recipe.

Step 1 – Preparing the Leaveners

Breadmaking generally uses some form of leavener to make the dough rise; this is done in various ways but the most common leaveners are yeasts in various forms, and sourdough starters.

Yeasts

All yeast requires some moisture to help it begin to work. Fresh and dried yeasts actually have water added to the yeast, whereas easy-blend yeast is activated by the moisture added to the dough. Water is the most common ingredient with which to start your yeast but you will need to be mindful of the temperature of the water; if using a thermometer, the ideal temperature is 37°C (98.6°F). If you don't have a thermometer, mix two-thirds cold water with one-third boiling water to make a tepid temperature that you can touch comfortably. If the liquid is too hot it will destroy the yeast, too cold and it will not activate it. However, if your kitchen is exceptionally warm, you can use cooler water in order to slow down the rising process.

Fresh yeast Crumble into a glass bowl and add tepid liquid according to your recipe. Using a wooden spoon, mix the yeast until it dissolves and forms a smooth paste. It is then ready to use.

Dried yeast Measure the stated amount of tepid liquid into a glass jug and sprinkle over the dried yeast. Set it aside in a warm place for about 5 minutes, then stir with a wooden spoon to dissolve thoroughly. In this time, the mixture should become frothy, which indicates that the yeast has started to work.

Easy-blend yeast Measure the flour required in the recipe and place in a large mixing bowl, then sprinkle the yeast over the flour. Mix it into the flour *before* adding the tepid liquid.

Sourdough starter

You need to make some advance preparations if you are planning to use a starter to make bread. Depending on the recipe you are following, it can take from 24 hours to several days to prepare and ferment, but the ingredients are always the same: flour, water and yeast.The following is a starter recipe you can use in some of the recipes in this book:

Storing your starter

If you are not using the starter straight away, cover it with clingfilm and store in the refrigerator for up to 2 weeks. Let it stand at room temperature for 30 minutes before using. Once established, the

Making a sourdough starter

- Prepare 25 g (1 oz) fresh yeast or 1 tbsp dried yeast with 200 ml (7 fl oz) tepid water as described above. (If using easy-blend yeast, simply stir 4 tsp into the flour before adding any water, see next step).
- Put 500 g (1 lb 2 oz) white bread flour (or use rice flour for a gluten free starter) and prepared yeast into a very large, clean glass bowl (the mixture will bubble and rise quite a bit). Gradually stir in a further 400 ml (14 fl oz) tepid water.
- Mix well with a wooden spoon to make a smooth, thick batter. Cover the bowl with a clean tea towel or piece of muslin (cheesecloth).
- Keep the mixture at a coolish room temperature out of direct sunlight, and leave undisturbed for about 3 to 5 days. The batter is ready to use when it begins to froth and has a fresh, pleasant sour aroma.

Follow the instructions in your recipe for using the starter.

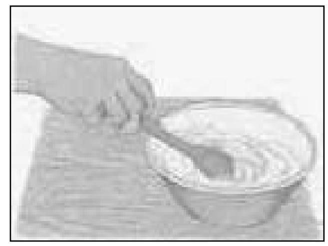
starter can be kept indefinitely if stored and used correctly. Every time you use some of the starter, you simply replace the flour and water. If you don't use any starter for two weeks, you will need to replenish it (see below). For long-term use, it is a good idea to store your starter in a large, clean non-corrosive kilner-type jar with a secure rubber seal.

Replenishing a Starter

If your recipe uses 300 ml (10 fl oz) starter, you need to replace the amount taken out with 125 g (4½ oz) bread flour and 150 ml (5 fl oz) water. Carefully blend the old and the new ingredients together and leave to ferment as before for 24 hours, then return to the fridge until required again.This should be an ongoing process enabling you to make a sourdough loaf whenever you want.

Step 2 – Mixing the Ingredients

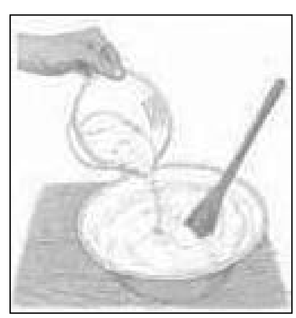
At this stage all your ingredients meet each other for the first time. There will be subtle variations between recipes but in general this is the route to follow:



If using fresh or dried yeast, put the required amount of flour and salt in a large bowl - if making Havoured breads, your recipe may state that other ingredients are added at this stage too. Make a well in the centre using a wooden spoon. If you are using easy-blend yeast, make a well in the centre of your combined dry flour and yeast mixture.

Pour the yeasty liquid in the centre of the well if using and gently mix together with a little of the flour. Some recipes require that the mixture forms a soft paste using just suficient amounts of lour from the edges of the bowl.The mixture is then covered and left in a warm place for a specified time to expand. This Sponge Method gives a loaf with lighter crumb and less yeasty flavour. After the paste has risen, continue as below.

Gradually pour and mix in the remaining liquid, stirring in all the dry ingredients from the edges of the bowl. As you add liquid the consistency of the mixture changes as it draws together. Don't add all the liquid in one go as it will be dificult to obtain an even blend and you may end up not needing all the amount of liquid.



Only continue to add liquid until the dough is mixed together to form a softish, ball-like mixture in the bowl. If it is still too dry after you have added all the liquid, add a little more. Variations in manufacturing processes and in flour quality can affect the amount of liquid necessary to achieve the desired texture.

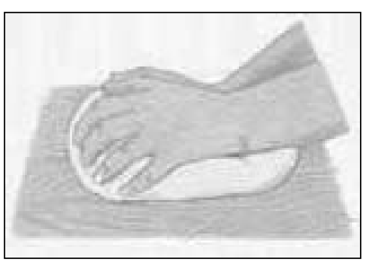
Step 3 – Kneading the Dough

At this stage of breadmaking you establish the basic structure of the mixture. By kneading you distribute the yeast throughout the dough so that it can start to work producing the gases that make an even texture and cause the bread to rise.At the same time, you are helping to form the gluten that creates the framework and holds the risen dough in place during baking.

Very lightly dust a clean, dry work surface with the same type of flour you are using in the recipe.

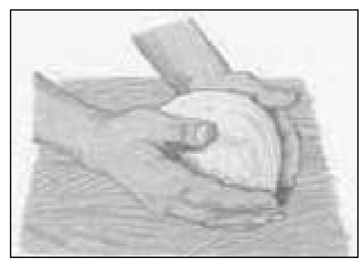
Turn the prepared, well-mixed contents of your bowl onto the surface and bring the dough together by continually folding the edges into the centre until it becomes smoother and easier to work with - if you Find the mixture very sticky, add a little flour but always use extra flour sparingly to avoid making the dough too dry.

Using the heel of one hand, push the dough from the middle, away from you, then roll up the top edge of the dough back towards you. With the other hand, turn the dough slightly, so that you are gradually pushing and rolling the dough round in a circle. Make sure you keep rotating in one direction only to help form an even texture—I usually turn the dough clockwise because I am right-handed, but you can do it however you like!



Keep kneading for about 10 minutes or until the dough feels smooth, firm, elastic and springy to the touch. Keep ushing the dough from the middle, away from you, then rolling up the top edge of the dough back towards you. It can be quite dificult to ascertain that you've kneaded the dough enough, so try the following test: take a small piece of the dough and stretch it so that it is very, very thin. If the dough is properly kneaded, it should stretch very thinly without breaking—as thin as blown bubble gum. If the dough doesn't stretch easily and tears, then carry on kneading a bit more. This test is more difficult with wholemeal and grain doughs because of the fibre in the dough, and in enriched doughs the fats coat the flour and affect its flexibility. However, it is still a reliable means to see how far you have come in preparing the dough.

When you have achieved the desired texture, form the dough into a smooth ball ready for the next stage.



Additions

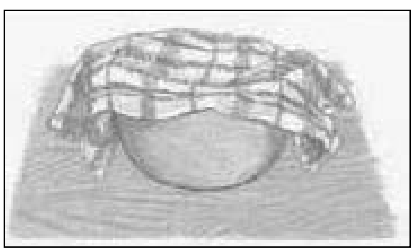
Towards the end of the kneading process is the perfect time to add flavourings to your bread mixture, including pieces of cheese, chocolate, dried fruits and marzipan. Adding them at this stage will mean they get properly incorporated without being over-processed.

Step 4 – Rising and Knocking Back

This part of the breadmaking process isn't an exact science since outside factors will affect the rate at which your dough rises.Warmth and increased humidity will speed up the dough rise, but the type of flour and whether you have used a starter can also have an effect.When you have made a few loaves, knowing the rising time of the dough will become second nature, but for the first time it can be dificult to gauge.You should aim for a slow, steady rising process and don't be tempted to speed things up.The test tip will help you decide if your dough is ready for the next stage.

Once your dough has been thoroughly kneaded and shaped into a ball, place it in a lightly floured or oiled glass, china or plastic bowl big enough to allow room for the dough to double in size.

Cover the bowl with a clean tea towel or muslin (cheesecloth) and leave to rise at room temperature out of draughts; a cool temperature is ine, but a very cold room will mean that the yeast will take a long time to get going.



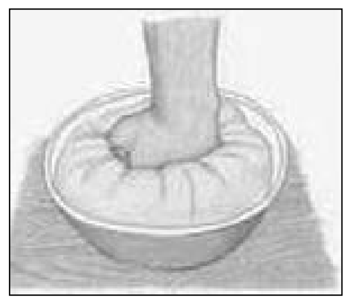
In ideal conditions, the dough should take1½—2 hours to double in size. Wholemeal flours and enriched doughs take longer. The slower the dough takes to rise, the more lavour and texture the loaf will have.

> **Test Tip**
>
> Before you leave the dough to rise, press the top of the dough a little with your finger and it should spring back almost immediately. Remember this action as this is a good bench mark indicator for later on when you want to know if your bread has risen enough.

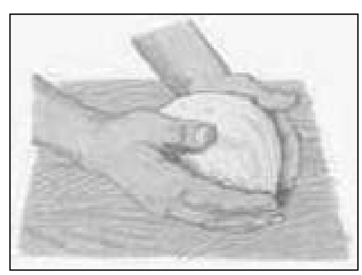
If you run out of time or your room is very cold, you can put the dough in the refrigerator for at least 8 hours where it will rise slowly and steadily. Cover the bowl with oiled clingfilm—make sure the bowl is big enough for the dough to expand without being restricted—and then put in the refrigerator. The dough will then need to stand for about 2 hours at room temperature before proceeding to the next stage.

To test that the dough has risen properly, remember the test you carried out before you put your dough aside to rise. Now, gently press the dough again with your finger. If the indent in the dough springs back gradually then the dough has properly risen; if the indent springs back quickly, then it needs to be left longer. If you've left the dough too long, the indent won't spring back at all and the dough is over-risen, in which case see the Troubleshooting guide on page 64.

Once the dough has risen to your satisfaction, push your knuckles into the dough to deflate it and turn it out onto a lightly floured surface; this process is called knocking back (see right).



Let the dough rest for 5 minutes on the work surface before you shape it. Once again, form the dough into a ball by cupping it in your hands and gently turning it on the work surface.As you turn the dough, gently press your hands down the sides of the dough to smooth the sides and then tuck the edges underneath. Keep turning and tucking until the dough forms a smooth ball shape.



Step 5 – Shaping Your Loaves

There are many ways to shape the dough ready for baking, and in the next few points, I will explain some of the basic shapes for loaves and rolls.You will find instructions for shaping specialist doughs in the methods of some of the individual recipes.

Shaping is an important part of breadmaking as it helps the structure and texture of the finished loaf. Sprinkle the work surface lightly with the flour you have used to make the dough. Handle the dough with care - at this point, over-shaping and heavy-handedness will cause the dough to tighten and feel hard (let it rest for a few minutes if this happens and then proceed again gently).

Tin-baked loaf

Keeping the dough in a round shape, flatten it gently with the palm of your hand to remove any large air pockets. Fold one side into the centre and seal it gently, then repeat with the other side so that the two folds overlap in the middle.

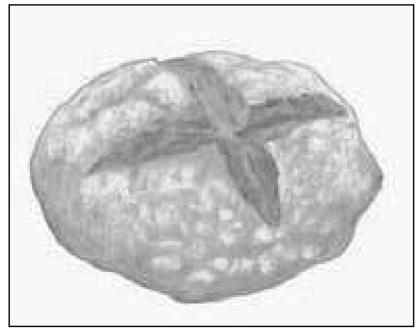
Press down gently and turn the dough over so it is seam-side down. Gently roll the dough, keeping an even thickness, until it is 5 cm (2 in) longer than your tin. Carefully lift the dough and fold the ends underneath so it will it the tin, and lower it into the prepared tin, seam-side down.

Long-shaped loaf

Follow the instructions for a tin-baked loaf but roll the dough to fit your prepared baking tray or to the measurements given in your recipe. There is no need to tuck the ends underneath for this loaf, but you may want to press the ends together to seal them neatly.Transfer to the baking tray, seam-side down.

Round loaf

Put the risen dough ball on the work surface and place your hands round the outside. Push your fingers into the base of the dough, tucking the dough into the centre of the ball.Turn the dough in your hands and keep tucking the sides underneath until the dough becomes smooth and rounded.Turn the dough over and pinch the seams together—this will be the bottom of the loaf.



Turn the dough back over and cup it in your hands, rotating and smoothing it until you are satisied with the shape.Transfer it to your baking tray. Note: this rounded dough can also be cooked in a large round tin if you prefer.The baked loaf will be straight-sided with a large domed top.

Oval loaf

Follow the instructions above to make a round loaf. Once you have formed the dough correctly, gently press either side of the centre with lat, stretched ingers and gently roll the dough backwards and forwards, applying even pressure, until the dough becomes suficiently tapered at the ends. Transfer to a baking sheet.

Dinner rolls

Roll pieces of dough about the size of a tangerine into small rounds and press down to get rid of any air bubbles. Cup the dough in your hand and roll it on the floured surface until it forms a smooth round roll.

Splits

Form the dough pieces into rounds as above, then gently start rolling the dough from either side of the middle using your fingers. As you roll, the dough will naturally taper at the ends.

Knots, twists, and plaits

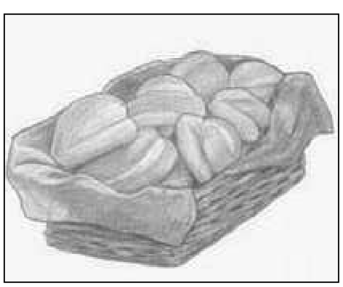
For **knots,** use pieces of dough about the size of a tangerine, and roll out using the palm of your hand to make a long sausage about 20 cm (8 in) long. Tie into a simple loose knot.

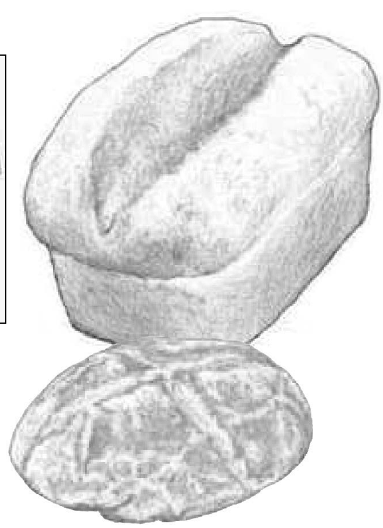
For **twists,** roll the dough into a sausage about 25 cm (I0 in) long and fold in half, then simply twist the two pieces together and pinch at the ends to seal.

For **plaits,** roll your dough into a 30 cm (I2 in) length, cut into three pieces and plait together (see two illustations below), pinching at the ends to seal.

Parker House rolls

Form the dough pieces into rounds as for dinner rolls, then press to form neat circles about I cm (½ inch) thick. Brush with beaten egg and fold over, ensuring the top piece of dough overlaps the bottom. Press down lightly on the folded edge.





Step 6 – Proving

Once your loaf or rolls have been shaped and either put in a baking tin or onto a baking tray, the shaped dough needs to rest and rise again before baking. This final rising is referred to as proving and is best done in a warm draught-free place.

Cover the loaf tin or trays of rolls with a sheet of lightly oiled clingfilm—drape it loosely to allow the dough to rise unhindered underneath.

Leave the dough until it has doubled in size, feels spongy to the touch and any indents gradually spring back. If in doubt, it is better to slightly under-prove the dough; if it proves for too long, the loaf will collapse in the oven.

Step 7 – Applying Glazes and Finishes

Most glazes and toppings are added to the dough once it has proved.You do need to be careful to avoid damaging the surface before baking. There is a wide selection of ingredients you

Adding decorative touches

After proving, your bread is now ready for oven. If you want to add any decorative touches, now is the time to do it—use a sharp knife or a pair of kitchen scissors. For a large loaf, use a small sharp-bladded knife to make a slash down the length of the loaf about 1 cm (½ in) deep—this will encourage an even rise on a large loaf. You can slash the middle of oval-shaped rolls as well.

For baguettes, slash the loaf diagonally as directed in the recipe. For rounded rolls, snip the top in a cross using scissors and pull back the points to make an open-cross shape.

can use to embellish the dough and add extra flavour, colour, and texture depending on the desired effect.

Glazes

These usually take a liquid form and are brushed onto the surface of your bread before it goes in the oven to be baked, although there are finishes that are added as soon as a loaf comes out of the oven. Here are a few things you might like to try.

Egg wash The most traditional golden-shiny finish for both sweet and savoury breads consists of a beaten egg; simply brush over the dough before baking. For an extra-rich brown glaze, reapply the glaze halfway through baking. For a less golden, but glossy glaze, use beaten egg white only with water. For a rich golden crust, blend I egg yolk with I tbsp water.

Milk Brush over the dough for a golden crust on sweet and savoury breads.

Melted butter, vegetable margarine and **olive oil** Brush over sweet or savoury floaves to give a soft crust, golden finish and extra-rich flavour.

Dairy- and **egg-free wash** Make a thin smooth paste of soy or corn flour and water, and brush over the surface of the dough.This gives a lightly golden colour and chewy crust to sweet or savoury breads.

Flour dusting Simply dust a little flour over the top of the proved dough before baking—use a small fine sieve for best results. This will give a soft crust to a baked sweet or savoury loaf.

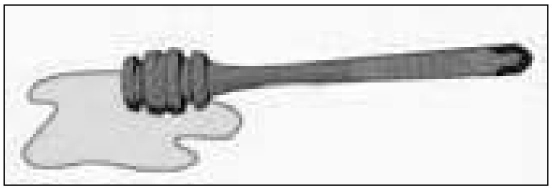
Applying toppings

As well as brushing the dough with a glaze, you may want to add a topping. The glaze will act as an adhesive to enable you to keep the topping in place. Here are some embellishments you may like to try:

- Small seeds; finely chopped or flaked nuts; rolled oats; bran flakes; cracked wheat; cornmeal
- Grated cheese; finely shredded cooked onion
- Coarse salt; freshly ground black pepper
- Lightly cracked spice seeds such as fennal, caraway, cumin and coriandert
- A little chilli powder, plain or smoked paprika, or tiny sprigs of fresh herbs.

For sweet breads try:

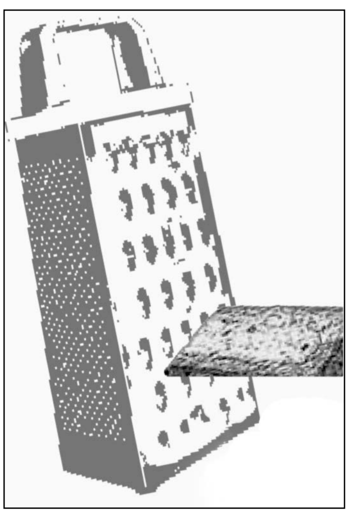
- Poppy seeds; rolled oats
- Coarse sugar such as Demerara or granulated; crushed sugar lumps
- Ground spices such as cinnamon, ginger, all spice and finely crushed cardamom seeds
- Baked sweet breads can also be dusted with icing sugar just before serving.



Honey or **maple syrup** For a sticky sweet finish, brush runny honey or maple syrup over bread as soon as it comes out of the oven.

Glacè icing For sweet breads and rolls, sift II5 g (4 oz) icing sugar into a bowl and gradually add 3–4 tsp warm water to make a smooth soft icing. Flavour with vanilla or almond extract, or citrus rind for extra lavour, or use freshly squeezed lemon, lime or orange juice instead of water to bind the icing if preferred. Drizzle over bread once the loaf or buns have cooled.

Water Brushing water onto a proved loaf or spraying with a light mister just before baking will give a crisp, golden crust. This technique is used in preparing French baguettes (see page 92).



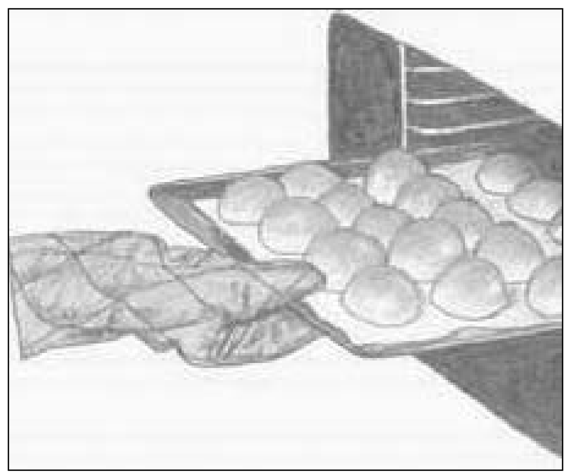
Step 8 – Baking

Baking is the next important step in breadmaking.Always preheat the oven to the temperature given in the particular recipe, although most breads cook in a hot oven at about 220°C (420°F/gas mark 7). If you have a fan oven, refer to the manufacturer's guidelines as you may need to adjust the temperature. In an ideal world, bread requires an even temperature but all ovens cook differently and temperatures may vary so if in any doubt, use an oven thermometer to check yours. If your oven has a 'hot spot', turn your bread round halfway through the cooking time.

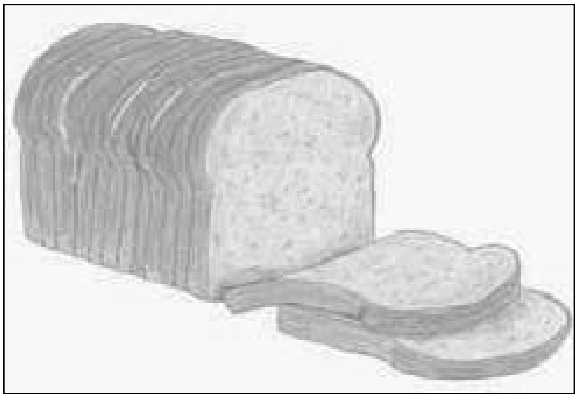
Place your bread on the middle shelf of the oven. Cooking times vary depending on the recipe and the size of your loaf. Some recipes call for extra moisture or steam during baking and this can be achieved by placing a tray of water in the bottom of the oven.

When is it done?

Unlike a cooked cake mixture, there is a firm crust to contend with on a loaf of bread, so it is impossible to see whether the dough is properly



cooked on the inside. However, a perfectly cooked loaf will be risen, have a golden brown crust and the texture should feel firm but not hard. Cover your hand with a clean oven cloth and carefully turn the bread out.Tap the underside of the loaf gently with your fingers; it will sound hollow when it is properly cooked. Immediately turn your cooked loaf onto a wire rack. Allow the loaf to cool completely on the rack and transfer rolls onto a rack using a spatula. Cooling your bread in this way



allows steam to escape quickly from the depths of the loaf without getting trapped and causing the bread to go soggy.

Step 9 – The Perfect Slice

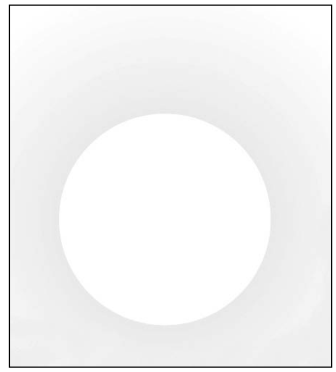
For maximum freshness, always cut bread just before serving as it dries out quickly and becomes stale. Bread doesn't have to be completely cool before you cut it, but if too hot, the knife will drag the crumbs together and make the texture doughy; nor will you benefit from the flavour if the bread is too hot when you eat it. Bread of all types is traditionally served in wicker or cane ware—this natural ibre helps keep the bread fresh, and will tolerate warmth.

To cut the perfect slice, sit the loaf on a clean wooden board (used only for bread) and cut with a sharp, serrated bread-knife. Use a steady sawing action across the top of the crust and continue straight down the loaf, sawing all the time to prevent spoiling the crumb—if you press down on a loaf you will risk squishing the crumbs together, causing a doughy texture.

Reheating

If you've baked bread earlier in the day and want to serve it warm for your guests or family, try this very easy and economical way I have discovered that avoids putting on the conventional oven. Simply put cooked rolls in a slow cooker dish, cover with the lid, switch onto the high setting and leave for about 25 minutes to warm through.

To use more conventional means, arrange your bread on a baking tray, spray lightly with water and place uncovered in a preheated oven at about 200°C (400°F/gas mark 6). Crusty loaves will take about 5 minutes to warm and crisp, rolls need only 2–3 minutes. Pitta and naan breads can be reheated by placing under a hot grill for 1–2 minutes on each side—spray them lightly with water too before heating.



Step 10 – Storing and Freezing

How long bread stays fresh depends on several factors. Some recipes will state that a certain loaf is best eaten on the day of baking—these tend to be small or thin, plainer breads, for example, white bread rolls, pitta bread and baguettes. Larger, thicker loaves will usually last a few days if stored correctly; loaves enriched with fat or oil are usually good keepers, as are the more rustic breads made with a starter. Gluten-free and yeast-free breads tend to dry out quite quickly once a slice has been taken off. Below are a few tips to help you store your bread.

Bread must be completely cold before storing—any warmth will speed up mould growth or cause the bread to go stale more quickly.

It sounds obvious, but keep bread at room temperature, away from direct sunlight in a cool and dry place in order to maintain freshness.

I always keep the crusty end of the loaf after I've cut it. I then use this as a natural seal for the end of the loaf.

Alternatively, you could wrap the end in clingfilm or aluminium foil but make sure you only cover the end; avoid wrapping the whole loaf as this will make it 'sweat' and lose its crustiness and texture. If you have a clean paper bag, you could wrap this round the bread.

Bread needs to "breathe" for better keeping.You will find cloth bags (plastic bags are not suitable) speciically designed for wrapping round a loaf, but you could try a clean tea towel or piece of muslin (cheesecloth)—a note from personal experience, avoid using a tea towel that has been freshly washed in particularly fragrant washing powder, otherwise you will end up with very strange-tasting bread!

You may prefer to put your wrapped bread away from the work surface; an earthenware crock, wooden, wicker or metal bread bin are suitable, but make sure they don't seal completely tight - air needs to circulate.You can use a plastic container, but make some holes in the top and sides.

Avoid putting bread in the refrigerator as this makes the bread dehydrate quickly and become stale. It is also likely to absorb aromas from other foods and become tainted.

Freezing bread

For long-term storage, freezing is the obvious solution.You can freeze baked bread as well as uncooked bread dough.

Freezing baked bread

After thoroughly cooling your loaf, either slice it beforehand for convenience or leave it whole. For freezing, bread does need to be well sealed, so wrap in heavy-duty aluminium foil and then either in clingfilm or a large freezer bag. Seal well and keep for up to three months. Rolls and thin breads as well as gluten-free and non-yeasted breads are best frozen as soon as they are cool on the day of baking; they can be wrapped and frozen as for larger loaves. Remember to date and label your breads.

Freezing dough

Once the dough is mixed and kneaded, form it into a neat ball shape. Oil the inside of a clean freezer bag and put the dough inside. Expel all the air, leaving a little room for the dough to expand slightly as it freezes (it will take a while for the yeast to become inactive in the freezer), then seal the bag. Date and label the bag and freeze for up to three months.

Defrosting bread

Cooked bread is best defrosted slowly. I haven't mastered the art of the 'quick defrost' in the microwave oven; it's always been a bit hit-and-miss and I only do it if I'm desperate. I can't recommend a quick way, just the way you should do it! Keep your frozen bread in the freezer wrappings and let it stand at room temperature for about 3 hours, or leave in the refrigerator for up to 10 hours, until it has thawed.When thawed in this way it will be dificult to distinguish it from freshly baked and it should retain good moistness without having dried out.

If you want to crisp up the crust, place the thawed loaf in a low or warm oven for 5–10 minutes—no longer, otherwise you will have hot bread! Bread can only be reheated once to crisp it up, after which time it will simply dry out and become stale.

Defrosting bread dough

Carefully remove the dough from the freezer and place in a large oiled glass, china or plastic bowl in the refrigerator—the bowl needs to be big enough to allow suficient room for the dough to rise. Cover with clingilm and leave for up to 24 hours or until doubled in size. Remove from the refrigerator, discard the clingilm and stand the dough at room temperature for 2 hours to thoroughly take the chill off, then you can shape, prove and bake your dough as described previously.

Cheese Making

Cheese: Ingredients and Equipment

BY BRETT L. MARKHAM

Protein is an essential part of the human diet. Though vegetable sources can provide protein, in most cases the protein lacks crucial amino acids. The most readily available complete proteins are meats, eggs, and dairy; the latter two are the least expensive. Continuing the theme of preserving nutritive content through fermentation, we arrive at cheese. Milk contains a lot of complete protein, but it is also highly perishable.

In the ages before refrigeration was reliably available, one of the few ways to make the nutritional value of milk last longer while also making it quite portable was turning it into cheese. Hard cheeses in particular, if waxed, can last for years.

Another advantage of cheese is that many hard cheeses lack lactose. Lactose is a sugar in milk that many folks (including myself!) cannot digest. As a result, if they consume most milk products they will suffer severe gastrointestinal distress—sometimes for days. When the whey and curd are separated in the first phases of making cheese, 94% of the lactose stays in the whey. Most aged cheeses lack lactose and as a result provide lactose-intolerant people with a delicious way of obtaining the nutritional benefits of milk.

Cheese also has its own health benefits. It is rich in cancer-preventing conjugated linoleic acid and sphingolipids, fights tooth decay, and helps maintain bone strength.

Like beer making, cheese making is both art and science. If anything, there is even more art to making cheese because it requires practice to master the various steps. So this chapter is enough to get you started, but you'll likely want to branch out once you've mastered the techniques covered here.

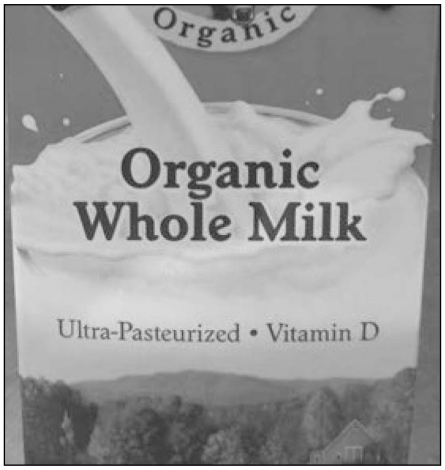
What Is Cheese?

Cheese is the coagulated fat and protein from the milk of domesticated dairy animals. The fats and proteins of milk are coagulated in various ways for the manufacture of different types of cheese. In some cases, a bacterial culture is added. The bacterial culture consumes lactose to make lactic acid; this lactic acid causes the coagulation.

In other cases, rennet is added. Rennet is a complex mixture of enzymes that likewise coagulates milk. In yet other cases, an acid such as citric acid, tartaric acid, or even vinegar is used to cause coagulation. Though the products of these various methods of coagulation are markedly different, they are all cheese because they have in common the coagulation of milk.

Milk: Where It All Begins

In the United States, cows are the usual source for milk; goats are utilized to a lesser extent. In other countries, the milk of bison, buffalo, sheep, horses, yaks, and other animals are also used. The nature of the milk of different species varies appreciably and this is reflected in the character of the cheese produced. Theoretically, you could make cheese using the milk of any mammal; I wouldn't attempt



Most organic milk is ultra-pasteurized, making it unsuitable for cheese.

this until you get good at making cheese from well-characterized herbivores such as cows and goats. Not only that, trying to milk a tiger or a bear is probably more dangerous than warranted.

Likewise, the components of the milk will vary between different breeds of dairy cattle. Even the milk of a particular cow will vary with season and diet. Probably the most striking example of this was in the cream cheese my grandmother would make from cows that had been eating wild onions. The smell and taste of the wild onions was transferred to the milk and hence to the cheese. In the case of cream cheese, the results were delicious!

It is important to know that though pasteurized milk is fine for making cheese, the ultra-pasteurized milk that you find in the store is unsuitable. This is unfortunate, because it is the organic brands that tend to be ultra-pasteurized. Ultra-pasteurization is used to extend the shelf-life of expensive milk that doesn't sell very quickly. Unfortunately, that process damages the protein in milk so extensively that it is unsuitable for making cheese.

Milk from other animals can certainly be made into cheese, but doing so would require changes in timing, temperature, quantities of ingredients, and so forth that are simply too extensive to be treated in a single chapter.

So we are going to use pasteurized, homogenized cow's milk from the grocery store as the learning medium for your first forays into cheese making. After you have mastered these skills, you can branch out from there. You can find specific types of milk suitable for your needs by finding a local dairy at www.smalldairy.com.

About Raw Milk

Cheese connoisseurs insist that the best cheeses are made from raw milk that has been neither pasteurized nor homogenized. The trouble is that raw milk is not readily available and quite often there are legal impediments to buying it directly from farmers. The basis for these legal impediments is widespread recognition of the likelihood of the presence of pathogens in raw milk.

In former times the largest risks of raw milk were brucellosis and tuberculosis; today the risks are e. coli, salmonella, and listeria. Testing of vats of milk in modern times shows that even from healthy cows, anywhere from 0.87% to 12.6% of raw milk harbors dangerous pathogens.[27] How do healthy cows give pathogen-infested milk? They don't. Inadequate sanitation and cleaning of equipment introduces fecal bacteria into the milk. The reason pasteurization became a requirement in the first place was that farmers were actively falsifying their records so that tuberculosis-infected cows wouldn't have to be removed from milk production.[28]

The reason it continues to be required is because human nature hasn't changed, and

[27] Position Statement on Raw Milk Sales and Consumption, Cornell University Food Science Department

[28] "Not on My Farm!: Resistance to Bovine Tuberculosis Eradication in the United States," Alan L. Olmstead and Paul W. Rhode, January 2005, *The Journal of Economic History* (2007), 67 : 768-809 Cambridge University Press, Copyright © 2007 The Economic History Association, doi:10.1017/S0022050707000307

maintaining sanitation on an industrial scale of a biological product created by an animal that excretes feces requires extreme levels of conscientiousness that cannot be guaranteed. In essence, because the healthiness of cows and their milk can be tested to assure a safe product without pasteurization, it is possible to sell perfectly healthy raw milk. But pasteurization is required anyway to compensate for the existence of lazy or dishonest people that will prioritize the production of a single infected cow over the health and well-being of their customers. I'm quite sure most people would do the right thing, but in an industrial system where the outputs of various farms are mixed together, it only requires one feces-contami-nated vat to sicken thousands of people.

Obviously, raw milk that does not contain pathogens can be made. Humans have consumed raw milk for thousands of years before pasteurization was invented. Such milk was collected at home by the end users, so there was a direct correlation between shoddiness and adverse consequences that would result from collecting milk in a bucket that wasn't clean. The milk was used immediately rather than transported thousands of miles, so any pathogens present had less opportunity to multiply to dangerous or infective levels. It is therefore possible to obtain raw milk that will not make you sick, provided it is supplied by an honest and conscientious farmer.

How to determine if someone is honest and conscientious, I can't say. If I could write a book describing a sure-fire technique of that sort, personnel managers across the world would rejoice. In the absence of that, I would instead look at the idea of mutual self-interest. If a farmer were to sell you raw milk that made you sick, your family could sue him into oblivion. So it is in his best interest, if he sells raw milk at all, to make sure it is pristine. Many such farmers use small-scale low-temperature vat pasteurization just to be sure, and this process is less damaging to the milk proteins than standard pasteurization processes.

One other layer of protection is to only use raw milk to make hard cheeses that are aged for longer than two months. The process of cheese-making, when combined with the conditions of aging in cheese, serve to eliminate potential pathogens and render the cheese safe. This only applies to aged hard cheeses! Soft cheeses and those eaten less than two months from manufacture should be considered as risky as raw milk, and I personally avoid making cheese from raw milk, but that's an individual choice.

If you use raw milk in cheese-making, there are only two procedural changes you'll need to adopt. The first is that you can avoid using calcium chloride (described later), and the other is that when heating the milk, especially for ther-mophilic cheeses, you will need to top-stir the milk. Top stirring is just slowly dragging a utensil across the top quarter-inch of milk in order to keep the milk fats from separating out.

To find raw milk, I recommend the following Internet resources:

- A Campaign for Real Milk: www.realmilk.com
- The Weston A. Price Foundation: www.westonaprice.org
- Farm-to-Consumer Legal Defense Fund: www.farmtoconsumer.org

Categories of Cheese

Cheese can be categorized in various ways depending upon the substances from which it is made, its appearance or consistency, whether it is aged or eaten fresh, and the procedures used to produce it. For our purposes, we will use fresh and aged cheeses as categories, as well as soft and hard cheeses, since these categories have the greatest differentiation.

Quality ingredients and equipment will contribute to a quality product.

Equipment

When it comes to the equipment needed to make cheese, quality matters. The good news is that most of this equipment is a once-in-a-lifetime purchase. You will likely end up ordering most of these items over the Internet because you may have difficulty finding them locally.

Measuring Cups and Spoons

You want both a large (2+ cup) and small (1 cup) Pyrex glass liquid measuring cups. You will also need measuring spoons, but not the ordinary cheap ones you get at the dollar store. You want high-quality stainless steel measuring spoons that measure in 1/32, 1/16, 1/8, and 1/4 teaspoon increments, as well as the traditional sizes.

I have noted by comparing volumes to my laboratory standards that cheap measuring spoons are often undersized or over-sized. This is not a critical matter when making a cake; when making cheese it can spell the difference between success and failure.

Large Double Boiler

With batches of cheese starting with a gallon of milk or less and that use a mesophilic starter culture (more on starter cultures later), you can get by with a standard large pot that you set in a sink of hot water. For batches of cheese requiring more than a gallon of milk or using a thermophilic starter culture, you will need a double-boiler. In cheese-making, this double-boiler is also called a "cheese pot" For very small batches of cheese starting with a quart of milk, you can improvise by setting a smaller pot into a larger one as long as the handles on the smaller pot will sit on the lip of the larger pot so the smaller one is surrounded by water.

Again, depending on the size of your largest intended batch of cheese, you may be able to use a double-boiler as small as eight quarts. But because it takes a large amount of milk to make enough curd to yield very much hard cheese after pressing, you won't go wrong with a boiler as large as 20 quarts. No matter what size you use, make sure it is stainless steel because acidified milk will leach aluminum or iron into your curd and impart metallic flavors.

If you don't already have a double-boiler, this is probably the most expensive item you'll need to get. Searching the Internet, I found prices ranging from $88 to $130 for a 20-quart model. It won't come cheaply, but you'll be thankful that you got it. You can use it for batches of cheese starting with anywhere from one gallon to four gallons of milk, and its configuration will help to hold temperatures steady while preventing scorching.

Colander

You'll need a large eight-quart colander that will fit into the cheese pot with the handles resting on the edges of the pot. You'll use this to separate the curds from the whey, with the whey going back into the pot.

Special Utensils

You need a large stainless steel slotted spoon, a stainless steel skimming ladle, and a stainless steel curd knife. This latter utensil is specialized so you will probably have to get it via an Internet source.

Cheesecloth

You want high-quality coarse (20 thread count) and fine (60 thread count) cheesecloth. The fine cheesecloth is used for making soft cheese such as cream cheese; the coarse cheesecloth is used to hold harder cheeses during the pressing or curing process.

Cheesecloth is packaged in two-yard increments, so you get a piece that is three feet wide and six feet long. Cut off pieces as needed with good scissors. Before use, cheesecloth must be sterilized. Put it in a pan of water, boil for five minutes and then dump the cheesecloth and water into a colander in the sink. Cheesecloth can be re-used. Rinse it under cool running water, work a few drops of dish liquid into it, rinse it thoroughly, and boil it for five minutes. After boiling, hang it up to dry, then store the dried cheesecloth in an airtight bag. Don't forget to sterilize it before using it again.

Bamboo Sushi Mats

These allow good air circulation for cheese that is either draining or aging, and is essential in making hard cheeses. Luckily, they are inexpensive at $4 each or less. They can't be sanitized and should be discarded after use.

Cheese Wax or a Vacuum Sealer

Cheese wax is used to protect the cheese from air while it ages. This is a special kind of wax that melts at a low enough temperature that it won't hurt the cheese when you brush it on. Don't try to substitute canning wax for this! Another alternative is to use a vacuum sealer to seal the cheese in an airtight bag from which all air has been evacuated. That's what I do because it is more convenient than waxing.

Two types of cheese press

Cheese Press and Mold

A cheese press is used to knit the curds together into a solid mass while expelling excess whey. There are a variety of designs of varying expense and complexity. A search on the Internet will even reveal many free design plans for making your own.

For most of the batches of cheese I've made, I have used a simple plastic press and mold that only cost $21. The downside is that you have to use external weights with it. Still, you can't beat it for the price and ease of use. Recently, I have acquired a stainless steel press made by Wood Lab that works very well.

Instant-Read Digital Thermometer

Temperatures are critical when making cheese. Some types of cheese require gradually raising the temperature or holding at a certain temperature for a specified time. The best thermometer for such purposes is one that gives you an instant and accurate reading. A good digital thermometer is not expensive.

I have a "Norpro electronic digital read thermometer/timer" that cost $16 and a hand-held Hamilton Beach instant-read digital thermometer. Both cost under $20, have stainless steel probes that are easy to sterilize, and can be found at cook-ware stores.

Dedicated Small Refrigerator

Traditionally, many styles of cheese were quite literally aged in caves. Caves maintain a constant temperature and humidity throughout the year. Most of us don't have access to a suitable cave, and we don't have an area in the house that will reliably maintain a certain temperature for months on end.

If you decide to make cheeses requiring aging, you will find a dedicated refrigerator indispensable. A second-hand dormitory-sized refrigerator and an external thermometer set up to turn it on and off as needed will work perfectly for such an endeavor. A refrigerator dedicated to cheese-making is called a "cheese cave."

Ingredients

Not all of these ingredients are needed for all cheeses, but you'll want them on-hand. Some of these you may already have from your excursions into wine, beer, and vinegar making.

Vinegar, Lemons, and Tartaric Acid

These common acids are used to make soft cheeses via the direct acidification method. In this method, the milk is heated to a certain temperature, a measured amount of acid is added and stirred into the milk, and then the milk clots after a period of time. This clotted milk is poured into a colander lined with cheesecloth; the cheesecloth is tied into a bag. The bag is hung in a warm place for the whey to drain out of the soft curds. These are among the easiest cheeses to make, and they work especially well as dips and spreads.

Calcium Chloride, 30% Solution

When milk is pasteurized, the calcium ion balance is upset in the milk, which can impede proper curd formation. A small amount of calcium chloride solution diluted further in distilled water and mixed into the milk can correct this imbalance.

You can order food-grade calcium chloride and make the solution yourself (percentages are by weight!), or you can order the pre-mixed solution from various Internet stores specializing in cheese making supplies.

Calcium chloride, incidentally, is also an ingredient in some ice melting pellets used to melt the ice on sidewalks and driveways. This is a very crude product that isn't suitable for human consumption, so make sure you get food grade calcium chloride.

Flaked or Canning Salt

Salt is used as a flavor enhancer, a bacteriostatic preservative, a modulator for enzymatic action, and it helps expel water from cheese curds through osmotic pressure. Special "flaked" cheese salt is available, but canning salt or Celtic sea salt will do as well.

The important thing is to avoid the ordinary salts in the grocery store because not only do many of them contain iodine, they often contain anti-caking agents and other chemicals that could interfere with cheese-making. So anything you use should be purely salt.

Starter Culture

You can buy starter culture in packets from a supplier, or you can make your own from buttermilk and yogurt. Starter cultures are either mesophilic (meaning "medium heat-loving") or thermophilic (meaning "high heat-loving"). Starter culture is an inoculant containing a mix of bacteria that eat the lactose in milk and excrete lactic acid. The first purpose of these bacteria is to lower the pH of the milk in order to encourage curd formation. The second purpose is the continuing development of flavor characteristics during the making and aging of the cheese. The nature of the starter culture strongly influences the flavor of the cheese.

Mesophilic starter cultures work best at room temperature—around 72 degrees. They usually contain at least *Streptococcus lactis,* and many also contain *Streptococcus lactis* var. *cremoris* along with other lactic acid bacteria such as *L. delbrueckii* subsp.

lactis, L. lactis subsp. *lactis* biovar *diacetylactis,* and *Leuconostoc mesenteroides* subsp. *cremoris.*

Streptococcus lactis is used to make cultured buttermilk; therefore fresh buttermilk with active live cultures can be used to make a mesophilic starter culture for cheese-making. Cheeses that begin with a mesophilic starter include farmhouse cheddar, edam, stilton, and Monterey Jack, among others.

Thermophilic starter cultures work best at temperatures above 80 degrees and below 130 degrees. A specific recipe will dictate the best temperature within this range for the particular cheese being produced, but the culture works best at 110 degrees. Exceeding 130 degrees may kill a thermophilic culture. This culture may like heat, but it doesn't want to be scalded or boiled. Thermophilic starters are used to create Swiss and Parmesan cheeses among others. *Streptococcus ther-mophilus* is a common bacteria in thermophilic starter cultures, but *Lactobacillus delbrueckii* subsp. *bulgaricus, L. delbrueckii* subsp. *lactis, L. casei,* and *L. plan-tarum* are all used.

Yogurt is made with thermophilic bacteria. One prominent brand of organic yogurt uses six live cultures that include *Streptococcus thermophilus, Lactoba-cillus delbrueckii* subsp. *bulgaricus,* and *L. casei.* This means that plain yogurt can be used to make more yogurt, and it can also be used to make a thermophilic starter culture for cheese.

If you opt to buy starter cultures from a cheese-making supply store instead of making your own, there are only two important things you need to know: You want the sort of culture called a "direct vat" culture, and you should put it in the coldest part of your freezer the very second you get it. Keep it in the freezer until ready for use.

Rennet

Rennet is an enzyme that was originally derived from the stomachs of suckling animals. It is a proteolytic enzyme that breaks protein bonds in such a way as to turn liquid milk into solid curds. All infant mammals produce rennet. This turns milk into a solid form that stays in their digestive tract longer. That's why when a baby spits up milk, it has mysteriously turned into a clumpy solid. Babies of all mammals have miniature internal cheese factories.

In practice, animal rennet is a byproduct of veal production. Animal rennet of this sort is extremely perishable and has to be kept refrigerated. It's also pretty expensive.

Rennet can also be made from certain fungi and plants. The sort made from plants has to be made fresh on the spot, which may not be feasible during winter or if you can't find the plants. For our purposes I am recommending vegetable rennet, which is actually made from fungi. It is inexpensive and if you put it in the freezer it will stay good for about six months. It comes in tablets that can be divided into halves and quarters; this must be done carefully as it has a tendency to disintegrate.

Rennet is an extremely powerful enzyme. Tiny quantities will clot gallons of milk. When adding rennet, dissolve the required amount into a quarter cup of distilled water over a period of 20 minutes, then sprinkle it over the surface of the milk. Mix it into the milk using up-down and back-and-forth motions rather than swirling because swirling doesn't mix as efficiently It's important that rennet be mixed efficiently because otherwise the curd it forms will be of uneven consistency.

How to Make Rennet from Nettles

In a pinch, you might need to make your own rennet from nettles. This rennet works, but it doesn't give as clean a break or as solid a curd.

Put a pound of stinging nettle tips in a large pot and cover with water. Bring to a light boil and boil until the volume has been reduced by half. Filter through cheesecloth into a clean container. You can keep this in the refrigerator for up to two weeks. You use one cup per gallon of milk to be curdled.

Other Cultures and Enzymes

As your cheese-making expertise increases, you'll want to try to make specific types of cheese. Toward that end, you will need different cultures and enzymes.

Lipase is an enzyme that splits milkfat into free fatty acids. It develops a characteristic picante flavor in the manufacturing of feta, blue, mozzarella, and provolone cheeses. Like rennet, it is extremely powerful. Unless a recipe directs otherwise, use between 1⁄16 and 1⁄8 tsp of the powder per gallon of milk. Dissolve the powder in a half cup of cool water for 30 minutes prior to use. Lipase is added immediately before rennet by sprinkling it on top of the milk and mixing it in using an up-down and back-and-forth motion.

Propionic Shermanii culture is used to create the characteristic holes and flavor of Swiss cheeses. As it ferments, it creates carbon dioxide that expands to create the holes. This is added to thermophilic starter culture at the rate of 1⁄16 tsp per gallon of milk.

Not all mesophilic or thermophilic starter cultures are created equal. The specific varieties of bacteria make a difference in the ultimate flavor of your cheese. As you learn more about cheese, you will want to try other starter cultures.

Practical Cheese Making Techniques

In this chapter, I am going to progress from the easiest and least time-consuming techniques to the more involved, using a few examples. By mixing, matching, and varying these techniques you can make a wide array of interesting cheeses. Buttermilk and yogurt are an ideal starting place because both can be used to make other cheeses while saving money on starter cultures.

How to Have a Lifetime Supply of Buttermilk and Mesophilic Cheese Starter

I have always loved cultured buttermilk. Its thick consistency with sweet-tartness is irresistibly delicious, and it makes wonderful pancakes as well! Buttermilk costs 70% more than regular milk, so if you like it, you can save money by making your own.

Start with cultured buttermilk from the store that uses live cultures. You can make any amount of buttermilk you'd like from this by re-culturing. To re-culture, put the amount of milk you would like to turn into buttermilk into a stainless steel container. Either use a double-boiler or put the container of milk into a sink of hot water, and raise the temperature to 86 degrees.

Hold at 86 degrees for ten minutes, then add ¾ cup of buttermilk per quart of milk. (1½ cups of buttermilk for a half-gallon and 3 cups of buttermilk for a gallon.) Remove the milk from the heat, cover with cheesecloth to keep out bugs but allow oxygen, and allow it to sit at room temperature undisturbed for twelve hours.

That's it. Really. If you refrigerate it after the twelve hours are up, it will keep in the refrigerator for up to two weeks. Anytime you want more buttermilk, just repeat this procedure using a bit of the buttermilk you already made and you can have buttermilk forever unless your supply becomes contaminated.

Anytime a cheese recipe calls for "mesophilic starter" you can use your buttermilk at the rate of four ounces of buttermilk per one gallon of milk that you'll be turning into cheese. It is possible to freeze buttermilk for use later to make cheese, but I don't recommend that as the viability of the culture becomes spotty. I recommend using only unfrozen buttermilk to make cheese.

How to Have a Lifetime Supply of Yogurt and Thermophilic Starter Culture

Yogurt is a bit more difficult to make than buttermilk because it requires the yogurt-in-progress to be held at a higher temperature for a long time. A yogurt-making machine can help, or make the yogurt on a weekend. If your family uses a lot of yogurt, it may be worthwhile to purchase a yogurt machine for less than $100. Yogurt costs anywhere from 300% to 400% more than milk, so if you eat a lot of yogurt you can save a lot of money by making your own.

You can make yogurt successfully from plain yogurt from the store, or you can buy a starter culture for the specific type of yogurt you wish to make. Viili culture produces a thick but mild yogurt similar to what you you mostly see in stores, whereas

Piimä culture makes a thinner, drinkable yogurt. There are many other cultures available, but no matter how you start your first batch, yogurt cultures are serial cultures, meaning that you can continue to propagate them indefinitely simply by using a quantity from the last batch to make the next.

If you decide to use plain yogurt from the store to make more yogurt, please read the ingredient label carefully to make sure you are buying a product made only from milk and cultures. There are some yogurt brands whose "plain" yogurt contains adulterants and other ingredients that won't be helpful. Pectin is often used as a thickener and this is okay.

First, heat your milk to 185 degrees in a double boiler while stirring often. This is to kill off competing organisms. Then, remove the milk from the heat and allow it to cool to between 105 and 122 degrees. Once it is between these two temperatures, add either your starter culture according to package directions or ¾ cup of live yogurt per gallon of milk. Pour the mixture into cleaned and sterilized quart canning jars, and adjust the two-piece caps for a seal. Keep the temperature of these containers at 105 to 122 degrees for the next eight hours. The temperature can be maintained by filling the sink with water at 120 degrees, and then adding a bit of boiling water to the water in the sink whenever the temperature drops below 110 degrees. After eight hours, put your jars in the refrigerator where the yogurt will keep for two weeks.

Maintaining this temperature for so long will be difficult, but the bacteria have a better sense of humor than most regulatory agencies, so as long as you keep the temperature above 98 but below 130, your yogurt will still be fine. To maintain this temperature you can use the sink method already mentioned, a mattress heating pad or an electric blanket; be sure you keep an eye on things and check frequently so it doesn't overheat. Or, use your oven if it can maintain temperatures under 120. A slow-cooker with water on the lowest setting may also work by setting the jars in water in the slow-cooker and watching the temperature. The key is to improvise creatively.

The yogurt you create is plain yogurt. You can mix anything with it you'd like—fruit, nuts, granola, sweeteners, etc. If you decide to use it as a thermophilic cheese starter, use four ounces of your fresh plain yogurt per gallon of milk that you will be turning into cheese.

Okay, Let's Make Some Cheese!

There are literally hundreds of types of cheese, all of which require differences in procedure, technique, or ingredients. Rather than try to cover all of it, I am going to illustrate how to make four representative cheeses that are easily made at home using the ingredients and equipment described. Between these four cheeses, all of the basic techniques will be covered, and you will gain enough experience to experiment and branch out.

I am going to cover a direct acidification soft cheese. Using the same principle, you could make a soft cheese using a different acid. Then, I will demonstrate a soft cheese using a starter culture. Next, I will demonstrate a minimally-aged hard cheese using both starter culture and rennet. Finally, I will describe making an aged cheddar cheese and most importantly the cheddaring technique.

Soft Cheese by Direct Acidification: Queso Blanco

Using a double boiler, raise the temperature of one gallon of milk to 180 degrees while stirring so the milk doesn't precipitate protein. Add ¼ cup of vinegar by slowly dribbling it into the milk while stirring. (You can use distilled vinegar or some of your homemade vinegar. For a different taste, you can use the juice of 3-5 lemons.) Continue to stir for

Raising the temperature to 180 degrees before adding the vinegar. Notice the cheesecloth boiling on the right.

The clotted milk draining in the colander.

I have a hidden hook under my cabinets for hanging cheese to drain.

This easy cheese is great on bagels or mixed with herbs as a vegetable dip.

ten to fifteen minutes until the milk is completely clotted. If the milk doesn't clot, add up to four more tablespoons of vinegar while mixing for another ten to fifteen minutes.

Meanwhile, prepare cheesecloth by boiling in a pan of clean water. After boiling, use the cheesecloth to line a colander. Pour the clotted milk into the cheesecloth-lined colander, allowing the liquid to go down the sink. After the cheese has cooled, form the cheesecloth into a bag, and hang it over a bowl until liquid no longer drains out of the bag. (This works best at standard room temperature. If the temperature is too cold, the cheese won't drain well. This process should complete within five to seven hours.)

Scrape the cheese out of the cheesecloth into a clean, covered container. Add and mix salt, dried herbs such as garlic powder, dill, or basil into the cheese as desired. This is what is called a "fresh" cheese and it should be refrigerated promptly after making. Use within a week to avoid spoilage. Because of all the different things you can mix with this, it is a very versatile cheese that can be used for bagels, dips, and dressings.

Soft Cheese using Yogurt Starter Culture: Farmer's Cheese

Add ½ teaspoon of 30% calcium chloride solution to ¼ cup of water, and mix thoroughly with one gallon of milk in a double boiler. Using the double-boiler, raise the temperature of the gallon of milk to 105 degrees. While the milk is heating, dissolve ¼ of a rennet tablet in ¼ cup of cool non-chlorinated water. Once the milk has reached 105

I'll add the yogurt once the milk reaches 105 degrees. You could also use commercial thermophilic starter culture for this step.

Here I am adding the dissolved rennet by pouring it slowly through a slotted spoon for better distribution.

The horizontal cuts are being made by tracing the grid with the knife held at a 45 degree angle.

The curds will release whey and shrink. The metal device is the temperature probe.

The cheese is being mixed with flaked cheese salt.

degrees, keep it there for five minutes and then add one cup of plain yogurt, stirring it in thoroughly. Keep the temperature at 105 degrees for ten minutes, then turn off the heat.

Once the temperature has dropped to 95 degrees, add the rennet by sprinkling it over the milk and mixing using a gentle up-down and back-and-forth motion. Remove the pot and cover it with the lid. Allow the mixture to set for about an hour and then check for the development of the curd. Check the curd by inserting a clean and sterile blunt object (such as a glass candy thermometer). If it can be withdrawn cleanly without anything sticking to it, and the hole it makes doesn't immediately fill with liquid, the curd is ready and you have what is called a clean break. If the curd isn't ready, allow the pot to set while covered for another fifteen minutes and check again.

Now that you have a clean break, you need to cut the curd. The purpose of cutting the curd is to allow for uniform drainage of the milk liquid (known as whey) from the curd. (Yes, this is the famous "curds and whey"—a primitive predecessor to cottage cheese—likely eaten by Miss Muffet in the nursery rhyme.)

Your goal in cutting the curd is to cut the curd into uniform-sized curds for even drainage of whey. In general, the smaller you cut the curds initially, the harder the style of cheese you are making; though there are practical limits. In this case, you are cutting the curd into one-inch cubes. Do this by using your curd knife to first cut a grid at right-angles the entire depth of the curd so you end up with a one-inch checkerboard pattern. Then, make horizontal cuts by positioning your curd knife at a 45-degree angle and cutting along one row of parallel lines in your grid. Though there are all sorts of other ways to do this and special gear you can buy, it is really that simple.

Once your curd is cut, cover the pot again and allow it to sit for another fifteen minutes so some whey can gather at the bottom of the pot. Then, put your pot back into the double boiler and slowly, over a period of 30 minutes or so, raise the temperature of the curds to 110 degrees. As the curds are heating,

I used a 2.5 pound weight on the cheese press, and it worked fine.

The completed cheese before wrapping it in plastic and storing in the refrigerator.

gently—very gently so you don't break them— use your slotted spoon to stir the curds in such a way as to exchange those on the top with those on the bottom in order to promote even heating. Once the curds have reached 110 degrees, keep at that temperature for thirty minutes while gently mixing every five minutes or so. You will notice the curds getting smaller and the amount of whey increasing. While this process is ongoing, prepare a large piece of cheesecloth by boiling.

Line your colander with a double-layer of cheesecloth, and gently pour the curds and whey into the colander. You can save the whey for baking later, add it to your compost pile or let it go down the sink. (If the whey is greenish, do not be alarmed—this is normal!) Let the curds drain in the colander for an hour or so, then put the curds into a bowl and salt to taste, turning the curds evenly for uniform distribution. I prefer sea salt for this, but you can also use cheese salt or canning salt. Do *not* use regular table salt (iodized or not) because it will make your cheese taste bitter.

Prepare some more coarse cheesecloth by boiling, and then use a double layer to line your clean cheese mold. Add the curds to the mold, fold the cheesecloth over top of the curds, and put the top of your mold on top of the cheesecloth. Put your mold in a shallow pan (a disposable pie plate would be ideal) to catch whey that is expelled. Add two pounds of weight on top of the mold, and place the whole works in the refrigerator.

Once the cheese and press have been allowed to work in the refrigerator for four or five hours, turn the cheese out of the mold, unwrap it, and place in a closed container in the refrigerator. Use within a week.

Hard Minimally Aged Cheese Using Mesophilic Starter: New Ipswich Jack

Mix one teaspoon of 30% calcium chloride solution into a quarter cup of water, and mix with two gallons of milk in a double-boiler. Bring the temperature of the milk up to 85-90 degrees, and add either ½ tsp of powdered mesophilic starter or one cup of fresh cultured buttermilk, mixing thoroughly. Cover the mixture and allow it to ripen for 30-40 minutes while maintaining the temperature between 85 and 90 degrees.

While the mixture is ripening, prepare your rennet solution by mixing ½ tablet of rennet with ¼ cup of cool non-chlorinated water. You'll know the mixture has ripened by the fact 30–40 minutes have passed and it smells like buttermilk or yogurt. Once the mixture has ripened, add the rennet solution by dripping it around the milk and mixing it gently but thoroughly using up-down and back-and-forth motions. Continue to maintain a temperature of 85 to 90 degrees while allowing the mixture to sit covered for an hour. At this point, the curds should give you a clean break.

Use your curd cutting knife to cut the cubes into ¼-inch cubes. Continue holding the temperature at 85 to 90 degrees for another 40 minutes while gently stirring the curds every five minutes or so. Keep the curds covered while not stirring or checking the temperature. You'll notice the curds shrinking and the volume of whey increasing.

Slowly increase the temperature to 100 degrees over a 30-minute period while stirring every five minutes or so. This amounts to about two degrees every five minutes. Hold the temperature at 100 degrees for another 30 minutes while stirring every five minutes.

Now, very gently so as not to damage or lose curds, pour off as much of the whey as you can. This may be easier to do with a helper holding back the curds using the slotted spoon while someone else tips the pot over the sink.

Put the pot back into the double boiler and continue to stir for another 30 minutes while maintaining the temperature at 100 degrees. Meanwhile, prepare a double-layer of course cheesecloth by boiling first, and use it to line a colander. Pour the curds into the cheesecloth-lined colander. Add two tablespoons of cheese salt and mix the curds gently.

Line your cheese mold with cheesecloth, and then pack the mold closely with the curds. Fold your cheesecloth over top of the curds, install the top of your mold, and put your mold in a shallow pan to catch the whey that will be expelled.

Put a ten-pound weight on top of the mold to press the cheese for fifteen minutes. Then, remove the cheese from the mold, take it out of the cheesecloth, flip it over within the cheesecloth, and put it back in the mold.

This time, press the cheese for 30 minutes with a thirty-pound weight. (I recommend stacking three 10-pound dumbbell weights as these are easier to handle.) Then, take the cheese out of the press, take it out of the cheesecloth, flip it again within the cheesecloth, re-cover it, and put it back in the mold. Press it this time with 40 pounds for twelve hours.

After this, take it out of the mold and cheesecloth, and lay it on a bamboo sushi rolling mat. Flip it on the mat once a day so that it dries evenly. After three to five days, it should be dry to the touch. Once it is dry to the touch, it is ready for aging.

This cheese should be aged at temperatures of from 50 to 60 degrees for anywhere from one to three months. Maintaining such temperatures is a tall order in most homes, but any temperature range from 45 to 68 will do. Luckily (at least in this respect) my house is old and drafty so I can age cheese in a kitchen cabinet anytime from November to April without need of maintaining a special environment.

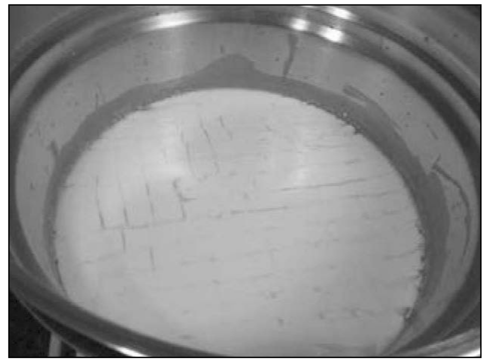
If, however, you happen to either live in a warmer climate or have a more energy-efficient home, you will likely need to create a cheese-cave from a dorm refrigerator as described earlier in this chapter.

Larger cheeses will form a natural rind that will protect them from invasion; smaller cheeses (like the size that we have made in this example) will need to be protected by either wax or plastic.

If using plastic, first wash the cheese using vinegar on a clean paper towel to reduce bacterial counts, then seal it in plastic using a vacuum sealer.

If you are using cheese wax, melt it by putting a small stainless steel bowl in a pot of boiling water

Despite a couple of imperfections in uniformity of coating, this waxed cheese is aging nicely.



The cut curds are starting to release whey.

and adding wax to the bowl. (This bowl will be almost impossible to clean after, so you might want to get a cheap bowl at a department store for this purpose.) After you have washed the cheese with vinegar, use a natural bristle brush to dip in the melted wax and then paint it onto the cheese. Once the wax has hardened on one side of the cheese, turn the cheese over and coat the other side. Check the cheese over thoroughly to make sure you haven't missed any spots and that the cheese is coated uniformly, and then set the cheese aside to age.

After this cheese has aged for a month, it is safe for people who are lactose intolerant; after it has aged for two months, it is safe even if made from raw milk.

Monadnock Cheddar

This cheese starts off identically to the New Ipswich Jack cheese, and the primary variance starts with the cheddaring process. Mix one teaspoon of 30% calcium chloride solution into a quarter cup of water, and mix this with two gallons of milk in a double-boiler. Bring the temperature of the milk up to 85–90 degrees, and add either ½ tsp of powdered mesophilic starter or one cup of fresh cultured buttermilk, mixing thoroughly. Cover the mixture and allow it to ripen for 45–50 minutes while maintaining the temperature between 85 and 90 degrees.

While the mixture is ripening, prepare your rennet solution by mixing ½ tablet of rennet with ¼ cup of cool non-chlorinated water. Once the mixture has ripened, add the rennet solution by dripping it around the milk and mixing it gently but thoroughly using up-down and back-and-forth motions. Continue to maintain a temperature of 85 to 90 degrees while allowing the mixture to sit covered for 45 minutes. At this point, the curds should give you a clean break. If not, allow to sit for another 15 minutes and test again.

Use your curd cutting knife to cut the curd into ½-inch cubes. Slowly increase the temperature to 97 to 100 degrees over the next 40 minutes while gently stirring the curds every five min- utes or so. Keep the curds covered while fc not stirring or checking the temperature. You'll notice the curds shrinking and the volume of whey increasing. Hold this temperature for another 30 minutes while stirring periodically to prevent matting or clumping. During the last five minutes, don't stir so the curds can settle on the bottom.

Line a colander with boiled cheesecloth and put the colander over a large pot to collect the whey. Pour the contents of your double-boiler into the colander and put a lid on top to retain heat, and allow to sit for one hour. (Make sure that the level

The slabs are cut and being stacked.

The cheese slabs are stacked. You can see the liquid draining from them.

Cheese in the process of milling.

of the whey in the pot isn't high enough to actually touch the curds. Any excess whey can be drained or put in your compost pile.)

Here is the the distinctive process that makes cheddar cheese and it is called "cheddaring." At the end of an hour you'll notice that the curds have amalgamated into a solid mass. Cut the mass of curd into slabs about ¼ inch thick. Stack the curds like dominoes and cover with the cheesecloth. Every fifteen minutes, rearrange the stack so the slabs that were outside are now inside, and those that were on the top are now at the bottom. After four or five rounds of this, the texture should resemble very firm tofu or turkey breast.

After the cheese slices have reached the desired texture, they need to be milled. That just means you need to cut these slices up into chunks about the size of a pea. Put the milled curd in a bowl and sprinkle with 1 ½ teaspoons of flaked salt while gently rolling the curds around for uniform distribution.

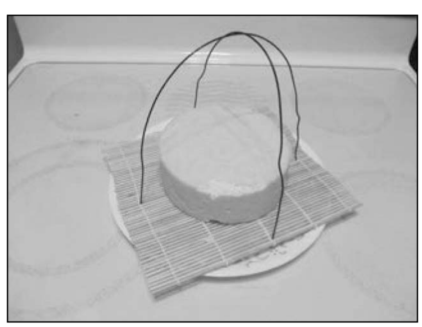
Line your cheese mold with cheesecloth, and then pack the mold closely with the curds. Fold your cheesecloth over top of the curds, install the top of your mold (also called the follower), and put your mold in a shallow pan to catch the whey that will be expelled.

Put a ten-pound weight on top of the mold to press the cheese for fifteen minutes. Then, remove the cheese from the mold, take it out of the cheesecloth, flip it over in the cheesecloth, and put it back in the mold. Press with the ten pounds of weight for another 45 minutes. The reason we use a light weight at first is to prevent expelling fat with the whey.

Then, flip over the cheese in the cloth, and increase the weight to 40 pounds for 24 hours. The next day, flip the cheese again, and continue to press with 40 pounds for another 24 hours. So in total, the cheese has been pressed for two days and an hour.

Now, remove the cheese from the cloth, wipe it down with either vinegar or a brine solution using a clean cloth, and place it in a protected room-temperature place on a bamboo mat for a day or two until a rind starts forming. (You can make brine

The pressed cheese wheel on a bamboo mat.



A wire scaffold will hold the cheesecloth away from the cheese and keep flies away.

solution by mixing as much salt into water as the water will dissolve.) What I do to keep insects away is put a wire scaffold over the cheese and drape some cheesecloth over it. Once the rind has started to form, either coat the cheese with cheese wax or seal it in a plastic bag using a vacuum sealer.

Mature the cheese from one to three months. The ideal temperature for aging cheddar is 50 degrees. During the winter, this is the temperature of my porch so I'm lucky. You can age it at temperatures ranging from 45 to 60 degrees and it will come out fine.

Tip for Maintaining Temperatures

Reading books about cheese making, you'd think everyone owns a precisely controlled stove that allows maintaining temperatures within a single degree for hours on end. In the real world, maintaining temperatures is somewhat difficult. Using a double-boiler keeps the milk from scorching. Unfortunately, when you raise the temperature of the milk to, say, 90 degrees using a double boiler, if the inner container is left in the outer container the temperature will continue to rise well beyond that of the culture you are using even if you turn off the heat.

Once the milk has reached the higher end of the temperature range, simply remove the inner container from the outer container and set it on an unused burner on the stove. Check the temperature once in a while and if it seems to be going too low, just set it back in the outer container for a few minutes, and take it back out once the temperature is in the proper range. Because the amount of milk and water involved has a substantial thermal mass, usually this need not be done more than once for a particular waiting period.

Experiment and Keep a Log

A lot of times people want to make cheeses like those that they buy at the store. If you want to do that, there are a host of sites on the Internet that give specific recipes. But what I recommend instead, is that you experiment and keep a log. I have covered all the fundamental principles you need to know in order to make your own unique cheeses. Fresh cheeses have to be refrigerated to be safe and should be used in less than a week. Cheeses made from raw milk have to be aged for at least two months to be safe. Hard cheeses need to be pressed with increasing amounts of weight. But now, from just the four cheeses I have given in this chapter, you can think about the variations.

The Queso Blanco recipe was a direct acidification cheese made with vinegar. What would happen if, instead of adding vinegar, you added a mesophilic starter and held it at 88 degrees for an hour before pouring into the cheesecloth? It would certainly taste different!

The soft Farmer's Cheese described earlier used a yogurt (thermophilic) starter culture. What if you used the same technique, but instead used a buttermilk (mesophilic) starter and varied the temperature accordingly?

The Jack cheese recipe is pretty interesting. Don't you wonder what would happen if you used a thermophilic starter and some lipase instead of a mesophilic starter? How would it come out? What would it taste like? What would happen if you added a pint of heavy cream and a tablespoon of wine vinegar to one of the recipes?

So rather than copying other recipes, what I am encouraging you to do is follow the general principles I have described here to make your own and keep notes. I think you will be very pleasantly surprised at how easy it is to make astonishingly good cheese that is uniquely your own and can't be bought anywhere at any price. This is ultimately what will make cheese-making a worthwhile thing for a mini-farmer.

Dutch Oven Cooking

BY J. WAYNE FEARS

If you saw a TV commercial that advertised one cooking pot that would bake bread, steam vegetables, boil shrimp, fry eggs, stew wild game, and broil meats, chances are you might be interested. But what if the commercial went on to say that this non-stick pot could be used to cook a meal on your home stove, in your den fireplace, on the patio, in a campfire at a state park, or on family camping trips, plus it was guaranteed to last several generations of use? Your interest would probably peak and you would want to know a lot more about this magic pot.

The magic cook pot that can do it all is the Dutch oven.

J. Wayne Fears has counted on the Dutch oven to produce good meals throughout his outdoor career. It has never let him down.

This Magic Pot Is the Dutch Oven

There are a lot of different designs of cooking pots that are called "Dutch ovens." Some are modern aluminum pots designed to be used with modern stoves. Others are cast iron pots with legs that have been made famous by cooks on African safaris. (The real name for these pots is *potjie* and it dates back to the 1500s.) Yet others are cast iron pots with rounded bottoms that are designed to be used hanging over an open fire. And there are flat-bottomed cast iron pots designed to sit on a stove. These are often called kitchen Dutch ovens. I have used them all with satisfaction, while debating against their being called Dutch ovens.

Most outdoor cooks are in agreement that the real Dutch oven is made from heavy cast iron, or aluminum, with a flat bottom sitting on three short legs protruding about two inches. It has a strong wire bail. The lid is made of the same heavy cast iron and has a small loop handle in the center. The rim of the lid is flanged so that hot coals will stay on the lid while cooking. Many people call these ovens "camp Dutch ovens" to distinguish them from other so-called Dutch ovens. For the purpose of this book this is the Dutch oven we will be talking about.

The Dutch oven has been piquing cooks' interest for many centuries. It has been used in this country since the first settlers began exploring the Atlantic seaboard. Today, 21st-century cooks are finding the "old-fashioned" Dutch oven just as much fun and valuable as did the colonial cooks who depended upon the pots to cook all their meals. While we don't have to stoop over a fireplace full of hot coals to cook a meal, cooks around the world are discovering the joy and good taste that come with cooking in a Dutch oven. Whether they are used for cooking for a party on the patio, cooking on a camping trip, or cooking in an emergency when the utilities are not working, the Dutch oven produces great-tasting food with a small amount of effort, and its use is a fun family activity.

My Life with Dutch Ovens

My earliest recollection of the Dutch oven was as a small child growing up in the mountains of Alabama. My dad was a trapper and, occasionally, would take me on his trapping expeditions. He had the simplest of camping gear but his camps were comfortable and the meals always good and plentiful. His cook kit was an old 10-inch cast iron Dutch oven. The night before we would leave to run his traps, I would lie awake in my bed too excited to sleep. I would visualize the old Dutch oven steaming on the campfire, full of stew. I could smell the hoe-cake he would be cooking on the inverted oven lid sitting on a small bed of coals. Morning would not come quick enough. He was a master at cooking in the black pot and today, more than 50 years later, I use the same Dutch oven to cook for friends and family on my patio. Every time I cook in the pot I think about those long-ago adventures with my dad, and the many meals we shared that were prepared in his Dutch oven.

A lot of pots, as shown, are called Dutch ovens, but most Dutch oven cooks only consider the one on the left area, Dutch oven.

At the age of eleven I joined the Boy Scouts and was surprised that Dutch cooking was a part of the skill training required if you were to be an active member of Troop 70. By the time I earned the rank of Eagle, I could cook up a pretty fair meal for a patrol-size group of scouts using a couple of Dutch ovens. It was during this period I was introduced to aluminum Dutch ovens and learned how to use them in conjunction with the cast iron ovens.

As I reached adulthood, I found the Dutch oven continuously part of my life. The cooking skills I learned in Troop 70 would come in handy countless times in the future. A career that combined wildlife management with outdoor writing found me working in remote camps throughout the world. From the frozen Arctic to southern Argentina I would work out of camps that depended on the Dutch oven to provide hungry outdoorsmen with good-tasting, wholesome meals. For several years I worked as an outfitter and guide with backcountry operations in Alaska, British Columbia, Colorado, Georgia, and Alabama. To feed my guests, I depended upon various sizes of cast iron Dutch ovens and was a constant student of Dutch oven cooking.

Dutch Ovens at Home

During the off-seasons I would bring my Dutch ovens home and store them by the fireplace in the family room of my home. Here they became the center of attention as visitors would ask about the "antiques" and whether I really used them. This gave me the idea to use the ovens to cook meals for dinner parties. Sometimes I would cook in the fireplace, as did our forefathers; on other occasions I would use charcoal briquets and cook out on the patio. These cooking sessions were always the highlight of the party and led to many of my friends becoming Dutch oven chefs. Also, it led to many Dutch ovens being sold for interior decoration rather than cooking purposes.

Today, Dutch oven cooking has become a favorite pastime for thousands of people from all walks of life. The Internet offers lots of Dutch oven cooking advice and recipes, some good, some bad. Dutch oven cook-offs have become popular gatherings for Dutch oven fans and tourists alike. Dutch oven enthusiasts have formed their own organization, the International Dutch Oven Society, to be a clearinghouse for Dutch oven information and to foster interest in Dutch oven cooking. For many people, Dutch oven cooking has become part of their recreational pursuit, for others—guides, cowboys, outfitters, back-to-the-landers, and people living in remote places—it is simply the way they cook hearty, wholesome meals daily.

Cow-camp cooks, hunting guides, and many others use a Dutch oven as a part of their daily routine.

Dutch Ovens in Print

Numerous writers have sung the praises of the Dutch oven. In 1906 famed outdoor writer Horace Kephart wrote in his best-selling book, *Book of Camping and Woodcraft,* "If it were not for its weight, [the Dutch oven] would be the best oven for outdoor use since it not only bakes but cooks the meat and pone in its own steam." The late and great camping writer John Jobson, wrote in *Sports Afield* magazine, "The Dutch oven is undoubtedly the most amazing, versatile, useful instrument ever conceived for tasty camp cooking." New Orleans chef and cooking writer George Prechter has written, "If I were to have to choose only one vessel in which to cook, indoors or out, it would be the Dutch oven." Ted Trueblood, one of America's best-known outdoor writers in the 1960s and 70s wrote in *Field & Stream* magazine, "The Dutch oven is the greatest piece of outdoor cooking equipment I have ever used." Well-known cooking author Sylvia Bashline once wrote, "The Dutch oven is the most versatile cooking utensil ever invented."

Don't Be Intimidated by the Learning Process

As you read this book Dutch oven cooking may, at times, sound like a lot of work and take a lot of time to master. That is not the case, and I would never want anyone not to give it a try because of this. Yes, it does take a little experience to learn to care for and successfully cook with Dutch ovens, but once you get it down, it can be one of the most fun cooking experiences you can have. In fact, it is the taking care of and the ever-expanding learning process that most Dutch oven cooks find most interesting. Spend time around a group of seasoned Dutch oven cooks and you will hear a lot of conversation about seasoning techniques, the best coals to use, cooking in the wind, and always, great newrecipes. So don't let the learning process scare you away from what may be a lifetime of fun and exciting eating. For many it is a hobby, and for a few it almost becomes a lifestyle.

Aluminum Versus Cast Iron

I can't believe what I am seeing," Barry exclaimed as he desperately tried to pull the aluminum Dutch oven from the fire.

We were on the first day of a five-day canoe trip down the Suwannee River. For cooking, we had packed two cast iron Dutch ovens and an aluminum Dutch oven in which to bake bread. In our haste to set up our first camp, my friend Barry had put the ingredients for a quick stew in a standard aluminum Dutch oven. To speed things up, he had placed the oven in the hot coals of our campfire. Then he placed a shovelful of hot coals on the lid.

As he helped with camp chores, a brisk wind blew through the campsite. The campfire coals glowed brightly. When he finally got around to checking on the stew he found the aluminum Dutch oven changing shape and the lid depositing hot pieces of molten aluminum into the stew. Needless to say, a lesson was learned that night, and we had peanut butter and jelly sandwiches for dinner.

The aluminum Dutch oven vs. the cast iron Dutch oven: you be the judge.

When most outdoor cooks think of Dutch ovens they think of the heavy cast iron Dutch ovens. However there are quality cast aluminum Dutch ovens, such as those made by GSI Outdoors, that have their place in outdoor cooking, provided you know their advantages and limitations. As I write this, GSI is introducing a line of new hard-anodized aluminum Dutch ovens that hold a lot of promise as they heat more evenly than standard aluminum Dutch ovens and they have a non-stick surface.

Advantages of the Aluminum Dutch Oven

There are several advantages that aluminum Dutch ovens have over their cast iron counterparts. But remember the old axiom: you must give up something to get something. Here are the advantages:

Lightweight

First and foremost, they are lightweight. An empty 12-inch aluminum oven will weigh about 7 pounds; the same size cast iron oven will weigh about 18 pounds. Quickly that tells you the aluminum model is more desirable when lightweight packing is a must. Also its light weight is an advantage when you pick up an oven full of food. Aluminum is a good choice for cooks with physical limitations.

Rustproof

The aluminum oven doesn't rust, thus you do not have to be as concerned about leaving it damp or storing it for long periods. I have seen poorly seasoned cast iron Dutch ovens rust overnight when left out in the dew.

Seasoning not Required

Since aluminum does not rust, you do not have to pre-season the oven as you do a cast iron oven. However, food will tend to stick to an unseasoned aluminum oven and some cooks pre-season their aluminum ovens for that reason. Breaking in an aluminum oven is simply a process of giving it a good washing to remove the protective oil coating put on by the manufacturer. The new hard cast aluminum ovens have a non-stick surface.

When light weight is a must, the aluminium oven can be counted on to produce good meals.

The new GSI hard-anodized ovens hold a lot of promise for those who want a heat-holding lightweight Dutch oven.

Easier to Clean

Unseasoned aluminum ovens can be cleaned by washing with soap and hot water. It makes for a quick and easy cleanup.

Does Not Discolor Food

Cast iron Dutch ovens, especially those not properly seasoned, can turn foods such as beans a dark color. Aluminum will not do this.

Heats Quicker

Aluminum ovens heat quicker than cast iron ovens, requiring less preheating time.

One of the real masters of Dutch oven cooking is George Prechter III. You will find me quoting George many times in this book. He is a well-known New Orleans chef and cooking writer who has studied Dutch oven cooking for many years. George states, "The aluminum Dutch oven is a valuable cooking vessel where lightweight is a must and the cook is well trained in the proper use of an aluminum oven. I like them for baking bread and making gravies."

Advantages of Cast Iron Dutch Ovens

Cast-iron Dutch ovens are steeped in history and tradition, and a large number of Dutch oven cooks prefer the advantages of cast-iron over aluminum. Here are the advantages most often given:

Long Lasting

Cast-iron ovens are famous for lasting generations and becoming family heirlooms. Many around today are well over one hundred years old. During the pioneering days of early America the family cast-iron Dutch oven was valuable enough to be included in wills. John Rutledge, writing in his excellent book, ***Dutch Ovens Chronicled***, tells of Mary Washington, mother of General George Washington, wanting to be certain her cast-iron vessels were cared for. In her will, dated May 20, 1788, she provided that half of her "iron kitchen furniture" would go to a grandson, Fielding Lewis, and the other half would go to a granddaughter, Betty Carter. Rutledge states, "Surely there were several Dutch ovens among her iron kitchen furniture." Most Dutch oven cooks will be quick to tell you that the older a cast iron oven gets, the better it cooks.

Distributes Heat Evenly

While cast-iron ovens take a little longer than aluminum to heat up, the heat is distributed evenly, resulting in fewer "hot spots" producing and giving ideal cooking conditions. If your food burns, you got the oven too hot. Less heat is needed with cast iron.

Retains Heat

Cast-iron ovens, once heated to a desired temperature, are easier than aluminum to keep at that temperature. Cast-iron ovens require less fuel and time refueling.

Heavy Lid Seals in Steam

The heavy, tight-fitting lid of a cast-iron Dutch oven helps hold steam in, so the oven acts as a pressure cooker and helps keep food tender and moist.

Nutritional Benefits

Cooking in cast-iron Dutch ovens is healthful, as cast iron cookware imparts a significant amount of dietary iron to your food, which is absorbed by the body.

Tolerates Higher Heat

No Dutch oven should be subjected to high temperatures, but on occasion it does happen, as I wrote at the beginning of this chapter. When it does, the cast-iron oven stands a better chance of

One of the merits of the aluminum oven is that it's rustproof.

The cast-iron oven has stood the test of time, over two centuries of testing, and is still the favorite among Dutch oven chefs.

surviving the event, as aluminum will melt at around 1175° Fahrenheit. Cast-iron melts at around 2200° Fahrenheit. Wind-blown coals and campfires can generate temperatures in those ranges. Also, cast-iron heats more slowly without sudden temperature flare-ups so that the food is protected from burning longer.

So which type Dutch oven is best? Most experienced Dutch oven cooks will agree that, with the exception of weight, the cast iron oven is the top choice. That is not to say you can't prepare good meals with an aluminum Dutch oven; you can, and the new hard-anodized aluminum ovens may have additional qualities similar to cast iron, but for total satisfaction you can't beat cast-iron. Most Dutch oven cooks have to agree with George Prechter when he answered an interviewer asking about his choice in Dutch ovens: "If given a choice and weight is not a factor, I will choose a cast-iron Dutch oven almost every time."

Seasoning

Two of the most common problems new Dutch oven cooks have with their cast-iron pots are:
1. seasoning them correctly the first time and
2. re-seasoning them after hard use.

Reasons to Season

Cast iron is very porous, and there are several reasons to season a cast-iron Dutch oven. The seasoning process creates a patina that keeps food from sticking to the sides, bottom, and lid of the vessel. Thanks to this sheen it is quicker and easier to clean. It also protects the vessel from rusting. An unseasoned (also called "natural finish") cast-iron oven can rust overnight just from the moisture in the air. The third reason to season an oven, and by far not the least important, is that it adds a flavor to the foods cooked in the oven that is unmatched in other types of cookware.

The theory behind seasoning cast iron is that oil will fill the tiny holes in the oven. The oil, when heated, will form a carbon non-stick coating on the Dutch oven. The oven will darken with each use and the patina will improve with each use to turn your oven into the ultimate non-stick vessel. A well-seasoned Dutch oven will be black.

A gas grill is one of the best tools to use in seasoning a Dutch oven.

Pre-seasoned Ovens May Now Be Purchased

Today, Lodge Dutch ovens may be purchased pre-seasoned. It is a process they call Lodge Logic. Lodge Logic is a process whereby Dutch ovens are electrostatically coated with a proprietary vegetable oil and cured at high temperatures to allow the oil to deeply penetrate the surface of the cast iron. It's ready to use when you purchase the Dutch oven.

As I was writing this book I also received word that Camp Chef would be shipping all its Advantage cast iron Dutch ovens pre-seasoned.

Even if you purchase these pre-seasoned ovens, chances are good you will need to re-season them sometime in the future. Be sure to follow the manufacturer's instructions when you first clean the new oven so as not to destroy the seasoning.

Clean a New Dutch Oven First

New unseasoned Dutch ovens are usually coated during the manufacturing process with a wax coating to protect them during travel to the retailer's shelves. When you get a new oven home remove all stickers and wash it with mild dishwashing liquid to remove the wax coating. Rinse and dry it thoroughly.

Compare the color of the unseasoned oven on the left to the seasoned oven on the right.

Season it immediately or the oven will rust at an amazing speed. Never cook in a Dutch oven without first seasoning it.

Seasoning a Dutch Oven

While some Dutch oven cooks look at the seasoning process as work, I look at it as a ritual where I get to know the new oven, and I feel that I play a small role in the success of many future meals. Here are several ways you can season or re-season your Dutch ovens.

To season a new cast iron Dutch oven, and I know many cooks who season their aluminum ovens as well, start by preheating your home oven to 350°. Open some windows and turn off the smoke detector as some smoke may be created by this process. Place the pot and lid in the oven and heat until they are almost too hot to handle. This opens the pores of the cast iron. Remove the pot and lid and, using a paper towel, rub a thin layer of liquid olive or vegetable oil or solid vegetable shortening I use solid Crisco on the inside and outside of the pot and lid. (Camp Chef has a product called Cast Iron Conditioner that also serves this purpose.) Do not use margarine or butter. Cover all surfaces, including the legs. Be sure not to coat the surface too thickly. Keep the coats very thin. I know of one Dutch oven cook that set his oven on fire because he used thick layers of lard to season his Dutch ovens.

Place the Dutch oven and lid on the top rack of your preheated kitchen oven. Be sure to put aluminum foil or better yet a cookie sheet on the lower rack of the oven to catch any excess oil. Not only does this help keep the oven clean, it protects the oven from drippings that could cause an oven fire.

Some people like to use spray oil to season their ovens, but I find it can leave a sticky coating. I have also tried lard and found it turns rancid during long periods of storage.

Bake the oven and lid for one hour. Turn the kitchen oven off and let the Dutch oven cool down to handling temperature. Repeat the process. Remove the pot and lid from the oven and wipe it out with a clean, dry cloth. Your Dutch oven is seasoned and ready for use.

If you don't want to run the risk of smoking up your home kitchen, there are several outdoor methods of seasoning your Dutch oven.

The first, and perhaps the easiest, is to simply have a fish fry and use your Dutch oven as a deep fryer. Frying several batches of fish, hush puppies, and French fried potatoes will fill the pores of the cast iron with vegetable oil. Once the cooking is over, pour out the oil and wipe the pot and lid clean with a paper towel.

I have a friend who lives in the bush of British Columbia and uses Dutch ovens almost daily. He seasons a new Dutch oven by frying thick-sliced, unsalted bacon in the pot and on the lid for several months. It works. His Dutch ovens have a beautiful black patina.

An outdoor method I like that doesn't smoke up your kitchen is to use a propane gas cooking

The home oven can be used to season a Dutch oven as long as some precautions are taken.

grill, which has a cover. Turn the grill on low and place the Dutch oven in the grill to preheat. When it becomes warm, remove the Dutch oven and wipe on a thin layer of vegetable oil, Camp Chef Cast Iron Conditioner, or shortening. Place the lid and oven in the grill and turn the grill to low. Lower the grill lid. Cook for one hour. Repeat the process. Remove the oven and lid and wipe it out with a clean, dry cloth. I have friends who use the same method using a charcoal grill. Be careful not to overheat the Dutch oven.

Re-seasoning an Oven

One of the major reasons cast iron Dutch ovens need to be re-seasoned is that they are often improperly cleaned. Harsh detergents and scrubbings with metal scrapers can do damage to an oven's seasoning. Be sure to read the chapter in this book about cleaning the oven the correct way.

Other reasons Dutch ovens need to be re-seasoned are if they become rusted or are improperly stored and the oil turns rancid. Regardless of the reason, the way to re-season a cast iron Dutch oven is identical to the method for a new one, starting with a very clean pot and lid, and repeating one of the above procedures.

Once your Dutch oven is seasoned, never use strong soap, harsh detergent, metal scouring pads, metal scrapers, or the dishwasher for cleaning. This destroys the seasoning, requiring you to go through the seasoning process again.

The author prefers to season his ovens with Crisco.

Care and Clean

It comes as a surprise to most first-time cast-iron Dutch oven cooks that their seasoned ovens are so easy to clean. It is much easier to clean a seasoned Dutch oven than it is to scrub most conventional cooking pots and pans. In fact, if there is a problem with cleaninga a Dutch oven, it is that too much cleanina is done. The result is an oven that needs to be re-seasoned.

Cleaning the cast-iron Dutch oven is a three-step process:

1. Remove Food

Using a wooden or plastic spoon, natural fiber or plastic scrub brush, or plastic or natural fiber scouring pad, scrape out all food. *Never* use a metal scraper or steel wool or wire scouring pad and *never* wash in a dishwasher, as this will ruin the pot's seasoning.

Many Dutch oven cooks say never to wash a seasoned oven and lid with soap, as it will ruin the seasoning and give the food cooked in the oven

A great way to store Dutch ovens is at home as fireplace decorations.

a soapy taste. I have found that a well-seasoned oven can be washed with warm water and *mild* dishwashing soap without negative results. Be sure to rinse well with warm water.

If you have cooked something that has stuck to the oven and is difficult to remove, partially fill the oven with clean, warm water and bring the water to a boil. Brush while boiling. Most stuck food will come off when boiled. If not, scour with a plastic scouring pad or plastic-bristle brush. Never pour cold water into a hot oven, or hot water into a cold oven, as it can cause permanent damage to the oven. I once saw a cook, cleaning a very hot oven, pour cold water into it. The pot cracked and it was ruined.

Once all food is out of the oven and off the underside of the lid, rinse the pot and lid in warm water.

2. Dry

Immediately after the oven has been rinsed, using a paper or clean cloth towel, dry the entire oven and lid. Many cooks dry their ovens by placing them on heat until they are hot to the touch. The point is, you want your oven as dry as possible to prevent rust. Once the oven and lid are dry, you will want to oil them lightly, at once, for long-term protection from rust.

3. Oil

Lightly coat the entire oven and lid, inside and out, with vegetable, mineral, or olive oil. Be careful not to get the oil coating too thick as it will become a gummy mess in time. Also, a thick coating of oil will turn rancid quickly. Do not use lard for oiling, as it will turn rancid in a short period of time. In fact, most oils will turn rancid during periods of long storage, especially if theovenis stored with the lid on tight. Food cooked in a rancid pot will taste the way the pot smells. I like to use mineral oil for long-term storage, as I have never had it turn rancid when my ovens were properly stored.

Care should be used in cleaning a seasoned cast-iron oven. Use only a soft brush or scrub pad.

Dutch ovens should be cleaned as quickly as possible after cooking a dish in them: the sooner the better. Never use a Dutch oven for storing food, as the acid in foods will quickly penetrate the seasoning on the utensil, allowing the cast iron to come in direct contact with water causing rust to appear when it is washed and dried. Never allow your oven to sit in water, or water to stand on it. A cast iron Dutch oven will rust before your eyes if you don't protect it from moisture.

Storage

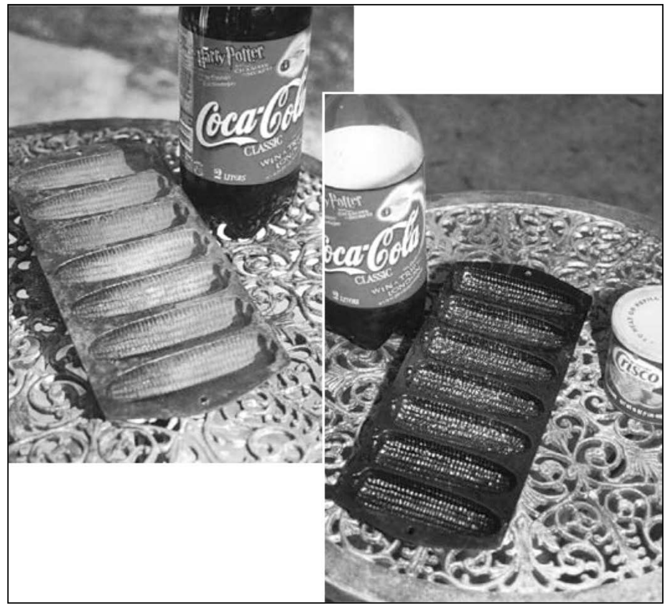
Since most Dutch ovens go for long periods without being used, proper storage techniques are important for the oven to protect it from rusting or turning rancid.

First, select a place to store your ovens that is protected from moisture and dust. Where I live in Alabama, a Dutch oven stored in an enclosed garage or outside storage room will be subject to rusting rapidly, due to our high humidity. I like to store my Dutch ovens in the family room as fireplace decorations. In the house, the central heat and air conditioning keep the humidity under control.

Regardless of where you store your Dutch ovens, *never* store them with the lid on tight. That will almost guarantee that moisture will condense on the inside and rust the pot. Also, the lack of air circulation will cause most oil coatings to turn rancid.

To properly store your Dutch oven, place the lid on the pot, using a spacer to keep the lid ajar to allow air movement. A couple of sheets of rolled up paper towels can serve this purpose. Some people use a small roll of aluminum foil as a spacer. You want a good exchange of air between the inside of the pot and the outside.

Some people go one step further and place a piece of real charcoal—not charcoal briquet—wrapped up in a paper towel inside the oven. This absorbs odor and moisture.



Coke can be used to clean rusted cast iron. The photo on the left is before cleaning.

Dealing with Rust

Rust is an enemy of cast iron, and even the most cared-for Dutch ovens can develop rust spots. The first rule in dealing with rust is to examine your oven regularly for rust spots. Be sure to look inside and out and examine the lid thoroughly. The sooner you find rust, the better. Over a period of time rust can ruin the oven and it can happen quicker than you might believe.

When rust is found on your Dutch oven it should be dealt with immediately. First remove the rust with a wire brush or steel wool. To save some elbow grease, some cooks soak the rusty area in Coca-Cola for a couple of hours then scrub the rust away using a wire brush.

Once the rust has been removed it will be necessary to re-season the pot or lid according to the instructions given in chapter five.

Transporting a Dutch Oven

Dutch ovens have a way of traveling a lot. It may be to a friend's house for a backyard cook-out, on a family camping trip, in the RV, on a canoe trip, or to the family cabin. Regardless of where it is going, the oven needs to be packed for the trip so that the oven and those items it comes in contact with are protected. I was once on a canoe trip when an improperly packed Dutch oven leg went through the canoe bottom, causing a major leak. I have seen Dutch ovens being unloaded from a vehicle dropped on concrete and broken. I have seen them break lantern globes in a station wagon cargo area. They need to be transported so that the oven and surroundings are protected.

Many Dutch oven cooks purchase specially designed padded Dutch oven transporting bags, such as the Camp Gourmet Dutch Oven Case available from GSI or the Camp Dutch Oven Tote Bag from Lodge Manufacturing Co. These are a good investment if your Dutch oven is to be transported.

Transporting a Dutch oven is best done with a padded carrying case, such as these GSI cases.

Other cooks build lidded wooden boxes to fit their Dutchovens. They work well but are heavy when the oven is in them. Some keep the cardboard box the oven came in when they bought it, but it usually doesn't last long. Whatever you use, treat your ovens and the items around them with care when transporting them. Allow them to bounce around without protection and the oven, as well as other items, will become damaged.

Using Charcoal

My first few years of cooking meals in cast-iron Dutch ovens were done in wilderness settings using coals from a campfire as a heat source. Then I discovered the fun of cooking for family and friends in the backyard. In this setting it was not possible to have a campfire going from which to get shovels of hot coals to heat my ovens. It was this backyard cooking that introduced me to using charcoal briquets to heat my ovens and I have been hooked ever since.

Charcoal briquets are the easiest way to heat Dutch ovens. They give a longer, more steady supply of heat, which aids greatly in controlling temperature.

Charcoal briquets have campfire coals beat in several ways. First, they do not require the work, time, and fuel involved with building a camp-fire. Using a charcoal chimney starter, charcoal briquets do not take but a few minutes to be ready to place on and under the oven. Quality charcoal briquets

Charcoal briquets are the easiest way to heat Dutch ovens. They give a longer, steadier supply of heat, which aids greatly in controlling temperature.

burn longer and more evenly than campfire coals. (I have gotten the best results with Kingsford charcoal.) Briquets are easier to place around Dutch ovens, and to move around than loose coals. Under ideal conditions, briquets burn for approximately one hour, campfire coals about half that. Briquets are easy to transport and much easier to clean up than campfire ashes.

Arranging Briquets for Controlled Heating

Arranging charcoal for temperature control is a personal thing with Dutch oven chefs, and the subject of many campfire and backyard debates. Some like to lay their briquets in a checkerboard pattern, both under the oven and on the lid. Others like to place their briquets in a circle under and on top of the oven. Yet others like to use a circle of briquets under the oven and a checkerboard on the lid. I have eaten some great dishes cooked by chefs who used each of these three methods so it depends which method you choose to master. Personally, I like the circle arrangement.

One charcoal briquet pattern that almost all Dutch oven cooks agree on is the pattern used for frying or boiling. Because a lot of heat is required for these two methods of cooking, a full spread of briquets is used under the oven. As the oil or water heats up, the heat can be reduced by removing a few briquets, using tongs.

For most dishes cooked in a Dutch oven, one of five temperatures is called for: 325°, 350°, 375°, 400°, or 425°. (I have found that most of my dishes are cooked at 350° and other Dutch oven cooks tell me they usually cook at 350°.) Obtaining and maintaining these temperatures is a challenge for the Dutch oven cook as wind, air temperature, sun, shade, humidity, ashes, and brand of charcoal can influence the cooking temperature. A strong wind can make the briquets burn extremely hot; accumulation of ashes on the briquets can make them burn cool. Cold outside air can make the pot colder than usual and high temperatures can increase the cooking temperature. High humidity can make briquets burn slow, producing less heat. Whether the cooking is done in the sun or shade can make a difference. Some cooks say it can make a 25° difference in cooking temperature. The point is, you must make adjustments in the number of briquets used, depending upon these local conditions.

Having said that, I will give some commonly accepted guidelines for the arrangement and number of charcoal briquet to use for Dutch oven cooking. I have used these guidelines with satisfaction, and they are the guidelines suggested by Lodge Manufacturing Co. for use with their Dutch ovens. I strongly suggest that you keep a notebook handy when you are cooking under different conditions and keep records of the briquet arrangement and the number of briquets you use for reaching the desired cooking temperatures under the conditions. That is some of the fun and one of the rewards of being a master of Dutch oven cooking.

Estimating Temperature

The following baking temperature chart will get you started, and with a little experience you will be able to make changes for your local conditions. The number to the right of the oven sizes is the total number of briquets required to reach the temperature. The numbers directly below those are the numbers of top/bottom briquets required to obtain the temperature.

Arrange the number of briquets needed by placing them under the oven's bottom in a circular pattern so that they are ½ inch inside the oven's edge. Arrange the briquets on top of the lid in a circle around the edge with one on either side of the handle.

Banking Temperature Chart

	Desired Temperature				
Oven Size	**325**	**350**	**375**	**400**	**425**
8-inch	15	16	17	18	19
	10/5	11/5	11/6	12/6	13/6
10-inch	19	21	23	25	27
	13/6	14/7	16/7	17/8	19/9
12-inch	23	25	27	29	31
	16/7	17/8	18/9	19/10	21/10
14-inch	30	32	34	36	38
	20/10	21/11	22/12	24/12	25/13
16-inch	34	36	38	40	42
	22/12	24/12	24/13	27/13	28/14

Courtesy of Lodge Manufacturing Co.

Avoid the temptation to pile all the coals in one bunch, either under the oven or on the lid. When this is done a hot spot is formed, guaranteeing burned food and possibly ruining the oven.

Dutch oven chef George Prechter recommends taking the oven off the coals every 15 minutes and rotating ½ turn. Then lift the lid and rotate it ½ turn in the opposite direction. This helps prevent hot spots from forming.

All of this sounds difficult to learn but it is quite easy and a fun process, especially the testing. I used biscuits as a test food when I was working out the number of briquets and configuration to use on a new 10-inch Dutch oven. I kept a jar of muscadine jam nearby and used it on the test biscuits I didn't burn. Soon I had all my neighbors helping with the test.

I have some friends who don't depend on experience to judge the temperature inside their Dutch ovens. They use a long-stemmed oven thermometer. Anytime they want to know the temperature inside the oven they ease the lid of their oven open, insert the thermometer, and read the temperature. Many do this too often. It allows moisture and heat to escape and there is a greater chance of ashes getting into the food. Also there is a greater chance of getting burned when doing this. You be the judge.

As with any new cooking technique, practice is required to master Dutch oven temperature control, but once you have a system that works, Dutch oven cooking is easy.

Cast iron is famous for holding heat for long periods, and proper placement of briquets helps distribute heat evenly.

Charcoal Safety

Keep these safety tips in mind as you use charcoal for your Dutch oven cooking:

1. Never burn charcoal inside homes, buildings, tents, vehicles, etc., as odorless toxic fumes may accumulate and cause death.
2. Never use gasoline to light charcoal.
3. Do not add lighter fuel directly to burning or hot charcoal.
4. After cooking, make sure ashes are completely cool before discarding.
5. Cook safely, away from flammable items, overhanging roofs or limbs, and out of the way of playing children or sports activities.

The charcoal briquet fire lets even the newest cook produce meals fit for a king.

Campfire Coals

Successfully cooking a Dutch oven meal with coals from a campfire requires more experience than cooking with charcoal briquets. It requires more experience to learn how to judge the amount of coals to place on and under the oven, the heat output from the coals, what coals burn best, and when to replace coals.

When I first started Dutch oven cooking, I thought the more hot coals on the campfire the better, and I burned a lot of food. My scoutmaster said I cremated everything I placed in a Dutch oven. Also, it took me a couple of ruined meals to learn that wood like pine, poplar, and cottonwood don't make good coals for Dutch oven cooking. However, it didn't take me too long to get the feel of campfire cooking and it's been easy ever since.

Design a Campfire for Cooking

The location of your cooking site will have a lot to do with the type of fire you build to heat coals for your Dutch oven cooking. Obviously, in many areas

It is hard to beat a bed of oak or hickory coals.

you cannot use an open fire and charcoal briquets will be your only choice. However, you may live in an area where you can have an open fire in your backyard and you may install a commercial fire ring or you may be in a backcountry camp where you can put in a keyhole fire with rocks for days of cooking, or you may be on the move, and a simple fire ring will have to do. The point is there is a campfire design for all situations that will give you a good supply of coals for your Dutch ovens.

Commercial Fire Rings

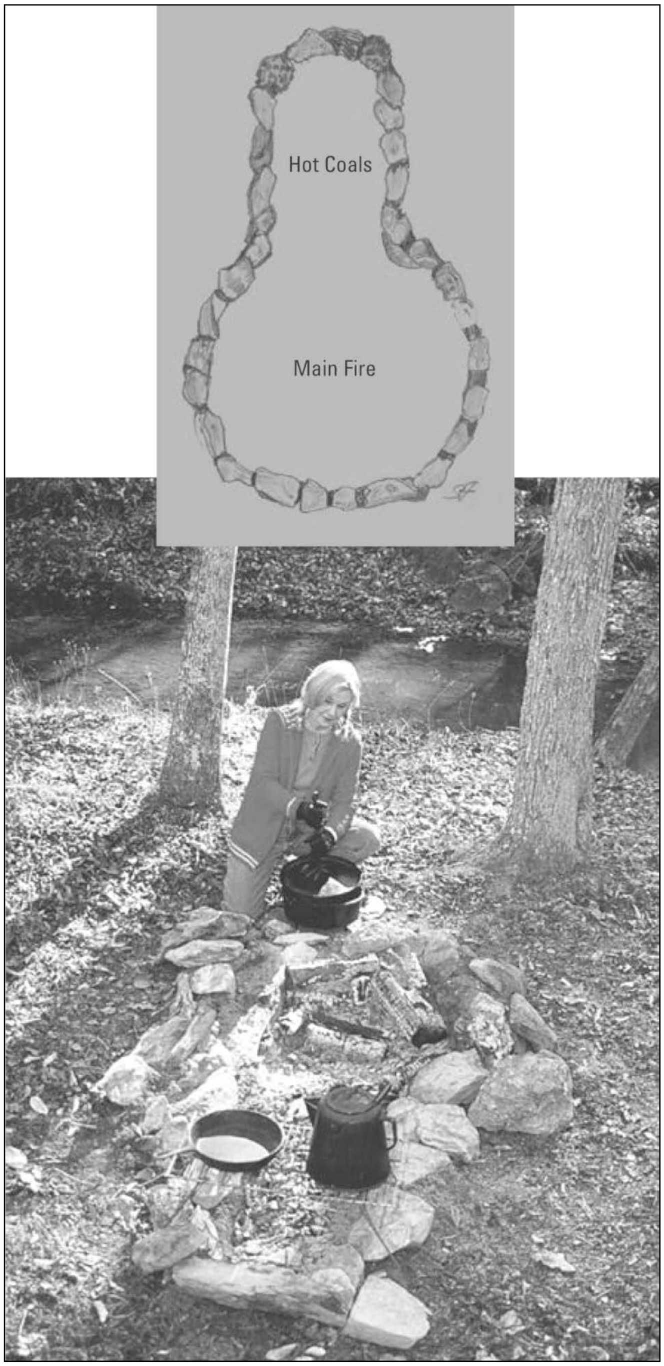
For those lucky enough to live where it is permissible to have an open fire in their backyard, the commercial fire ring is a safe way to have a fire to produce hot coals for Dutch oven cooking. I have visited many ranches in the West where Dutch oven suppers were the norm, cooked on the patio using an open fire. Many of these ranches have put in an all-steel commercial fire ring. A lot of state and national parks have commercial fire rings that work well for Dutch oven cooking while camping. I have a commercial fire ring at my cabin in Cross Creek Hollow and that is the favorite gathering place for visitors, especially if the Dutch ovens are heating. It has a heavy-duty grill that can be lowered on the fire for frying or boiling in a Dutch oven and when the grill is not needed it is swung back, out of the way, to make shoveling hot coals easy.

When I was looking for my fire ring I found it difficult to find a commercial source and I was lucky to have a friend who had an extra one. Since then I have found several sources. A manufacturer with a good variety of fire rings is Pilot Rock Park Equipment Company. They have fire rings with adjustable cooking grates. The grate tips back out of the way so as not to interfere with getting coals for Dutch ovens, or obstruct the view of people sitting around the campfire during storytelling sessions. Here are some other features of these well-made fire rings:

- Flanged fire ring. The 1-inch top flange is both a safety feature and reinforces the ring against heat warpage.
- Infinite adjustment of cooking surface. You can adjust the grate for various cooking levels.
- Grate tips back for easy fire building. Grate will lift up and out of the ring for fire building and clean-out.
- Three fire barrier heights. Rings are available with 7-inch, 9-inch, or 11¼ inch height. Choose the degree of fire barrier you need.
- Unique handle design. The handle design allows the cooking grate to lower inside the ring and keeps the spring grips out of the heat.
- Public-use-type spring grips. The spring grips are coiled from a ½ inch steel flat bar for a safer, cooler handle.
- Fire ring tips back for easy cleaning. The entire ring lifts up on hinges to make clean-out easy.
- Installs without a concrete pad. The fire ring may be installed on the ground or on gravel, eliminating the trouble and expense of a concrete pad.
- Conserves firewood. The cooking grate will lower inside the ring, allowing the user to cook over a low fire.
- Reinforced grate foils vandalism. The structurally reinforced grate design is strong enough to deter vandalism.

Pilot Rock makes fire rings in a variety of diameters, ranging from a wood-conserving 28 inches to a group size of 60 inches. Also, they make models that are wheelchair accessible and models that are raised high enough for cooking comfort.

Where were these fire rings when I was looking for mine? If you don't heed all the features of a commercial fire ring, you can make one from a large truck or tractor tire rim by taking a cutting torch and cutting out the middle. However, since the fire ring is an item you will probably buy only once, why not get the commercial model with all the conveniences?



The keyhole fire ring gives the cook space to cook and a good supply of hot coals at the same time.

The Keyhole Fire

Many years ago when I first started going into the backcountry of the Rocky Mountains, I noticed that several of the old outfitters that cooked in Dutch ovens used a campfire design they called a “keyhole” fire. They would pick a safe and logical location for the cooking fire and would take rocks and make an outline that was shaped like a keyhole, round at one end, with a rectangle running from it. The round part would be up to 36 inches in diameter and the rectangular part would be from 12 to 24 inches wide and about 36 inches long. A fire of choice hardwood would be built in the round part and then hot coals would be pulled out into the rectangular part, where it would be easy to get a shovel of coals to put on Dutch ovens without disturbing the main fire. Also, the narrow part of the keyhole would be used to place a grill to set Dutch ovens on for stewing or frying. It was a most efficient arrangement for long-term base-camp cooking.

Cooking Platform

Regardless of what type campfire you choose to use, you will need a flat, level surface on which to place your hot coals and Dutch ovens. Cold, wet ground will rob the ovens of heat rapidly and leave scorched earth. Many Dutch oven cooks have a heavy-duty, flat piece of metal they use as a cooking

Cooking with hardwood fueling the Dutch oven dates back to the earliest days of the oven. It still works well today.

platform. Others carry a folding steel cooking table, such as is used with charcoal briquet cooking, for use with campfire coals. I have seen many backcountry cooks place a large flat rock near the campfire for this purpose. I use a flat rock adjacent to the fire ring at my cabin. And, when commercial fire rings are permantely placed, a concrete pad is often poured, specifically to create a safe, level location for Dutch oven cooking.

No matter what type fire ring you use with an open fire you will need a safe, level place in which to cook in Dutch ovens, so give some thought ahead of time as to what it will be. I once spilled a stew in front of a lot of people because I hastily picked a cooking spot near my campfire. The ground gave way under the weight of the full cast iron oven and my guests watched their dinner run out onto the ground. That was many years ago, but I still hear about it today.

Choice of Cooking Woods

One of the fun debates you will often hear when a group of Dutch oven cooks get together, especially if they are from different parts of the United States, is what type of firewood burns into the best coals to use for Dutch oven cooking. Cowboy cooks from the Southwest will fight for mesquite, Southern cooks will argue for hickory, Northern cooks will brag about oak, and some Midwestern cooks swear by Osage orange.

Several years ago, after writing a magazine article about Dutch oven cooking in *Sports Afield* magazine, I received a call from a new Dutch oven cook from Louisiana. This cook was having trouble getting his dishes done through and through before the outer edges of the food were burned. It was obvious that at some poin this oven was getting too hot but it was strange that the food was still raw in the center. At some point I asked him about the wood he was burning for his coals. It was pine. That answered all the questions. The pine was burning hot for a short period of time but burned out quickly. Softwoods are not good for Dutch oven cooking, except possibly for kindling to get a hardwood fire going.

What the Dutch oven cook wants is a heat-holding coal that will burn evenly and hot for long periods of time. Consider only proven hardwood fuel wood for making coals for Dutch oven cooking.

Unfortunately, not all hardwoods produce good coals for Dutch oven cooking. Poor choices of hardwoods are poplar, cherry, elm, aspen, birch, gum, cottonwood, and sycamore, to name a few. They will make a good conversation fire, and kindling for starting fires, but will not give hot, long-lasting coals for cooking with Dutch ovens.

In my opinion, give the highest consideration to hickory, oak, mesquite, and hard maple, in that order. I have friends who are master chefs with the Dutch oven who prefer other woods. Medrick Northrop, a great cook in the bush and at home, lives in Alaska. His wood of choice for Dutch oven cooking is pecan, something that is in short supply where he lives. Ken French, known as the “woods wizard” in his home state of Maine, likes walnut. I once watched him make coals for Dutch oven cooking using a supply of “factory reject” rifle stocks. That was some of the most beautiful wood I have ever seen go into a campfire.

Other Dutch oven cooks agree with me about hickory. Arizona Dutch oven expert Stella Hughes, states in her well-known book, *Bacon & Beans,* “I’ve only had one experience in using hickory wood and it made me a lifetime disciple of this wonderful hardwood. Hickory burns down to a bed of hot coals that keeps an even, generous heat for hours.”

Supply can have a lot to do with the wood you choose for your Dutch oven campfire, but given a choice use hickory, oak, mesquite, or hard maple and you will have some good coals for your ovens.

A good supply of hardwood seasoning in woodshed can give the Dutch over cook many pleasant meals. When putting up the wood is a good time to invite those you cook for over to help.

Obtaining and Storing Hardwood Firewood

If you do a lot of cooking using campfire coals, you will want a supply of firewood.

If you plan on buying firewood, the density of the wood is important because wood is usually bought by volume. The most common unit is the "cord," that is a stack of wood 4 feet wide, 4 feet high, and 8 feet long. Sometimes wood is sold by the truckload, which is a highly variable measure. A rule of thumb is that a half-ton pickup truck is capable of carrying ⅓ cord of wood. To find out what fraction of a cord you are buying, use this formula: (height of wood) x (width of wood) x (depth of wood) divided by 128. The answer is a fraction of a cord.

The tighter the wood is packed, the more wood for your money. The denser the wood, the fewer trips you will have to make to the woodshed.

With a little effort on your part and a one-time investment in tools, including a chain saw, wedges, bow saw, ax, files, hearing protection, safety glasses, and maul, you can get wood for free or for little cost. If your home or cabin is sitting on wooded acreage, a rule of thumb is that with proper management, one cord of wood can be cut annually for each acre you own. (A local forest ranger or forester can advise you as to how to manage this forest.) This practice will keep your wood supply renewable, as well as beautify your woodlands by removing old and diseased trees.

The USDA Forest Service and some state forests have programs to permit the public to cut firewood of down or dead hardwood trees for little or no cost. Other free or low-cost sources of wood are utility company pruning, pulp and paper companies, sawmills, town dumps, and farmers clearing new ground. Always be sure to secure permission from the proper authorities.

As a side note, I always watch for new house construction when driving around. This is sometimes a good free source of hardwood flooring scraps, which can be split up into Dutch oven fuel. Most builders will be glad for you to haul it away.

If you don't want to cut your own wood, you can usually find a local firewood dealer. When buying wood, be sure it is split and dry (why pay for water?), dense, and tightly packed. If you must buy green wood, buy it in the early spring because it takes months to dry. Be sure to measure your fire ring and have your firewood cut small enough to fit.

Once you have the wood, how do you prepare it for burning? If it is moist, it should be air-dried before use. If the wood's diameter is greater than 8 inches, it should be split and cut small enough lengthwise to fit your fire ring and stack easily in the woodshed. Split wood dries faster than wood that is not split and is easier to stack. Stacking firewood off the ground will permit air to circulate freely in the woodshed and will help prevent ground rot.

Stacking the wood in a sunny location and covering it with clear plastic sheeting can accelerate the drying of wood. It is best to keep the plastic away from the ends of the woodpile to allow good airflow, which speeds the evaporation process.

An interesting and fast method for drying firewood is the use of a solar wood dryer. This easy-to-build device is simply a rack for stacking cut firewood off the ground. The rack is placed in a sunny spot near the cabin and loaded with hardwood. Next, the wood and rack are wrapped in clear plastic, except the ends. A vent opening is designed in the top of the dryer. The sun and air speed up the drying process. This is a good method to dry wood if you are late in the season cutting your firewood.

One way to tell if wood is ready for burning is to weigh a few identified pieces on a bathroom scale. Record the weight and place the identified wood back into the woodpile. Wait a month, and then weigh the wood again. If the wood has lost weight, it is drying.

Another method for determining if wood is ready for burning is to examine the ends of the logs to see if cracks are appearing. Cracks appear only when wood is relatively dry.

Store your supply of firewood in a woodshed to keep it dry and from getting scattered. My woodshed is small but it holds enough wood to keep me in cooking fuel for months. It is made from log siding and measures 8 feet wide by 4 feet deep by 6 feet 6 inches tall. In the front of the shed is a large wooden box that holds split kindling. I built the shed in one day, without help, so a woodshed is not a major project.

Start your hardwood fire early to get a good supply of hot coals before you start cooking.

Start the Fire Early

Good hardwood burns slowly so be sure to start your fire early, before you need to start cooking. I once saw a young inexperienced chuck wagon cook, preparing his first supper on the trail, build a mesquite fire less than 10 minutes before the hungry cow boys came in to eat. It was two hours after they arrived before the meal was ready. That young man learned a very valuable lesson that night and was reminded of it for years.

Start your hardwood fire atleast 45 minutes you need hot coals.

Tools for Campfire Cooking

Besides the tools normally needed for Dutch oven cooking, you will need a long-handled shovel for moving coals from the fire to your ovens. As I stated earlier in this book, many cooks drill holes in their shovel to allow ashes and smaller-than-desired coals to fall out.

A whisk broom is handy to use when using campfire coals because you are always dealing with fine ashes and the broom is a good way to keep the oven lid clean when removing it.

Keeping firewood cut in a size to fit your fire ring calls for a sharp hatchet and the knowledge of how to use it properly and safely. Remember, it doesn't take a large fire to produce good coals so keep the fire small with small pieces of wood.

To remove ashes from the lid when adding new coals or removing lids to serve food, use a whisk broom.

Judging Cooking Time

When cooking with coals from an open campfire it can be difficult to judge cooking times until you have gotten a lot of experience. Neither this, nor any other book, is going to give you guidelines that will get you cooking with campfire coals without some risk of burning food. As with charcoal briquets, campfire coal heating values are determined, in part, by humidity, wind, shade, temperature, etc. Another factor, unlike with charcoal briquets, is the type of wood that is being burned and the amount of coals that is placed on and under the oven: the latter varies greatly from person to person. It is much easier to tell someone how many charcoal briquets to use than it is how many shovelfuls of coals, of an undetermined size, to use.

Here Are Some Tips to Follow as You Get Experience

- When taking coals from the fire to the ovens, try to get coals of the about the same size. Here is where a shovel with holes in it is valuable.
- Resist the temptation to heap hot coals under and over the oven. It takes a lot fewer coals than most people think. You simply need the oven to be hot, not an inferno.
- Place coals in a 2:1 ratio, top to botton. If you place a ¼ shovelful of coals under a 10-inch oven, place ½ shovelful on the lid.
- Keep the coals under the bottom in a circle toward the outside of the pot. The coals on the lid should be placed around the inside of the flange. Coals heaped under or on an oven can cause hot spots and unevenly cooked food.
- Resist the temptation to bury the oven in the campfire. I know that sounds unnecessary to say but there are people who do it and wonder why their food is burned beyond recogntion. There is a lot of magic in the black pots but not that much.
- Always, when cooking with campfire coals, turn the oven ¼ turn every 15 minutes and the lid ¼ turn in the opposite direction. This prevents hot spots and helps keep the cooking temperature even.
- While learning to judge cooking temperature, open the pot every 15 minutes and check the doneness of the food. Keep notes, including the type of wood used and amounts used. In time you will get a feel for cooking time and will be the envy of those who watch you work your magic.
- Be sure to keep an eye on the coals under and over the oven. Coals from a campfire do not burn as long as charcoal briquets and must be replenished regularly.
- Stay with your cooking and keep an eye on the coals under and on your ovens. Many a meal has been ruined by a cook forgetting he was on duty.
- By keeping careful notes and remembering the details of your cooking sessions it will not take you long to get the feel of cooking with campfire coals. One of the best rules to follow is to take a peek at the food as it cooks. These inspections will teach you when to add coals and when to brush a few away.

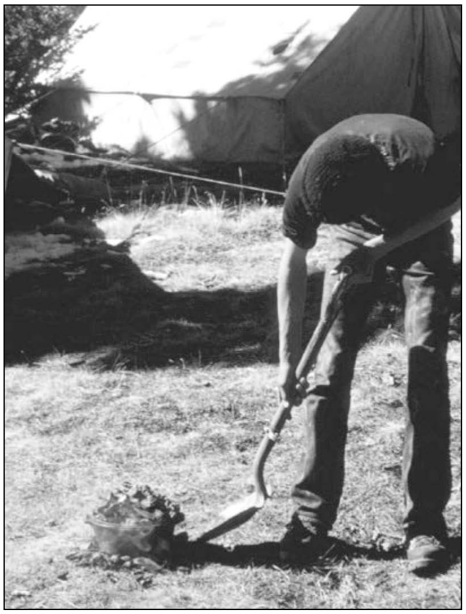
Safety Tips

Anytime you are cooking around an open fire you must keep the actions and safety of others in mind. Keep children and adults who act like children away from the fire and hot ovens. I once was cooking on a canoe expedition down the Alapaha River in Georgia. Most of the "adventurers" were university professors. I kept the cooking area roped off so that I would have room to cook and wouldn't have anyone stumbling over my ovens. One night I had a math professor slip under the rope and go over to my Dutch ovens. I guess he wanted to see what was on for supper. Without thinking, he picked up a hot oven lid. It was a lesson he will never forget.

Keep hatchets and other sharp tools in a safe place and out of reach of curious hands.

Keep an eye on the wind and keep sparks from flying into dry tinder. Everyone knows that campfires cause many forest and brush fires each year.

Successfully cooking in Dutch ovens fueled with campfire coals is nothing new. Our forefathers did it daily. With a little practice it is easily mastered; you just have to want to and to spend a little time serving your apprenticeship.



Resist the temptation to heap coals on and under the oven. That will guarantee burned food.

Use fire safety and common sense when working with fire. Many grass, brush, and forest fires have been started by campfires.

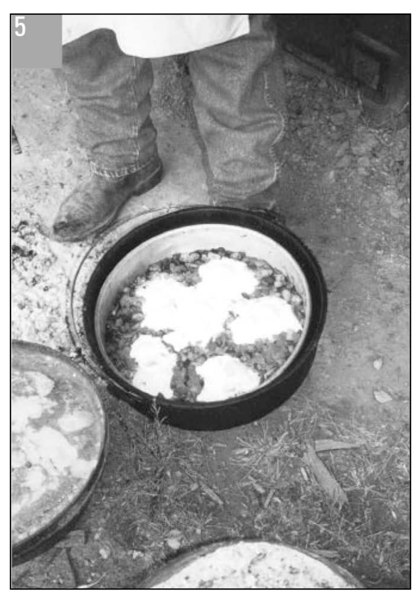
Bean Hole Cooking

A favorite method of Dutch oven cooking in hunting and fishing camps in the northeastern United States and Canada is what is commonly called "bean hole cooking." Dating back to early colonial days, this method of baking in a hole in the ground has survived several hundred years of improvements in stoves, ovens, and baking techniques.

Back before electric and gas stoves were common, miners, logging camp cooks, remote resort lodge cooks, hunting and fishing camp cooks, and homestead cooks did much of their baking in cast iron Dutch ovens in a hole filled with hot coals and covered with dirt. Because beans were the most common dish baked, the term "bean hole cooking" became the name of this technique.

Early American outdoor writer Horace Kephart, in his 1906 bestselling book, *Camping and Woodcraft,* called the bean hole a "bake-hole." He wrote, "Every fixed camp that has no stove should have a bake-hole,

Lowering the pot in a permanent bean hole



1. Once the bean hole is hot and full of coals, remove some of the coals and insert the oven.
2. The bean hole is covered with dirt and left for hours as the food slowly cooks.
3. The moment of truth as the meal is uncovered.
4. There is a moment of excitement as all the non-believers gather around the bean hole for the uncovering of dinner.
5. "Dinner from a hole, how cool!"

if for nothing else than baking beans." He continued,

> The hole can be dug anywhere, but it is best in the side of a bank or knoll, so that an opening can be left in front to rake out of, and for drainage in case of rain. Line it with stones, as they hold heat and keep the sides from crumbling. Have the completed hole a little larger than your baking kettle. Build a hardwood fire in and above the hole and keep it going until the stones or earth is very hot (not less than half an hour). Rake outmost of the coals and ashes, put in the bake-pot (Dutch oven), which must have a tight fitting lid, cover with ashes and then with live coals; and, if a long heating is required, keep a small fire going on top. Close the mouth of the oven with a flat rock. This is the way for beans or braising meat.

One of the best testimonials I have ever read about bean hole cooking was written by Oregon writer Ed Park. In the book *Campground Cooking,* Ed tells of cooking a stew in an elk-hunting camp.

"Just before we left for the day's hunt, I shoveled away the burned wood of our campfire and dug an oven-sized hole down in the middle of the deep layers of hot ashes. Then I lowered the Dutch oven into the hole, shoveled more hot coals on top of it and covered the whole works with more coals. Then, I covered all this with warm dirt. That night's dinner was already cooking.

"All day long, while my hunting partner and I let those elk make fools of us, our dinner was slowly cooking. The heavy cast iron Dutch oven, plus the hot coals and earth packed around and over it, held the heat and kept the juices simmering.

"By the time we dragged ourselves out of the canyon we were soaked, hungry, and weary beyond belief. It was my night to cook, and I'm sure that if I'd had to start from scratch right then, I'd not have made it.

"But fortunately I didn't have to begin fresh. Instead I merely took the shovel and scratched carefully around in the snow-dampened earth where we'd had our morning's campfire. Soon I took our small camp broom and brushed away the last of the dirt and burned-out coals that covered the recessed lid of a large cast iron pot and lifted the pot out of the still-warm ashes that encased it. I hauled the pot inside, set it on the dirt floor of our tent, beside our sheepherder's stove, and dinner was ready.

"When I lifted the lid on that pot, the hot-sweet smell of a delicious all-day stew hit us and revived us enough to want more. Silently I spooned out generous helpings for each of us and grinned as my hunting partner dug in with gusto."

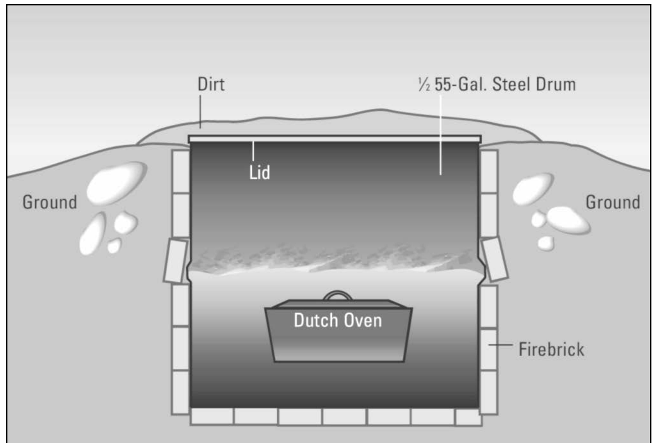
Build a Permanent Bean Hole

Each year I hunt and fish with Pam and Ken French from their log cabin camp, named Camp Quitchabitchin, in central Maine. Outside their cabin, down near the lakeshore, Ken has built a permanent bean hole. Miss Pam prepares her tasty dishes that require baking and Ken places the cast iron Dutch oven into the hot coals in the bean hole. The top is placed on the hole and it is covered with dirt. After a day of hunting or fishing we return, uncover the pot or pots, and the evening meal is hot and ready to eat.

Following Ken's instruction, I have built a permanent bean hole at my cabin in Cross Creek Hollow in Alabama. Now it is the center of attention anytime I am cooking for a group of guests. Here is how you can build your own permanent bean hole.

Take a clean 55-gallon drum and cut it in half. Save the lid and discard the upper half. In a safe area, outside your cabin or camp, dig a hole a little deeper and wider than the half drum. Line the bottom and sides of the hole with firebricks. Next, drill several small holes in the bottom of the drum to allow water to drain, in the event water should ever get inside. Place about three inches of sand in the bottom of the drum to prevent it from burning out. Put the drum in the firebrick-lined hole and fill in the spaces between the bricks, and between the bricks and drum, with sand. Place the lid on top of the drum and you have a permanent bean hole.

When you want to bake a pot of beans or any other dish, simply build a fire in the bean hole, and when a hot bed of coals is ready, take a shovel and remove half of them from the bean hole. Next, place a cast-iron Dutch oven filled with beans into the bed of coals in the bean hole, and put a couple of shovelfuls of hot coals on top of the Dutch oven. Put the cover on top of the drum and cover with dirt or sand. This will keep the temperature even for a long period of time. Go hiking or fishing for the day and return to a hot meal. As with most methods of cooking, it will take a few trials to get the method perfected, but it is fun and, once it is worked out, will become a favorite method of baking in your camp.



BEAN HOLE COOKER

Survival Skills

Fire

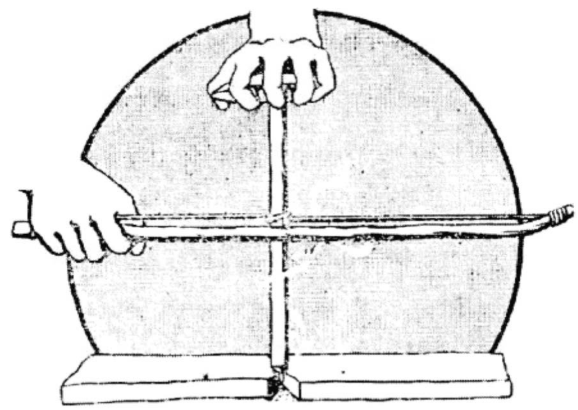
BY E.H. KREPS

The most common way of building a fire among savages who have not adopted the ways of civilization is by means of a bow, spindle and block.

This way of making fire has been exploited by writers on woodcraft subjects; but the reader should not be deceived into the belief that if he becomes lost in the woods and night coming on finds him without matches, he can build a fire by this means. While any boy scout can demonstrate the method and can produce fire in a very few minutes, he can do so only by having prepared the necessary materials long in advance. The wood must be as dry as wood can be made, and such wood is never found in die forest. To get wood into the proper condition for fire making by the friction method requires the selection first of the proper kind of wood, and then a thorough drying indoors for weeks or even months. Only certain kinds of woods are really good for the purpose and among these kinds cedar, balsam and cottonwood seem to be the best. Spindle and block must be of the same kind of wood and equally dry.

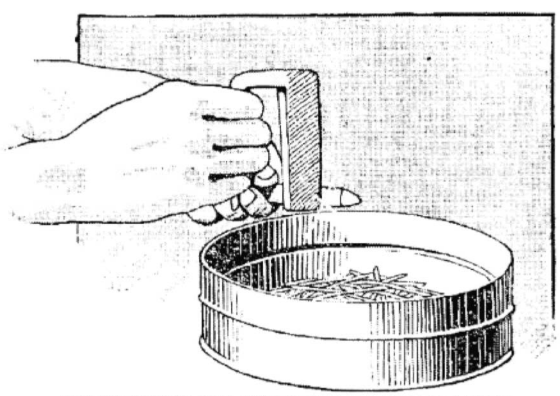
The materials needed for making a fire are the bow, spindle, block, under, and a shell, a stone with a small cavity, or other similar object which can be used as a bearing or cap on top of the spindle. A mussel shell is the best natural object for the purpose, as it is light and has a hollow side which is smooth and makes an excellent bearing for the spindle end.

The bow, about two feet long, may be made of hickory or any springy wood, strung with a stout, hard laid twine. The spindle, of any of the favorite woods, should be about sixteen inches long by three-fourths or one inch in thickness. The top should be rounded and the lower end shaped to a blunt, smooth point. It must be very dry. The block should be an inch or a little more in thickness and of any width and length found convenient, but it should be large enough to be easily held down firmly with the knees when in the kneeling position assumed when working the drill. It should be of the same kind of wood as the spindle. The tinder may be any inflammable material which can easily be fired from the burning dust, such as the shredded inner bark of a cedar tree, very dry and fine, mixed with shreds of white cotton cloth.



Using the bow drill in making fire

To use the outfit the operator cuts a V-shaped notch about three-quarters of an inch deep in the edge of the block. On the flat side of the block at the apex of the notch he then makes a small hole with the point of a knife as a starting place for the spindle. Around this notch he places a small quantity of the tinder. Then, giving the string of the bow a turn around the spindle he kneels on the block, places the point of the spindle on the mark at the point of the notch, places the shell over the other end, and throwing his weight upon the spindle he works the bow back and forth quickly and steadily. The spindle, revolving rapidly, bores its way down into the block, the dust which is worn from the block and spindle filtering down through the notch among the dry tinder. An increasing heat develops from the friction of the dry wood, and soon an odor of scorching wood will be noticed; then a thin wisp of smoke arises from the dust in the notch and this grows stronger, after awhile the smoldering fire itself is visible in the dust which has accumulated in the notch and about the base of the spindle. At this stage the operator stops the drill and blows the fire into flame. All that is necessary then is to place fine, dry twigs over the tinder and then coarser wood, and this wonderful feat of building a fire without matches is accomplished.



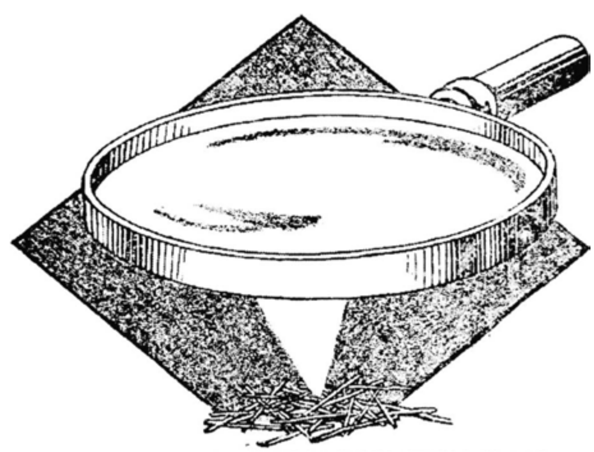
Using the flint and steel to start a fire

Matches are a comparatively recent invention. When this country was first settled they were unknown and fires generally were made by means of flint and steel. By striking glancing blows with a steel object along the edge of a piece of flint, showers of sparks were thrown into a little pile of tinder to be blown into a flame by the fire-kindler. It is said that for an expert the trick was not at all difficult, and that fire could be produced very quickly; but it is obvious that very dry materials were necessary.

To the unfortunate who is cast away on a desert island, like the hero of fiction, this latter method of fire making is the most promising, for he usually has some steel object, even if only a pocket knife and a piece of his coat may answer as tinder. The difficulty will be in finding the flint, but that is easy in the story.

But the easiest of all ways to make a fire without matches is by means of magnifying glass or other lens. A reading glass, if the sun is bright, will produce fire if used the right way. In the absence of a reading glass, a watch or comp; crystal, an eye glass, the lens from a field glass or camera, or even a bottle, may be used for concentrating the sun's rays onto a pile of tinder and thus producinj fire. If you are skeptical as to the heat caused by a concentrated light ray, just hold a reading glass a few inches above your hand and turn the glass towards the sun so that a tiny point of intense light is thrown onto your hand and you will surprised to see how quickly it will burn a blister. A pipe may be lighted that way very easily, something that is worth knowing if one happens to get caught in the woods without matches and with a magnifying glass in his pocket.

But he may not have a glass of any description and then—well here is another way: A man traveling



Starting a fire with a magnifying glass

in the woods nearly always carries a gun of some kind . . . He removes the bullet from a cartridge and substitutes a small bunch of dry tine for shredded dry cotton cloth, and loading this cartridge into the gun, fires it into another smaller pile of tinder and blows the smoldering pile into a flame.

The safest and most convenient way of all is, of course, to carry matches, and to have a portion of them in a waterproof box. Matches are cheap and a waterproof box will not bankrupt a woodsman.

I always carry my regular supply loose in a small pocket when in an emergency.

There was one time that I well remember when that box of dry matches was to me about the most valuable thing in the world. That was the time when I broke through the ice of a lake in the northern wilderness, far from camp, and my clothes froze stiff before I had gone a hundred paces. The dry matches enabled me to make a fire quickly and dry my frozen clothes. What could I have done without the waterproof match box?

Fire is as useful to the modern woodsman as it was to the prehistoric man and in the far north it stands between him and death when King Boreas reigns. But it can also do a world of mischief. Is it not strange that the great forces which are so terribly destructive when let loose in all their strength are the most beneficial and useful to mankind? We could not exist more than a few days without water, yet floods destroy each year millions of dollars worth of property and thousands of lives. Electricity is, perhaps, the most useful power in the world and we have grown so used to it that to give up its comfort, which we derive in the form of light, power and heat, would be an awful hardship, and yet electricity is the most dangerous and deadly element known.

Fire also is so needful that we could no longer exist without it. It alone can make our homes comfortable when the winter winds howl without. Its heat is necessary for the preparation of the greater portion of our food. Yet fire is a dangerous and destructive element, and must be closely watched at all times to prevent it from breaking out of bounds. From the harmless comforter of the home it becomes the relentless destroyer.

The loss by fire would be reduced greatly if all persons would observe a few simple rules and in the hope that some of the readers may become just a little more careful in this respect I will give these rules here:

1. Use only "safety" matches. They will ignite only by friction on the preparation found on the side of the box in which they are purchased. If one of these matches falls on the floor it is harmless since it cannot light accidentally and thus cause a fire. If they fall into the hands of children they are also harmless as far as starting a fire is concerned.
2. Do not throw a lighted match onto the floor, or among rubbish. Burned matches should always be placed somewhere where they cannot possibly ignite anything in case a little fire still smolders in the burned wood.
3. Don't drop cigarettes or cigar ends into places where they can do harm, and if there appears to be the least possible danger they should be carefully extinguished. A pipe dumped into a waste basket has many times started costly fires.
4. Be sure that there is no woodwork so near the stove that it grows scorching hot when the stove is overheated. Likewise make sure that no rubbish is thrown near the stove or fireplace and that there is no danger of fire dropping out onto the floor.
5. Never leave the house with a fire burning in the stove, or fireplace.
6. Kerosene and similar substances should never be used for kindling fires; their use is exceedingly dangerous. Gasoline especially is very dangerous, not alone through the fact that it is very inflammable but even more so from the fact that

the fumes of gasoline explode with great violence. It should never be used in a house where there is a fire or a lighted lamp, and a fire should never be lighted in a room where it has been used until the fumes are completely cleared from the room.

Burning oil can be extinguished by smothering with woolen blankets, or by throwing sand on it. Water merely spreads the fire.

While fires in settled communities do the most damage, a dry season may see many destructive forest fires. Such conflagrations destroy the forests and kill game and song birds, besides being a menace to settlers. This country suffers great losses through forest fires, many of which could be prevented by an observance of the rules already given, especially those relating to smoking. Campers are also responsible for many fires of this kind by failing to extinguish camp fires, or by building them in places where rubbish abounds. A camp fire should never be made except on a spot of clean ground and if necessary a spot should be cleared before building the fire, digging away the vegetable matter on the surface, if need be. Likewise the camper should be certain that there is no danger from the fire spreading before he leaves it.

Ordinarily he can feel sure of this only when he has completely extinguished the fire by pouring water upon it.

Shelters

BY COL. PETER T. UNDERWOOD, USMC

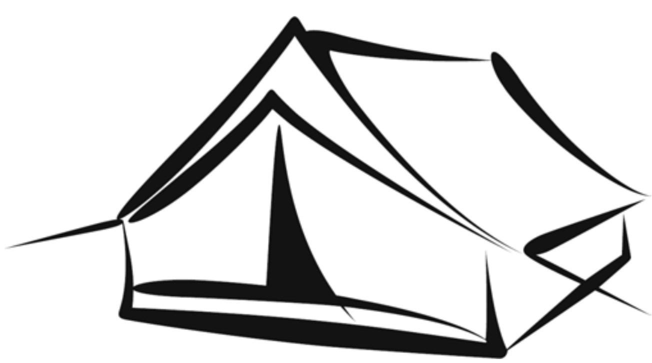
A shelter can protect you from the sun, insects, wind, rain, snow, and hot or cold temperatures. It can give you a feeling of well-being. It can help you maintain your will to survive.

In some areas, your need for shelter may take precedence over your need for food and possibly even your need for water. For example, prolonged exposure to cold can cause excessive fatigue and weakness (exhaustion). An exhausted person may develop a "passive" outlook, thereby losing the will to survive.

The most common error in making a shelter is to make it too large. A shelter must be large enough to protect you. It must also be small enough to contain your body heat, especially in cold climates.

Shelter Site Selection

When you are in a survival situation and realize that shelter is a high priority, start looking for shelter as soon as possible. As you do so, remember what you will need at the site. Two requisites are:



- It must contain material to make the type of shelter you need.
- It must be large enough and level enough for you to lie down comfortably.

When you consider these requisites, however, you cannot ignore other factors contributing to your safety. You must also consider whether the site:

- Is suitable for signaling rescuers.
- Provides protection against wild animals and rocks and dead trees that might fall.
- Is free from insects, reptiles, and poisonous plants.

You must also remember the problems that could arise in your environment.

For instance:

- Avoid flash flood areas in foothills.
- Avoid avalanche or rockslide areas in mountainous terrain.
- Avoid sites near bodies of water that are below the high water mark.

In some areas, the season of the year has a strong bearing on the site you select. Ideal sites for a shelter differ in winter and summer. During cold winter months you will want a site that will protect you from the cold and wind, but will have a source of fuel and water. During summer months in the same area you will want a source of water, but you will want the site to be almost insect free.

Types of Shelters

When looking for a shelter site, keep in mind the type of shelter (protection) you need. However, you must also consider:

- How much time and effort you need to build the shelter.
- If the shelter will adequately protect you from the elements (sun, wind, rain, snow).
- If you have the tools to build it. If not, can you make improvised tools?
- If you have the type and amount of materials needed to build it.

To answer these questions, you need to know how to make various types of shelters and what materials you need to make them.

Poncho Lean-To

It takes only a short time and minimal equipment to build this lean-to (Figure 5-1). You need a poncho, 2 to 3 meters of rope or parachute suspension line, three stakes about 30 centimeters long, and two trees or two poles 2 to 3 meters apart. Before selecting the trees you will use or the location of your poles, check the wind direction. Ensure that the back of your lean-to will be into the wind.

To make the lean-to:

- Tie off the hood of the poncho. Pull the drawstring tight, roll the hood longways, fold it into thirds, and tie it off with the drawstring.
- Cut the rope in half. On one long side of the poncho, tie half of the rope to the corner grommet. Tie the other half to the other corner grommet.

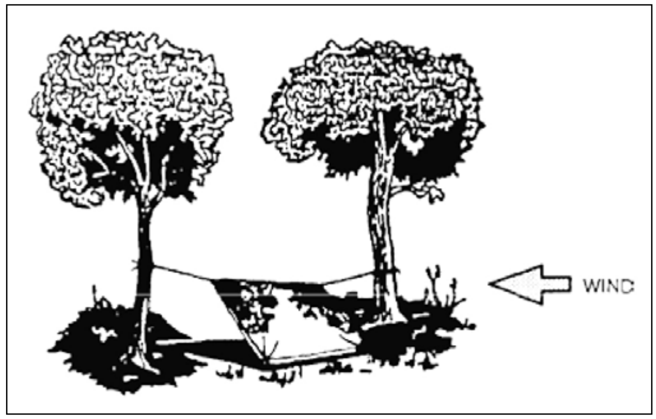


Figure 5-1 Poncho lean-to

- Attach a drip stick (about a 10-centimeter stick) to each rope about 2.5 centimeters from the grommet. These drip sticks will keep rainwater from running down the ropes into the lean-to. Tying strings (about 10 centimeters long) to each grommet along the poncho's top edge will allow the water to run to and down the line without dripping into the shelter.
- Tie the ropes about waist high on the trees (uprights). Use a round turn and two half hitches with a quick-release knot.
- Spread the poncho and anchor it to the ground, putting sharpened sticks through the grommets and into the ground.

If you plan to use the lean-to for more than one night, or you expect rain, make a center support for the lean-to. Make this support with a line. Attach one end of the line to the poncho hood and the other end to an overhanging branch. Make sure there is no slack in the line.

Another method is to place a stick upright under the center of the lean-to. This method, however, will restrict your space and movements in the shelter.

For additional protection from wind and rain, place some brush, your pack, or other equipment at the sides of the lean-to.

To reduce heat loss to the ground, place some type of insulating material, such as leaves or pine needles, inside your lean-to.

Note: When at rest, you lose as much as 80 percent of your body heat to the ground.

Poncho Tent

This tent (Figure 5-2) provides a low silhouette. It also protects you from the elements on two sides. It has, however, less usable space and observation area than a lean-to. To make this tent, you need a poncho, two 1.5- to 2.5-meter ropes, six sharpened sticks about 30 centimeters long, and two trees 2 to 3 meters apart.

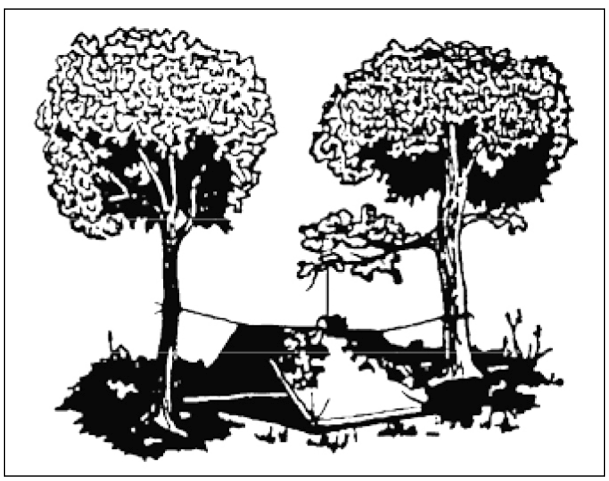


Figure 5-2 Poncho tent using overhanging branch

To make the tent:

- Tie off the poncho hood in the same way as the poncho lean-to.
- Tie a 1.5- to 2.5-meter rope to the center grommet on each side of the poncho.
- Tie the other ends of these ropes at about knee height to two trees 2 to 3 meters apart and stretch the poncho Figure 5-2 Poncho tent using overhanging branch.tight.
- Draw one side of the poncho tight and secure it to the ground pushing sharpened sticks through the grommets.
- Follow the same procedure on the other side.

If you need a center support, use the same methods as for the poncho lean-to. Another center support is an A-frame set outside but over the center of the tent (Figure 5-3). Use two 90- to 120-centimeter-long sticks, one with a forked end, to form the A-frame. Tie the hood's drawstring to the A-frame to support the center of the tent.

Field-Expedient Lean-To

If you are in a wooded area and have enough natural materials, you can make a field-expedient lean-to (Figure 5-5) without the aid of tools or with only a knife. It takes longer to make this type of shelter than it does to make other types, but it will protect you from the elements.

You will need two trees (or upright poles) about 2 meters apart; one pole about 2 meters long and 2.5 centimeters in diameter; five to eight poles about 3 meters long and 2.5 centimeters in diameter for beams; cord or vines for securing the horizontal

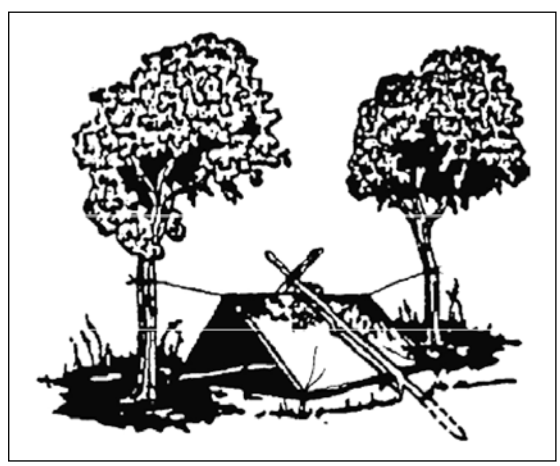


Figure 5-3 Poncho tent with A-frame

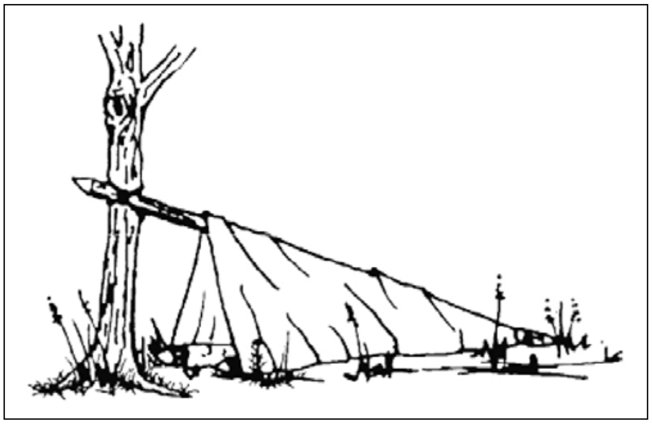


Figure 5-4 One-man shelter

support to the trees; and other poles, saplings, or vines to crisscross the beams.

To make this lean-to:

- Tie the 2-meter pole to the two trees at waist to chest height. This is the horizontal support. If a standing tree is not available, construct a biped using Y-shaped sticks or two tripods.
- Place one end of the beams (3-meter poles) on one side of the horizontal support. As with all lean-to type shelters, be sure to place the lean-to's backside into the wind.
- Crisscross saplings or vines on the beams.
- Cover the framework with brush, leaves, pine needles, or grass, starting at the bottom and working your way up like shingling.
- Place straw, leaves, pine needles, or grass inside the shelter for bedding.

In cold weather, add to your lean-to's comfort by building a fire reflector wall (Figure 5-5). Drive four 1.5-meter-long stakes into the ground to support the wall. Stack green logs on top of one another between the support stakes. Form two rows of stacked logs to create an inner space within the wall that you can fill with dirt. This action not only strengthens the wall, but makes it more heat reflective. Bind the top of the support stakes so that the green logs and dirt will stay in place.

With just a little more effort you can have a drying rack. Cut a few 2-centimeter-diameter poles (length depends on the distance between the lean-to's horizontal support and the top of the fire reflector wall). Lay one end of the poles on the lean-to support and the other end on top of the reflector wall. Place and tie into place smaller sticks across these poles. You now have a place to dry clothes, meat, or fish.

Swamp Bed

In a marsh or swamp, or any area with standing water or continually wet ground, the swamp bed (Figure 5-6) keeps you out of the water. When

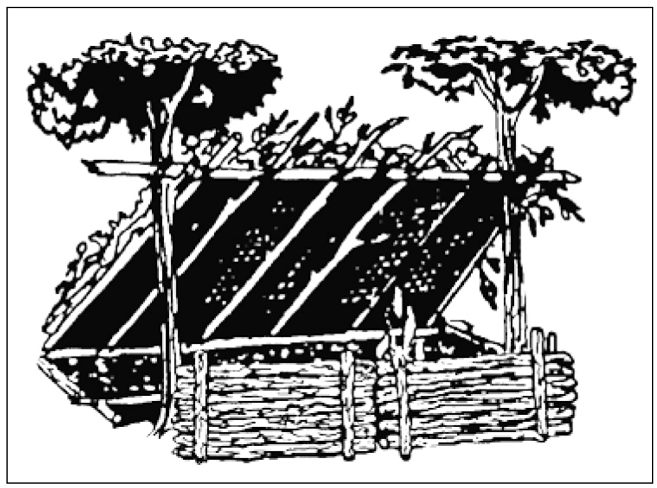


Figure 5-5 Field-expedient lean-to and fire reflector

selecting such a site, consider the weather, wind, tides, and available materials.

To make a swamp bed:

- Look for four trees clustered in a rectangle, or cut four poles (bamboo is ideal) and drive them firmly into the ground so they form a rectangle. They should be far enough apart and strong enough to support your height and weight, to include equipment.
- Cut two poles that span the width of the rectangle. They, too, must be strong enough to support your weight.

- Secure these two poles to the trees (or poles). Be sure they are high enough above the ground or water to allow for tides and high water.
- Cut additional poles that span the rectangle's length. Lay them across the two side poles, and secure them.
- Cover the top of the bed frame with broad leaves or grass to form a soft sleeping surface.
- Build a fire pad by laying clay, silt, or mud on one comer of the swamp bed and allow it to dry.

Another shelter designed to get you above and out of the water or wet ground uses the same rectangular configuration as the swamp bed. You very simply lay sticks and branches lengthwise on the inside of the trees (or poles) until there is enough material to raise the sleeping surface above the water level.

Natural Shelters

Do not overlook natural formations that provide shelter. Examples are caves, rocky crevices, clumps of bushes, small depressions, large rocks on leeward sides of hills, large trees with low-hanging limbs, and fallen trees with thick branches. However, when selecting a natural formation:

- Stay away from low ground such as ravines, narrow valleys, or creek beds. Low areas collect the heavy cold air at night and are therefore colder than the surrounding high ground. Thick, brushy, low ground also harbors more insects.

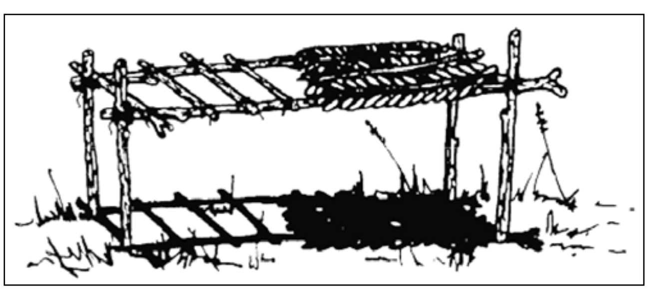


Figure 5-6 Swamp bed

- Check for poisonous snakes, ticks, mites, scorpions, and stinging ants.
- Look for loose rocks, dead limbs, coconuts, or other natural growth than could fall on your shelter.

Debris Hut

For warmth and ease of construction, this shelter is one of the best. When shelter is essential to survival, build this shelter.

To make a debris hut (Figure 5-7):

- Build it by making a tripod with two short stakes and a long ridgepole or by placing one end of a long ridgepole on top of a sturdy base.
- Secure the ridgepole (pole running the length of the shelter) using the tripod method or by anchoring it to a tree at about waist height.
- Prop large sticks along both sides of the ridgepole to create a wedge-shaped ribbing effect. Ensure the ribbing is wide enough to accommodate your body and steep enough to shed moisture.
- Place finer sticks and brush crosswise on the ribbing. These form a latticework that will keep the insulating material (grass, pine needles, leaves) from falling through the ribbing into the sleeping area.
- Add light, dry, if possible, soft debris over the ribbing until the insulating material is at least 1 meter thick—the thicker the better.
- Place a 30-centimeter layer of insulating material inside the shelter.
- At the entrance, pile insulating material that you can drag to you once inside the shelter to close the entrance or build a door.
- As a final step in constructing this shelter, add shingling material or branches on top of the debris layer to prevent the insulating material from blowing away in a storm.

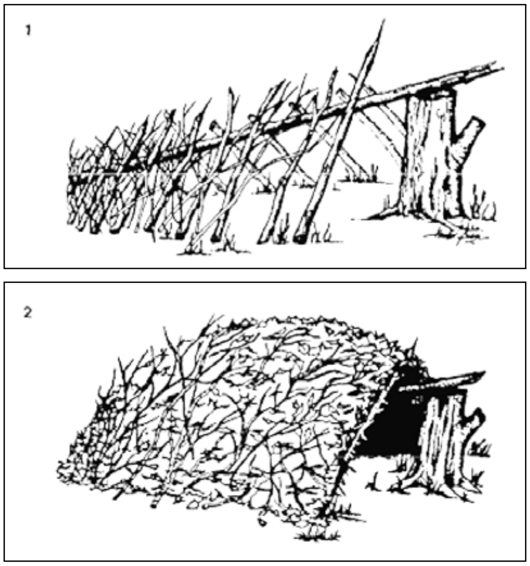


Figure 5-7 Debris hut

Tree-Pit Snow Shelter

If you are in a cold, snow-covered area where evergreen trees grow and you have a digging tool, you can make a tree-pit shelter (Figure 5-8).

To make this shelter:

- Find a tree with bushy branches that provides overhead cover.
- Dig out the snow around the tree trunk until you reach the depth and diameter you desire, or until you reach the ground.
- Pack the snow around the top and the inside of the hole to provide support.
- Find and cut other evergreen boughs. Place them over the top of the pit to give you additional overhead cover. Place evergreen boughs in the bottom of the pit for insulation.

See Chapter 15 for other arctic or cold weather shelters.

Beach Shade Shelter

This shelter protects you from the sun, wind, rain, and heat. It is easy to make using natural materials.

To make this shelter (Figure 5-9):

- Find and collect driftwood or other natural material to use as support beams and as a digging tool.
- Select a site that is above the high water mark.
- Scrape or dig out a trench running north to south so that it receives the least amount of sunlight. Make the trench long and wide enough for you to lie down comfortably.
- Mound soil on three sides of the trench. The higher the mound, the more space inside the shelter.
- Lay support beams (driftwood or other natural material) that span the trench on top of the mound to form the framework for a roof.
- Enlarge the shelter's entrance by digging out more sand in front of it.
- Use natural materials such as grass or leaves to form a bed inside the shelter.

Desert Shelters

In an arid environment, consider the time, effort, and material needed to make a shelter. If you have material such as a poncho, or canvas, use it along with such terrain features as rock outcropping, mounds of sand, or a depression between dunes or rocks to make your shelter.

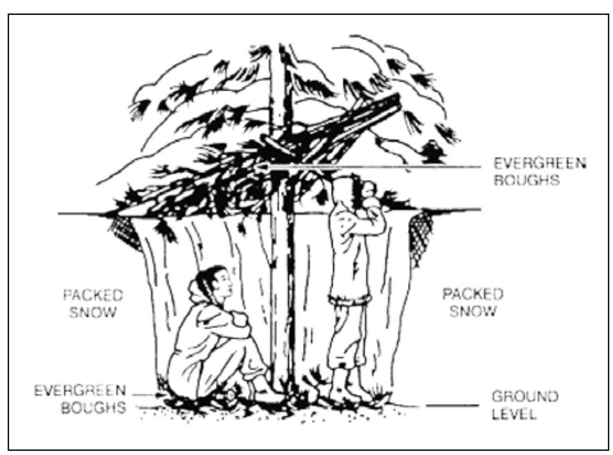


Figure 5-8 Tree-pit snow shelter

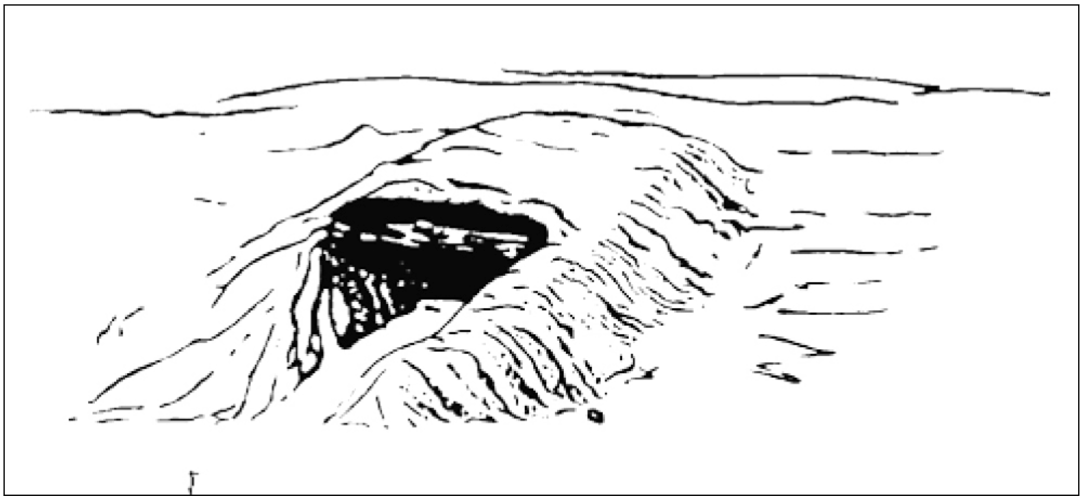


Figure 5-9 Beach shade shelter

Using rock outcroppings:

- Anchor one end of your poncho (canvas or other material) on the edge of the outcrop using rocks or other weights.
- Extend and anchor the other end of the poncho so it provides the best possible shade.

In a sandy area:

- Build a mound of sand or use the side of a sand dune for one side of the shelter.
- Anchor one end of the material on top of the mound using sand or other weights.
- Extend and anchor the other end of the material so it provides the best possible shade.

Note: If you have enough material, fold it in half and form a 30-centimeter to 45-centimeter airspace between the two halves. This airspace will reduce the temperature under the shelter.

A belowground shelter (Figure 5-10) can reduce the midday heat as much as 16 to 22 degrees C (30 to 40 degrees F). Building it, however, requires more time and effort than for other shelters. Since your physical effort will make you sweat more and increase dehydration, construct it before the heat of the day.

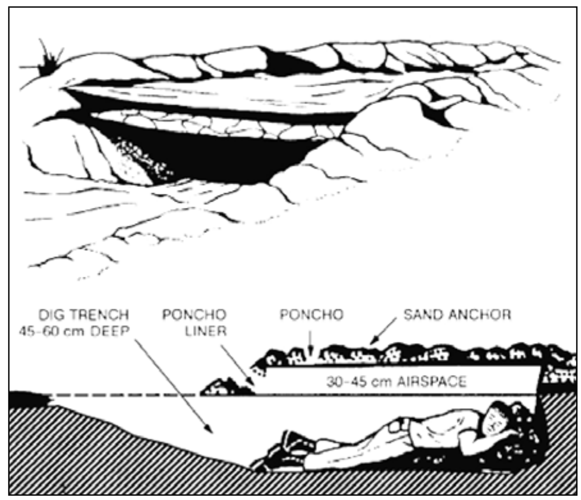


Figure 5-10 Below-ground desert shelter

To make this shelter:

- Find a low spot or depression between dunes or rocks. If necessary, dig a trench 45 to 60 centimeters deep and long and wide enough for you to lie in comfortably.
- Pile the sand you take from the trench to form a mound around three sides.
- On the open end of the trench, dig out more sand so you can get in and out of your shelter easily.
- Cover the trench with your material.
- Secure the material in place using sand, rocks, or other weights.

If you have extra material, you can further decrease the midday temperature in the trench by securing the material 30 to 45 centimeters above the other cover. This layering of the material will reduce the inside temperature 11 to 22 degrees C (20 to 40 degrees F).

Another type of belowground shade shelter is of similar construction, except all sides are open to air currents and circulation. For maximum protection, you need a minimum of two layers of parachute material (Figure 5-11). White is the best color to reflect heat; the innermost layer should be of darker material.

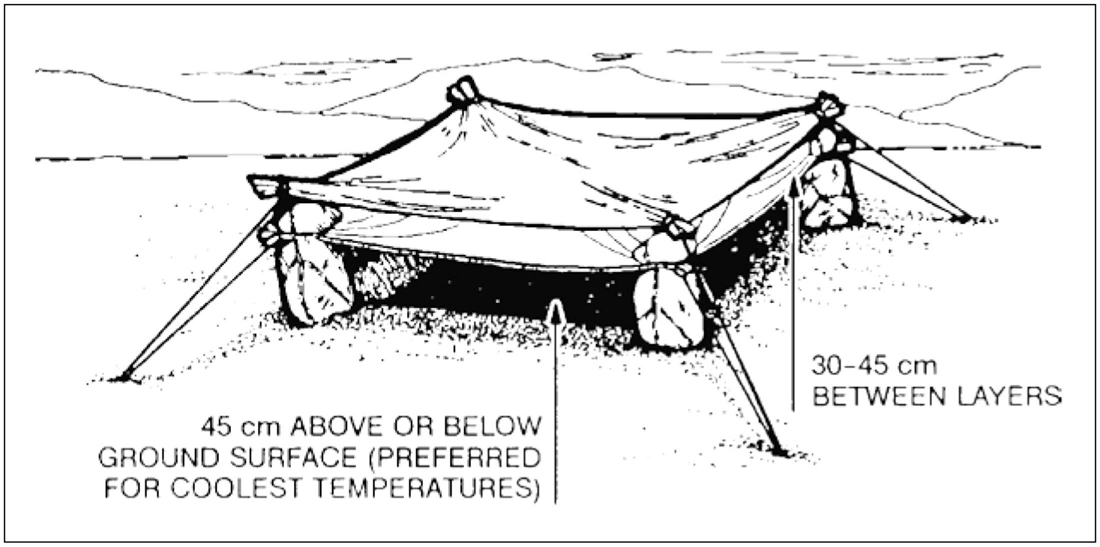


Figure 5-11 Open desert shelter

Direction Finding

In a survival situation, you will be extremely fortunate if you happen to have a map and compass. If you do have these two pieces of equipment, you will most likely be able to move toward help. If you are not proficient in using a map and compass, you must take the steps to gain this skill.

There are several methods by which you can determine direction by using the sun and the stars. These methods, however, will give you only a general direction. You can come up with a more nearly true direction if you know the terrain of the territory or country.

You must learn all you can about the terrain of the country or territory to which you or your unit may be sent, especially any prominent features or landmarks. This knowledge of the terrain together with using the methods explained below will let you come up with fairly true directions to help you navigate.

Using the Sun and Shadows

The earth's relationship to the sun can help you to determine direction on earth. The sun always rises in the east and sets in the west, but not exactly due east or due west. There is also some seasonal variation. In the northern hemisphere, the sun will be due south when at its highest point in the sky, or when an object casts no appreciable shadow. In the southern hemisphere, this same noonday sun will mark due north. In the northern hemisphere, shadows will move clockwise. Shadows will move counterclockwise in the southern hemisphere. With practice, you can use shadows to determine both direction and time of day. The shadow methods used for direction finding are the shadow-tip and watch methods.

Shadow-Tip Methods. In the first shadow-tip method, find a straight stick 1 meter long, and a level spot free of brush on which the stick will cast a definite shadow. This method is simple and accurate and consists of four steps:

Step 1. Place the stick or branch into the ground at a level spot where it will cast a distinctive shadow. Mark the shadow's tip with a stone, twig, or other means. This first shadow mark is always west—everywhere on earth.

Step 2. Wait 10 to 15 minutes until the shadow tip moves a few centimeters. Mark the shadow tip's new position in the same way as the first.

Step 3. Draw a straight line through the two marks to obtain an approximate east-west line.

Step 4. Stand with the first mark (west) to your left and the second mark to your right—you are now facing north. This fact is true everywhere on earth.

An alternate method is more accurate but requires more time. Set up your shadow stick and mark the first shadow in the morning. Use a piece of string to draw a clean arc through this mark and around the stick. At midday, the shadow will shrink and disappear. In the afternoon, it will lengthen again and at the point where it touches the arc, make a second mark. Draw a line through the two marks to get an accurate east-west line (see Figure 10-1).

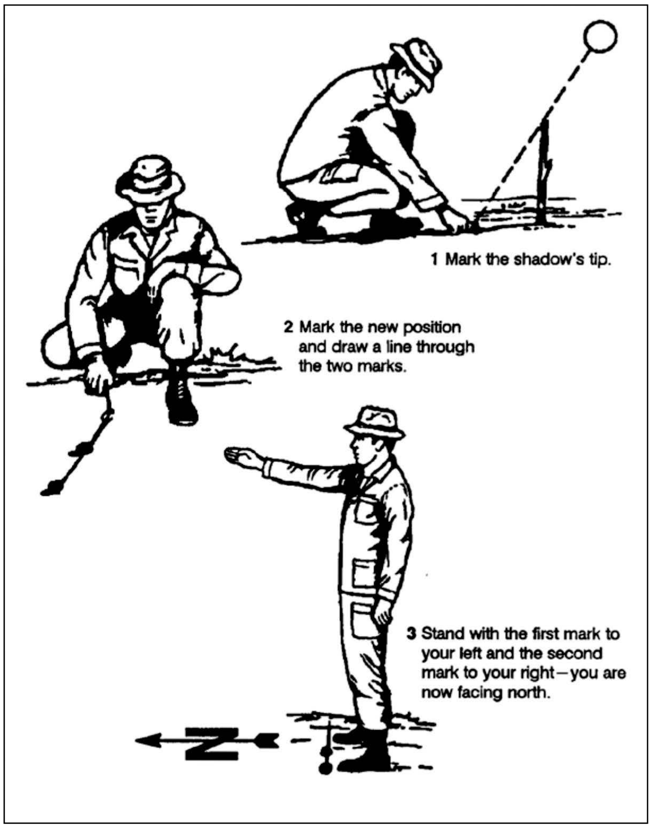


Figure 10-1: Shadow-tip method

The Watch Method. You can also determine direction using a common or analog watch—one that has hands. The direction will be accurate if you are using true local time, without any changes for daylight savings time. Remember, the further you are from the equator, the more accurate this method will be. If you only have a digital watch, you can overcome this obstacle. Quickly draw a watch on a circle of paper with the correct time on it and use it to determine your direction at that time.

In the northern hemisphere, hold the watch horizontal and point the hour hand at the sun. Bisect the angle between the hour hand and the 12 o'clock mark to get the north-south line (Figure 10-2). If there is any doubt as to which end of the line is north, remember that the sun rises in the east, sets in the west, and is due south at noon. The sun is in the east before noon and in the west after noon.

Note: If your watch is set on daylight savings time, use the midway point between the hour hand and 1 o'clock to determine the north-south line.

In the southern hemisphere, point the watch's 12 o'clock mark toward the sun and a midpoint halfway between 12 and the hour hand will give you the north-south line (Figure 10-2).

Using the Moon

Because the moon has no light of its own, we can only see it when it reflects the sun's light. As it orbits the earth on its 28-day circuit, the shape of the reflected light varies according to its position. We say there is a new moon or no moon when it is on the opposite side of the earth from the sun. Then, as it moves away from the earth's shadow, it begins to reflect light from its right side and waxes to become a full moon before waning, or losing shape, to appear as a sliver on the left side. You can use this information to identify direction.

If the moon rises before the sun has set, the illuminated side will be the west. If the moon rises after midnight, the illuminated side will be the east. This obvious discovery provides us with a rough east-west reference during the night.

Using the Stars

Your location in the Northern or Southern Hemisphere determines which constellation you use to determine your north or south direction.

The Northern Sky. The main constellations to learn are the Ursa Major, also known as the Big Dipper or the Plow, and Cassiopeia (Figure 10-3). Neither of these constellations ever sets. They are always visible on a clear night. Use them to locate Polaris, also known as the polestar or the North Star. The North Star forms part of the Little Dipper handle and can be confused with the Big Dipper. Prevent confusion by using both the Big Dipper and

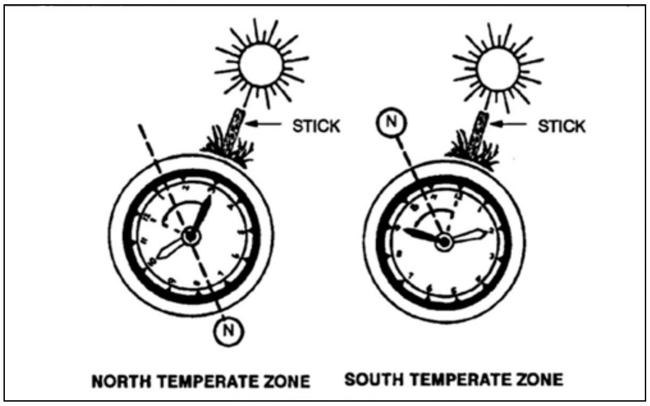


Figure 10-2: Watch method

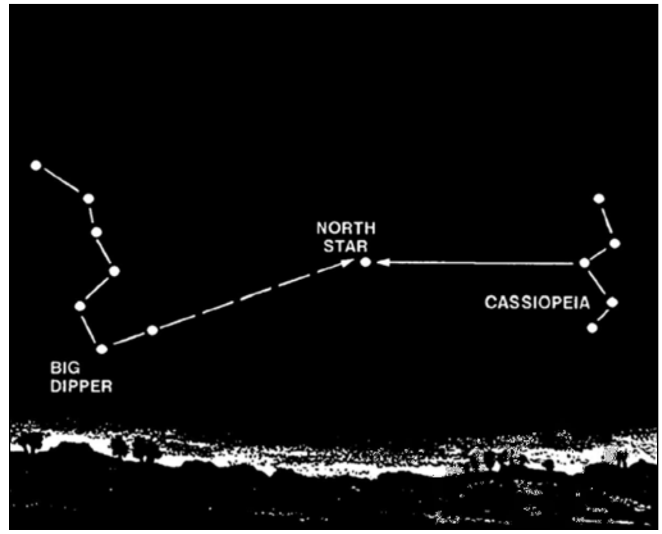


Figure 10-3: The big Dipper and Cassiopeia.

Cassiopeia together. The Big Dipper and Cassiopeia are always directly opposite each other and rotate counterclockwise around Polaris, with Polaris in the center. The Big Dipper is a seven star constellation in the shape of a dipper. The two stars forming the outer lip of this dipper are the "pointer stars" because they point to the North Star. Mentally draw a line from the outer bottom star to the outer top star of the Big Dipper's bucket. Extend this line about five times the distance between the pointer stars. You will find the North Star along this line.

Cassiopeia has five stars that form a shape like a "W" on its side. The North Star is straight out from Cassiopeia's center star.

After locating the North Star, locate the North Pole or true north by drawing an imaginary line directly to the earth.

The Southern Sky. Because there is no star bright enough to be easily recognized near the south celestial pole, a constellation known as the Southern Cross is used as a signpost to the South (Figure 10-4). The Southern Cross or Crux has five stars. Its four brightest stars form a cross that tilts to one side. The two stars that make up the cross's long axis are the pointer stars. To determine south, imagine a distance five times the distance between these stars and the point where this imaginary line ends is in the general direction of south. Look down to the horizon from this imaginary point and select a landmark to steer by. In a static survival situation, you can fix this location in daylight if you drive stakes in the ground at night to point the way.

Making Improvised Compasses

You can construct improvised compasses using a piece of ferrous metal that can be needle shaped or a flat double-edged razor blade and a piece of nonmetallic string or long hair from which to suspend it. You can magnetize or polarize the metal by slowly stroking it in one direction on a piece of silk or carefully through your hair using deliberate strokes. You can also polarize metal by stroking it repeatedly at one end with a magnet. Always rub in one direction only. If you have a battery and some electric wire, you can polarize the metal electrically. The wire should be insulated. If not insulated, wrap the metal object in a single, thin strip of paper to prevent contact. The battery must be a minimum of 2 volts. Form a coil with the electric wire and touch its ends to the battery's terminals. Repeatedly insert one end of the metal object in and out of the coil. The needle will become an electromagnet. When suspended from a piece of nonmetallic string, or floated on a small piece of wood in water, it will align itself with a north-south line.

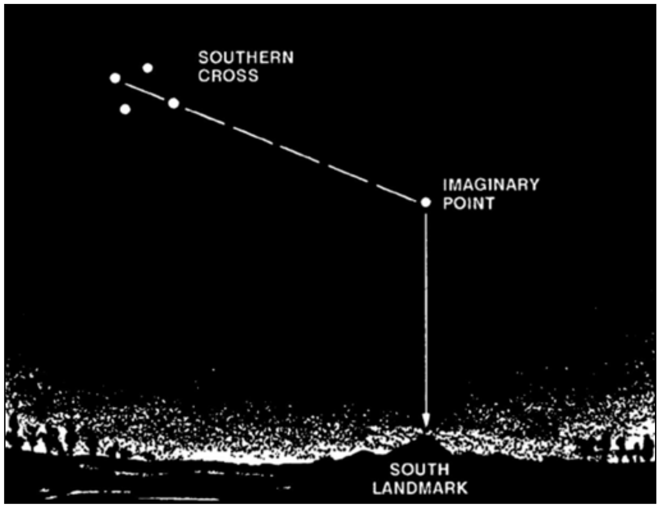


Figure 10-4: The Southern Cross

You can construct a more elaborate improvised compass using a sewing needle or thin metallic object, a nonmetallic container (for example, a plastic dip container), its lid with the center cut out and waterproofed, and the silver tip from a pen. To construct this compass, take an ordinary sewing needle and break in half. One half will form your direction pointer and the other will act as the pivot point. Push the portion used as the pivot point through the bottom center of your container; this portion should be flush on the bottom and not interfere with the lid. Attach the center of the other portion (the pointer) of the needle on the pen's silver tip using glue, tree sap, or melted plastic. Magnetize one end of the pointer and rest it on the pivot point.

Other Means of Determining Direction

The old saying about using moss on a tree to indicate north is not accurate because moss grows completely around some trees. Actually, growth is more lush on the side of the tree facing the south in the Northern Hemisphere and vice versa in the Southern Hemisphere. If there are several felled trees around for comparison, look at the stumps. Growth is more vigorous on the side toward the equator and the tree growth rings will be more widely spaced. On the other hand, the tree growth rings will be closer together on the side toward the poles.

Wind direction may be helpful in some instances where there are prevailing directions and you know what they are.

Recognizing the differences between vegetation and moisture patterns on north- and south-facing slopes can aid in determining direction. In the northern hemisphere, north-facing slopes receive less sun than south-facing slopes and are therefore cooler and damper. In the summer, north-facing slopes retain patches of snow. In the winter, the trees and open areas on south-facing slopes are the first to lose their snow, and ground snow pack is shallower.

First Aid

It's impossible to predict when an accident will occur, but the more you educate yourself ahead of time, the better you'll be able to help should the need arise. The first step in an emergency situation should always be to call for help, but there are many things you can do to help the victim while you're waiting for assistance to arrive. The most important procedures are described in this section.

Keep a buoy nearby whenever spending time in or near the water.

Drowning

1. As soon as the patient is in a safe place, loosen the clothing, if any.
2. Empty the lungs of water by laying the body breastdown and lifting it by the middle, with the head hanging down. Hold for a few seconds until the water drains out.
3. Turn the patient on his breast, face downward.
4. Give artificial respiration: Press the lower ribs down and forward toward the head, then release. Repeat about twelve times to the minute.
5. Apply warmth and friction to extremities, rubbing toward the heart.
6. Don't give up! Persons have been saved after hours of steady effort, and after being underwater for more than twenty minutes.
7. When natural breathing is reestablished, put the patient into a warm bed, with hot-water bottles, warm drinks, fresh air, and quiet.

Sunstroke

1. Move the patient to a cool place, or set up a structure around the patient to produce shade.
2. Loosen or remove any clothing around the neck and upper body.
3. Apply cold water or ice to the head and body, or wrap the patient in cold, damp cloths.
4. Encourage the patient to drink lots of water.

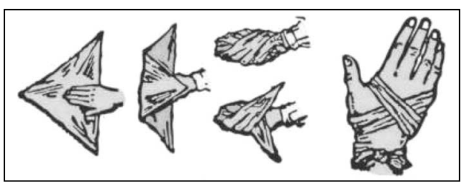
Burns and Scalds

1. Cover the burn with a thin paste of baking soda, starch, flour, petroleum jelly, olive oil, linseed oil, castor oil, cream, or cold cream.
2. Cover the burn first with the paste, then with a soft rag soaked in the paste.
3. Shock always accompanies severe burns, and must be treated.

Shock or Nervous Collapse

A person suffering from shock has a pale face, cold skin, feeble breathing, and a rapid, feeble pulse, and will appear listless.

1. Place the patient on his back with head low.
2. Give stimulants, such as hot tea or coffee.
3. Cover the patient with blankets.
4. Rub the limbs and place hot-water bottles around the body.



A simple hand bandage can be made from any square cloth or handkerchief.

Cuts and Wounds

1. After making sure that no dirt or foreign substance is in the wound, apply a tight bandage to stop the bleeding.
2. Raise the wound above the heart to slow the bleeding.
3. If the blood comes out in spurts, it means an artery has been cut. For this, apply a tourniquet: Make a big knot in a handkerchief, tie it around the limb, with the knot just above the wound, and twist it until the flow is stopped.

How to Make a Tourniquet

The tourniquet is an appliance used to check severe bleeding. It consists of a bandage twisted more or less lightly around the affected part. The bandage—a cloth, strap, belt, necktie, neckerchief or towel—should be long enough to go around the arm or leg affected. It can then be twisted by inserting the hand, and the blood stopped.

If a stick is used, there is danger of twisting too tightly.

The tourniquet should not be used if bleeding can be stopped without it. When used it should be carefully loosened every 15 to 20 minutes to avoid permanent damage to tissues.

Fainting

Fainting is caused by a lack of blood supply to the brain and is cured by getting the heart to correct the lack.

1. Have the person lie down with the head lower than the body.
2. Loosen the clothing. Give fresh air. Rub the limbs. Use smelling salts.
3. Do not let the person get up until fully recovered.

Snake Bite

1. Put a tight cord or bandage around the limb between the wound and the heart. This should be loose enough to slip a finger under it.
2. Keep the wound lower than the heart. Try to keep the patient calm, as the faster the heart beats, the faster the venom will spread.

3. If you cannot get to a doctor quickly, suck the wound many times with your mouth or use a poison suction kit, if available.

Hemorrhage or Internal Bleeding

Internal bleeding usually comes from the lungs or stomach. If from the lungs, the blood is bright red and frothy, and is coughed up; if from the stomach, it is dark, and is vomited.

1. Help the patient to lie down, with head lower than body.
2. Encourage the patient to swallow small pieces of ice, and apply ice bags, snow, or cold water to the place where the bleeding is coming from.
3. Hot applications may be applied to the hands, arms, feet, and legs, but avoid stimulants, unless the patient is very weak.

Insect Stings

1. Wash with oil, weak ammonia, or very salty water, or paint with iodine.
2. A paste of baking soda and water also soothes stings.

Poison

1. First, get the victim away from the poison. If the poison is in solid form, such as pills, remove it from the victim's mouth using a clean cloth wrapped around your finger. Don't try this with infants because it could force the poison further down their throat.
2. If the poison is corrosive to the skin, remove the clothing from the affected area and flush with water for 30 minutes.
3. If the poison is in contact with the eyes, flush the victim's eyes for a minimum of 15 minutes with clean water.

How to Put Out Burning Clothing

1. If your clothing should catch fire, do not run for help, as this will fan the flames.
2. Lie down and roll up as tightly as possible in an overcoat, blanket, rug, or any woolen article—or lie down and roll over slowly, at the same time beating the fire with your hands. Smother the fire with a coat, blanket, or rug. Remember that woolen material is much less flammable than cotton.

Ice Rescue

1. Always have a rope nearby if you're working or playing on ice. This way, if someone falls through, you can tie one end to yourself and one to a tree or other secure anchor onshore before you attempt to rescue the person.
2. You could also throw one end to the victim if his head is above water.
3. Do not attempt to walk out to victim. Push out to him or crawl out on a long board or rail or tree trunk.
4. The person in the water should never try to crawl up on the broken ice, but should try merely to support himself and wait for help, if it is at hand.

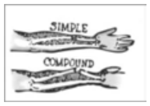
For elbow, arm, or wrist injuries, a simple sling can be made out of a piece of cloth or clothing.

Broken Bone

A simple fracture is one in which the bone is broken but does not break the skin. In a compound fracture, the bone is broken and the skin and tissue are punctured or torn. A simple fracture may be converted into a compound fracture by careless handling, as a broken bone usually has sharp, saw-tooth edges, and just a little twist may push it through the skin.

1. Do not move the patient without supporting broken member by splints.

A compound fracture is one that breaks through the flesh.



2. In a compound fracture, bleeding must be checked—by bandage over compress, if possible, or by tourniquet in extreme cases. Then splints may be applied.
3. Where skin is broken, infection is the great danger, so exercise care that compress or dressing is sterile and clean.

Dislocation

A dislocation is an injury where the head of a bone has slipped out of its socket at a joint.

1. Do not attempt to replace the joint. Even thumb and finger dislocations are more serious than usually realized.
2. Cover the joint with cloths wrung out in very hot or very cold water. For the shoulder— apply padding and make a sling for the arm.
3. Seek medical assistance.

A There are many ways to carry someone with an injury. If neck or spine injury is suspected, do not attempt to move the victim if you can get help to come to the victim instead. If the victim must be moved, the head and neck must first be carefully stabilized.

First Aid Checklist

To administer effective first aid, it is important to maintain adequate supplies in each first aid kit. A first aid kit should include:

Nature's First Aid

Antiseptic or wound-wash: A handful of salt in a quart of hot water.

Balm for wounds: Balsam fir. The gum can be used as healing salve, usually spread on a piece of linen and laid over the wound for a dressing.

Cough remedy: Slippery elm or black cherry inner bark boiled, a pound to the gallon, boiled down to a pint, and given a teaspoonful every hour.

Linseed can be used the same way; add honey if desired. Or boil down the sap of the sweet birch tree and drink it on its own or mixed with the other remedies.

Diuretic: A decoction of the inner bark of elder is a powerful diuretic.

Inflammation of the eyes or skin: Wash with a strong tea made of the bark of witch hazel.

Lung balm: Infusion of black cherry bark and root is a powerful tonic for lungs and bowels. Good also as a skin wash for sores.

Poison ivy: Wash every hour or two with hot soapy water, then with hot salt water.

- Adhesive bandages: These are available in a large range of sizes for minor cuts, abrasions, and puncture wounds.
- Butterfly closures: These hold wound edges firmly together.
- Rolled gauze: These allow freedom of movement and are recommended for securing a wound dressing and/or pads. These are especially good for hard-to-bandage wounds.
- Nonstick sterile pads: These are soft, super-absorbent pads that provide a good environment for wound healing. These are recommended for bleeding and draining wounds, burns, or infections.
- First aid tapes: Various types of tapes should be included in each kit. These include adhesive, which is waterproof and extra strong for times when rigid strapping is needed; clear, which stretches with the body's movement and is good for visible wounds; cloth, recommended for most first aid taping needs, including taping heavy dressings (less irritating than adhesive); and paper, which is recommended for sensitive skin and is used for light and frequently changed dressings.
- Items that can also be included in each kit are tweezers, first aid cream, thermometer, an analgesic or equivalent, and an ice pack.

Witch hazel bark can be brewed and used to soothe irritated skin or eyes.

Backyard Medicine

BY JULIE AND MATTHEW SEAL

Agrimony

Agrimonia eupatoria, A. procera, A. gryposepala

Agrimony stops bleeding of all sorts, and is used in trauma treatment and surgery in Chinese hospitals. It helps relieve pain too, and has a long tradition as a wound herb as well as for treating liver, digestive, and urinary tract problems.

Agrimony tightens and tones the tissues, and, in a seeming contradiction, also relaxes tension, both physical and mental. This is the herb for when you're feeling frazzled, when stress and tension or pain are causing torment.

You can hardly miss this tall and bright summer garden herb, which readily earns its old name of church steeples. The sticky burrs that cling to passers-by lie behind another name, cocklebur.

Agrimony used to be a significant herb in the European tradition, being the Anglo-Saxon healing plant "garclive," but it is underused and underrated in modern western herbalism.

Agrimonia eupatoria is the "official" agrimony, but John Parkinson in *Theatrum Botanicum* (1640) preferred fragrant agrimony, *Agrimonia procera,* if available. The two can be used interchangeably.

In Chinese medicine, *A. pilosa* is the species used, and its name, *xian he cao,* translates as "immortal crane herb," which gives an idea of the reverence in which it is held. It is used in surgery and trauma treatment to stop bleeding, and has been found to be effective against *Trichomonas* vaginal infections and tapeworms, as also for dysentery and chronic diarrhea.

Dr Edward Bach chose agrimony as one of his 38 flower essences. It is for people who soldier on, who say everything is fine when it is not, hiding inner turmoil behind a cheerful facade and ignoring the darker side of life. The out-of-balance agrimony person often resorts to alcohol, drugs, or adrenaline-producing sports to avoid dealing with life issues.

Use Agrimony for . . .

Agrimony, from Woodville's *Medi-cal Botany* (1790–3)

Contemporary American herbalist Matthew Wood has written more deeply about agrimony than anybody else. He uses it as a flower essence, herbal tincture, and homeopathic preparation, and has researched it in great detail, expanding on the traditional picture of the plant. Wood calls agrimony "the bad hair day remedy" - imagine the cartoon picture of a cat that has had a fright or put its paw into an electric socket. He has found it works for people with mental and physical tension or work-related stress, with "pain that makes them hold their breath" and a range of other conditions.

Agrimony Tea

- eyewash, conjunctivitis
- gargle for mouth & gum or throat problems
- in footbath for athlete's foot
- in bath for sprains & strained muscles

Agrimony Tincture

- appendicitis
- urinary incontinence
- potty training
- cystitis
- weak digestion
- diarrhea/constipation
- tension
- irritable bladder
- asthma
- childhood diarrhea
- burns

. . . ***there are few of our wild flowers which are in more esteem with the village herbalist than the agrimony. Every gatherer of simples know it well.***

– Pratt (1857)

Agrimony is a great herb for treating intermittent fever and chills, or in alternating constipation and diarrhea, as it helps the body to recover a working balance between extremes, by releasing the tension and constricted energy that cause such problems.

Pain is very often associated with constriction, with one condition reinforcing the other. Agrimony can help release us from this self-perpetuating spiral, allowing body and mind to relax and restorative healing to begin as blood and energy flow are brought back to normal.

Agrimony is a wonderful wound herb, as it rapidly stops bleeding and also relieves pain. It is thought that a high tannin and vitamin K content account for its remarkable coagulation properties. In the 1400s agrimony was picked to make "arquebusade water," to staunch bleeding inflicted by the arquebus or hand gun.

Agrimony works well for burns too put tincture directly on the burn and take a few drops internally; repeat until pain subsides.

Agrimony has an affinity for the liver and digestive tract, working to co-ordinate their functions. John Parkinson—the herbalist to King James II and King Charles I—wrote in 1640 that "it openeth the obstructions of the Liver, and cleanseth it; it helpeth the jaun-dise, and strengthneth the inward parts, and is very beneficiall to the bowels, and healeth their inward woundings and bruises or hurts."All these are uses borne out today and explained by the herb's bitter and astringent qualities.

Agrimony's other main affinity is for the urinary tract, being used to good effect to ease the pain of kidney stones, irritable bladder, and chronic cystitis. It can be given safely to children for bedwetting and anxiety about potty training, and to the elderly for incontinence.

Harvesting Agrimony

Harvest when the plant is in bloom in the summer, picking the flower spike and some leaves. For agrimony tea, dry them in the shade until crisp, and then strip the flowers and leaves off the stems, discarding the stems. Store in brown paper bags or glass jars, in a cool dry place.

Agrimony Tea

Use 1–2 teaspoonfuls of **dried agrimony** per cup of **boiling water,** infused for 10 to 15 minutes. The tea has a pleasant taste and odor, and was often used as a country beverage, especially when imported tea was expensive.

Dose: The tea can be drunk three times a day, or used when cool as an eyewash or gargle for gum irritations and sore throats.

Agrimony Bath

Make a strong tea with a handful of **dried agrimony** infused in 1 pint of freshly **boiled water** for 20 minutes.

Poured hot into a foot bath, this soothes athlete's foot or sprained ankles; added to a hot bath it helps strained muscles after exercise, and general tension that has stiffened the muscles, back, and joints.

Agrimony Tincture

To make agrimony tincture, pick the **flowers and leaves** on a bright sunny day. Pack them into a glass jar large enough to hold your harvest—clean jam jars work well—and pour in enough **brandy or vodka** to cover them. Put the lid on the jar and keep it in a dark cupboard for six weeks, shaking it every few days. Strain off the liquid, bottle, and label.

Amber or blue glass bottles will protect your tincture from UV light. If you use clear glass bottles, you will need to keep your tincture in a dark cupboard. It doesn't need to be refrigerated and should keep for several years, although it is best to make a fresh batch every summer if you can.

Dose: For tension or interstitial cystitis: 3–5 drops in a little water three times a day; as an astringent to tone tissues (as in diarrhea), half a teaspoonful in water three times daily.

The tincture can be used as a first-aid remedy for burns. First cool the burn thoroughly by holding it under water running from the cold tap for several minutes. You can just pour a little tincture onto the burn, but for best results, wet a cotton ball with the tincture and hold it in place until the burn stops hurting.

Birch

Birch has a multitude of historical uses but is less familiar for its undoubted medicinal benefits. The sap makes a clear and refreshing drink that can be preserved as a wine, beer, or spirit. The leaves produce a pleasant tea and an infused oil. In each form, birch is an excellent tonic and detoxifier, mainly working on the urinary system to remove waste products, as in kidney or bladder stone, gravel, gout, and rheumatism. It reduces fluid retention and swellings, and clears up many skin problems.

Birch is one of the most useful of trees as well as one of the most graceful. From adhesives to wine, baskets to yokes, and boats to vinegar, it has been a boon to people in the cold north for thousands of years. Its medicinal qualities have been historically valued and should be better known today.

Called the oldest tree in Britain, birch was a pioneer species when the ice caps retreated, moving in on the devastated land, growing quickly and then rotting to leave more fertile earth in which other species could take over. In its rapid life cycle birch pushes upward too fast to develop a strong heart wood, but this makes it perfect for making buckets and canoes.

As a youngster (writes Matthew), I was a suburban Hiawatha, and wanted to be a “Red Indian.” I had read in my weekly comic, the *Eagle,* how my heroes had made birch bark canoes and wrote on bark paper. Birch was a common enough tree, but I never really got down to the canoe or the paper. Soccer was more important.

But now these memories return, as Julie and I tap a birch in our garden. It is that time in spring after most of the frosts and before the birch buds and leaves emerge. The tree is now forcing its sap upward in prodigious quantity, and you simply tap into the flow, remembering to be kind to the tree after you have taken your share by closing off the wound.

A stand of silver birch in the English Surrey hills, where the birch is so common it earned the name “Surrey weed”

Birch sap is rich in fructose whereas maple has sucrose. Sucrose is sweeter to the taste and the maple yields more per tree, so maple syrup is by far the bigger commercial industry. On the other hand, birch sap is cool, refreshing and clear. It tastes even better when reduced by simmering down into a golden-brown ambrosia. It’s the sort of drink the elves would envy!

Betulaceae
Birch family

Description: Deciduous trees that often hybridize, with whitish papery bark.

Habitat: Woods, heaths, moors, and gardens. Downy birch prefers wetter places.

Distribution: Silver birch or European white birch *(Betula pendula)* and downy birch *{B. pubescens)* are native to northern temperate regions of Eurasia, and found as introduced species in North America. Sweet birch *(B. lenta)* is native to eastern North America.

Related species: Worldwide, several birch species have medicinal value. In Ayurveda, Himalayan silver birch *(B. utlis)* is used.

Parts used: Sap, tapped in early spring; leaves, gathered in spring and early summer. The bark is also used.

Use Birch for . . .

Birch sap, birch water, or blood, had a folk reputation for breaking kidney or bladder stone and treating skin conditions and rheumatic diseases. It can be drunk in spring as a refreshing and cleansing tonic, clearing the sluggishness of winter from the system. The fermented sap also makes birch wine and country beers and spirits.

. . . birch water is the hope, the blessing and the panacea of rich and poor, master and peasant alike . . . almost unfailingly cures skin conditions . . . and countless chronic ills against which medical science is so prone to fail. – Baron Percy (c. 1800)

Besides being a source of tinder and paper, birch bark has been used for tanning leather, especially in Russia, and for preserving nets and ropes. Another product of this gracious tree is an oil tar from the bark. This is used commercially in birch creams and ointments for chronic skin conditions.

The fresh leaves or buds of birch offer a powerful but pleasant tea for general detoxing, urinary complaints, cystitis, rheumatic and arthritic troubles, and gout. Some herbalists add a pinch of sodium bicarbonate to improve the tea's ability to cut high uric acid levels. Any condition of fluid retention, such as cardiac or renal edema and dropsy, will be helped by the tea. Birch is rich in potassium, so that (like dandelion) it does not deplete the body of this mineral in the way that medical diuretics do.

Being such a good eliminator, birch tea is also effective as a compress applied directly to the skin for herpes, eczema, and the like.

You can easily make your own birch leaf oil by infusing the leaves in olive or sweet almond oil. This goes into commercial cellulite treatments, and can be used as a massage oil to relieve muscle aches and pains, fibromyalgia, and rheumatism. Drink birch tea as well for maximum benefit.

Birch is regarded as safe medicinally and no side effects have been reported.

Birch Leaf Oil

Pick the **leaves** in late spring or early summer, while they are still fresh and light green. Put them in a jar large enough to hold them and pour in enough **extra virgin olive oil or sweet almond oil** to cover them. Put a piece of cloth over the jar as a lid, held on with a rubber band. This will allow any moisture released by the leaves to escape. Put the jar in a sunny place indoors and leave for a month but stir it fairly regularly, checking to see that the leaves are kept beneath the surface of the oil.

Strain off into a jug, using a nylon jelly bag or a large strainer (if you use muslin, it will soak up too much of the oil). Allow to settle–if there is any water in the oil from the leaves, it will sink to the bottom of the jug. Pour the oil into sterile storage bottles, leaving any watery residue behind in the jug, and label. Using amber, blue, or green glass will protect the oil from ultraviolet light, so if you use clear glass bottles remember to store your oil away from light.

This can be used as a massage oil for cellulite, fibromyalgia, rheumatism, and other muscle aches and pains. It can be also used on eczema and psoriasis–but remember that these also need to be treated internally, so ask your herbalist for advice.

Birch leaf oil

- cellulite
- detoxing massage
- aching muscles
- rheumatism
- eczema
- psoriasis

Birch leaf tea

- spring cleanse
- kidney stones
- urinary gravel
- cystitis
- gout
- arthritis
- rheumatism
- psoriasis
- eczema
- fluid retention
- fevers

Birch sap

- cleansing tonic

Birch Leaf Tea

Pick the leaves in spring and early summer while they are still a fresh bright green. They can be used fresh in season or dried for later use. To dry, spread the leaves on a sheet of paper or on a drying screen, which can be made by stretching and stapling a piece of netting to a wooden frame. Dry them in the shade, until crisp when crumbled.

Our own crude birch tap: you can probably do better!

To make the tea, use 4 or 5 **leaves** per cup or mug of **boiling water**, and allow to infuse for 5 to 10 minutes.

Dose: Drink a cupful up to three or four times daily.

Birch Sap

To collect the sap, drill a hole through the bark in the early spring, before the tree gets its leaves. Insert a tube into the hole–a straw with a flexible end works well–and put the other end in a bottle or collection bucket. After you have collected for about a week, make sure you plug the hole with a twig the right size so that the tree doesn't keep "bleeding."

The sap is a delightfully refreshing drink as it comes from the tree, or it can be gently simmered down to taste to produce an amber ambrosia or further reduced to make a syrup.

Dandelion

Taraxacum officinale

Dandelion is a wonderful food as well as a beneficial medicine. It supports overall health by gently working to improve the functioning of the liver, gallbladder, and urinary and digestive systems. It is excellent for cleansing the skin.

Next time you spend an hour removing dandelions from your garden or lawn, turn them into medicine instead of throwing them out, and rejoice in the fact that they will always grow back!

Asteraceae (Compositae) Daisy family

Description: A familiar weed of lawns, with bright yellow flowers, seed "docks," a bitter white latex in the stem, and a long tap root.

Habitat: Lawns, fields, and roadside verges.

Distribution: Worldwide in temperate zones.

Related species: *Taraxacum officinale* **is** actually a group of several hundred plants. These are divided into nine sections and are very difficult to distinguish. The most common dandelions belong to the *Ruderalia* section. They are all safe medicinal plants. In Chinese medicine, *T. mongolicum* is used to clear heat and toxicity.

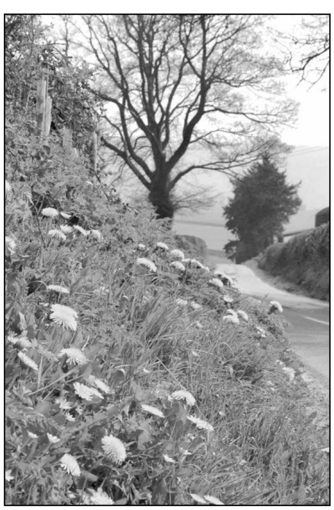
Parts used: Leaves, roots, flowers, and sap.

Dandelions: where to begin? They do so much! They were once much used in Britain as a spring tonic, and still are in Europe. In the US fresh dandelion leaves for salads was a three-million-dollar-a-year industry in 1999.

Dandelions have followed European settlers around the world, though it is probably native in China and most of Asia. Most people know them as lawn weeds, but we're prepared to upset the gardeners to say: consider the benefits of a lawn of brightly blooming dandelions. Can grass give you salad, tasty fritters, wine, a coffee substitute, tea, useful medicine and more besides?

This plant is almost indestructible: it is a perennial and, unusually, it is self-fertilizing; its deep tap roots make it hard to dig out, and any pieces left will regenerate. Its seeds soar miles on little parachutes, whether or not helped by children playing the "clock" game. It flowers almost all year long.

Any amount of mowing, herbi-tide, and flamethrowing fail to eradicate this sunny plant from the garden. Really, you'll be happier if you view dandelions as a culinary and medicinal gift, a superb "cut and come again" crop, rather than as an annoying weed!



An old companion of man, it has accumulated many names. Blowball and telltime refer to the seeds, priest's crown to the stem after the seeds have flown, and swine's snout to the unopened flower. And "dandelion" itself? The "teeth of the lion" *(dent de lion)* explanation, from the appearance of the saw-edged leaves or perhaps the tiny florets, is found in many languages. But there is also a case made for an older link to the sun.

In many cultures the lion has been the animal symbol of the sun since antiquity, as in the astrological sign Leo. Dandelions are yellow disks, like the sun, and open and close along with it. So, perhaps the old name might mean "rays of the sun" rather than "teeth of the lion"? In any case the Chinese, who have long used the dandelion, have even better names for it: two are "yellow-flowered earth-nail" and "golden hairpin weed."

An ancient connection with man: dandelions at Avebury henge in England in April.

It is very effectual for the obstructions of the liver, gall and spleen, and the distempers that arise therefrom, jaundice and the hypo-chondriacal passion. It wonderfully opens the urinary tract.

- Coles (1657)

Use Dandelion For . . .

It is high in minerals, especially potassium, and vitamins A, B, C, and D. The young leaves boiled up into a tea or eaten fresh in salads are detoxifiers, clearing blood and lymph by increasing elimination through the kidneys and bowels. This in turn benefits overall health.

If dandelion says "think spring," it also suggests "think liver." It has a reputation as a safe liver herb, especially where there are toxins and heat in the blood. The plant's chemicals cause the gallbladder to contract, releasing bile, stimulating the liver to produce more.

Liver-related conditions aided by dandelion include jaundice and hepatitis, gallstones and urinary tract infection, painful menopause, PMT, and menstruation; improvements are achievable in the pancreas, spleen, skin, and eyesight.

One monograph on dandelion lists two pages of remedies, from abscess and acne to varicose veins and venereal warts; to the author it is a "self-contained pharmacy."

It is the bitterness in dandelion leaves that makes them so good for your digestion. The bitter taste stimulates secretion of the digestive fluids, including stomach acid, bile, and pancreatic juices. Dandelion promotes the appetite, and is recommended for those who have been ill or have lost their enthusiasm for food in advanced age.

Roasted dandelion root is a well-known and caffeine-free coffee substitute. We grind the roasted root with a few pods of cardamon just before brewing; it's also tasty with cinnamon and fennel seed. The root can also be eaten as a vegetable.

The flowers don't look very edible, but they are surprisingly good eaten straight off the plant, mild

and slightly sweet. Eating a few dandelion flowers often relieves a headache too. They are delicious washed, dipped wet into flour, and fried in butter until golden brown. This needs to be a lunch dish, as the flowers only open when the sun is shining, and they are too bitter when picked in the evening.

One of Julie's first paid jobs as a girl in Jackson Hole, Wyoming, was collecting paper bags full of dandelion heads for a neighbor to make dandelion wine. This is a beautiful golden color, like distilled sunshine. The flowers also yield a refreshing dandelion "beer" and a face wash.

The sap or latex of the stems was once used in patent medicines, and was said to remove freckles and age spots, corns and warts, to help hair grow, and treat bee stings and blisters.

Dandelion is known as "piss-en-lit" in French, "pissabed" in English, and is justly renowned for its diuretic properties, that is, increasing the flow of urine. What is less familiar is how well it strengthens the urinary system. It is effective in treating

Dandelions will grow almost anywhere, from cracks in sidewalks to car hoods. They are wonderfully adaptable survivors.

> *Dandelions may well be the world's most famous weed. . . . Up until the 1800s, [American] people would actually pull the grass out of their yards to make room for dandelions and other useful "weeds" such as chickweed, malva, and chamomile.*
>
> – Mars (1999)

bedwetting in children and incontinence in older people. All parts of the plant have this effect, but especially the leaves.

With most diuretic drugs potassium is lost from the body and has to be supplemented, but dandelion is naturally high in potassium. It can safely be used long term with out causing imbalance. The leaves boiled with vegetable peelings make a potassium-rich broth.

Dandelion's diuretic effect makes it a good herb for treating swollen ankles, for fluid retention, and high blood pressure. It can also be used to alleviate shortness of breath in the elderly.

As a medicine the whole plant is invaluable for liver and gallbladder problems, and for skin complaints including eczema and acne. Its action helps reduce high blood pressure, high cholesterol, and the pain of arteriosclerosis and joints, digestive problems, chronic illness, viral infections, and heart and lung irregularities.

Dandelion can form part of a natural cancer treatment, and taken regularly as a food and medicine may help prevent some cancers, especially breast cancer, and other chronic illnesses by keeping the body clean, toned, and healthy.

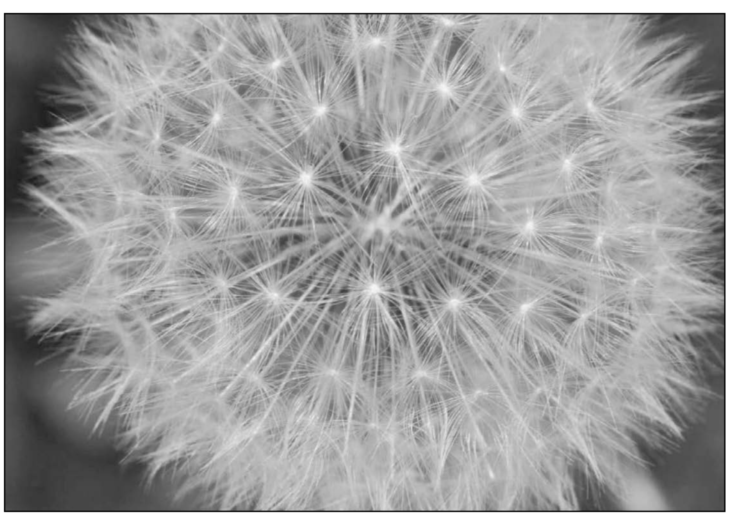
Dandelion Sap
- warts
- calluses
- corns
- rough skin

Dandelion salad
- sluggish liver
- constipation
- urinary problems
- fluid retention

Dandelion tincture
- skin problems
- sluggish liver
- constipation
- urinary problems
- fluid retention
- arthritis
- gout
- hangovers
- chronic illness

Dandelion Tincture

The root or the leaves can be tinctured separately for specific uses, but for general use we prefer to use the whole plant. Dig up **dandelion plants,** wash the dirt off and remove any dead leaves. The plants can be left whole or chopped up. Place in a jar large enough to hold them, and pour enough **vodka** in to cover the plants completely.



Put the jar in a cool place out of sunlight. If you chop up your plants, the tincture can be ready in as little as two weeks, otherwise leave it for a month before straining, squeezing the residue in a jelly bag or piece of muslin to get all the liquid out. Pour it into clean amber or blue glass bottles, label, and store until needed.

Dosage

- For general health maintenance, take half a teaspoonful twice daily.
- For acute skin eruptions, take 10 drops in water frequently throughout the day until the skin clears.
- For digestive problems, recuperation from chronic illness, sluggish liver, arthritis, gout, eczema, and psoriasis, take half to 1 teaspoonful three times daily in water.
- For overindulgence in food or drink, take 10 drops in water every hour until you are feeling better.

Dandelion Flower Beer

Pick 100 dandelion flowers. Boil 4 pints of **water** with three and a half ounces of **light brown sugar** until the sugar has dissolved. Allow to cool until tepid, then pour over the dandelion flowers in a large container. Add **a lemon, finely sliced.**

DANDELION FLOWERS

Flower infused oil

- muscle tension
- muscle aches
- stiff necks
- arthritis

Cover the container with a clean cloth and set aside in a cool place for three or four days, stirring occasionally. Strain and pour into tightly corked bottles. The beer will be ready to drink in just a few days.

Dandelion Flower-Infused Oil

Pick enough dandelion flowers to fill a clean, dry jam jar. Pour in extra virgin olive oil slowly, allowing it to seep down around the flowers until the jar is full and there are no air pockets left.

Cover the jar with a piece of cloth held in place with a rubber band, and put the jar in a warm sunny place. It can be left outdoors during the day if the weather is clear, and brought in at night, or left on a sunny window ledge. The cloth cover lets any moisture escape. You may need to prod the flowers down to keep them immersed in the oil, as they can go moldy if left in the air.

After a week or two, or when the flowers are limp and have lost their color, strain off the oil. If you put the flowers in a cloth or jelly bag to squeeze out the oil you may get some juice as well, so you'll need to let the oil stand for a while in a jug. This will allow any water to sink to the bottom. The oil can then be carefully poured off into bottles, leaving the watery bits at the bottom of the jug.

Dandelion flower oil is an excellent rub for muscle tension and cold, stiff joints. It is good for dry skin, and can be rubbed into the delicate skin around the eyes. Don't forget this oil can be eaten too, adding a taste of sunshine to salads and other foods.

For external use, you can add essential oils to your home-made flower oil, using up to 20 drops per 3 fl oz of oil. The essential oils act as a natural preservative, and bring their own healing qualities to the mixture. Lavender, ylang ylang, and rosemary all combine well with dandelion.

Harvesting from the Wild

Harvesting wild plants for food or medicine is a great pleasure, and healing in its own right. We all need the company of plants and wild places in our lives, whether this is in an old wood, a mountainside or the seashore, just down the street, or in our own backyard. Gathering herbs for free is the beginning of a valuable and therapeutic relationship with the wild. Here are a few basic guidelines to help you get started.

Why pay others to frolic in the luscious gardens of Earth, picking flowers and enjoying themselves making herbal products? You can do all that frolicking, immersing yourself in wondrous herbal beauty, and uplifting your mind and spirit. Making your own herbal medicine both enhances your happiness and boosts your immune system. – Green (2000)

When collecting, try to choose a place where the plant you are harvesting is abundant and vibrant. Woods, fields, and minor roads are best, though many of our fifty plants are also found in the city. Avoiding heavy traffic is safer for you and your lungs, and plants growing in quiet places are less polluted. Plants growing next to fields may receive crop sprays.

We usually want to harvest herbs when they are at their lushest. It's best to pick on a dry day, after the morning dew has burned off. For St John's wort and aromatic plants the energy of the sun is really important, so wait for a hot day and pick while the sun is high in the sky, ideally just before noon.

It is really important to make sure you have the right plant. A good field guide is essential - for North

America we recommend the Peterson Field Guide series, which has regional guides including *A Field Guide to Medicinal Plants and Herbs of Eastern and Central North America.* Some herbalists and foragers offer herb walks–great for learning to identify plants. For distribution maps and other information, go to the USDA PLANTS database: http://plants.usda.gov/.

Harvest only what you need and will use; leave some of the plant so it will grow back. When picking "above-ground parts" of a plant, only take the top half to two-thirds. Never harvest a plant if it is the only one in a particular area.

We have included a few roots in our recipes. It is important not to over-harvest these, even though most of the plants we describe are widespread. The law states that you must seek the permission of the landowner before you dig up roots, if this is not on your own land.

Collecting equipment is simple: think carrier bags or a basket, and perhaps gloves, scissors, or shears. If you are harvesting roots take a shovel or digging fork.

Horse Chestnut

Aesculus hippocastanum

Hippocastanaceae Horse chestnut family

Description: A tall tree, up to 130 ft, with palmate leaves in spring and huge candelabras of white-pink flowers in summer, followed by conkers in fall.

Habitat: Gardens, parks, and roadsides.

Distribution: Native to Asia and south-east Europe, but widespread as a planted and naturalized species in western Europe and in eastern North America.

Related species: The red horse chestnut (*A. carnea*) is used as a flower essence. The North American buckeyes (*Aesculus sp.*) are related, but the sweet chestnut *(Castanea sativa)* is not.

Parts used: Conkers, collected in fall; leaves in spring.

Familiar for its nuts, called conkers, horse chestnut is a beautiful introduced ornamental tree. It also has significant medicinal uses, particularly for supporting weakened veins, as in varicose veins, hemorrhoids, and capillary fragility. It is used for two Bach Flower Essences and in commerical quantities for allopathic and homeopathic remedies for irregularities of the veins. It also has some surprising other uses.

A shapely tree, with glossy brown sticky buds in winter, lime green hand-shaped leaves in spring, then soft and frothy Folies-Bergere-like pink and white flowers in summer, and hard spherical auburn nuts, conkers, in fall–no wonder the all-season beauty of horse chestnut was such a hit when the tree was introduced into England in the early 1600s.

At first a tree of kings and owners of great estates, it later came to belong to everybody as Britain's municipal tree of choice, planted ornamentally in every avenue and park, in every Chestnut Villas of every Victorian city. Horse chestnut trees are mainly admired for their looks - the wood is soft and spongy, poor for carpentry or building.

The tree's scientific and popular names may derive from its use in Turkey, one of the countries of origin of the first specimens to reach Western Europe. The Turks mixed flour from the conkers with oats to improve the breathing of broken-winded horses.

Other plant historians suggest that "horse" is meant as a derogative comparison to the native and tasty sweet chestnut (which is unrelated botanically). Horse chestnut conkers do contain a complex bitter chemical, escin (aescin in UK spelling), as the plant's active principle, and this is said to be toxic to humans in very large quantities.

The tree has surprisingly varied uses. The bark was an emergency quinine substitute for malaria and other fevers. The flower buds once made an ersatz flavoring for beer. Conkers produce a good soapy lather for shampoo and to clean clothes, stop mold, and repel clothes moths.

And, little known today, conkers were used for explosives during the First World War. With other sources of acetone unavailable, British children collected 3,000 tons of conkers secretly in summer 1917 (their schools received a certificate). The research chemist seconded to the government's chestnuts plan, Chaim Weizman, then in Manchester, would become first president of Israel in 1948.

Other new "explosive" chestnut issues include worries about a leaf miner moth damaging (but not killing) mature trees, and the charge that children are at risk while playing with conkers if they chew or eat them. Sadly, the game is now banned in some English schools, but it would need concerted force-feeding to reach toxic levels of escin, and the bitter taste is already off-putting to children.

[Aescin, found in conkers] ... reduces leakage and is used in the treatment of oedema (lower leg swelling) and has proved to be as effective as compression stockings. It strengthens and tones the blood vessels and is becoming very important in the treatment of varicose veins and chronic venous insufficiency (CVI) ... Haemorrhoids respond well too...
–Howkins (2005)

Use Horse Chestnut for . . .

Horse chestnut is a leading herbal treatment for weakened veins, including varicose veins, hemorrhoids, acne rosacea, and chronic venous insufficiency (CVI). It has an unusual capacity to strengthen small blood vessel walls by reducing the size and number of the pores; it also works well on wrinkles by tightening the skin (an alternative to Botox, perhaps?), and for fluid retention or edema.

Horse chestnut is taken both internally as a tincture and externally as a cream, oil, or lotion. Internal use should be in small doses and under the supervision of an herbalist, in case of stomach irritation.

Commercially, it is grown for horse chestnut seed extract (HCSE) and a homeopathic remedy. It also makes two Bach Flower Essences, namely chestnut bud and white chestnut.

> Aesculus *has unique action on the vessels of the circulatory system. The herb appears to increase the elasticity and tone of the veins while decreasing vein permeability.* –Hoffmann (2003)

Conker tincture
- varicose veins
- thread veins
- fragile capillaries

Horse chestnut leaf oil
- varicose veins
- thread veins
- fragile capillaries

Horse chestnut lotion
- varicose veins
- thread veins
- fragile capillaries

Cautions: May cause digestive irritation when taken internally. If you are pregnant or breastfeeding, or using blood-thinning medication, only take horse chestnut under professional supervision.

Conker Tincture

Collect the **conkers** as soon as they drop to the ground in early fall. They will usually come out of their green spiky husks by themselves. While fresh, they are quite soft, but they soon harden and are much more troublesome to cut. Use a serrated knife and be careful in chopping them up, as they can skid out from under the knife blade.

Put the chopped conkers in a jar and pour in enough **vodka** to cover them. Leave in a dark cupboard for a month, shaking every few days. It is normal for the alcohol to extract a milky sediment from the seeds. Strain and bottle, or use to make the lotion below.

Internal use: 5 drops in water twice a day, or as recommended by your herbalist.

Horse Chestnut Leaf Oil

Pick leaves in spring before the flowers open. Chop them up and put them in a jar large enough to hold them. Fill the jar with extra virgin olive oil. Stir to remove any air bubbles, and top up with more oil if necessary. Put on a sunny windowsill to infuse for a month, then strain off the oil into a jug. Allow this to settle for half an hour. Carefully pour the oil into jars, leaving any watery sediment behind at the bottom of the jug. Apply directly to the skin or use to make the lotion below.

Horse Chestnut Lotion

Chill equal amounts of **conker tincture, horse chestnut leaf oil,** and **castor oil** in the fridge overnight, then blend until creamy. Bottle. Shake well before use, as it may separate on standing. Apply twice a day.

Mint
Mentha spp.

Mint is wonderful for the digestion, as a tea, in food and medicinally. It also relieves nausea, spasms, and gas, and offers the benefits of being both warming and cooling to the body.

Lamiaceae (Labiatae) Deadnettle family

Description: Aromatic perennials with dense whorls of lilac flowers.

Habitat: Most species prefer stream sides and damp places in woods or grassland.

Distribution: Native and naturalized mints are found around the world.

Species: Peppermint (*M. x piperita*) and field or wild mint (*M. an/ensis*) are native and widespread in North America and Europe. Other European species such as water mint (*Mentha aquatica*), pennyroyal (*M. pulegium*), spearmint {*M. spicata*), and apple or round-leaved mint (*M. suaveolens*) are naturalized in North America. They hybridize easily with each other and with garden mints. Any of them can be used, but avoid pennyroyal if you are pregnant.

Parts used: Leaves and flowers, harvested in spring and summer.

A hot, hazy, sultry afternoon in high summer, under a high blue sky with scudding white clouds. We are visiting a wet part of the wood behind our house. Water mint and peppermint abound, at their washed-out purple peak, along with the almost identical colors of hemp agrimony and the commoner thistles.

This is an example of collective taking of turns as plants of similar color ripen together. The pale purple flowers are active this week along with attendant pollinators. Butterflies, bees, flies, and smaller insects are pulled to the mints, and red admirals, peacocks, meadow browns, commas, and whites feast on the flowers. Photographing them is another matter, but eventually a meadow brown stays still.

It's one of those days when herbal medicine is at its most pleasant and mellow, with the sweet tang of bruised mint and lazy buzz of insects giving us a feeling we have taken to calling content-mint.

But what do we mean by "mint"? There are at least two dozen different species and hundreds of cultivars, if you add the wild and garden mints together. Moreover, the mints hybridize willingly and produce subtle new forms. As a ninth-century treatise on plants put it, "if one were to enumerate completely all the virtues, varieties and names of mint, one would be able to say how many fish are swimming in the Red Sea . . ."

We must simplify, and suggest you can use any garden or wild mint. Mints are chemically divided by smell and taste into pepperminty mints and spearminty mints, though there are many variations.

What we usually mean by "mint" is probably peppermint (*M. piperita),* which has flourished in gardens and in the wild since the seventeenth century. It is considered to be a hybrid of watermint and spearmint, but has a stronger proportion of aromatic oils than either. These oils, particularly menthol, account for the greater "mintiness" of peppermint and for its commercial use.

Modern commercial uses of mint build on older and proven herbal applications, but to our mind the focus on taste has all but negated the original herbal virtues.

Use Mint for . . .

Finding that mint cleaned the breath and settled the digestion, Romans of classical times valued it; they didn't have chocolate, but they did have after-dinner mint! They also brought mint to Britain. Perhaps, indeed, chewing mint leaves is superior, given that our chocolate "mint" doesn't contain any of the herb, and precious little of its oil. It's also moot whether it'd be better for us to clean our teeth on freshly picked mint than use a spurious "mint" toothpaste.

The savor or smell of the water Mint re-joyceth the heart of man, for which cause they use to strew it in chambers and places of recreation, pleasure, and repose, and where feasts and banquets are made.

–Gerard (1597)

"Altogether," says Dr Braddon, "the oil of Peppermint forms the best, safest, and most agreeable of known antiseptics."

–William Thomas Fernie (1897)

The essence of summer: flowering mint, meadow grasses, sultry sunshine, and feeding butterflies. Norfolk, England in July

The vertues of the wild Mints are more especially to dissolve winde in the stomack, to helpe the chollick and those that are short-winded, and are an especiall remedy for those that have venerous dreames and pollutions in the night, used both inwardly, and the juyce being applyed outwardly to the testicles or cods. -Parkinson (1640)

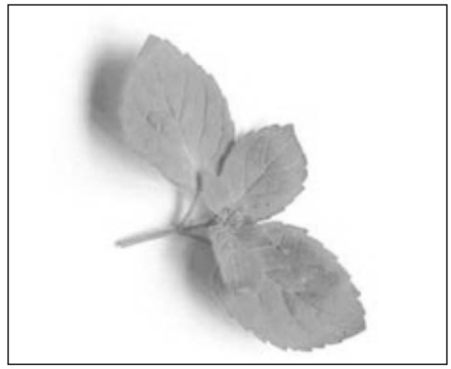
Caution: Avoid taking pennyroyal if you are pregnant.

Peppermint's higher levels of aromatic oils come with necessary cautions, especially if you use peppermint essential oil. For example, while a mint tea of any species is soothing to the stomach, taking peppermint essential oil internally can lead to stomach spasms; it has been implicated in miscarriages. A drop or two of the essential oil, diluted with a carrier oil and applied to the brow, can relieve a migraine but larger quantities can cause bad headaches. Using any of the wild mints is considered safe, although pennyroyal should not be taken in pregnancy. Peppermint is the strongest and most cooling mint and is the "official" mint. Mints with more of a spearmint taste are gentler and warmer, and are better for children's fevers, lack of appetite and weak digestive systems.

Medicinally, mint is classified as both cooling and heating, depending on use, species and form taken. This dual energetic pattern, tellingly, is recognized in traditional Chinese, Ayurvedic and western herbal traditions. You can feel the effect when taking mint tea: it warms, then cools the palate and digestion, even the skin; it is stimulating and then soothing.

The heating effect is seen in the way mint is used as a heart tonic, which relieves palpitations, sending blood to the skin's surface, in the form of sweating. Hot mint tea is an excellent recourse for disturbed digestion, relieving spasms and relaxing the stomach walls, while also anesthetizing them. It is a proven and peerless remedy for such socially embarrassing conditions as bad breath, flatulence, and hiccups; it works for indigestion, bloating, griping, colic, nausea, and vomiting (including morning and travel sickness).

Mint is also antiseptic and mildy antiviral and antifungal. It combats mouth ulcers caused by *Herpes simplex* virus. It is good for coughs, colds, and fever, alone or with elderberry. It also has a traditional use in treating gallstones and for hives, sinusitis and emphysema, earache and toothache, all in addition to its culinary versatility. And, who knows, as Parkinson writes (see left), mint may still be used to reduce "ven-erous dreames and pollutions in the night," if that is what you want.



Mint Tea

Fresh mint is better than dried to use for tea. Put a couple of sprigs in a teapot and pour in a cupful of **boiling water.** Cover and let infuse for a few minutes before straining and drinking.

But when you do not have fresh mint available, dried is still good. Dry the leaves on a screen outdoors or in a warm cupboard, until they crumble in the fingers. Use a teaspoonful per cup. Dried mint is a very useful addition to other medicinal herb teas, to make them taste better.

Mint and Raspberry Water

Water can be deliriously and subtly flavored by adding a few sprigs of mint and some raspberries, and left to stand in a cool place for a couple of hours. Either still or sparkling water can be used. This is a lovely cooling and refreshing summer drink.

If you want a stronger flavor, add a little cool mint tea to the jug.

Sekanjabin: A Persian oxymel of mint and vinegar Boil 1 cup of water with 4 tsp of white sugar, till the sugar dissolves. Add ½ cup of vinegar (we like to use raspberry vinegar). Simmer for 20 minutes, stirring occasionally.

Remove from heat and add some sprigs of fresh mint, which adds its flavor to the oxymel as it cools. Serve diluted in ice-cold water, as you would a cordial. Alternatively, freeze in the form of ice cubes and store for future use.

Mint In White Wine

Put a few sprigs of **mint** and a bottle of **white wine** in a jug, cover with a cloth and leave overnight. Remove the mint. This is a refreshing summer drink that can be served chilled, to keep you cool and improve your digestion.

For a more medicinal aperitif, add a few heads of meadowsweet blossom and a couple of sprigs of mugwort to your wine as well as the mint. This can be done at the same time or added later.

Mint Foot Bath

Make a big pot of mint tea, strain it and pour it into a foot bath or a basin large enough for your feet. When it is the right temperature, put your feet in the liquid and soak for ten to twenty minutes. Use it hot for tired, achy feet or cold if your feet are really hot and sweaty.

Mint tea
- indigestion
- colds and flu
- hot conditions
- flatulence
- nausea
- travel sickness
- headache
- stomach pains

Sekanjabin
- hot conditions
- lack of appetite
- weak digestion
- indigestion

Mint in white wine
- lack of appetite
- weak digestion
- indigestion

Mint foot bath
- tired, achy feet
- hot, sweaty feet

God's wrath is His vinegar, mercy His honey.
These two are the basis of every oxymel. If vinegar overpowers honey, a remedy is spoiled. The people of the earth poured vinegar on Noah; the Ocean of Divine Bounty poured sugar. The Ocean replenished his sugar, and overpowered the vinegar of the whole world.
–Rumi (13th-century Persia)

Oak

Quercus robur, Q. petraea, Q. alba

Oak has been a sacred and an economically productive tree for millennia, the symbol of Britain's secure power (many other countries rightly claim it too). But it has been a victim of its own success, with most of its old forests now gone.

In terms of herbal medicine it still has uses, mainly of the bark, leaves, and acorns rather than the galls used in earlier times. Oak is also one of Dr Bach's original flower essences, so its subtle authority lives on.

We have chosen the picture on the left from among many we've taken of oak in order to convey something of the massive presence and protecting influence of this most stalwart of trees.

There is insufficient space to relate the myths, sacred and secular, the uses, and the central role of oak in the British consciousness. Geoffrey Grigson points out that it has been too necessary and familiar a tree to allow any other general names than its own: oak it is.

Suffice it to say that oak's timber built houses, cathedrals, and ships, made furniture, barrels, and pews; its bark tanned leather for shoes and saddles, and provided dyes; its acorns fed pigs and was a famine food or coffee substitute; its galls (oak apples) gave ink; its wood supplied fuel and charcoal; the tree was a space for mistletoe, ivy, and ferns; it sheltered insects, birds, animals - and outlaws (Robin Hood) and kings (Charles II).

There was once a saying that oak was so important that a person came in contact with it every day of their life, from newborn's cradle to old man's coffin. Such a universal and steadying presence has been lost in modern times, but the tree still offers uses for an enthusiast of herbal medicine.

Use Oak For...

The bark is the "official" botanical drug, used as an astringent. The **British Herbal Pharmacopoeia** specifies dried bark from younger stems and branches of **Quercus robur**, though herbalists in practice find that other oak species can be used interchangeably and that acorns, leaves, and oak apples, also rich in tannins, have equivalent benefits (nobody uses oak root!).

Tannins were first isolated chemically from oak bark, and it is thought that "tannin" came from a Celtic term for oak. Oak, tannins, and leather tanning have always been synonymous.

Fagaceae Beech family

Description: A well-loved tree, which grows to 130 feet tall and can live for a thousand years. The lobed leaves are mainly deciduous, and the flowers are catkins borne in spring. Acorns In little cups are diagnostic for all oaks.

Habitat: Forests, woods, parkland.

Distribution: The English or pedunculate oak (*Quercus robur*) Is native to most of Europe, and is found naturalized In parts of North America. The sessile or Durmast oak (*Q. petraea*) is a European species. White oak (*Q. alba*) Is found across eastern North America.

Species: White oak (*Q. alba*) Is the main North American species used medicinally. The American oaks with rounded leaves generally have edible acorns, while the oaks with pointy leaves have acorns that are high in tannin and very bitter.

Parts used: Bark, leaves, acorns, galls.

Oak should be placed first on any list of native remedies for hikers and backpackers. It is common, easily identifiable, easy to use, and effective for most of the potential problems faced in the wilderness.
– Moore (1979)

For the first time in history we can manage without oak. The reputation remains, but the worshlpful and powerful tree has declined into a patriarch on half-pay.
– Grigson (1958)

Astringents are the body's tighteners and driers, being effective in binding and toning tissue and reducing excess discharges. The conditions treated by astringent herbs include diarrhea, dysentery, eye, mouth, and throat inflammations, disturbed mucous membranes of the digestive tract, and bleeding, burns, and sores.

Astringents are also anti-microbial and antiseptic, helping to create a barrier against infection. Herbalist David Hoffmann explains this by saying "astringents produce a kind of temporary leather coat on the surface of tissue."

Oak bark is most often taken as a decoction, small strips of bark from young branches being boiled in water for 10-15 minutes and drunk. It is strong and bitter from the 15% to 20% of tannins it contains, and is the primary treatment for acute diarrhea, taken in small but plentiful doses. If self-medication for diarrhea is not successful after three or four days, the usual advice is to consult a professional.

The same preparation is good as a mouthwash for gargling in sore throats, tonsillitis, and laryngitis, as a douche for leucorrhea, and as an enema for hemorrhoids.

In Germany the "official" uses for oak bark decoction include inflammation of gums and throat, sweating of the feet, chilblains, and anal fissures (the last three in a bath at room temperature). The dried young bark is also

powdered in a grinder as a tooth powder, as in our recipe on the next page.

The leaves of oak in spring have been used hot as a tea to relieve diarrhea, and after cooling as a soothing compress for sore eyes. Culpeper writes that the distilled water of oak leaves is "one of the best remedies I know of for the whites [leucorrhea] in women." In the field, chewing the leaves and applying them to bites, open wounds, or ulcers eases inflammation and promotes healing.

Acorns are the signature of oaks worldwide, and well chosen as a symbol for Britain's National Trust. While enjoyed raw by pigs and squirrels, humans find acorns palatable only when cooked after repeated boiling and renewing of the water, the tannins being gradually leached out. Acorns were a famine food for the Anglo-Saxons, but some North American oaks have more palatable acorns, and Native Americans living in forested areas had acorn flour as a staple part of their diet.

During the First World War an ersatz coffee was made in Germany from roasted and ground acorns. The drink is still available today. It is tasty, good for those with poor digestion and has little caffeine.

Acorns were once an herbal specific for alcoholism, a use reflected

in a modern homeopathic remedy formulated to control craving.

Oak Twig Toothbrush

Oak twigs can be used as a natural toothbrush with built-in antiseptic and anti-inflammatory benefits. Simply pick a small twig and chew the end to fray it, then use this to massage your gums and clean your teeth.

Harvesting Oak Bark

Select young branches up to about an inch in diameter, and use a sharp knife to remove small strips of bark, cutting along the length of the branch. The bark is thicker than you might expect, brown

on the outside but white underneath. Dry the bark strips in a warm place.

Oak twig toothbrush

- gum problems

Tooth powder

- gum disease
- weak gums
- bleeding gums
- mouth ulcers

Using Your Herbal Harvest

Herbs can be used in many different ways. Simplest of all is nibbling on the fresh plant, crushing the leaves to apply them as a poultice, or perhaps boiling up some leaves as a tea. Many of the plants discussed in this book are foods as well as medicines, and incorporating them seasonally in your diet is a tasty and enjoyable way to improve your health.

But because fresh herbs aren't available year round or may not grow right on your doorstep, you may want to preserve them for later use. Follow these guidelines.

Tooth Powder

Break up the dried oak bark into small bits and grind finely in a coffee grinder. Sieve to remove larger pieces. The fennel seed in the recipe can also be ground in this way.

Mix 3 parts oak bark powder with 1 part cinnamon powder, 1 part fennel seed powder and 1 part bicarbonate of soda, or to suit your own taste.

Store in a small jar, and use to brush your teeth every day.

Equipment Needed

You don't need any special equipment for making your own herbal medicines. You probably already have most of what you need. Kitchen basics like a teapot, measuring cups, saucepans, and a blender are all useful, as are jam-making supplies such as a jelly bag and jam jars. A mortar and pestle are useful but not essential.

You'll need jars and bottles, and labels for these. It is a good idea to have a notebook to write down your experiences, so you'll have a record for yourself and can repeat successes. Who knows, it could become a future family heirloom like the stillroom books of old!

There is a list of suppliers at the end of the book to help you source any supplies or ingredients you may need.

Drying Herbs

The simplest way to preserve a plant is to dry it, and then use the dried part to make teas (infusions or decoctions). Dried plant material can also go into tinctures, infused oils, and other preparations, though these are often made directly from fresh plants.

To dry herbs, tie them in small bundles and hang these from the rafters or a laundry airer, or spread the herbs on a sheet of brown paper or a screen. (Avoid using newspaper as the inks contain toxic chemicals.) You can easily make your own drying screen by stapling some mosquito netting or other open-weave fabric to a wooden frame. This is ideal, as the air can circulate around the plant, and yet you won't lose any small flowers or leaves that are loose.

Generally, plants are best dried out of the sun. A linen cupboard works well, particularly in damp weather.

Storing Dried Herbs

Once the plant is crisply dry, you can discard any larger stalks. Whole leaves and flowers will keep best, but if they are large you may want to crumble them so they take up less space. They will be easier to measure for teas, etc. if they are crumbled before use.

Dried herbs can be stored in brown paper bags or in airtight containers such as candy jars or plastic tubs, in a cool place. If your container is made of clear glass or other transparent material, keep it in the dark as light will fade leaves and flowers quite quickly. Brown glass jars are excellent - we have happily worked our way through quantities of hot chocolate in order to build up a collection of these!

Dried herbs will usually keep for a year, until you can replace them with a fresh harvest. Roots and bark keep longer than leaves and flowers.

Teas: infusions and decoctions The simplest way to make a plant extract is with hot water. Fresh or dried herbs can be used. An **infusion,** where hot water is poured over the herb and left to steep for several minutes, is the usual method for leaves and flowers.

A **decoction,** where the herb is simmered or boiled in water for some time, is needed for roots and bark. Infusions and decoctions can also be used as mouthwashes, gargles, eyebaths, fomentations, and douches.

Part of a summer's herbal harvest: *(from left)* St John's wort in olive oil; dried mug-wort; dandelion flower oil; raspberry vinegar; meadowsweet ghee; meadowsweet, mug-wort, and mint in white wine; rosehip oxymel.

Tinctures

While the term tincture can refer to any liquid extract of a plant, what is usually meant is an alcohol and water extract. Many plant constituents dissolve more easily in a mixture of alcohol and water than in pure water. There is the added advantage of the alcohol being a preservative, allowing the extract to be kept for several years.

The alcohol content of the finished extract needs to be at least 20% to adequately preserve it. Most commercially produced tinctures have a minimum alcohol content of 25%. A higher concentration is needed to extract more resinous substances, such as myrrh resin.

For making your own tinctures, vodka is the simplest alcohol as it can be used neat, has no flavor, and allows the taste of the herbs to come through. If you can get pure grain alcohol (95%) it can be diluted as needed. Whisky, brandy, or rum can also be used. Herbs can also be infused in wine, but this will not have as long a shelf life.

To make a tincture, you simply fill a jar with the herb and top up with alcohol, or you can put the whole lot in the blender first. It is then kept out of the light for anything from a day to a month to infuse before being strained and bottled.

Tinctures are convenient to store and to take. We find amber or blue glass jars best for keeping, although clear bottles will let you enjoy the colors of your tinctures. Store them in a cool place. Kept properly, most tinctures have a shelf life of around five years. They are rapidly absorbed into the bloodstream, and alcohol makes the herbal preparation more heating and dispersing in its effect.

Wines and Beers

Many herbs can be brewed into wines and beers, which will retain the medicinal virtues of the plants. Elderberry wine and nettle beer are traditional examples, but don't forget that ordinary beer is brewed with hops, a medicinal plant.

Glycerites

Vegetable glycerine is extracted from palm or other oil, and is a sweet, syrupy substance. It is particularly good in making medicines for children, and for soothing preparations intended for the throat and digestive tract, or coughs. A glycerite will keep

well as long as the concentration of glycerine is at least 50% to 60% in the finished product.

Glycerine does not extract most plant constituents as well as alcohol does, but is effective for flowers such as red poppies, roses, and St John's wort. Glycerites are made the same way as tinctures, except the jar is kept in the sun or in a warm place to infuse.

Glycerine is a good preservative for fresh plant juices, in which half fresh plant juice and half glycerine are mixed, as it keeps the juice green and in suspension better than alcohol. This sort of preparation is called a **succus**.

Vinegars

Another way to extract and preserve plant material is to use vinegar. Some plant constituents extract better in an acidic medium, making vinegar the perfect choice. Herbal vinegars are often made from pleasant-tasting herbs, and used in salad dressings and for cooking. They are also a good addition to the bath or for rinsing hair, as the acetic acid of the vinegar helps restore the natural protective acid pH of the body's exterior. Cider vinegar is a remedy for colds and other viruses, so it is a good solvent for herbs for these conditions.

Herbal Honeys

Honey has natural antibiotic and antiseptic properties, so is an excellent vehicle for medicines to fight infection. It can be applied topically to wounds and burns. Local honey can help prevent hay-fever attacks.

Honey is naturally sweet, making it palatable for medicines for children. It is also particularly suited to medicines for the throat and respiratory system as it is soothing and also clears congestion. Herb-infused honeys are made the same way as glycerites, or can be gently heated in a bain-marie.

Oxymels

An oxymel is a preparation of honey and vinegar. Oxymels were once popular as cordials, both in Middle Eastern and European traditions. They are particularly good for cold and flu remedies.

Honey can be added to an herb-infused vinegar, or an infused honey can be used as well.

Electuaries

These are made by stirring powdered dried herbs into honey or glycerine to make a paste. Electuaries are good as children's remedies, and are often used to soothe the digestive tract. This is also a good way to prepare tonic herbs.

Syrups

Syrups are made by boiling the herb with sugar and water. The sugar acts as a preservative, and can help extract the plant material. Syrups generally keep well, especially the thicker ones containing more sugar, as long as they are stored in sterilized bottles.

They are particularly suitable for children because of their sweet taste, and are generally soothing.

Herbal Sweets

While we are not recommending large amounts of sugar as being healthy, herbal sweets such as coltsfoot rock and peppermints are a traditional way of taking herbs in a pleasurable way.

Plant Essences

Plant essences, usually flower essences, differ from other herbal preparations in that they only contain the vibrational energy of the plant, and none of the plant chemistry. To make an essence, the flowers or other plant parts are usually put in water in a glass bowl and left to infuse in the sun for a couple of hours, as in the instructions for our self-heal essence. This essence is then preserved with brandy, and diluted for use.

Infused Oils

Oil is mostly used to extract plants for external use on the skin, but infused oils can equally well be taken internally. Like vinegars, they are good in salad dressings and in cooking.

We prefer extra virgin olive oil as a base, as it does not go rancid like many polyunsaturated oils do. Other oils, such as coconut and sesame, may be chosen because of their individual characteristics.

Infused oils are often called macerated oils, and should not be confused with essential oils, which are aromatic oils isolated by distilling the plant material.

Ointments or Salves

Ointments or salves are rubbed onto the skin. The simplest ointments are made by adding beeswax to an infused oil and heating until the beeswax has melted. The amount of wax needed will vary, depending on the climate or temperature in which it will be used, with more wax needed in hotter climates or weather.

Ointments made this way have a very good shelf life. They absorb well, while providing a protective layer on top of the skin.

Ointments can also be made with animal fats or hard plant fats such as cocoa butter.

Butters and Ghees

Butter can be used instead of oil to extract herbs, and, once clari-fled by simmering, it keeps

Nettle, from Woodville's *Medical Botany* (1790–3) well without refrigeration, making a simple ointment. Clarified butter is a staple in Indian cooking and medicine, where it is called ghee. It is soothing on the skin and absorbs well. Herbal butters and ghees can also be used as food.

Skin Creams

Creams are made by mixing a water-based preparation with an oil-based one, to make an emulsion. Creams are absorbed into the skin more rapidly than ointments, but have the disadvantages of being more difficult to make and not keeping as well. Essential oils can be added to help preserve creams, and they keep best if refrigerated.

Poultices

The simplest poultice is mashed fresh herb put on to the skin, as when you crush a ribwort leaf and apply it to a wasp sting. Poultices can be made from fresh herb juice mixed with slippery elm powder or simply flour, or from dried herb moistened with hot water or vinegar.

Elderflower, from Woodville's *Medical Botany* (1790-3); (opposite), elder in Lincolnshire, England in June.

Change the poultice every few hours and keep it in place with a bandage or bandaid.

Fomentations or Compresses

A fomentation or compress is an infusion or a decoction applied externally. Simply soak a flannel or bandage in the warm or cold liquid, and apply. Hot fomentations are used to disperse and clear, and are good for conditions as varied as backache, joint pain, boils, and acne. Hot fomentations need to be refreshed frequently once they cool down.

Cold fomentations can be used for inflammation or for headaches. Alternating hot and cold fomentations works well for sprains and other injuries.

Embrocations or Liniments

Embrocations or liniments are used in massage, with the herbs in an oil or alcohol base or a mixture of the two. Absorbed quickly through the skin, they can readily relieve muscle tension, pain, and inflammation, and speed the healing of injuries.

Baths

Herbs can be added conveniently to bathwater by tying a sock or cloth full of dried or fresh herb to the hot tap as you run the bath, or by adding a few cups of an infusion or decoction. Herbal vinegars and oils can also be added to bath water, as can essential oils.

Besides full baths, hand and foot baths can be very effective, as can sitz or hip baths where only your bottom is in the water.

Douches

Herbal infusions or decoctions can be used once they have cooled as douches for vaginal infections or inflammation.

Willow

Salix alba, S. fragilis, S. nigra

Salicaceae Willow family

Description: Tall deciduous trees that frequently hybridize with each other.

Habitat: Mainly river-banks and other wet areas.

Distribution: Willows are found all around the world, in a wide variety of habitats.

Species used: Crack willow *(S.fragilis)* usually has higher levels of salicin than white willow *(S. alba)*, which is the species mentioned in most herbals.

In North America, the black willow *(S. nigra)* Is the main species used. Many species are used medicinally worldwide.

Parts used: Bark, collected in spring, and leaves.

It is a fine cool tree, the boughs of which are very convenient to be placed in the chamber of one sick of a fever.

– Culpeper (1653)

The branch tips and leaves, known as willow tips... are traditionally used in many parts of South Africa to treat rheumatism and fever.

– Van Wyk *et al.* (1997)

Willow bark contains salicin and other aspirin-like compounds. It is used to treat pain and inflammation, but does not have the stomach-irritating or blood-thinning effects of aspirin.

Willow helps to lower fevers, and can be used as a gentle pain reliever for headaches, arthritis, gout, rheumatism, muscle aches, and lower back pain.

Willows are graceful trees often found growing by water. White willow is particularly elegant, with its silvery leaves swaying in the wind. Crack willow is so named because the fast-growing trunk often cracks and splits under its own weight. The familiar silver catkins, "pussy willow," are from the sallows, a group of willows with broader leaves.

Willows are highly adaptable trees, and will usually root readily from a stick put in the ground. Willow leaves, mashed up and soaked in water, can be used as a natural rooting hormone to help root cuttings of other plants.

Willows have many uses. The flexible shoots, mainly of osier *(Salix viminalis)*, make excellent wicker baskets, and the wood of a variety of white willow is used commercially for clogs and cricket bats. Willow wood is burnt to make charcoal for drawing, and willow charcoal was once used in producing gunpowder.

Willow contains high levels of pain-relieving salicin. The modern use of aspirin is said to begin in 1763 when Rev. Edmund Stone extracted salicylic acid from willow bark for his parishioners' use. During the nineteenth century various scientists produced salicylic acid in the laboratory, and in 1853 the French chemist Charles Gerhardt made a

primitive form of aspirin. Later a German chemist discovered a better method for synthesizing the drug, and it started being marketed by Bayer in 1899. Aspirin, acetylsalicylic acid, is one of the most widely used drugs in the world today.

Interestingly, the early herbals do not focus on willow for relieving pain but more on its astringent action in stopping bleeding, diarrhea, and other "fluxes." The leaves, boiled in wine and drunk over an extended period of time, were considered an effective treatment to reduce lust in both sexes.

It is possible that willow was used for pain as a folk remedy that didn't make it into the books. Willow bark was chewed by country folk to relieve headaches and toothache, and to treat the ague, a type of malarial fever.

Today herbalists use willow mainly for pain, inflammation, and fever. Our son, who suffered from ME for several years as a young teenager, always asked for it for his headaches and muscle aches and pains. Like meadowsweet, it is effective for arthritis and rheumatism, and can help with the pain of polymyalgia rheumatica and fibromyalgia, for which it combines well with Guelder rose.

Note that if you are taking aspirin as a blood thinner, you cannot replace it with willow, which lacks this effect. But for long-term pain relief willow may be better for the stomach than aspirin.

Cautions: Do not take willow if you are allergic to aspirin or while breastfeeding.

Willow bark tincture

- aches and pains
- headache
- arthritis
- rheumatism
- muscle aches
- backache
- gout
- period pain
- colds and flu
- sports injuries

Willow Bark Tincture

Harvest the bark in the spring, from branches where it isn't too thick. Use a sharp knife to strip thin slices of bark lengthwise off the branch on one side, taking care not to take too much from any one place.

Put the willow bark in a jar, and pour in enough vodka to cover it. Leave it in a cool dark place for a month, shaking regularly every few days. Strain off the liquid, bottle, and label it.

Dose: 1 teaspoon three times a day, taken in a little water when needed for relief of pain and inflammation.

Dealing with Disasters

Make a Plan!

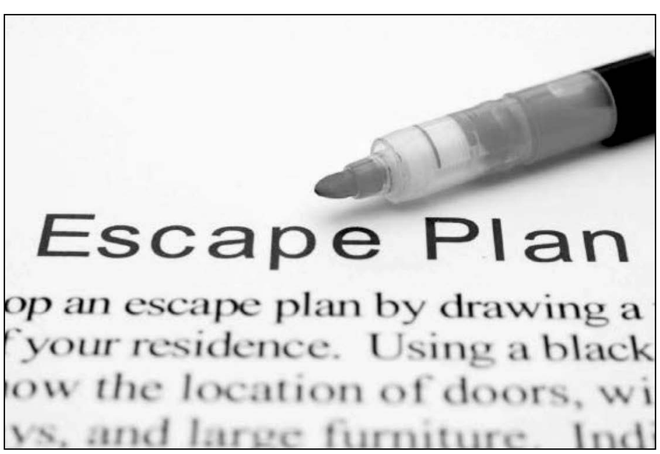
BY KATE AND JIM ROWINSKI

Will you be ready if an emergency strikes? Have you thought about where to meet with your family, how you'll communicate, what resources you have for heating and transportation, and how to handle the basic functions of your home?

If not, take the time now to create your plan and walk the entire family through it. It's not enough for you to know what to do; other members of the household need to know too!

Many of us who were around on 9/11 realized after the fact just how vulnerable we were when it came to reaching out to family and friends in the middle of an emergency. Phone lines may be jammed, networks may be down, and confusion can quickly turn into panic.

With work, school, and a myriad of other activities, chances are that your family may not be together if a disaster strikes. That's why it is so important to plan in advance. Get your family together and discuss your emergency plan.



How Will You Know If There Is an Emergency?

State and local agencies may have alerts available that you can register for simply by providing your email address. Likewise, the National Oceanic and Atmospheric Administration (NOAA, www.noaa.gov) issues regular weather alerts.

What Is Your Safe Place?

If your home is not an option due to storms or fire, agree on somewhere else to meet that everyone in the family is familiar with. Include the neighbors in your plan. Have safe houses identified for your children to go to in case parents are unable to get home.

Get a Weather Radio

If you are in an area where weather emergencies can strike suddenly, a weather radio will alert you to dangerous weather approaching. Weather radios broadcast NOAA's National Weather Service forecasts, watches, and warnings over a network of more than 1,000 stations.

The presence of a weather radio is especially comforting after dark, and many people keep

(*Continued*)

Get a Weather Radio *(Continued)*

the radio near their bed for nighttime alerts. Weather radios make a loud noise when there is a threat of bad weather anywhere in the listening area. Most are programmable so that you can tune it to only alert when the threat is in your immediate location. Most can be plugged in to a regular household outlet and have a provision for battery power as well, so make sure to keep the appropriate size batteries in your storage.

If a WATCH is announced, it means that conditions are right for the development of bad weather. Be alert and monitor conditions. Make sure you are ready for power outages, and make sure animals are inside.

If a WARNING is announced, it means that bad weather has been seen on the radar, and is occurring or imminent in your area. Take shelter immediately.

How Will You Communicate?

Be sure every member of your family carries important phone numbers and has a cell phone, coins, or a prepaid phone card to call their emergency contacts.

Having mobile phone service is not enough. In an emergency, phone lines are often jammed, so phone service may not be available. Text messages can often get through when a phone call cannot. Chances are that you may get information through the modern day version of the jungle drum beat—your text messages. Messages can spread like wildfire when emergencies strike. Right after an earthquake hit the East Coast, in spite of jammed phone lines, I knew in the span of only a few minutes the status of my home in the country, how the horses reacted, where my son was, and whether my friend had felt it in Boston. I was able to get a friend to check on my dogs and connect someone whose house was damaged with emergency housing.

Set up an emergency chain for your family and friends to communicate with each other. If one tells two, and two tells four, soon you will have made connections and initiated plans. Make sure everyone in the family knows how to use text messaging.

In a local emergency, it is often easier to call out of state than it is to call across town. Identify a friend or relative who lives out of state that everyone can notify that they are safe.

If you have a cell phone, program your emergency contact as "ICE" (In Case of Emergency) in your phone. If you are in an accident, emergency personnel will check for an ICE listing in your contacts in order to get ahold of someone you know. Make sure to tell your family and friends that you've listed them as emergency contacts.

Teach children to call 911.

Keep a collar, license, and ID on your dog at all times.

Write down your plan and keep a copy of it in your safe or fireproof box, so you can access it in the event of a disaster. Adults should keep a copy in their wallets or handbags, and children can have a copy in a school pack or taped to the inside of a notebook.

How Much Cash Do You Need?

Ask any expert about cash reserves and their answer will be about the same. Keep enough for three to six months of expenses readily available. Put this money in a regular savings account, not locked

Ready
Prepare. Plan. Stay Informed. ®

Family Emergency Plan

FEMA

Make sure your family has a plan in case of an emergency. Before an emergency happens, sit down together and decide how you will get in contact with each other, where you will go and what you will do in an emergency. Keep a copy of this plan in your emergency supply kit or another safe place where you can access it in the event of a disaster.

Out-of-Town Contact Name: Telephone Number:
Email:
Neighborhood Meeting Place: Telephone Number:
Regional Meeting Place: Telephone Number:
Evacuation Location: Telephone Number:

Fill out the following information for each family member and keep it up to date.

Name: Social Security Number:
Date of Birth: Important Medical Information:

Name: Social Security Number:
Date of Birth: Important Medical Information:

Name: Social Security Number:
Date of Birth: Important Medical Information:

Name: Social Security Number:
Date of Birth: Important Medical Information:

Name: Social Security Number:
Date of Birth: Important Medical Information:

Name: Social Security Number:
Date of Birth: Important Medical Information:

Write down where your family spends the most time: work, school and other places you frequent. Schools, daycare providers, workplaces and apartment buildings should all have site-specific emergency plans that you and your family need to know about.

Work Location One
Address:
Phone Number:
Evacuation Location:

School Location One
Address:
Phone Number:
Evacuation Location:

Work Location Two
Address:
Phone Number:
Evacuation Location:

School Location Two
Address:
Phone Number:
Evacuation Location:

Work Location Three
Address:
Phone Number:
Evacuation Location:

School Location Three
Address:
Phone Number:
Evacuation Location:

Other place you frequent
Address:
Phone Number:
Evacuation Location:

Other place you frequent
Address:
Phone Number:
Evacuation Location:

Important Information	Name	Telephone Number	Policy Number
Doctor(s):			
Other:			
Pharmacist:			
Medical Insurance:			
Homeowners/Rental Insurance:			
Veterinarian/Kennel (for pets):			

up in a CD or other non liquid account where withdrawing early will cost you a penalty. Calculate your total bills and other essential expenses such as food and gas, and use that as your baseline. You can round up or down, based on your own comfort level. But remember, liquid assets don't earn much interest, so don't go overboard and keep all your assets liquid.

As to actual cash, we use the three-day rule. We try to keep enough cash in our home safe to get by for three days in case we have to leave the house suddenly due to a fire or other natural disaster. The amount of money should be enough to cover food, gas, hotel rooms, or other emergency needs such as extra clothes or toiletries. For us, that figure is about $1,000. If that amount sounds like too much, calculate your own figure.

Keep an assortment of bills in your home stash. If the power is out and stores are unable to run their registers, a nice supply of one and five dollar bills will be very handy. A roll of quarters may come in handy for tolls, the laundromat, or pay phones. Keep your money in a home safe or fireproof box along with your other important papers.

Survival Kits

“Luck is where the crossroads of preparation and opportunity meet.”—*Seneca*

What to pack in your survival kit when your life might depend on it? The answer to this question depends on several contingencies—where you‘re going, the terrain, climate, the amount you can comfortably carry, and the expected length of the trip.

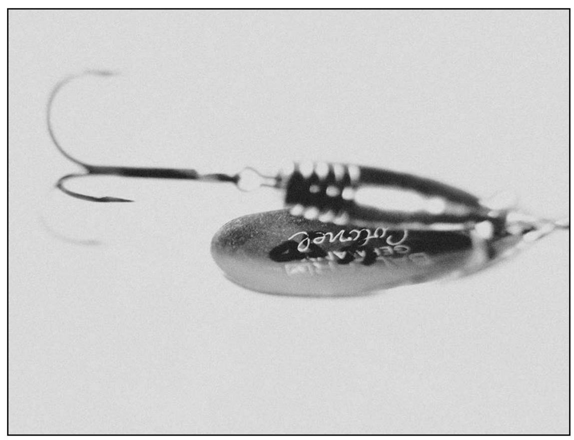
As you put together your survival kit, consider the different types of products on the market. Know how to use everything in the kit.

U.S. Military Survival Kits

The U.S. military has several types of basic survival kits, which are issued primarily to aviators. There are kits for cold climates, hot climates, and overwater. There is also an individual survival kit that contains a general packet and a medical packet. The cold climate, hot climate, and overwater kits are held in carrying bag and normally stowed in the aircraft’s cargo/passenger area. The army’s survival kits contain the following:

Cold Climate Kit

Attaching strap
Compressed trioxane fuel
Ejector snap
First aid kit
Food packets
Frying pan
Illuminating candles
Insect head net
Kit, inner case
Kit, outer case
MC-1 magnetic compass
Packing list
Plastic spoon
Pocket knife
Saw/knife blade



Fishing hook

Utensils

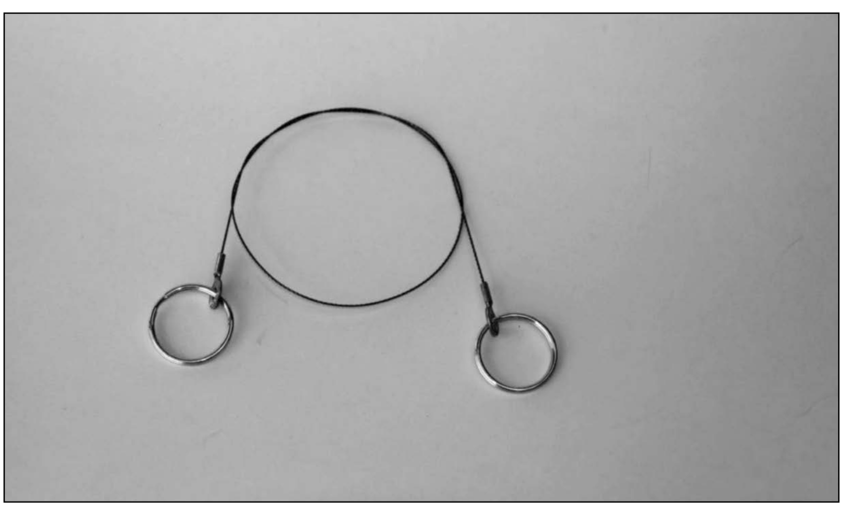
Saw-knife-shovel handle
Shovel water bag
Signaling mirror
Sleeping bag
Smoke, illumination signals
Snare wire
Survival fishing kit
Survival manual (AFM 64-5)
Survival utensils
Waterproof matchbox
Wood matches

Hot CIimate Kit

Attaching strap
Canned drinking water
Compressed trioxane fuel
Ejector snap
First aid kit
Fishing tackle kit
Food packets
Frying pan
Kit, inner case
Kit, outer case
MC-1 magnetic compass
Packing list
Plastic spoon
Pocket knife
Poncho
Plastic whistle
Pocket knife
Reversible sun hat
Signaling mirror
Smoke, illumination signals
Snare wire
Sunburn preventive cream
Survival manual (AFM 64-5)
Tarpaulin
Took kit
Waterproof matchbox
Wood matches

Overwater Kit

Boat bailer
Compressed trioxane fuel
First aid kit
Fishing tackle kit
Fluorescent sea marker
Food packets
Frying pan
Insect head net
Kit, packing list
MC-1 magnetic compass
Plastic spoon
Pocket knife



Compact survival saw

Raft boat paddle
Raft repair kit
Reversible sun hat
Seawater desalter kit
Signaling mirror
Smoke, illumination signals
Sponge
Sunburn preventive cream
Survival manual (AFM 64-5)
Waterproof matchbox
Water storage bag
Wood matches

NSN	DESCRIPTION	QTY/UI
1680-00-205-0474	SURVIVAL KIT, INDIVIDUAL SURVIVAL VEST (OV-1), large, SC 1680-97-CL-A07	
1680-00-187-5716	SURVIVAL KIT, INDIVIDUAL SURVIVAL VEST (OV-1), small, SC 1680-97-CL-A07	
	Consisting of the following components:	
7340-00-098-4327	KNIFE, HUNTING: 5 in. lg blade, leather handle, w/sheath	1 ea
5110-00-526-8740	KNIFE, POCKET: one 3-1/16 in. lg cutting blade, & one 1-25/32 in. lg hook blade, w/safety lock & clevis	1 ea
4220-00-850-8655	LIFE PRESERVER, UNDERARM: gas or orally inflated, w/gas cyl, adult size, 10 in. h, orange color, shoulder & chest type harness w/quick release buckle & clip	1 ea
6230-00-938-1778	LIGHT, MARKER, DISTRESS: plastic body, rd, 1 in. w, accom 1 flashtube; one 5.4 v dry battery required	1 ea
6350-00-105-1252	MIRROR, EMERGENCY SIGNALING: glass, circular clear window in center or mirror for sighting, 3 in. lg, 2 in. w, 1/8 in. thk, w/o case, w/lanyard	1 ea
1370-00-490-7362	SIGNAL KIT, PERSONNEL DISTRESS: w/7 rocket cartridges & launcher	1 ea
6546-00-478-6504	SURVIVAL KIT, INDIVIDUAL *consisting of*	1 ea
4240-00-152-1578	GENERAL PACKET, INDIVIDUAL SURVIVAL KIT: w/ mandatory pack bag; 1 pkg ea of coffee & fruit flavored candy; 3 pkg chewing gum; 1 water storage container; 2 flash guards, w/infrared & blue filters; 1 mosquito headnet & pr mittens; 1 instruction card; 1 emergency signaling mirror; 1 fire starter & tinder; 5 safety	1 ea

Individual survival kit with general and medical packets.

NSN	DESCRIPTION	QTY/UI
1680-00-205-0474	SURVIVAL KIT, INDIVIDUAL SURVIVAL VEST (OV-1), large, SC 1680-97-CL-A07	
1680-00-187-5716	SURVIVAL KIT, INDIVIDUAL SURVIVAL VEST (OV-1), small, SC 1680-97-CL-A07	
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1370-00-490-7362	SIGNAL KIT, PERSONNEL DISTRESS: w/7 rocket cartridges & launcher	1 ea
6546-00-478-6504	SURVIVAL KIT, INDIVIDUAL *consisting of*	1 ea
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Individual survival kit with general and medical packets.

The Basic Navy SEAL "Layout"

U.S. Navy SEALs separate their gear into three categories, or lines. The gear list changes according to area of operation, terrain, climate, enemy situation, support assets, and so on.

First line gear contains the everyday essentials needed for immediate short-term survival. SEALs do not go anywhere without their first line gear. Cammies, weapons, maps, compass, knife, 550 cord, and watches are all typically included in first line gear. If the second and third lines of equipment are abandoned, the first line gear will give the operator enough gear for short-term survival.

Second line gear contains necessary extras carried in load-bearing equipment (LBE) or tactical vests. It's gear that is quickly available should the need arise. Equipment such as ammunition, grenades, water and purification tablets, and medical supplies are all considered part of second line gear. Second line gear is always carried or worn when working (operating).

Third line gear is made up of supplies needed for a mission that aren't as critical for immediate use. Radios and batteries, claymore mines, ponchos, water filters, and night vision goggles are all included in third line gear. Corpsmen fit their medical gear into this category. A SEAL is never too far away from his third line gear. In urban areas, it may be kept in a rucksack in the trunk of a vehicle; while berthing, it may be at the foot of the cot or bed.

Ideally a SEAL is never in a situation where he does not have all of his gear. However, if he is caught in a situation when he must travel light, he may leave behind his third line gear.

Examples of First Line Gear:

Wrist compass
Small LED (red) flashlight
Surefire (or other compact & bright light)
Swiss Amy knife
Leg holster
Sidearm
Two spare magazines
Small water container
Large knife on leg holster (opposite side)
Compact survival kit
Fishing hooks, line, sinkers
Fire starter and waterproof matches (inside waterproof container)

Pliers

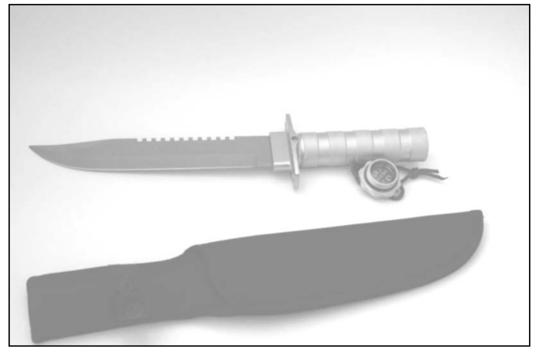
Water purification tablets
Parachute cord
Signal mirror
Whistle

Examples of Second Line Gear

Assault rifle
Four spare magazines
Flares
Carabiners
Spare flashlight batteries (enough for twenty-four hours)
Water container
Binoculars
Body warmer (air-activated pad)
Poncho with liner
Several pouches of freeze-dried food
QuikClot (powder that quickly clots blood)
Large gauze compress
Duct tape
Snakebite kit
Maps
Compass
Fire starter (cotton smeared in Vaseline inside of a pill bottle)
Lighter

Pocket knife

Leg holster



Survival knife with compass top

Examples of Third Line Gear

Fifty feet of parachute cord/550 cord
Large water container
Water purifier
Sleeping bag or bivy sack

Flares

Dehydrated meal

Warmers

Extra socks
Ten full freeze-dried meals
Rain gear
Batteries (twenty-four-pack per device)
Flashlight
Extra ammo (usually 300 rounds per weapon)
Extra pair of gloves

Customize your Gear to Fit Your Personal/ Operational Needs.

Your survival kit should be:

- Lightweight and compact
- With you when you need it
- Packed with equipment you can rely on
- Adjusted for the season and expected weather

Be sure to:

- Periodically check the service ability of all survival kit components.
- Check that each person in your group carries his own survival kit.
- Build your own survival kit, since commercial kits compromise the quality of the components in order to keep the overall price of the kit down—it' s better to build your own.

Basic Survival Kit Considerations

Water

Water-purifying straw. Good for twenty to twenty-five gallons of water (depending on how contaminated it is). It's not just a filter, but actually treats water with antibacterials.
Water purification tablets. Each tablet can purify one or two quarts of water, depending on how dirty the water is. You can also crush one water purification tablet and add about a teaspoon of water to make a strong iodine topical solution for treating injuries.
One-hundred ounce reservoir filled with water
Five feet of plastic tubing, i.e., fish tank tubing
Bottle ORS
Aluminum canteen cup

Shelter/Bivy Material

Tent
Bivy sack
Sleeping bag
Large, heavy-duty orange plastic or Mylar survival bags
Kydex/painter's tarp (nine feet by seven feet). This thin plastic sheet can be used for a variety of purposes—making a shelter, waterproofing a roof, collecting rainwater, or used as a solar still. It tears easily, so you might want to pack two.
Survival blanket. Made of durable, tear-resistant polyethylene, these blankets reflect back body heat to keep you warm. Make a frame out of sticks, and stretch the blanket over it; you can also use it as a very large signaling mirror. Also works for waterproofing your shelter, collecting rainwater, or wrapping around yourself as a poncho or shawl.
Plastic or fabric tube tents
Sheet plastic
550 cord

Water purifier tablets

Survival bivy sack

Firestarting Material

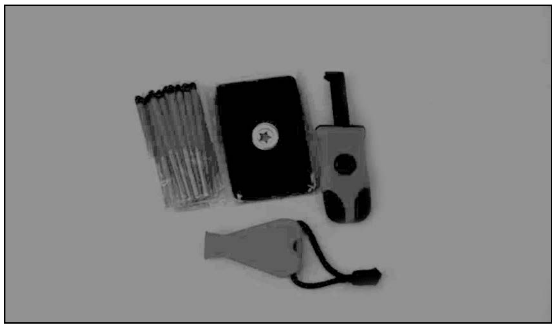
Windproof lighter
Survival matches
Metal match with a scraper
Magnifying glass
Magnesium/flint bar fire starter. Shave the magnesium with a knife; collect all the shaving into a pile about the size of a dime. The magnesium ignites with a flame like a blow torch and will burn for several seconds.
Tinders
Thirty-six hour candle in a can
Survival saw

Signaling Equipment

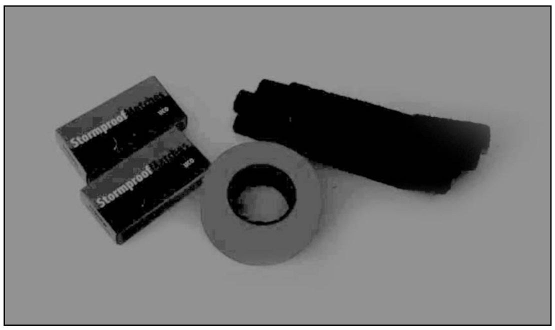
Whistle with lanyard
Signal mirror
Fluorescent plastic surveyor' stape
Brightly colored fabric
Fire starting material
Light sticks or chemical lights
Rugged LED strobe/flashlight

Personal Protection

Whistle with lanyard
Emergency foil bag/space blanket
Body warmers
Additional clothing, including rain gear—for warmth and protection from wind and wet



Fire starter, whistle, matches, signal mirror



Waterproof matches, tape, fire starter sticks

Polypropylene balaclava
Insect head net
Bug spray
Sunscreen and sunglasses

First Aid Kit

Sunscreen and sunglasses
Wound prep pads
Soap towelettes
One-by three-inch adhesive bandages
Butterfly bandages
Two-by four-inch flex bandages
Knuckle bandage
Eye patch
two-by-three-inch nonstick pads
Hydrocortisone cream
Triple antibiotic ointment
Burn ointment
Motrin
Tylenol
NoDoz
Imodium AD
Safety pins
Lip balm SPF 15
Roll one-half-inch medical tape
Tweezers
Waterproof pouch, (five by seven inches)

Medical Trauma Gear

Trauma dressings
High-absorbency gauzes
Tourniquet
Snakebite kit

Headlamp With Spare Bulbs and Batteries

LED flashlight with spare batteries and bulbs. I recommend a mini LED flashlight with either a white, yellow, green, or blue light. They're great when you need to locate items in the dark, and can also be used for signaling at night. Pack extra batteries, as they take up very little space and last a long time. I recommend putting some electrical tape between each to keep them from discharging. As each battery is about the size of a dime, this takes very little space in the kit. If your light requires a tool to change the batteries, make sure you have one with you.

Food Supplies

Hard candies
Nuts and seeds
Bouillon cubes
High calorie emergency rations (such as energy bars high in carbohydrates)
Commercial dried packaged food
MREs
Eating utensils/cup/spork
Thirty feet of fifteen-pound test fishing line, fifty feet of eighty-pound test fishing line, and six fishhooks for fifteen-pound test line. Use the lighter line for fishing in rivers and streams. The heavier line is as tough as nails and has thousands of uses—including shelter building, snare making, and for unattended fishing purposes.

Hooks
Fishing flies
Snares

Navigation

Maps in waterproof containers
Compass
GPS
Five feet orange flag tape (for marking your position)

Miscellaneous Gear

Knife and/or multitool
Sewing kit
Croc-Lock™ clips
Five feet duct tape wrapped around water containers. Makes it possible for you to repair just about anything—patch holes in tarps, bandage cuts, fix a point to an arrow or spear, and so on.
550 paracord (twenty feet). The uses of paracord in a survival situation are almost too numerous to list. Use it for shelter, whether for tying Frame members together or for stringing up a tarp between trees. It also works for snares and building other weapons. True paracord is constructed of an outer sheath, which contains seven inner strands. Each inner strand is fifty-pound test, while the outer sheathing is rated at about 200 pounds. If you need more string in an emergency situation, you can remove the inner strands. The outer sheathing can serve well as shoelaces.
Safety pins. For quick repairs of clothing and other gear. Can also be fashioned into emergency fishhooks.
Zip ties. Use them for setting up your emergency shelter, among other purposes.
Ziploc freezer bags. Use as canteens, waterproof storage, and so on.
Scalpel blades. Come in sterile wrapping, are extremely small, and have a multitude of uses, from medical to skinning and gutting game to whittling.
MilSpec snare wire. Has a multitude of uses, from snaring to trip wire to hanging food items over a fire for cooking.
Fifty dollars cash in local currency (or even an extra credit card).

Familiarity with Survival Equipment— by Wade Chapple

Being on your own in a life or death struggle for survival is not the time to familiarize with your equipment, nor is it the time to pull out a handheld GPS only to find it without batteries or with the batteries depleted. It goes without saying that special operators are always intimately familiar with and can effectively maintain the weapons systems they carry.

Unfortunately, I have found that these same special operators do not always have a good understanding of how to operate or maintain the survival equipment packed into their “go” bags. For that matter, unfamiliarity with survival aids and equipment is a common trend I find with all of our clients, both U.S. and foreign.

For example, we were once called to assist in the search for two missing crew members who had ejected from their fighter jet over the mountains of Colombia. We collectively managed to safely recover the two crew members, but during our post-incident analysis, we discovered that the pilot was actually carrying a survival radio with a 406MHz emergency distress beacon, and he did not activate it at all. If he had activated the survival radio, we would have located his position very quickly and reduced his exposure to the elements and to the enemy who was also searching for him.

After questioning the pilot, I learned that he had never received any training on how to operate or maintain the survival radio and that the radio’s battery was dead because he had never checked or tested it before flying. The crew members were very fortunate in this particular example, but their plight would definitely have been shortened if the pilot knew how to operate and maintain his survival radio before becoming isolated.

Whatever it is you decide to pack for use during a survival situation, the following guidelines will ensure that those items are useful to you in a time of need:

- Learn how to operate or use all of the survival gear that you pack. If it requires batteries, make sure the batteries are fresh before going to the field and pack extra (sealed) batteries in order to extend the use of battery-operated items during survival situations. While training for survival situations, use the equipment you are carrying to ensure proficiency with the same.
- Before going out to the field, inspect all of your survival gear. Turn on and conduct a function test of anything that is battery operated.
- Try to acquire equipment with common batteries (if a flashlight uses AA batteries, for example, try to a acquire a GPS and strobe light that also use AA batteries).
- Swap out items that are damaged.
- Organize your survival gear so you don't have to fumble around at night looking for the item that you need.
- I have found that battery-operated chemlights are better for survival situations than the disposable, one-time-use chemlights. However, I also pack a couple of infrared chemlights that are one-time use but very good for tactical signaling.

Know the Dangers

Every area has its quirks, and mother Nature is bound to surprise us from time to time with an unexpected event. It may seem an impossible task to prepare for any emergency, but the reality is that it only takes a little preplanning to understand what types of emergencies may be present in your area and the steps you need to take to be ready for them.

Earthquakes

While California is famous for its earthquakes, they can strike in any number of states. You can check with the U.S. Geological Survey (www.usgs.gov) to see if your area is prone to quakes. Even a relatively mild quake can cause injuries or service disruptions. Preparation for an earthquake begins with the basics—how to survive the quake itself. Most quake injuries are caused by falling objects, so knowing the safe zones is the key to safely getting through the tremors.

Earthquake Drill

If you are in an area that is known for earthquakes, it is essential for everyone in the family to know what to do the moment a tremor begins.

- DROP down onto your hands and knees before the earthquake knocks you down. This position protects you from falling, but still allows you to move if necessary.
- COVER your head and neck (or your whole body, if possible) under the shelter of a sturdy table or desk.
- HOLD ON to your shelter (or to your head and neck) until the shaking stops. Be prepared to move with your shelter if the shaking shifts it around.

At Home

- Walk through the house to identify safe areas and evacuation routes.

- Review your emergency plans and supplies, checking to see if any items are missing. Replenish anything that has been used or is out of date. Make sure everyone knows where emergency lighting and other supplies are stored.
- Identify tall furniture, windows, or glass that could shatter or fall during a quake. If you are near one of these when the shaking begins, move away as quickly as possible.

- Identify tables, cabinets, or desks to use for shelter. Doorways are not adequate.
- If there is no shelter nearby, get down near an interior wall or next to low-lying furniture that won't fall on you. If you can, grab something to shield your head and face from falling objects.
- If a quake occurs during the night, stay in bed and cover your head with a pillow.
- Make sure everyone knows the location of emergency supplies.
- Mark where utility switches and turn-off valves are located.
- Discuss alternative ways to get out of the house, if damaged, and identify a safe meeting area outdoors.
- Once outside, stay away from exterior walls, utility wires, and fuel lines.

Away from Home

- Know your school's and office's emergency plans.
- Provide family members with a written emergency plan with phone numbers to carry in wallets or school bags.
- Identify a meeting place for reuniting if a quake strikes while your family is away from home.
- If you are in your car, pull over immediately, preferably away from buildings and power lines. Do not stop under an overpass. When the tremors stop, proceed with caution, watching for downed debris and damaged roads.
- If you are in a public area, do not try to rush out of the building or use elevators. Just hold on until the shaking stops, and proceed calmly to the nearest exit.

Tornado

If you live in tornado-prone area, learn about the conditions that spawn tornadoes. A simple thunderstorm can quickly cause conditions that are right for forming tornado activity, leading authorities

to issue a tornado watch. Tornadoes often strike suddenly, sometimes without a thunderstorm in the vicinity. Just because you don't see a funnel cloud doesn't mean one is not lurking nearby.

When weather conditions change, stay tuned to local weather information. Take cover if you see a dark or green-colored sky, a dark, low-lying cloud, or hail. A loud roar that sounds like a freight train may accompany the approach of a funnel cloud.

- Before storm season, review your emergency plans and supplies, checking to see if any items are missing. Replenish anything that has been used or is out of date, including batteries, water, and first aid supplies.
- If a tornado takes dead aim at your house, there is very little that can be done to prepare it for a hit. If you know ahead of time that there is a threat of severe weather, secure or put away anything that could become a flying projectile.
- Know your area's emergency warning system. If a tornado warning is issued, take cover immediately.
- If possible, go to the interior part of a basement. If you don't have a basement, go to an interior room or hallway on the lowest floor. Stay away from windows.

- Do not stay in a mobile home during a tornado warning. If you cannot get to a secure building, lie flat in a ditch or low spot on the ground.
- If you see a tornado when you are driving your car, get out immediately and seek other shelter.

After the Storm

If your home suffers damage from a tornado or severe thunderstorm:

- Check utilities and turn off gas or electricity lines until they can be inspected for damage. If you smell gas, leave the house immediately.
- Half of all injuries associated with tornadoes occur after the storms are over. Be careful of downed trees, power lines, and scattered debris. Never touch downed lines or frayed wires.
- Wear sturdy shoes, and watch for broken glass and exposed nails.
- Continue to monitor weather reports and emergency messages.
- Retrieve your insurance documents, photographed household inventory, and vehicle registration so that you will be prepared to quickly file claims.

Hurricane

If you live in hurricane country, chances are you already know the drill. The good news about hurricanes is that there is usually plenty of warning. Sky watchers track hurricanes from the moment they form and generally have a pretty good idea where they are going. The bad news is that hurricanes can be very fickle, spinning off all sorts of weather. When a hurricane comes by, be prepared for high winds and heavy rain along with funnel cloud activity.

Because you have had the good sense to prepare, you will not be out there fighting the crowds for the last piece of plywood or gallon of water. Your stockpile is in place, and you are ready.

Do a last-minute check to make sure everything is in place. Before storm season, review your emergency plans and supplies, checking to see if any items are missing. Replenish anything that has been used or is out of date.

As soon as a hurricane watch is issued, you should:

- Tune in for weather updates.
- Secure or put away items such as outdoor furniture, bicycles, grills, and propane tanks.
- Cover windows and doors with plywood or boards. Ideally, you should have purchased and labeled these boards *before* hurricane season. If you can afford it, consider installing hurricane shutters.
- Plan ahead for the care of animals and pets. Emergency shelters cannot accept animals, so if possible, plan to stay with friends who can accept

them or identify hotels on your evacuation route that accept animals.

- Place vehicles under cover.
- Even though you have stored water, fill sinks and bathtubs with water for an extra supply.
- Turn the thermostat on refrigerators and freezers to the coldest setting. If a freezer is only partially full, add jugs of water to fill the space. When the jugs freeze, they will help to keep your food cold longer.
- Identify the safest place to take shelter in your home. Choose an interior room without windows, such as a bathroom, and cover yourself with plywood or a mattress.
- Make sure cars have a full tank of gas. If evacuation becomes necessary, long lines quickly form and fuel may become scarce. Make sure your emergency kit is up to date and in the car. Know your evacuation route.

After the Hurricane

You may face wind and water damage after a hurricane passes. Standing water poses all sorts of risks, so don't wade through it without good boots. Snakes and stray animals may be displaced during a storm, and mosquitoes may be a problem. Don't drive through high water.

- Inspect your home for damage. Check for gas leaks and leave the house immediately if you smell gas.
- Wear waterproof boots when wading through storm water. Chances are good that it contains sewage and other runoff chemicals.
- Make sure tetanus shots are up to date. Cover hands with gloves to avoid exposure to contaminated water and accidental skin wounds.
- Listen for public announcements about the water supply. In the event of a "boil water" advisory, do not drink tap water or use it to brush your teeth unless you have boiled it for at least one full minute. You may also treat water by adding one-fourth teaspoon of bleach to a gallon of cloudy water. Let it stand for thirty minutes before using.
- Remove items that are soaked and cannot be cleaned and dried. Throw out mattresses, carpeting, upholstered furniture, pillows, and all paper products.
- Open all doors and windows. Turn on fans and dehumidi-fiers to remove moisture.
- Tackle mold with a mixture of one cup of bleach to one gallon of water. Open windows to make sure there is plenty of ventilation. Then scrub surfaces, rinse with clean water, and let dry. Wear boots, rubber gloves, and eye protection when cleaning with a strong bleach mixture. NEVER mix bleach and ammonia.
- Rinse off hard surfaces with fresh water and a little soap. Then spray down surfaces with a mild bleach mixture of one cup of bleach to five gallons of water.

Flood

"Water, water everywhere, but not a drop to drink" may be a very appropriate way to describe the aftermath of a flood. You will be dealing with contaminated water which contains sewage, chemical runoff, and debris of all types. Even tap water may be unusable; check with authorities to

learn if the public water supply is safe to drink. In the event of a "boil water" advisory, do not drink tap water or use it to brush your teeth unless you have boiled it for at least one full minute. You may also treat water by adding one-fourth teaspoon of bleach to a gallon of cloudy water. Let it stand for thirty minutes before using.

- Keep children and pets out of the flood area until cleanup has been completed.
- Wear waterproof boots when wading through storm water.
- Make sure tetanus shots are up to date. Cover hands with gloves to avoid exposure to contaminated water and accidental skin wounds.
- Remove items that are soaked and cannot be cleaned and dried. Throw out mattresses, carpeting, upholstered furniture, pillows, and all paper products.
- Open all doors and windows. Turn on fans and dehumidi-fiers to remove moisture.
- Tackle mold with a mixture of one cup of bleach to one gallon of water. Open windows to make sure there is plenty of ventilation. Then scrub surfaces, rinse with clean water, and let dry. Wear boots, rubber gloves, and eye protection when cleaning with a strong bleach mixture. NEVER mix bleach and ammonia.

- Rinse off hard surfaces with fresh water and a little soap. Then spray down surfaces with a mild bleach mixture of one cup of bleach to five gallons of water.
- Remove and discard drywall and insulation that has been soaked by flood waters.
- Wash clothing that has been contaminated with flood water in hot water and detergent. Go to a laundromat if possible with these clothes, until you have determined that your own water supply is clear.
- If you have to evacuate, follow posted instructions. Never drive through high, moving water.

Landslides and Mudslides

Landslides are caused by disturbances in the natural stability of a slope. They can accompany heavy rains or follow droughts and earthquakes. Mudslides develop when water-saturated rock, earth, and debris start to slip. Slides can occur anywhere there are steep slopes, particularly where there is surface runoff. Learn whether your area has ever been prone to slides like these, and prepare an emergency evacuation plan in the event of conditions that could create slides.

- Monitor weather information when there is a threat of intense storms.
- Watch for signs of increased water flow in streams and on surfaces. Tilted trees or bare spots on hill sides may indicate that the earth is shifting.
- If you hear rumbling or see rock and debris coming toward you, act quickly to move to the nearest high ground away from the path of the slide. If you can't get out, take shelter under a desk.

After a Slide

- Be aware that the area of the slide is very unstable. Do not inspect it on your own until all signs of additional slides have passed.
- Report damaged power wires and gas lines.
- Seek professional engineering assistance to determine the extent of the damage and alternatives.

Wildfires

Any home that is situated in a forested area needs to be prepared for the possibility of wildfire. Forest fires may start quickly under favorable wind and weather conditions and travel rapidly. But unlike weather, wildfires can be prevented, and with some preparation damage can be avoided or at least minimized.

- Know local fire laws, and only burn during approved times and conditions.
- Make certain that your driveway is clearly marked and accessible by emergency vehicles.
- Teach children about the danger of fires; keep matches and other flammable items out of their reach and make sure they know how to call for emergency assistance.
- If your home is in a forested area, create a buffer around the house to keep flames from reaching it. Make sure tree branches do not overhang the roof or chimney, and keep dead wood pruned and removed. Clear leaves and debris away from structures and underneath porches.
- If you notice branches that could threaten power lines, call the electric company and ask for someone to come out to clear them.
- Store flammable materials, such as gas and propane, in approved containers away from the house, and make sure wood ashes are thoroughly cooled before disposing of them.
- Inside the house, make sure smoke detectors are in good working condition and fire extinguishers are up to date. Inspect and clean chimneys as needed.
- Make sure you have water outlets outside the house and a garden hose capable of reaching any area of the house.

If there is a threat of wildfire:

- Close all doors and windows.
- Shut off gas lines.
- Keep animals indoors and readily available to grab in case of evacuation.
- Wet shrubs immediately around the house, and place lawn sprinklers on the roof.
- Make sure the car is parked in a location suitable for easy escape and you have three days of emergency supplies stored inside.
- Identify escape routes and destination.

Learn to Use a Fire Extinguisher

Emergency items such as fire extinguishers are only as useful as the person using them. Do an occasional check of your extinguishers to make sure there is no rust, leakage, or denting. Make sure that everyone in the family knows where extinguishers are and how to use them. Some fire departments give classes in fire extinguisher usage.

Always stand between the fire and your escape path, so that you can easily turn and run to safety. Be aware that it is not just flames that are dangerous. Smoke can overwhelm you suddenly. Know when a fire is too big to handle; the average home extinguisher only has about 10 seconds of power, so it is always safer to evacuate than try to fight a fire that is burning quickly.

OSHA makes it easy with their four-step method called PASS:

PULL the pin. This will break the seal.

AIM the nozzle at the base of the fire. Don't point it at the flames themselves. The goal is to hit the substance that is actually burning.

SQUEEZE the handle to release the extinguishing liquid.

SWEEP the fire extinguisher from side to side until extinguished.

Smoke

You don't have to be in the location of a serious wildfire to be affected by it. Smoke from wildfires can hurt your eyes and irritate your respiratory system. If you suffer from asthma, allergies, or other lung diseases, exposure to smoke may be very dangerous.

- Listen to public announcements on air quality and heed their directions. If you see visible smoke, take appropriate precautions.
- If you are advised to stay indoors, keep windows and doors closed. Run an air conditioner with the fresh-air intake closed. Make sure the filter is clean to prevent outdoor smoke from getting inside.

Winter Weather

Winter sports enthusiasts welcome big snowstorms as a cause for celebration. But ice storms and heavy snows can take down power lines and make for some very uncomfortable days and nights without the use of your furnace. Have a backup plan in place in case your normal source of heat is out of commission.

- Before winter, review your emergency plans and supplies, checking to see if any items are missing. Replenish anything that has been used or is out of date. Note the condition of snow shovels and other winter tools. Make sure that bags of cat litter and snow-melting salt are stored for icy conditions.
- Tune up car for cold weather and make sure winter tires are in good condition. Check your emergency car kit and replace or replenish anything missing or outdated.
- Winter is a particularly bad time to be low on fuel, so make sure you have at least a half a tank of gas at all times.
- Tune in for weather updates.
- If you have a fireplace, make sure you have a wood supply ready and accessible (and not under feet of snow). If you do not have a fireplace, keep one alternative heating source available. Make sure the space heater you choose is designed for indoor use. Never use generators indoors.
- Choose one room to keep warm. Arrange sleeping bags, pillows, and blankets for sleeping. If there are drafty windows or doors, put towels in place to reduce heat loss.
- Cover windows with blankets at dusk to keep out the night cold.
- Wear layered clothing to bed. Body heat escapes quickly through the head, so make sure everyone includes a hat in their nightwear.
- Make sure you have plenty of quality food and snacks so that your body can generate its own heat. Have a way to provide hot water for drinks and hot water bottles.

- Provide entertainment! Books and games are particularly welcome when you have to stay huddled in one place to stay warm.
- Keep bathroom doors open so that plumbing can be exposed to any available heat. Open cupboard doors under sinks. If possible, wrap plumbing with insulation. If you have running water, keep a little water flowing to help prevent pipes from freezing.

Radiation

A radiation emergency, such as a nuclear power plant accident or a terrorist attack, can expose people to radiation. A catastrophic release of radiation or a nuclear bomb could result in many casualties and acute radiation sickness. Immediate medical attention is required in the event of this type of exposure.

As scary as that sounds, most radiation leaks or even so-called “dirty bombs” would likely cause exposure to a relatively small amount of radiation. This level of exposure may not result in immediate sickness, although there may be cancer concerns over the long term. If you are informed of potential radiation exposure, the best place to be is at home.

- If you are outside when an alert occurs, get inside as quickly as possible. Remove your outer layer of clothing, and place it in a bag or out-of-the-way location. Wash skin that was exposed to the air with soap and water.

- If you live near a nuclear power plant, you can monitor radiation levels with a RAD sticker.
- If you are contaminated, you can spread the contamination by touching surfaces or even walking through a house. Body fluids from internally contaminated people can contaminate other people in the household.
- The safest place to be in case of radiation leaks is at home. Make sure your home is ready for "sheltering in place" and has an adequate supply of safe drinking water and food to keep you comfortable indoors for several days.
- Close and lock all doors and windows. Close fireplace dampers.
- Turn off fans, air conditioners, or heating units that bring in fresh air from outdoors.
- Move to an interior room or basement.
- Make sure you have a reliable source for news and information.

- Potassium iodide (KI) should only be taken in a radiation emergency that involves the release of radioactive iodine, such as an accident at a nuclear power plant or the explosion of a nuclear bomb. You should only take KI if you have been instructed to do so by local public health or emergency management officials.

Evacuation

Because there is no way to see which way a radiation plume is moving, it is important to listen to the advice of local professionals before deciding to evacuate the area. If you are asked to evacuate, act quickly.

- Close up your house and turn off all heat and air conditioning.
- Follow the directions of local authorities to avoid the radiation plume.
- In the car, keep windows closed and ventilation systems off.

Store Water

Water is the most critical element of survival. In spite of the discomfort hunger can cause, the reality is that most of us could get by days and even weeks without food. But we can't last a week without water. In fact, the average person in a reasonably comfortable environment, using very little energy, could probably only survive three to five days without water.

How Much Water Do You Need?

Something as simple as an electrical outage can throw your normal routine into a tailspin. Suddenly your pump won't work, making that tap water just outside your grasp. For this reason, you should always have at least a three-day supply of potable drinking water for every person and animal in the household. For adults and large dogs, that's about a gallon a day. Children and small pets may be able to get by with a little less. That means that for a family of four, you should always have at least twelve gallons of drinking water available. For cleaning and hygiene, another gallon per person per day would also be desirable.

Floods and storms can damage or contaminate wells and municipal water systems, potentially making access to previously-available resources out of the question for longer periods of time. Water is very heavy, which makes keeping a three-month supply rather daunting. That's ninety gallons per person, *just for drinking*. Plan on another gallon per day for sanitation and personal needs.

Storing Water

Tap water is safe to store, so filling your own food-grade containers is a good way to get started. For large quantities of water, consider water storage barrels that can contain up to fifty-five-gallons—enough for about a month for two people. Fifty-five-gallon food-quality drums are relatively easy to fill and store, but when full weigh over 400 pounds. We prefer to store smaller containers, including five-gallon drums. Packaged water is available in every size imaginable, from personal bottle size to sealed five-gallon containers, and many of these can be reused for water storage.

Keep water in a cool, dark place. Though freezing will not hurt water, it could cause overfilled

containers to leak. Water does not have a definite shelf life, but it doesn't hurt to check large containers for cloudiness before use. Sealed containers should stay fresh indefinitely.

If your freezer is not full, consider keeping containers of water in there too. Frozen water containers will help keep the freezer cold longer, and provide an extra source of water as they melt. Just make sure to leave headroom for expansion in the water containers you store there.

Purifying Nonpotable Water

Water that has not been treated could contain organisms that may cause serious gastric distress. Water from lakes or streams, or rainwater in your outdoor rain barrels should always be treated before use. This applies to drinking water, as well as any water that you use to clean food, wash dishes, or brush your teeth.

If water is cloudy or contains particulates, strain it before disinfecting. Home water filters are not designed for disinfecting water but they may help to make your disinfected water more palatable, so it's a good idea to run water through your filter after boiling or bleaching it.

Boiling

Bring water to a full rolling boil and continue for three to five minutes. Cool and store.

If you want to keep sterilized water available for special purposes, such as infant formula or sterile wound cleaning, you may boil water and then process glass jars of your sterilized water in a water bath canner.

Clean and sterilize quart jars, and fill with your boiled water, leaving about an inch of headspace. Tighten lids and rings into place and process for about twenty-five minutes.

Disinfecting with Bleach

You can make water safe to drink by adding bleach. Bleach by itself is pretty toxic, so it is important to follow the instructions for purifying water exactly. Use only a pure liquid bleach, not one that contains soap or any other ingredients.

Got Bleach?

The surprising thing about bleach is not how useful it is, but how little is actually needed to do the job.

- Place one-half teaspoon (yes, that's all) into five gallons of water to purify it for drinking. If the water is cloudy, use twice that amount.
- Bleach is indispensable for removing mold and mildew. One cup of bleach in two gallons of water will remove stains from hard surfaces. Scrub, rinse, and repeat if necessary.
- Bleach makes a great disinfectant. Just mix one tablespoon of bleach in a gallon of water to clean almost anything.
- Sanitize secondhand items, old dishes, and glassware by soaking in one gallon of dishwater with a couple of tablespoons of bleach. Ten minutes should do the trick. Rinse and air dry items in the sun.
- One-fourth teaspoon of bleach in a quart of water will keep cut flowers fresh longer.

The label should say "Sodium hypochlorite." Most household bleaches come in a concentration of about 5-6 percent. To purify one gallon of water, add one-eighth teaspoon of bleach. For five gallons, use one-half teaspoon. Shake the container to thoroughly incorporate the bleach into the water. Let your treated water sit for at least forty-five minutes before using to kill any bacteria that may be present.

Water for Hygiene

In addition to drinking water, you will want an available source of water for cleaning, maintaining your toilet, and basic hygiene. When there is a threat of storms, simply filling the bathtub may give you the extra water you need for these basic tasks. Likewise, outdoor rain barrels are great for collecting this type of emergency water. Swimming pool or hot tub water may be handy for NONdrinking purposes, like cleaning or flushing toilets, but because of the chemicals used in this type of water, avoid it as a source of drinking water.

Running Your Toilet

There are two ways to use your toilet during a power outage. The first is to fill the toilet tank with water and flush as usual. The second way is simpler: just pour water directly into the bowl after use to flush waste. Make sure to keep some water in the bowl at all times so fumes from the sewer or septic tank don't seep into the house. Only flush when absolutely necessary!

If you don't have enough water for running your toilet, there are camping toilets and even disposable bucket toilets designed for camping.

Laundry

Faced with days without power, you may wonder what happens the day you run out of clean clothes. Hot water, a washtub, and a scrubber will accomplish the task, along with a heavy-duty clothesline. But a little forethought can keep the laundry from piling up.

For clothes that are not actually dirty, rather than tossing them in the laundry basket as you normally would, spray a little fabric freshener on them and hang them out in a well-ventilated place at the end of the day. Consider adding a T-shirt under your other clothes; this underlayer can be washed more easily than a heavy sweatshirt. Keep certain

clothes for messy tasks like cooking, and change into those before you get started. If you do get a stain, stop and treat it immediately rather than changing clothes completely. A pen-style laundry stain remover can rescue a shirt for another day of use.

Personal Hygiene

Days without a shower can seem like torture for those of us accustomed to this everyday luxury. As long as you have enough water available, you can fashion a bath of sorts from hot water and soap. We keep wet wipes in our storage specifically for power outages. Not only does this save a lot of water, we find that using them for everything from washing faces and hands to substituting them for toilet paper keeps everyone feeling (relatively) fresh. Likewise, a squirt of liquid hand sanitizer allows you to avoid reaching for the water bottle unless you have something on your hands that really requires rinsing. A spray bottle of water can also go a long way after a hot or sweaty day.

Of course, nothing beats a good shower! We discovered the solar shower years ago when we started camping. This simple five-gallon PVC bag hangs in the sun where it can warm up water, and comes with a small shower head.

Conserving Water

The first step to having enough water is knowing how to use it. We learned this the hard way one year when a particularly bad drought threatened our water supplies for several months. We learned in a hurry when and how to make the most of our water supply, how to find alternatives to running water, and how to collect and store water. We quickly replaced our high-flow toilets with more efficient models and learned to stay clean with a minimum of showers. Paper plates and utensils were a lifesaver.

Before you have a water crisis, conduct an audit of your house to make sure you are doing all you can to conserve:

- Check faucets, pipes, and toilets for leaks.
- Install water-saving showerheads and toilets.
- Run the laundry and dishwasher only when you have a full load.
- Learn to take shorter showers, and shut off water while you brush your teeth or shave.
- Keep a bottle of cold water in the refrigerator rather than running tap water until it is cold.
- Outside, mulch plants to keep the soil around them moist.
- Add rain barrels or a rainwater tank to catch runoff.

Fill Your Pantry

A long-term food storage plan is your very own "food bank account." You want that bank account to be a sound investment, one that you have ready access to, and one that will provide you exactly what you need when you need it. Remember: no matter what a great deal it is, how long its shelf life, or how practical it might sound, there is absolutely no point in storing food you don't want to eat.

So What Should Go into Your Food Pantry?

Build your own individualized food pantry using the common-sense "eat what you store, store what you eat" approach. This means that you only buy food you actually want to eat, food that your family is accustomed to, and food that you actually use every day, rather than accumulating food and locking it up tight for some future imagined time.

Because you are always rotating through your pantry, you don't have to wait for a full-scale emergency to use your food. You always have your own piggy bank to draw from, even when it's just a week where your budget is a little pinched.

To start creating your own customized food pantry, consider the kinds of meals your family currently eats. Look at your favorite recipes and see how you might adapt those to items that are in a storage pantry. Try to take a balanced approach to meal planning and storage. The following ratios are an example of foods that would contribute to a balanced diet:

PROTEIN: 13 percent of your food supply. This category includes legumes, meat, peanut butter, and assorted nuts.

GRAINS: 40 percent of your food supply. This would include cereals like oatmeal, as well as pasta, rice, and breads.

VEGETABLES: 20 percent of your food supply. This would include carrots, peas, green beans, corn, and other vegetables.

DAIRY: 12 percent of your food supply. This would include milk, yogurt, and cheeses.

FRUITS: 15 percent of your food supply. This would include canned peaches, berries, and other fruits, including tomatoes.

These ratios are only a guideline and apply to a full day, so you may find that more cereal and fruit are eaten at breakfast, while proteins and vegetables make up the rest of the day's meals.

Staples

Your long-term food storage plan begins with the fundamentals, including grains, beans, fats, sweeteners, dairy items, and basic baking ingredients.

At the most basic level, every person needs about one pound of dry matter every day to survive. Dry matter may mean legumes, grains, sugar, pasta, dried vegetables, or rice. This dry matter represents calories, the stuff that is needed to produce energy in the body. A pound of dry matter represents about 1,600 calories, a reasonable amount of energy for the average adult.

A One-Year Emergency Pantry

To feed a family of four for a full year, a pantry that consisted entirely of staple ingredients would look something like this:

500 pounds of whole grain wheat for grinding	100 pounds of cornmeal
100 pounds of flour	100 pounds of oats
50 pounds of millet	50 pounds of quinoa
200 pounds of rice	12 pounds of jam
100 pounds of pasta	12 pounds of sprouting seeds
120 pounds of dried beans	40 quarts of vegetable oil
20 pounds of lentils	240 pounds of dry milk
20 pounds of split peas	48 cans of evaporated milk
40 pounds of soy beans	4 pounds of baking powder
16 pounds of peanut butter	4 pounds of baking soda
1½ gallons of dehydrated eggs.	2 pounds of yeast
50 pounds of TVP	20 pounds of salt
160 pounds of sugar	2 gallons of vinegar
12 pounds of honey	20 pounds of dry soup mix
12 pounds of molasses or maple syrup	A variety of spices and seasonings

A consistent diet of dry matter would, of course, be deadly dull, and over the course of a few months, the body would begin to suffer from the lack of protein, fresh greens, and essential vitamins. Still, it is good to keep in mind as you make decisions about what to store.

Some people do keep an emergency pantry that contains only these essentials—whole grains, dried beans, oils, and sweeteners. The problem is that these foods require that you to cook in a way that may not be compatible with your current lifestyle. You need to have a basic understanding of cooking and baking techniques, as well as a high tolerance for boring meals! If you decide to make these staples the center of your food pantry, take the time to learn to use them in your everyday meals.

Long-Term Food Storage

Every item in your storage pantry wants three conditions to maintain its optimum quality: cool, dry, and dark. High temperatures, humid or wet conditions, and exposure to light are the primary causes of spoiled food. In addition, food must be kept safe from bugs and rodents. Keep these factors in mind when storing any food products. The following are specific recommendations for each food group.

Whole grains, dried beans, and white rice are very durable, but they prefer to be stored in a cool, dry location. Flours, sugars, oils, dry milk, and canned goods want the same conditions, but generally have a shorter shelf life, so check on life expectancy before deciding on how much to store. Temperatures of 50—60°F are ideal for ensuring maximum longevity. Overheating or wide temperature swings will shorten shelf life. Likewise, humidity causes challenges. Any time moisture is present there is a danger for molds and bacteria to grow.

Shelf life of foods

“Sealed” refers to hermetically sealed containers. These are estimates, and will vary based on storage conditions. Check the manufacturer’s dates for specific information.
For commercial products, check the manufacturer’s “best by” date, and use that as your “sealed” date.

PROTEINS	SEALED	OPEN
Canned ham	2-5 years	3-4 days in refrigerator
Freeze-dried meats	25 years	1 year
Commercially made jerky	2 years	1 year
Home-dried jerky	1–2 months	1-2 months
Hard/dry sausage	6 weeks in pantry	3 weeks in refrigerator
Dried eggs	12–15 months	Refrigerate after opening. Use within 7 to 10 days. Use reconstituted egg mix immediately or refrigerate and use within 1 hour.
Canned tuna	18 months	3–4 days in refrigerator
Other canned meats	18 months	3–4 days in refrigerator
LEGUMES	**SEALED**	**OPEN**
Dried beans	30 years	5 years
Instant dried beans	30 years	1 year
TVP	10 years	1 year
Peanuts		
Peanut butter, natural	2 years from manufacturer’s date	2-3 months
Peanut butter, emulsified	2 years from manufacturer’s date	18 months

(Continued)

Shelf life of foods (*continued*)

Peanut butter powder	4 years	1 year
GRAINS AND FLOUR		
Wheat	10–12 years	2 years
Dry corn	10–12 years	3 years
Millet	10–12 years	4 years
Flax	10–12 years	4 years
Barley	8 years	18 months
Quinoa	20 years	1 year
Rolled oats	8 years	1 year
Whole wheat flour	2 years	6 months
White flour	4 years	1 year
Spelt flour	5 years	8–12 months
Flaxseed flour	1 year	2–3 months
White rice	10 years	1 year
Brown and wild rice	1–2 years	6 months
Pasta	8 years	3 years
NUTS	**SEALED**	**OPEN**
In the shell	9 months	6 months
Shelled	2 years	18 months
FRUITS AND VEGETABLES		
Low–acid canned goods, such as soups, vegetables, stews	2–5 years	3–4 days in refrigerator
High–acid canned goods, such as fruits, tomatoes, and vinegar–based items	12–18 months	5–7 days in refrigerator
Home–canned foods	1 year	3–4 days in refrigerator
Dehydrated fruit	25 years	12–18 months
Dehydrated vegetables	25 years	1–2 years
BAKING SUPPLIES		
Yeast	2 years	4 months
Honey	10 years	2 years

White sugar	30 years	2 years
Brown sugar	10 years	1 year
Molasses	2 years	6 months
Baking powder, baking soda, and salt	30 years	2 years
Vinegar	2 years	1 year
Spices and seasonings	2 years	2 years
Boullion	5 years	2 years
OILS	**SEALED**	**OPEN**
Cooking oils	6 months	3–6 months
Shortening	2 years from manufactured date	1 year
Shortening powder	10 years	1 year
DAIRY PRODUCTS		
Dry milk	25 years	2 years
Sour cream powder	10 years	1 year
Cheese, dried	15 years	6 months
Butter powder	5 years	9 months
OTHER		
Seeds for sprouting	5 years	4 years
OILS	**SEALED**	**OPEN**
Cooking oils	6 months	3–6 months
Shortening	2 years from manufactured date	1 year
Shortening powder	10 years	1 year
DAIRY PRODUCTS		
Dry milk	25 years	2 years
Sour cream powder	10 years	1 year
Cheese, dried	15 years	6 months
Butter powder	5 years	9 months
OTHER		
Seeds for sprouting	5 years	4 years

Using Oxygen Absorbers

Oxygen absorbers begin absorbing oxygen the moment they are exposed to air, so don't open your package until you are ready to use them. Remove only the number you need, and immediately place the remaining absorbers in a glass jar with a tight lid.

Rotation

The "store what you eat and eat what you store" family pantry is a living, breathing organism. It is designed to use every day, not just in an emergency. Because, for the most part, you are stockpiling foods that are a standard part of your family's diet, you should have an easy time keeping foods fresh and used before their expiration dates.

Always remember FIFO—first in, first out. Develop a system. You can keep older items front and center on your shelf, and fill your shelves from the rear when you add new foods. Or you can store from left to right, always using from the left and adding on the right. Food rotation shelving helps you create an almost foolproof system for your canned goods, feeding them to you in the order you fed them into the shelf.

All bulk foods used for long-term storage should be carefully sealed to keep them safe from pests and rodents. To store a large quantity of dried bulk foods, choose food-grade five-gallon buckets with gasket lids. Line each bucket with a Mylar bag. Place one 500cc oxygen absorber in the bottom of the bag. Fill the bag about half way, shaking the bucket to settle the food. Add another oxygen absorber, and then fill the bucket, leaving about an inch of space on top. Place another oxygen absorber on top.

Pull the bag up as high as you can, settling the food into the bucket. Use a hot iron to seal the Mylar bag. Place a board on the edge of the bucket, lay the bag top straight and start sealing the bag from left to right, making sure to squeeze out excess air before finishing the seal. Fold the bag down, and place the gasket lid on the bucket.

Learn to Cook Off the Grid

If you plan to cook using an outdoor propane grill or gas stove, cooking will not be much different than it is inside the house on your kitchen stove. But to get the most out of cooking with alternative forms of fuel, there are a couple of methods that I find particularly useful.

Cooking in a Thermos

This is the simplest possible method of cooking off the grid. With a good quality wide mouth thermos and some boiling water, you can have a hot breakfast waiting for you in the morning.

To make thermos oatmeal, put on a pot of water to boil. Fill the thermos with the hot water and close the lid. Set it aside to warm up.

Boil another batch of water. When it is ready, open the thermos and pour out the water. Put one cup of steel-cut oatmeal in the thermos and add about 3.5 cups of boiling water. Close the lid and shake the thermos. Wrap it in a blanket or towel if you like, to help keep it hot. Set it aside. The oatmeal will be ready to eat in less than an hour, but will stay warm all night and be ready to eat in the morning.

This method will work for grains and lentils too. Experiment with a combination of rice, beans, or dried vegetables for a nutritious, hot dinner.

Cooking with a Solar Oven

This is the gentlest and most environmentally friendly method of cooking, nothing but the sun is needed to produce great meals. The solar oven comes in a number of varieties, but it is essentially nothing more than a box that concentrates and traps the heat of the sun. The food inside is gently cooked at a temperature of around 325°F or higher, depending on the intensity of the sun. To cook your

food, all you do is place it inside the oven, point it at the sun and wait. Think of it as a natural crock pot.

The solar oven works very well when the sun is in full force, so it is designed for use during the day. The only tending needed is to check and adjust its position every couple of hours to make sure that it is getting the full force of the sun. Because your food won't burn, there is no need to stir or fuss with it during its cooking time. Because no smoke is

produced and the gentle heat never reaches dangerous temperatures, the solar oven can be left unattended.

Bright sun is the only requirement for cooking. But even on the sunniest day, cooking times will be affected by factors such as outside temperatures, wind, and elevation, so it may require a bit of experimentation to learn the time needed to cook your food. Smaller batches work best, small cuts of meat rather than large roasts, sliced potatoes instead of whole ones. A small pot of rice will cook in approximately four hours, a simple chili or stew in four or five hours, a small roast in about six hours. The solar oven will bake basic breads or cookies, but they will not brown like a conventional oven.

Great Campfire Coffee

What to do without that electric drip pot? Try this recipe for Egg Coffee!

Fill a pot with ten cups of water and bring it to a boil. In a bowl, combine coffee grounds, egg, and one-fourth cup of water. Stir the egg and coffee mixture into the boiling water and continue to boil for two to three minutes. Before serving, remove from heat and add one cup of cold water. This settles the coffee grounds to the bottom of the pot. Pour a cup, using a strainer if you prefer your coffee without any floating debris.

Why eggs, you ask? I am not sure, although I do know the egg adds body to the coffee and helps to remove any bitterness, leaving you with a smooth, mild cup.

Using a Dutch Oven

When it comes to campfire cooking, there is nothing that compares with the Dutch oven. The Dutch oven is a fryer-broiler-stewer-roaster-steamer-baking oven all-in-one. It is designed to keep moisture in and retain and circulate heat directly around your food. Dutch ovens are designed for outdoor use with wood or charcoal briquettes.

Off-the-grid cooking often means outdoor cooking—and that brings with it a number of factors that have to be considered. Wind, air temperature, humidity, location, and your cooking surface all play a part in how you will generate and maintain your heat. A little wind can gobble up your coals faster than you had planned, high humidity can slow them down, and a shady location or cold ground surface can lower your temperature by twenty-five degrees or more.

Calculating Heat

The Dutch oven is such a versatile cooking unit, it makes sense that there a number of ways to heat and cook with it. Learn to calculate your coal needs based on a few basic rules.

A single charcoal briquette generates around 15°F. That means to maintain a temperature of about 350°F, you would use approximately twenty-four coals. This is handy to know, but not entirely reliable because it doesn't factor in oven size or other conditions. It is just a good starting point. It is always best to be a little conservative when starting out. An overly hot oven can burn your food. It is always easier to build the heat than it is to cool down a hot Dutch oven.

Laying coals for different types of cooking is a matter of ratios. If you are reading a Dutch oven recipe, you may see two numbers. The first number always refers to the coals you will put on top of your oven. The second number is the number of coals you will put on the bottom. For example, 4:1 means four times as many coals on the top of the oven as on the bottom. One the other hand, 1:4 means that there would be four times as many coals on the bottom as on the top. Baking requires a different ratio than roasting, and simmering requires a different ratio than frying. To get the most out of a Dutch oven, learn the basics of regulating temperature.

Develop Self-Sufficiency

People who live a modern lifestyle must depend on someone else for almost everything. Whether it is having the doctor fix every little ache, a foreign factory making your clothes, or Middle Eastern oilfields providing your heat, it may seem almost impossible to develop a self-sustaining lifestyle.

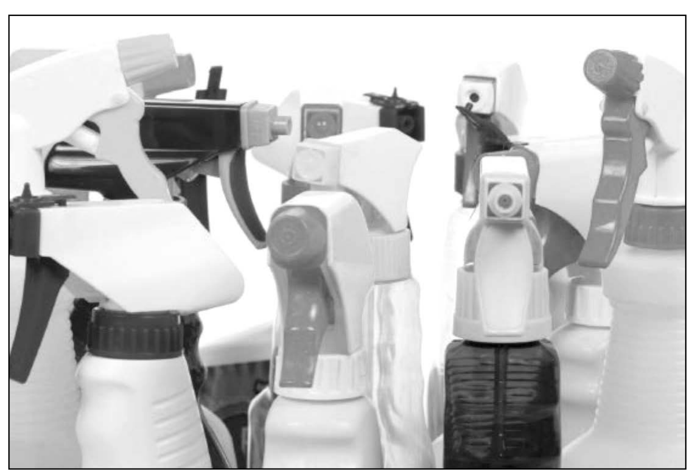
But self-sufficiency is not an all-or-nothing proposition. It does not mean that you have to go it alone. As a matter of fact, in this day and age, it would be extremely unlikely that you would suddenly find yourself in remote backwoods with no one to depend upon but yourself.

There is a lot of value in knowing how to provide and preserve food, keep everyone safely sheltered, and rely on your own resources to take care of your family. So strive to be a little more self-sufficient today than you were yesterday. If you are entirely dependent on outside resources, aim for 10 percent self-sufficiency. If that works out, look for ways to be 20 percent self-sufficient. Decide how you want to spend your time and resources. Some people are content to stockpile food. Others want to grow and preserve their own. Still others find it fulfilling to seek out and barter for local goods, foods, and services. All of these things help loosen the stranglehold the world has on your life.

Keep Germs at Bay

The most important rule of the prepper—keep yourself healthy. That means making sure you do not unnecessarily expose yourself to anything that could make you sick. Make sure you have a good plan for handling basic sanitation needs in the event of loss of power or water supplies, and know how to keep food and water supplies safe.

The very best way to reduce or prevent the spread of illness is to keep your hands clean. Germs accumulate on your hands as you go throughout



your day, and even the most innocent of objects may carry your next cold.

How to Wash Your Hands

Always wash your hands BEFORE preparing or eating food, or anytime you have to care for a sick or injured person.

Always wash your hands AFTER handling raw meat, using the bathroom or changing a diaper, blowing your nose, treating a sick or injured person, or anytime your hands get dirty or you handle contaminated materials.

To wash your hands:

- Wet hands with warm water and add soap.
- Rub your hands together for about twenty seconds, making sure to scrub all surfaces, including the back of the hand, between fingers, wrists, and under nails. (This takes about as long as it takes to sing Happy Birthday twice.)
- Rinse hands thoroughly with warm running water.
- If you are in a public location, dry your hands with a paper towel. Use that towel to turn off the water and open the door before discarding.

Baking Soda!

Baking soda is good for more than baking. It is great for deodorizing almost anything, works as an acid neutralizer, and can even stop an itch.

- Mix it in your bath water for a deodorizing cleanse.
- Make a paste with it for brushing your teeth and freshening your breath.
- Stir a little soda into water to make a soothing drink to counteract an upset stomach.

- Use a dash of baking soda under the arms as a replacement for deodorant.
- Apply a paste of baking soda and water to stings and bites to reduce itching.
- Add baking soda to laundry to eliminate smells and loosen stains.
- A little baking soda instead of powder in the diaper can help neutralize ammonia.

- If water is not available, use a hand sanitizer that contains at least 60 percent alcohol. Your hands may not actually be clean, but they should be more or less sterile.

Get Immunized!

Vaccines have been the subject of controversy in the news, particularly as to how they impact childhood development. But the fact is that vaccines are the best defense we have against some of the most common serious and even deadly contagious diseases. Childhood vaccines are generally mandated by law in order for children to attend school, but if you have special concerns, discuss them with your doctor.

Adults should also discuss with their physicians what vaccines they need to maintain. For example, an up-to-date tetanus vaccine can remove worry about puncture wounds or other dirty skin wounds. The good news is that a booster shot lasts ten years, so updating it is not a real hardship. Flu shots may be appropriate for anyone who cannot afford an extended illness or is caring for children or seniors. Seniors may want to protect themselves from shingles, pneumonia, or whooping cough, which can take a greater toll on an older body.

Build a First Aid Kit

Make up a complete first aid kit of your own, containing enough of the basics to get you through just about anything. Tailor it for any special needs of your family. Even more importantly, KNOW HOW TO USE IT. Take a class in first aid and CPR from your college's continuing education department or your local hospital.

A good kit includes:

- Burn ointment
- Triple antibiotic cream
- Hydrogen peroxide
- Benzalkonium chloride
- Adhesive bandages
- Small splints
- Gauze
- First aid tape
- Small scissors
- Tweezers
- Sterile cotton balls and swabs
- Matches
- Thermometer
- Cold medicine
- Antacids
- Antibiotics
- Antidiarrheal medicine
- Syrup of ipecac
- Antihistamines
- Laxatives
- Multi-vitamins
- Petroleum jelly
- Prescription medicines
- Heavy string
- Sunscreen
- Aloe cream

Take Vitamins

The best way to be healthy is to stay healthy. Store multi-vitamins for everyone in your household, and make sure that you have vitamin C on hand as well. Keeping your immune system strong will help you avoid many of the most common illnesses.

Stock Prescriptions

Make sure you have an extra one- to three-month supply of any necessary prescription drugs that the family takes. Get a few months extra and keep it in your surplus personal stock, making sure to rotate it to keep it fresh.

Some people try to stockpile antibiotics. Be cautious about administering antibiotics. Although they are potential lifesavers, misuse or overuse can get you into trouble. If you think you need an antibiotic, see a doctor.

Have an Extra Set of Eyeglasses

Make sure you have an extra set of eyeglasses for anyone in the family who uses them. Anytime you get new glasses, save previous eyeglasses in your first aid kit in case of emergencies or breakage, or take advantage of the two-for-one deals that many eyeglass companies offer.

Prepare for Dental Emergencies

The best defense against dental emergencies is a good offense. Make sure that your family keeps up a good regimen of brushing and flossing to keep teeth and gums in prime condition. Avoid excessive amounts of highly-acidic foods that can weaken tooth enamel. If you do eat high-acid foods, don't run straight to the bathroom to brush your teeth. Acid actually softens enamel, so immediate brushing may do more harm than good. Wait at least an hour before you brush.

Let your kids chew sugar-free gum with xylitol. It helps to reduce acid and increase saliva flow. Saliva actually helps prevent enamel erosion by strengthening teeth with key minerals.

Keep fluoride toothpaste in your pantry, along with a supply of extra toothbrushes. Toothbrushes should actually be replaced every three months or so, more often if you have gum disease.

Plan for dental emergencies by having a few key items in your healthcare cupboard. These items might include:

- Cotton rolls
- Dental mirror
- Sterile gauze pads
- Temporary filling material
- Crown cement
- Oral anesthetic for treating gum or tooth pain
- Floss, mouthwash, and dental picks

Control Aches and Pains

Know how to handle the everyday aches and pains of work and exercise. Paying attention to minor aches and strains will help you to avoid overusing a joint that is sending out warning signals!

How do you know whether to use heat or cold on your aching joints?

Use ice packs immediately after an acute injury or to treat joints immediately after a workout. Ice helps to reduce swelling and limit internal bleeding. Ice an injured joint for ten minutes at a time. Let the skin return to a normal temperature, and then repeat the icing, up to three times. Do this for one to three days after an injury.

Heat therapy is used for chronic aching joints and stiffness, and is useful for arthritic conditions. Heat can be used before exercise to help loosen stiff joints and is great for relaxing tight muscles and treating spasms. Use warm, damp towels or warm therapy packs, and leave on the joint for fifteen to twenty minutes. Moist heat combined with eucalyptus ointment makes an especially comforting treatment. Just rub ointment onto the joint, wrap the area in plastic wrap, and leave in place for about

twenty minutes. Note: never use heat on an inflamed or swollen joint, or immediately after exercise.
Your aches-and-pains kit should include:

- Ibuprofen
- Hot water bottle
- Hot and cold therapy packs
- Freezer gel packs
- Moleskin pads
- Elastic bandages
- Rubbing alcohol
- Eucalyptus ointment
- Epsom salt
- Elastic bandages

Basic First Aid

Assist Choking Victims

Choking is caused when the airway is partially or completely blocked by a piece of food or another object. When the airway is partially blocked, a person may be able to cough out the offending object. Stay with them until the choking is resolved.

But when the airway is completely blocked, the person will not be able to speak, cough, or breathe. Learn the Heimlich maneuver to assist someone in this condition.

1 Stand behind the choking person and wrap your arms around his waist.
2 Make a fist and place the thumb side of your fist against his upper abdomen, below the ribcage and above the navel.
3 Place your other hand over your fist and press into his upper abdomen with a quick, upward thrust.
4 Repeat until the object is dislodged and the person can catch a breath.

For a young child:

Lay the child on his back and position yourself facing him. Place the middle and index fingers of

both hands below the rib cage but above the navel. Gently press into the upper abdomen with a quick, upward thrust. Repeat until the object is dislodged and the child can catch a breath.

For a baby:

Sit the infant or toddler on your lap facing away from you and place the middle and index fingers of both hands below the rib cage but above the navel. Gently press into the upper abdomen with a quick, upward thrust. Repeat until the object is dislodged and the child can catch a breath.

If you are alone and choking:

If you can't speak or breathe, there may not be time to seek assistance from someone else. Make a fist and place it against your upper abdomen, just below the ribcage. Grasp your fist with your other hand and press into your upper abdomen with a quick, upward thrust. If you cannot gain enough traction, press your abdomen against the back of a chair or the side of a table to produce an upper thrust. Repeat until the object is dislodged and you can catch a breath.

CPR

If at all possible, take a CPR training course. The American Heart Association, the American Red Cross, and many hospitals and fire departments offer courses and can provide more thorough instructions.

If you do run into a situation where immediate assistance is required, do the following:

- Call 911 immediately if a person is clearly in distress or unresponsive.
- If the person is not breathing normally, cannot cough, or is not moving, start chest compressions by pushing down in the center of the chest. Press hard and fast—your rate should be at least 100 pumps per minute, or almost twice per second. Press about two inches down and repeat thirty times.
- Tilt the person's head back and lift the chin. Pinch the nose and cover the mouth with yours. Blow in two breaths of about one second each. You should be able to see the chest rise.
- Repeat the pattern of thirty pumps and two breaths until help arrives. If the person starts to vomit, turn the head to the side and try to clear the mouth.

Stop the Bleeding

If bleeding occurs due to a cut or other traumatic injury, there is only one step. Stop the bleeding. Put direct pressure on the wound immediately. If you can get some clean gauze or a towel, place that over the wound and hold it down tightly. If the gauze bleeds through, just add more on top. Don't peel it away, as that will cause the bleeding to begin again. Once the bleeding is under control, clean and bandage the wound. If bleeding begins again, reapply pressure until it is under control again. If bleeding is severe, watch for signs of shock. Lay the person flat, cover with a blanket, and keep the injured area above heart level if possible.

Treat Cuts

When it comes to minor cuts and scrapes, keep it simple. Even small cuts can bleed heavily, so if there is significant bleeding, first apply pressure to reduce the flow. Wash the wound with soap and water and apply an elastic bandage, being careful that it is not tight enough to cut off circulation. Before bedtime, change the bandage, making it a little looser than the daytime bandage. Do this twice a day until the wound has stabilized and the bandage can be removed. The most important thing is to keep the wound dry; do not use first aid ointment, and change the bandage if the wound area gets wet.

Stop a Bloody Nose

Whether from a good whack in the nose or simply dry nasal passages—when a nose decides to bleed, it may take a little time and patience to get it under control. Follow these steps:

- Have the person lean forward so that any dripping blood leaves the body, rather than going down the throat.
- Find the area just below the bridge and pinch the nose together firmly. Hold it for a full five minutes; it may take that much time for the blood to clot. If you can, add a cold compress just above the bridge to help constrict the blood vessels.
- If the nose is still bleeding after five minutes, pinch and hold again. This time wait ten minutes before releasing. If you still cannot get the bleeding under control, see a doctor. If a head injury occurred but there is no sign of facial injury, a bloody nose may be a sign of a more serious situation. Contact a physician immediately.

Treat Burns

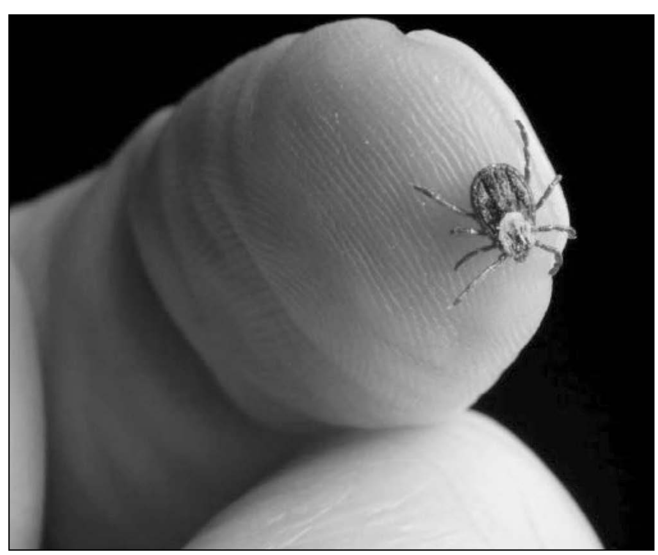
Burns are very common around the home, and quick action really helps to lessen the pain! For minor burns, the first thing to do is get the affected area under cold running water. It doesn't have to be icy to reduce the pain. If you don't have running water, use a cold compress. Once the pain subsides, cover the burn with a sterile bandage. Give acetaminophen or ibuprofen for pain. Do not break a blister or use ointment on the burn.

If a burn is severe, cool and cover the burn, and then watch for signs of shock. Lay the person flat and cover with a blanket. Elevate the burn above the heart.

Remove Ticks

Ticks are more than a nuisance; they can carry Lyme disease. If you get a tick bite, you need to remove it as soon as you can. Don't try to smother or get the tick to back out using petroleum jelly or rubbing alcohol. This may actually cause the tick to release toxins into your system.

Avoid the temptation to grab the tick with your fingers and yank. Instead, take the time to get a good pair of tweezers. Carefully grab the tick as close to your skin as possible. Don't twist it, just pull gently until it detaches. Look at the tick to make sure you



got the whole thing. If not, try to remove the head from the skin with your tweezers. Clean the wound with rubbing alcohol, and then wash your hands thoroughly with soap and water.

If a rash develops around the bite site, or fever or flu-like symptoms occur within weeks of the bite, see a doctor to be checked for Lyme disease.

Dealing with Bee Stings

People often get multiple bee stings, because bees just seem to know when to call in the cavalry! So if you get a bee sting, the first thing to do is get out of there! Bees will even give chase, so don't stop until you know you are out of their path. Then check the sting. If the stinger is still there, remove it by pulling it out quickly. Place ice on the sting immediately. Pain, itching, and swelling are common. A paste of baking soda and water applied to the sting may bring some relief.

Watch for signs of a more serious reaction called anaphylaxis. If the person has been stung more than ten times or if there is shortness of breath or tightening of the throat, seek professional help immediately. An antihistamine like Benadryl can help slow the reaction, but it is still best to have the person checked out by a doctor. Ibuprofen or acetaminophen can be given for pain.

Note: if the person has an identified bee allergy and carries an EpiPen, help him administer the injection immediately before symptoms appear!

Animal Bites

The best way to handle animal bites is to avoid them. Animals carry a number of diseases; even domestic animals' mouths can transfer harmful bacteria. Do your best to prevent animal bites by wearing long pants and boots in areas of heavy brush. Never approach a wild animal or unfamiliar domestic pet. Make sure tetanus shots are up to date, and get a booster if you are unsure of when your last one was given.

If someone has been bitten by an animal, thorough cleaning is required. Get bleeding under control first by applying pressure to the wound. If the bite is on the hand, remove any rings or jewelry that could become stuck in the event of swelling. Flush out the wound with soap and water. Apply antibiotic cream and cover with a sterile bandage. Keep the wound clean by changing the bandage twice a day, and reapplying antibiotic cream. Puncture wounds may be harder to clean thoroughly, and need to be watched for signs of infection.

Signs of infection such as heat, redness, and swelling require additional care. If fever or increased pain occurs, antibiotics may be needed. See a doctor if the bite area fails to heal normally.

Remove a Splinter

Splinters of any kind are irritating, and depending on what kind they are, can cause infection if left in the skin. Wash your hands thoroughly before attempting to remove the splinter. Clean a needle and a pair of tweezers with povidone-iodine or isopropyl alcohol. Clean the area around the splinter with soap and water, and wipe it down with the iodine solution.

If the splinter end is protruding, try to gently grasp it with tweezers and pull it out of the skin. A little pushing around the sides and bottom of the splinter may help raise it to the surface.

If the entire splinter is under the skin, open the skin gently using the needle. When you have exposed the splinter, use the tweezers to grasp and remove it. Clean the area again and inspect for signs of any slivers left behind. Wipe down the site with povidone-iodine.

Treat Soft Tissue Injuries

Use the **R-I-C-E** method for dealing with simple soft tissue injuries, like pulls or sprains.

Rest: Stop using the injured area for forty-eight hours.

Ice: Put an ice pack on the injured area for twenty minutes at a time, four to eight times per day.

Compression: Use an elastic bandage to provide compression for an injured ankle, knee, or wrist. This will help to reduce the swelling.

Elevation: Keep the injured area elevated above the level of the heart. Use a pillow to help elevate an injured limb.

Treat the Common Cold

There is nothing common about the common cold. In fact, the common cold isn't just one condition. There are actually hundreds of different viruses that are responsible for the symptoms we associate with a cold.

Colds are just one of those annoyances of life—no matter how hard you try, one is going to catch up with you every now and then. Prevention is all about keeping your hands clean and avoiding direct exposure to coughing or sneezing. Anything that negatively impacts your immune system will make you more susceptible to colds, so eat well, exercise and get enough sleep, avoid smoking and pollutants, and try to keep stress at manageable levels to keep your body's resistance high.

If you do succumb to a cold, expect about seven days of symptoms. There is an old saying that it takes two days to get a cold, three days to have a cold, and two days to get rid of a cold. If you have symptoms for a lot longer than that, or if your symptoms worsen just when they should be getting better, you may be dealing with more than a cold. Antibiotics are of no use in treating colds, but may be indicated if symptoms worsen and indicate the presence of a bacterial infection.

Because there is nothing you can do to get rid of a cold, the goal of treatment is to make you more comfortable. Drink plenty of fluids to loosen phlegm and flush toxins out of your system. Gargle with salt water to ease a sore throat, and use nasal saline drops to relieve stuffiness. Use a humidifier to moisten the air in your home, and try eucalyptus to ease congestion. Oh, and your mom was right, chicken soup helps.

Take pain relievers for head and body aches. If you want to take cold medicine, make sure you match your medicine to the symptoms. If in doubt, ask the pharmacist for a recommendation. Don't accidentally overdose yourself on pain remedies. Many cold medications already contain pain relievers so don't add another round of acetaminophen or ibuprofen to your regimen. An overdose of acetaminophen can damage the liver, causing a life-threatening situation.

Be cautious about giving children cold medication. Many over-the-counter medications are not safe for children under four. Try to keep young children occupied and comfortable, and see a doctor if there is a fever of more than 102°F, you see symptoms of dehydration, ear pain, or thick green mucous discharge.

Counteract Nausea

Nausea is that queasy I-feel-yucky sensation you get in the stomach. Often you feel the need to vomit, and may feel shaky, sweaty, or crampy. Nausea is not an illness in itself. It tends to be a symptom of some other type of condition. Motion sickness, pregnancy, migraines, flu, even bad smells can trigger nausea. Occasionally, nausea also signals a more serious condition like appendicitis, food poisoning, a bad reaction to medication, or even heart attack.

When nausea strikes, rest quietly, but do not lay down flat. Instead, rest in a reclining position. Drink clear fluids and nibble on bland foods like saltine crackers or plain bread. Eat very lightly, with small meals throughout the day. Cold foods also seem to be more agreeable than hot foods, and as you start to feel better you may have a desire for something salty or acidic. Avoid strong cooking smells, fatty foods, and stuffy rooms.

Ginger is considered a good home remedy for nausea. Nibbling on candied ginger or even smelling ginger can be helpful. Some people like peppermint, citrus, or chamomile teas.

Nausea should not last very long. If you continue to experience symptoms of nausea for several days, see a physician. There are medications to help control symptoms, but it is important to understand the underlying cause of extended bouts of nausea.

Stop Diarrhea

A bout of diarrhea may be no more than an annoyance, but if it goes on too long, it can quickly turn serious, particularly for children. The greatest danger with diarrhea is dehydration and loss of electrolytes. The most important thing for someone who is experiencing diarrhea to do is to keep hydrated. Provide clear broth, chamomile tea, water, or electrolyte drinks. Avoid milk, apple juice, alcohol, or caffeine products, which may make symptoms worse. A bout of diarrhea should be considered serious if it goes on longer than twenty-four hours in children and two to three days in adults.

Antidiarrheal medicines are not necessarily the way to go. First, whatever it is that caused the problem is trying to flush itself out of the system, and that's a good thing. Second, antidiarrheal medicines can cause more problems than they fix—turning that steady stream into constipation. If you need immediate relief, know what the various medicines do. Kao-pectate absorbs fluid, while Imodium slows the action of the gut. Pepto-bismol seems to work at soothing the gut and may kill some of the bad bacteria. Get advice from your doctor about the best choice for children.

When symptoms start to subside, ease back into solid food slowly. Try starchy, low fiber foods like bananas, rice, applesauce, or white toast. Avoid fatty or high fiber foods. Once the worst has passed, add some live culture yogurt to the diet to help get the good bacteria back into the gut.

Protecting Your Property

BY BOB STEARNS

There are two categories of property protection. First is the protection of your personal property: those important items that make up your life. Second, and certainly no less important since it also directly affects the protection of your personal property, is the protection of your home.

Personal Property

Some tough decisions are at times necessary here, so the first step is to prioritize. What are the most important items in the makeup of your life? Certainly among these should be such things as medications, especially prescription medicines. Always make sure you have at least a two-week supply of each medication on hand for everyone in your household because it could be a while before you will be able to reorder.

Protect critical documents from water damage with a waterproof box or heavy-duty plastic bag. These might include copies of Social Security cards, passports, driver's licenses, birth certificates, wills, and other important instruments of personal identification. Financial documents should always be included: insurance papers on the house, car, and other expensive items; financial and tax records; deeds, titles, and mortgage records. It's also a good idea to have a contact list with addresses and telephone numbers that include doctors, banks, and other important institutions, agents who handle your insurance, utility companies, and family members who should be contacted in case of an emergency.

All these lists are, I know from personal experience, a lot of work to compile, but once you do it thoroughly for the first time, only minor updates are necessary to keep it current.

If you are computer-oriented and use one to keep your personal and financial records, or in a professional capacity, consider an external hard drive to maintain an up-to-date backup of all that information. Or buy a flash memory stick, sometimes known as at humb drive. These have become very inexpensive in recent years, and have sufficient capacity to back up important documents that you might need to access immediately on a different computer, even if they don't have the capacity to store large numbers of high-resolution images. Unlike a hard drive that may not be as easy to access on a different computer (such as backing up a Macintosh and trying to read it with a PC), flash memory can instantly be read by any computer system that has a USB port.

If you use a Mac as your own computer and wish to able to read the files on a flash memory drive with a PC, first format the flash drive on a PC and then write the files to it with your Mac. If you are using a PC, all of your backup files can be read with a Mac without any additional formatting. This includes both an external hard drive and flash memory.

As for an external hard drive, that is still the best way to maintain long-term backups of data and image files too large for a thumb drive. And they too have become much cheaper in recent years. So,

An external hard drive for a computer, with a thumb-sized flash drive on top

even if you lose your entire computer and related peripherals through flooding, as long as the hard drive was stored in a safe, dry place you will be able to quickly and easily rebuild all of your information.

Finally, there are those physical items representing a personal part of your life, such as photographs and mementos. You'll likely have far too much to save all of it, so just pick those most important first and then protect as much of the rest as time and space permit.

Your House

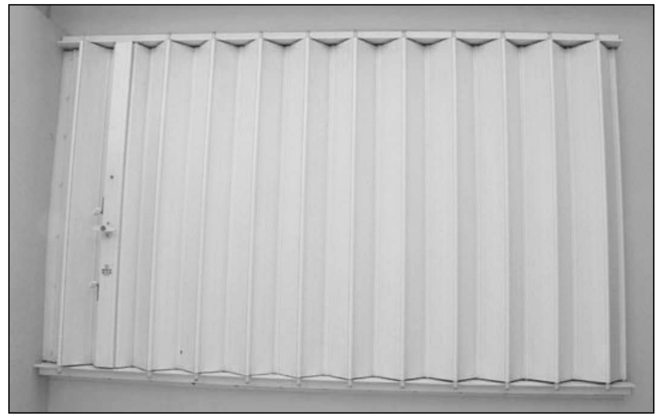
The best way to storm-proof your house is to use reliable code-approved coverings for *all* openings, especially those openings that have glass in them, such as windows and doors with glass insets. The importance of this cannot be stressed too much, because if the storm winds should get *inside* your house via a busted window or door, the chance of completely losing your roof increases significantly. And even if the roof doesn't go, the damage caused by wind and rain will be disastrous.

Do not waste your time taping windows. Tape does absolutely nothing to improve the strength of the glass, and it will not prevent that glass from shattering. But it will leave you with a sticky mess that is very difficult to remove once the storm has passed. One of the major hazards in a hurricane is wind-borne flying debris, such as tree branches, boards, and pieces of roofing, and it takes a substantial barrier to keep these outside.

In terms of cost, the biggest bang for the buck is the overlapping shutter. They are code-approved and come in aluminum, galvanized steel, and more recently clear high-impact plastic. Both aluminum

These aluminum panels provide protection for a glass-enclosed patio from the hurricane's winds.

These vertical tracks allow storm panels to be mounted horizontally. Note the top panel is mostly clear to allow light in.



Accordion type hurricane window shutters can be closed and latched in just seconds.

and clear plastic shutters are lighter than steel and somewhat more expensive, but they also will not rust and that's a major consideration if you live on or very close to the coast where they are subject to salt air. All of these shutters must be pre-installed by someone who knows how to do it correctly. The best installations include heavy-duty angle-aluminum tracks that are permanently mounted on both sides or the top and bottom of the opening. These tracks have threaded studs that allow each panel to be mounted in seconds using wing nuts. The panels can be stored wherever convenient. Because of their light weight, they are easily handled by almost any adult or large child. Just don't wait until the wind is blowing too hard to try to carry them around.

Plywood is a little cheaper than metal shutters, but to be really safe you need at least ½-inch (many experts recommend ⅝- to ¾-inch, especially for large windows). It works best if used in panels as large as possible, which makes them heavy and difficult to handle, especially in any wind. Plywood also takes more time to install, and it suffers weather damage quickly in wind, rain, and sun. In the long term, metal panels are much cheaper and easier to store. Plywood takes up a lot more space in storage, and once wet it is often ruined.

The clear plastic panels are especially attractive to those who don't like that living-in-a-cave feeling that goes with metal or plywood shutters that block out all light. These panels are made of transparent, heavy-duty plastic that meets local codes and even passes the air cannon test. They are installed in the same manner as metal shutters, and cost a little more than the metal shutters. Some homeowners use just one of the clear shutters mixed in with metal shutters to get a comfortable level of light inside the house while at the same time reducing the overall cost of window shutters.

In terms of convenience, by far the most popular hurricane shutters today are the accordion style. Permanently mounted on either side of the opening, these heavy-duty aluminum shutters can be easily pulled together by hand in seconds to create a barrier that meets the most stringent coastal county building codes. They are about three times more expensive than metal panels, but their convenience is a major asset. They also add significantly to the resale value of they house.

Another type of window protection that is gaining popularity, especially in the southern United States, is the aluminum Bahama shutter. It is hinged at the top, so that when the time comes it is simply lowered from its downward-angled position until it is flat with the side of the building,

Accordion shutters in open position

Hurricane-proof aluminum Bahama shutters can be lowered to completely cover the window.

where it is secured with clips. These cost slightly more than accordion shutters, but they are also now available with small holes or louvers to allow some light into the room while at the same time keeping direct sunlight out, and this certainly does help keep air conditioning costs down. Thus in the long run there is a definite payback, and they also contribute greatly to the value of the house at resale because of their long-term durability.

Electric roll-down shutters are by far the most expensive. They also require regular maintenance to keep them working. And if you do opt for this very convenient form of protection, keep in mind that such shutters must also be equipped with a mechanical means of lowering and raising them if the power is off.

Another newer means of protection that is growing in popularity is shatterproof window glass. Just like the windshield on your automobile, this is a very strong clear plastic film sandwiched in between a double layer of permanently installed window glass. As of 2005, this glass was code-approved by Miami-Dade County Florida, which has perhaps the toughest such standards in the country. Compared to normal window glass, it is several times more expensive. But also involved is the high cost of completely removing old windows and replacing them with these new designs, and for that reason shatterproof windows are for now mostly appearing in new construction.

High-impact window film, designed as a burglary deterrent, is also available. While it does not meet Miami-Dade windstorm codes, it does considerably improve the ability of the glass to withstand impact by flying debris. It must be permanently installed on existing glass by a qualified technician, and it does also reduce room heating (and fading of furnishings) by direct sunlight, so there is eventually significant payback.

A final note on shutters and panels: The rash of hurricanes in 2004 and 2005 brought out another type of scam artist—companies that collect hefty advances before starting installation, then never even start the work. Surprisingly, some of these have been local companies, both licensed and unlicensed. Not all of these probably started out to be scams; they simply got greedy and contracted for more work than they could do within the time specified. But the end result is still the same: Either way you don't have the shutters you paid for by the time the next hurricane season rolls around. So be careful and check out any company before you sign a contract and pay a big advance. And be very wary of any contractor from out of town.

The Roof

After windows and doors, your roof is likely the next weakest part of your house. Even if it only loses some shingles or tiles instead of the entire covering, the probability of damage skyrockets if any damage has previously occurred. Rain can enter through a partially compromised roof and flood the interior, resulting in widespread damage. Carpets and drapes are ruined; ceilings fall; walls are soaked; furniture, appliances, electronics, and clothing are a total loss. Just cleaning up the mess is expensive and a major effort, and that's before any repairs can even begin. Meanwhile mold and fungus begin to appear everywhere, creating a serious health hazard.

By far the most wind damage—resistant roof shape is the so-called hip design. The hip roof has no flat vertical surfaces at the ends, as does the very popular gabled roof. Thus every part of the roof has a slope, which allows the wind to flow over the top with far less resistance.

A flat roof also offers less wind resistance, but it has other vulnerabilities. In cold climates, heavy snow can pile up dangerously, and even in warm climates there is the problem created by standing water that eventually begins to seep through as the materials age. Pinhole leaks go unnoticed, often for years, until the underlying layers are seriously damaged and thus weakened, even though the surface layer still looks reasonably intact. The impact of flying debris in a situation like this can lead to the loss of most or all of the roof covering.

Your first step should be to make sure your existing roof is in good shape and also in compliance with local building codes in terms of materials and installation. This could even affect your insurance coverage.

The types of materials used to cover the roof decking vary considerably in cost and durability. The strongest roof is metal, now available in many shapes, finishes, and configurations that are far more attractive and up-to-date than the older flat-panel tin roof style. It is, unfortunately, the most expensive, but it will last far longer than any other material out there today, so in the long run it is probably among the least expensive.

There are many other different types of roofing materials available, from concrete shingle to barrel tile, on down to traditional asphalt shingles. The cheapest, and by far the least wind-resistant, are the so-called three-tab shingles. This is the most common shingle style used throughout the United States today. It is thin, soft, and easily lifted by a strong wind. It also has short life span. Given enough wind and time, it is easily torn completely off.

The next step up, and actually only slightly more expensive in terms of material cost, is the dimensional shingle. These shingles, when installed, have the irregular shape that looks much like a cedar shake roof. Each tile is far stiffer and more wind-resistant than the cheaper three-tab, and will last much longer.

One of the biggest costs in roofing is labor, which gets even more expensive with each passing year. And worst of all, trying to find a qualified roofing company to work on your house after a major storm has passed through your area is almost always beyond difficult. Many months will almost certainly pass before you can get any work done. And in the meantime your desperation makes you potential prey to unscrupulous fly-by-night roofers who do shoddy work that won't pass inspection and are likely not even licensed in your area.

There are two steps you can take beforehand to greatly reduce the potential for post-storm agony. First, if your roof is more than 10 years old, get it professionally inspected at least every other year.

Blue and silver plastic tarps used to cover a hurricane-damaged roof

Annually is even better, especially for flat roofs. It may need repair work to survive a strong storm. If the roof has weak spots, all it may take is one strike by a piece of flying debris to cause enough damage for hurricane force winds to get a toehold. Once weakened roofing material starts to come up, the odds are the rest will go too, or at least enough of it to allow a serious amount of rainwater to get inside the house.

If it needs replacing, get a contract for the job right away. That way, even if a hurricane comes through and does serious damage to the roof before it can be replaced, you will at least be among the first in line for repairs or replacement as soon as the severe weather is over. Otherwise you will be forced to make endless telephone calls to all of the roofing companies in your area (who are also getting an endless number of calls from everyone else with a roof problem), and at best you will be at the end of a long line of others with the same problems. Expect a very long wait before help arrives, which could take up to a year or more.

If you live in an area that is particularly hurricane-prone, the logical second step is to buy and store a couple of large plastic tarps, big enough to cover roof damage immediately after the storm has passed. The blue plastic variety is light and compact for easier handling, and not expensive. And once installed it is good for up to a year before it deteriorates too much to provide protection. Trying to find tarps after a hurricane is difficult or even impossible, so get them before the season starts.

Installing these tarps as an emergency roof cover isn't difficult. On sloping roofs the tarp must be large enough to start two feet or so on the opposite side of the ridgeline and extend far enough down the slope to completely cover the damaged area. If the roof is flat, it must be large enough to cover the entire roof and hang down over the edges by a foot or so. Flat roofs are difficult to cover successfully, by the way.

If it is necessary to overlap two or more tarps to get sufficient coverage, make sure the overlap extends for several feet. This works pretty well on a sloped roof. The only way to overlap on a flat roof is by using a piece of lumber at least two inches thick underneath the area where both tarps overlap by at least two feet to create a tent effect. Sometimes this works well enough to significantly reduce water damage inside the house. It's worth a try and definitely better than nothing.

In order to keep these tarps in place, it is necessary to nail strips of wood along all exposed edges; otherwise, even a relatively low-velocity wind will eventually tear them loose or cause rips that leak. Remember, the tarps may have to stay up there for many months.

Wind turbines like this one should be removed and the opening capped before the storm arrives.

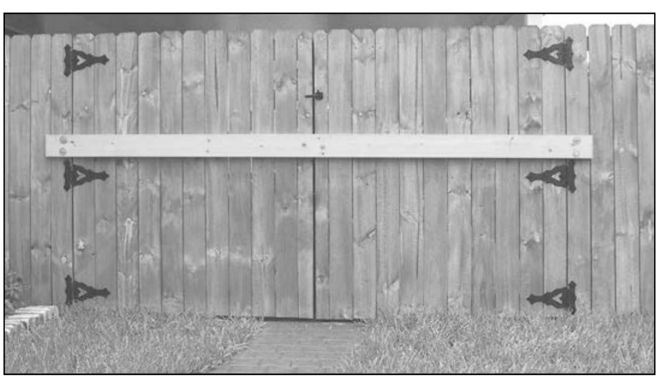
Ultimately, tarps are only an emergency measure and do not always work as well as we'd like. The only surefire protection is to keep the covering on your roof in tip-top shape at all times, and in the long run that is also the most cost-effective way (by a huge margin) to stay protected.

Rooftop wind turbines are not nearly as popular today as they were 20 to 30 years ago, mostly because they have been demonstrated to have little effect on attic temperatures. But there are still plenty of them around and they do significantly increase the vulnerability of the roof to hurricane wind and water damage. There is always a high probability they will blow off during a strong storm, leaving a large gaping hole in the roof where water can pour in. If you have any wind turbines on your roof, completely remove them and cover the opening long before the hurricane is predicted to reach your area. Such coverings are available at the same building supply stores that sell turbines. Don't wait until the last minute to go looking for them; by then there may be none left in your area.

Fencing

Wooden fences are very vulnerable to hurricane-force winds. The stockade type (boards fitted tightly together) and the board-on-board variety have virtually no openings to allow the wind to pass through, making them the most susceptible to wind damage. One way to reduce the wind loading is to remove every other board and stack them where the wind cannot get to them, if you have time. Otherwise, at least try to brace any gates as much as possible. I have a large double gate in my fence, which I brace with a 12-foot 2x10 on the outside, plus a leaning brace on the inside made of heavy-wall 2-inch pipe that's anchored at the bottom on the concrete pad with a large lag bolt, and also at the top with another bolt. I lost part of my fence in Hurricane Wilma (2005), but the most expensive part—the gate—survived undamaged.

A suitable length of heavy-wall pipe is anchored to the gate at one end and the concrete pad at the other. This considerably increases the wind resistance of the gate.



A 2x8 is used as a brace to strengthen this double gate.

Trees

Each year a great many houses that would have otherwise survived a severe hurricane are severely damaged or destroyed by trees falling on them. Almost all of this is preventable by properly trimming those trees that are close enough to the house to cause damage. This should be done by a qualified arborist so that the canopy is properly thinned and shaped to reduce wind loading. They will look a lot better, too. I have mine done every other year in late winter or early spring, and I've convinced my neighbors to do the same, so that we all get a "bulk price" for the job.

If you have trees planted so close to the house that they can bend far enough make contact with the edge of the roof during hurricane-force winds, they should be removed completely or at least moved farther from the house. Constant banging against the edge of the roof will eventually loosen shingles or tiles, and once that starts, the wind gets a toehold and you stand a good chance of losing most, if not all, of its waterproof covering—a certain recipe for house flooding by heavy rains.

Security and Defense

BY LEN MCDOUGALL

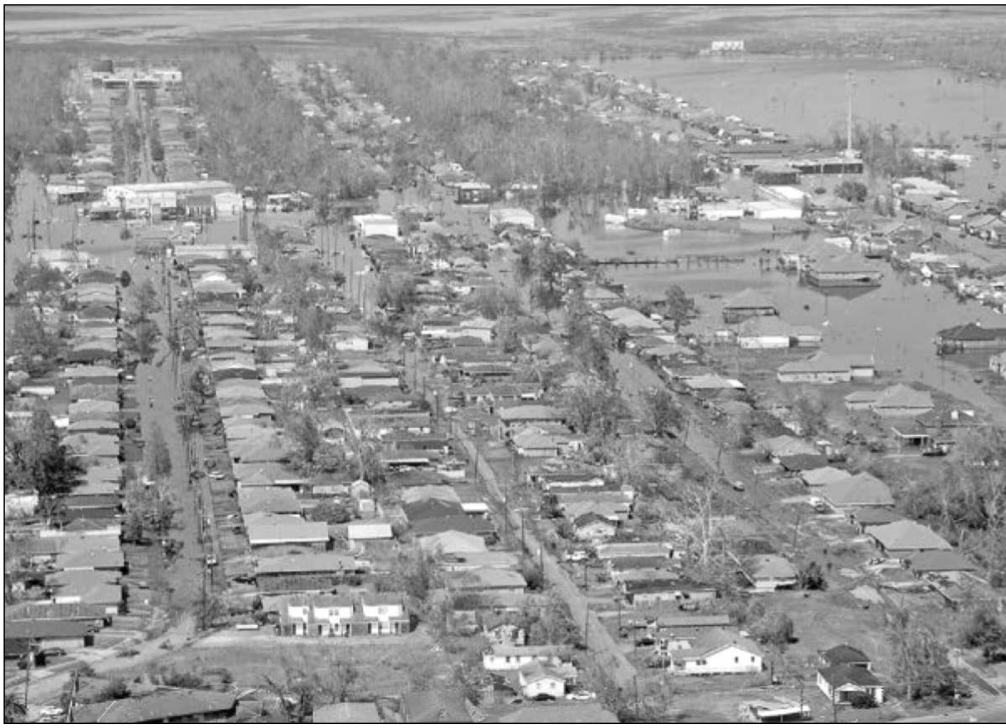
When the grand old city of New Orleans was hammered by Hurricane Katrina, even the most ardent believer in doomsday had to be surprised at how swiftly that nexus of cultures disintegrated into lawless anarchy. Within a week the remains of the city saw a scourge of roving predators and looters, and average citizens who had not heeded the official order to evacuate found themselves fearing to be on the street. One of the most haunting sights was an Associated Press photo showing a pair of toddlers playing innocently on a sidewalk in the shadow of a decaying corpse in a wheelchair.

It is a fact that hard times make hard people, both mentally and physically. And while adversity brings out the best in some people, it makes others purely mean. If you are reading this book, it's a fair bet that you wouldn't want to be one of those who can survive only by preying on others. This author's recommendation is that you the survivor should avoid making contact with the marauders who inevitably coalesce into gangs after any disaster that causes an interruption of goods and services. Combat is the antithesis of survival, and you gain nothing by engaging hoodlums in any kind of conflict.

Even so, there might come a time when it becomes necessary to defend one's self or loved ones, and should that frightening situation come to pass it pays to be sure that you'll have the upper hand. That doesn't necessarily imply the use of lethal force, just an ability to swiftly and surely blast assailants with enough physical and mental anguish to derail an attack while you escape.

Non-Lethal Defense

Real-life hand-to-hand fighting doesn't resemble the ballet-like choreography seen in martial arts



movies. It is dirty, painful, and exhausting, and frequently leaves the winner seriously injured. One Shotokan instructor advised, “run away. If you can’t run away, hurt your assailants until you can run away.”

To summarize Master Bruce Lee’s secret, practice with kicks and punches trains the body to accurately deliver blows, while the key to fighting an actual opponent lies in not having a plan, but rather anticipating and responding to the opponent’s actions. Beyond that, avoid getting hit, and hit as hard as you can against sensitive areas—like the groin the short ribs along the bottom of the ribcage, the collar bone, the eyes, the knees... Wherever it would hurt to be hit on your own body is a target on your opponent’s body.

Chemical Defenses

Aerosol bad-guy repellents have been on the market for a long time, and that fact alone is proof of their value to average citizens. One of the latest and most improved versions of a pepper-spray blaster is the Tiger Light (http://www.tigerlight.net) which claims a 96% effectiveness at stopping assailants in their tracks. At night, the Tiger Light masquerades as a bright LED flashlight, but should someone bent on evil spring from hiding, a flip of the wrist turns the unit into a weapon that can envelope a half-dozen assailants in a dense cloud of burning, choking capsicum spray before they can close their eyes or hold their breaths. The unit’s heavy metal body, held against the palm by a padded strap, is a bludgeoning weapon by itself.

Meaner versions of pepper gas that once caused a media uproar are the aerosol oven cleaners that have been referred to as “poor-girl’s mace.” The caustic lyes contained in oven cleaners burn skin on contact, causing ulcerated sores unless washed off immediately. They can also cause permanent damage to the eyes.

Striking Weapons

From China to Galilee to the Sherwood Forest of Little John and Robin Hood, staves and walking sticks have served as effective weapons for defense and offense. The end of a 5-foot walking stick being swung with intent is traveling about 90 miles per hour—the speed of a Major League fastball—and one blow from it can break bones, even kill.

A more effective version of the staff is the lance, a long, stout, sharply-pointed spear—preferably with a dagger-type spear point for stabbing and slashing. Not meant to be thrown, a lance extends the distance to which its owner can inflict wounds, and with a spearhead increases the severity of those wounds. A preferred weapon of the Spartans, the power of a long spear is still demonstrated in the way African lions will actually withdraw at the approach of Masai tribesmen carrying their traditional long spears and shields.

The *ko-budo-nunchaku* is an ancient Japanese rice-threshing tool that proved dangerous enough as a weapon to be quickly outlawed throughout the United States in the 1970s. Known colloquially—even on television—as “Nunchucks,” the *nunchaku* is essentially just a pair of equal-size wooden billy-clubs, each about 18 inches long, that are joined securely to one another at one end with about 6 inches of tough rope or chain. When swung from one end so that the free end strikes a target, the

impact force transferred to the target is magnified beyond what a single club would generate; and when the blow is delivered using heavy-weight "combat sticks," a single strike is often enough to render an assailant harmless with perhaps multiple broken bones and internal injuries. In the hands of an expert, the nunchaku's flexible design is deadly fast, able to change direction fluidly, to strike with lethal energy in one place, then again in another so fast that it can't be seen. But the beauty of this weapon is that it can be used effectively by someone with no training at all.

Edged Weapons

When I was a boy, and in a few years throughout my adulthood, my family and I raised pigs. In autumn I'd herd a selected 260-pound hog into the kill-chute, where I'd shoot it through the top center of its skull with a .45 ACP. The pig always collapsed instantly, but then it needed to be "bled" to drain as much blood as possible from its tissues before its heart stopped beating, otherwise there would be objectionable blood clots throughout the meat. And this had to be done within approximately 5 seconds of the gunshot, before the pig went into the mind-less but violent after-death kicking convulsions that are a trademark of hog-killing. I'd safety the Colt and lay it down, draw a long, narrow-blade knife, drop to one knee and drive it almost to the hilt into the carcass's neck, just above the sternum. Then I'd draw the inserted blade's cutting edge across the neck, making an incision 6 inches deep by 10 inches long, and cutting through the top of the pig's heart. Some farmers skipped the shooting step altogether, "sticking" 200-pound hogs with a quick slash that left them walking around for the next 2 or 3 minutes before falling over dead from blood loss.

As the above is meant to illustrate, knives and swords are fearsome close-quarters weapons, capable of inflicting a mortal wound with every strike. What this pig-sticking story did not describe is how awful a weapon a knife can be. When my shaving-sharp blade's tip drew across a hog's heart, it severed the tissue almost effortlessly, opening a huge, fatal gash that allowed all of the pressurized blood in the animal's venous and arterial systems to literally spurt outward in a great red gush that washed over my hand up to the wrist. A rinse bucket close by enabled me to quickly wash off my hand and knife because blood can make a knife handle dangerously slippery—something to be aware of in selecting a personal-defense knife. Police officers are instructed to draw their sidearms at the sight of a knife, and to shoot a knife-wielding suspect who closes to within 10 feet of them, because within its reach, a knife can inflict more severe wounds than a pistol.

Tactical Folding Knives

In today's world, the dirk has been down-sized to become the "tactical" folder, a locking-blade folding knife that usually clips to the inside of a hip pocket, where it is secure but easy to draw. Tactical folders typically have blades of at least 3 inches, with sharply pointed tips. They are designed for fast deployment and most now have legal "opening-assist" mechanisms that push the blade into battery as soon as the user pushes against its opening stud, hole, or lever. On most days these close-quarters

combat folders are relegated to opening mail, but they can be a formidable defensive weapon when danger steps from the shadows.

A tactical folder is designed to effectively slash and slab. Based on fatalities due to knife wounds stabbing is the major cause of death, largely because those wounds penetrate deeply enough to pierce vital organs. The point of a tactical folder is pointed, with a false edge opposite the cutting edge at the tip of its blade to enable easier penetration through heavy clothing—even Kevlar vests. Some have an inch or 2 of serrations at the beginning of their cutting edges adjacent to the "choil" (the unsharpened portion of blade between where the cutting edge begins and the knife's handle). The serrations help when cutting through thick rubberized fabrics (tires), thick plastics and wet hemp rope, but also shred their way through heavy ballistic nylon and most fabrics.

A tactical folder needs to be rugged, strongly made and assembled to open, handle and close smoothly enough for its operation to become a habit. It must have a secure lock to keep the blade from closing over its user's fingers. It must have an ergonomically-contoured handle that provides a sure grip in all hand positions, even when slippery, and won't allow a user's hand to slide onto the blade. It should also be unobtrusive in carry mode, comfortable for its owner, and not strikingly colored, or positioned to attract attention.

Fixed-Blade Fighting Knives

Even though he has designed one or two folding combat knives, martial arts master James Williams (www.bugei.com), himself one of the most dangerous close-quarter fighters in the world, openly admits that a fixed-blade knife is always a preferred combat knife. The strength of a one-piece blade with a full-length hilt (handle) incorporated into its design is much greater than with a two-part knife, and it's ready for action as soon as it is drawn. A good combat fixed-blade knife can be used to pry with from any direction, and except for the very tip of sharply-pointed designs, it should be unbreakable under maximum hand pressure.

When electronics warfare expert Lt. Colonel Iceal Hambleton was shot down by a missile over Vietnam in 1972, he survived for a week while evading enemy patrols who badly wanted the knowledge he possessed, all the while making his way to a safe extraction point. When Hambleton was attacked by a machete-wielding farmer while raiding the man's hooch for food, the 53-year-old Hambleton

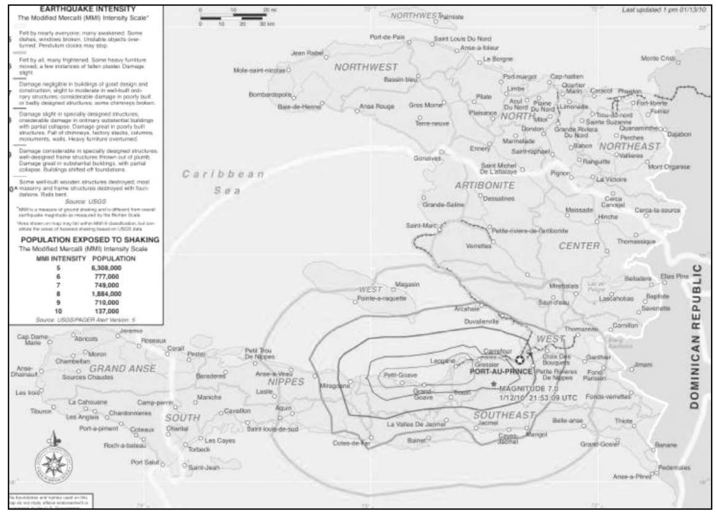
overpowered his assailant and killed him with the 5-inch blade of his issue USAF Survival Knife

Most knife-fighting experts consider 5 inches to be on the short side for fixed-blade combat knife, even though most admit that 4 inches is sufficient to quickly end a human's life. Larger knives with longer blades are most preferred, because the object is always to get the pointy end into the other guy before he does the same to you and longer reach is better. The real deciding factor is how comfortable a person is with his or her knife; if a knife feels comfortable in your hand, able to be used, manipulated and switched between grip positions without fear of cutting yourself, it's probably a good choice for you. A larger knife is no advantage to a person who doesn't wield it easily.

Dirks

Aside from ceremony and open warfare, full-size swords with blades the length of a person's leg were not common everyday wear; they were just too cumbersome for normal activities—like sitting in a chair—and long blades were impeded and entangled in the confines of most buildings. But going about unarmed is unwise during lawless times, and that problem was nicely remedied by the dirk, a heavy shortsword that can slash through bone or stab through a ribcage with equal ease, and do either in the blink of an eye.

Combine those properties with modern manufacturing technologies and today's greatly homogenized and precisely hardened alloys, and you have the finest fighting blades in the history of mankind, available at prices nearly anyone can afford. Even in untrained hands, a dirk can sever bones and tendons with a single clumsy blow, or it open wide an abdominal cavity; in expert hands it can cleanly decapitate an enemy. In normal times, the carry of a dirk, even openly, may be considered a felony, but that in itself is a good indication of just



how effective this shortsword can be in a no-holds-barred street fight.

Escape And Evasion

Whether you should relocate before or after a disaster, or hunker down and wait it out can depend on a number of variables. Most authorities agree that heavily populated areas will not be good places to stay after a disaster like the recent Haitian earthquake that left unidentified corpses piled like cordwood on the sidewalks of Port-au-Prince. The world recoiled at the sight of nameless thousands being plowed into mass graves by bulldozers, but the health hazards posed by so many decaying bodies made them an immediate threat to those who survived.

In urban areas there may be little point in attempting to drive out of a city because, as in the movies, all avenues are likely to be blocked by the cars of people who have already tried it. A motorcycle or scooter might get through, but probably the best wheeled escape vehicle is a bicycle. Bicycles today can be tricked out to carry a tent, sleeping bag, and other equipment strapped to their frames, but a bug-out bike is probably best kept as light as possible for carrying past obstacles, while survival gear is carried in a small pack on the rider's back.

Bugging-out

If you must relocate to escape the effects of falling volcanic ash, wind-borne radiation, or to find a more hospitable place to live, use information from the preceding chapters to outfit yourself as functionally as possible before embarking. Emphasis should be placed on water, water purification, and water carriers, with drinking needs estimated at one to two gallons per adult per day, depending on exertion levels. Food needs should be assessed using the FDA's 2,000-calories-per-day recommended daily diet as a minimum, and foods carried in your traveling backpack should be dry and lightweight.

Survival gear for an on-foot egress from inhospitable areas is mostly the same as it would be for navigating any wilderness: a map of the country being traveled, a good compass (satellites may be out of commission), warm bedroll, lightweight bivy shelter, first-aid, food, water, and the means to obtain more food and water. Canadian bush pilots carry backpacks loaded with back-country provisions because if reaching safety after surviving a crash entails walking long distances—and in Canada it probably will—a backpack loaded with no more than a third of its bearer's weight is the best method of hauling survival gear.

Bugging-out of a devastated area after a disaster is unlike crossing a less hostile wilderness, because a post-disaster scenario will entail keeping your head down, moving furtively, seeing other survivors before they see you, and avoiding contact until you can positively identify whether or not those others are friends or foes. You believe you have something to live for and a future worth rebuilding; they may not share your optimism.

There is little good about the process of survival, which by definition means that a person is being subject to conditions that have a potential to be fatal unless something is done to at least moderate the dangers they pose. Anticipate that your own disaster-survival experience will be heartbreaking, with injured people you cannot mend, sickly people you cannot heal, and thirsty people you might not be able to provide with water without taking it from your own family. There is sometimes a fine line between what has been termed "lifeboat survival" and the noble traits that constitute humanity. I believe there are no right or wrong answers for such dilemmas: there are only survivors and otherwise, and survivors must live with the choices they make.

The Bug-out Bag

The surest means of escaping a post-disaster city will usually be on foot, which means that your home survival system will include what has recently

become known as a bug-out bag. Once called a "grab-and-go" backpack, the bug-out bag is a survival kit that can be snatched up and carried away at a moment's notice.

In real life, possible needs for a grab-and-go survival kit are generally less than adventurous, but no less critical. A family that awakens to find its house on fire, or flooded, or about to be flattened by a powerful twister may have time to grab one item before fleeing into a chill night. That one thing should be a large, easily carried survival kit packed with as many potentially lifesaving tools as it can hold.

Building a Bug-out Bag

No survival kit can provide for every contingency in every environment, but some items are generic to all conditions. Most fundamental are water, shelter, warmth, and food, either in the form of the provisions themselves or tools for obtaining those necessities. Which of those needs is most important depends entirely on the situation—in the desert, water may be critical; in a northern Ontario winter, it will be warmth—so use as much foresight as possible to predict the conditions your bug-out kit will be called upon to address.

Begin with the container into which your tools will be placed. This grab-and-go survival kit needs to be easily transportable, preferably wearable—that pretty much narrows the options to a backpack. The all-purpose survival backpack has a carry capacity of at least 2,000 inches, a full, padded suspension that includes waist belt and sternum strap to help make the loaded pack a part of your body, and as many secure pockets and pouches as you can find, to accommodate segregating gear into individual kits that can be easily found in the dark. A good day-and-a-half backpack, as this size is generally known, can be had for under $100, fully outfitted with the necessities of survival in all environments for around $400, and weighs in at an all-day carry weight of under 20 pounds.

Personal Survival Kits

The grab-and-go backpack shouldn't be the only layer of protection a person has against unpleasant surprises. A favorite jacket can be transformed into a rudimentary survival kit, and many outdoor knives made today include cargo pouches on their sheaths. A parka shell in hurricane country can easily carry a working-size folding knife, a butane lighter and tinder in a ziplock bag, compass and map, AA flashlight, cord, granola bars ... and still have room to spare. Think of your disaster preparedness system in terms of levels: A belt knife kit will keep you breathing under almost any circumstances; an outfitted parka shell kit allows a few more comforts; the bug-out bag has all you'll need to weather a disaster in relative comfort.

The following lists include some of the best survival tools on the market today. Products mentioned by name should be viewed as examples of acceptable quality only, because some manufacturers discontinue models as fast as they introduce new ones. None of the survival kit contents listed here are absolute, and they should be added to or subtracted from as needed to match different situations. Some items are duplicated in larger and more capable kits, because, as NASA already knows, it pays to have some redundancy in an environment where small problems can have large consequences.

Belt Knife Survival Kit:

- Knife, strong, sharp: Schrade EXTREME BT01, Ontario Knife RAT-7
- Sheath: Secure snap-down retainer, thigh tie-down, large cargo pouch
- Compass, pocket: Silva Type 7, Brunton 11HNL
- Fire Starter: Ultimate Survival Technologies Strike Force or Sparkie

Pocket Survival Kit:

- Compass: Coleman 3-in-1 compass/whistle/match case, Brunton 11HNL with whistle
- Map: Trail or topographical, preferably laminated with clear contact paper
- Folding Knife, pocket-clip, open-assist: Columbia River Natural, Schrade
- Fire Starter: Butane lighter, UST Sparkie, waxed cotton-string "fire wicks"
- First-Aid Kit (in ziplock bag): Roll of 1-inch Safety Tape, tube of triple antibiotic ointment
- Space Blanket or disposable painter's drop cloth

Survival Parka Shell (Includes All Of The Above):

- Parka Shell, hooded, many pockets, waterproof, ventilated: Columbia Titanium
- Orienteering Compass: Brunton SightMaster, Brunton 8099 Eclipse
- Folding Multi-Function Tool: Gerber Multi-Tool, Buck BuckTool, Leatherman
- Fire Starter: Butane Lighter, Strike Force flint-and-steel, tinder
- Cord: At least 15 feet of military-issue parachute cord
- Gloves, leather shell: Wells Lamont
- Fishing Kit (in pill bottle): Hooks, sinkers, at least 20 feet of strong fishing line
- Snacks: High-carb, 1,000 calories, for fending off hypoglycemia
- Water Bladder: One-liter, MSR Platypus
- Water Purification Tabs: Katadyn MicroPur MP-1
- Flashlight: Gerber OMNIVORE, Coleman AXIS AAA LED headlamp
- Signal Mirror, lightweight, with sighting hole: UST Star Flash

Survival Day Pack, All-Day Carry (Includes All of The Above):

- Daypack, many pockets, padded, adjustable harness: Exponent Otero, Kelty Bison (camouflage)
- Compass: Brunton 8099, Brunton SightMaster
- Map: Detailed area map, topographical preferred
- GPS (optional, secondary to compass)
- Heavy Machete (strapped onto pack): Ontario Knife SP-8, Kershaw OUTCAST
- Shelter, bivy-type, compact: Exponent Kraz X1, Integral Designs Mega Sola Water Filter: Katadyn Vario, MSR Waterworks II
- Water Bladder: MSR Platypus 2-liter
- Sleeping Bag, ultralight mummy, synthetic-fill, rated about 20 degrees: Exponent Canyon
- Sleeping Pad: Therm-A-Rest Pro-Lite 3 (inflatable), Therm-A-Rest Z-Lite (closed-cell foam)
- First-Aid Kit: Packed in its own kit, comprehensive—dysentery, pain, bleeding allergies, sprains . . .
- Fire Starters: Butane lighter, matches, waxed-cotton "fire wicks," military Trioxane tabs
- Cord: Gl 550-pound parachute cord, 50 feet or more

- Cord: Nylon packaging string, 50-yard spool
- Socks, synthetic-knit, padded: SmartWool, Wigwam
- Radio Receiver, AM-FM-SW: Kaito KA1102
- Cook Set, lightweight, designed for boiling: European military surplus cook pot set, MSR Titanium Mini-Cookset
- Cup, metal, about one pint: Coleman Peak 1, MSR Titan titanium cup
- Spoon, teaspoon with metal handle bent backward into a hook, for snagging hot handles from fire
- Food, nonperishable, 6,000 calories (three days) per person: Granola bars, rice, raisins, chocolate. . .
- Three-tined Spearhead: carried with points safely embedded in foam etc.
- Slingshot, folding, latex-tubing, wrist brace: Wham-0 Wrist Rocket

Optional Items For The Survival Kit

How important an item might be to survival depends on conditions. If you suffer a dizzy spell from hypoglycemia, getting blood sugars back to operating levels is imperative. In a cold rain, making fire may save your life. In desert, water becomes critical. Since you can't predict what item might have lifesaving value, it pays to prepare for as many contingencies as you can. Presuming a person knows roughly where on earth he or she will be should a situation come up that requires survival techniques, that person can prepare to

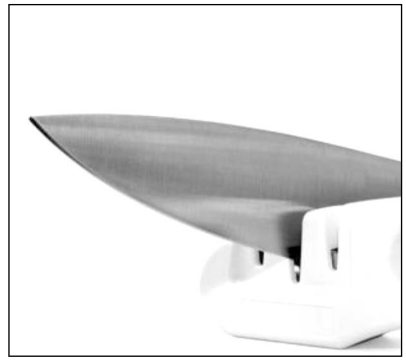
live indefinitely with whatever conditions might be found there.

Sharpening Knives And Edged Tools

My grandpa used to say that he knew only six people who could properly sharpen a knife, and that he'd taught the skill to three of them. He probably wasn't exaggerating by much; the science of making knives sharp hasn't been part of the average person's life since a fixed-blade sheath knife was part of almost every American's daily work attire. A rugged knife is the original multi-tool, enabling its owner to cut chop, whittle, skin, butcher, drill, and it could be a prudent sidearm in the days when there was more wilderness than people. As the need to use a knife tapered off, so did the need—and then the ability—to sharpen them back to working condition.

Honing a knife—or lawnmower blade, axe or scythe—to shaving sharpness demands first knowing why a sharp edge is sharp. The key to sharpness lies in bringing both sides of a blade to meet at a very pointed and highly polished apex. A dull blade is one that has had that very pointed joining of its two sides worn off, which basically translates to driving a broader surface area into a material being cut, and requiring more downward force to sever a given material. Restoring, then polishing an edge to its original (or sharper) bevel is accomplished by

The original knife and tool sharpener is a dense, abrasive sandstone, and it served people who relied on their blades well into the twentieth century.



This inexpensive Chef's Choice manual sharpener has three blade guides with pre-angled diamond hones at their bottoms to sharpen and smooth the edge of virtually any knife to skinning sharpness.

removing sub-microns of blade material until the sharpest and most-pointed meeting of the two sides has been achieved.

The traditional re-sharpener is a stone, coarse enough to abrade a few molecules at a time from a blade when the two are rubbed against one another. If you can keep the angle between knife and stone constant while smoothly grinding the sides of a blade to terminate in a keen point from handle to blade tip, you can achieve an edge that requires care in handling. By polishing that even bevel against a harder honing surface—like the traditional Arkansas oilstone—to make it mirror-smooth, even an axe can be honed to hair-shaving sharpness.

I believe you can forget all you might have heard about keeping a blade at a specific angle to a honing surface. Most American and European blades have cutting edges ground to 20 degrees, while Asian knives are historically angled to 15 degrees, but that really doesn't matter, because gauging precise angles by eye alone is virtually impossible. The secret of an expert honesman is a learned ability to "feel" the edge as it slides against a honing surface. If it slips, catches, or slides jerkily as you grind the blade against it, then there is not a broad enough or flat enough surface against the stone to create an even bevel that drags smoothly. A skilled knife sharpener can restore his or her knife's cutting edge in the dark, just by feeling how smoothly the blade drags. Angle doesn't matter—old skinners sometimes increase the angle of their knives' edges to create a steeper point where the sides meet, which increases the amount of wear needed to make it dull (but makes it more prone to chipping when used for chopping).

There is no wrong way to create the sharp bevel of a keen edge. The classic honing motion is to begin at the choil, where the sharpened edge ends, just ahead of the handle. Move the blade in a circular motion that grinds it against the honing surface at a narrow angle, as though you were trying to slice a very thin layer from the hone. As you rotate the blade in even-size circles, draw the knife back from handle to tip to grind an even cutting edge with a needle-sharp point. As the circling blade rounds the "belly" that leads to its point, raise the handle to increase the honing angle as cutting angle changes

It's usually easier to sharpen a knife by grinding its edge against a hone, but some blade metals like D2 tool steel and beta-titanium tend to roll off to one side when they meet at a thin point. These metals get sharpest by honing with the edge, with most friction applied away from the cutting edge. All edges can be sharpened by honing with their cutting edges, but they must first have an evenly-beveled cutting edge.

To save time when sharpening a very dull knife, I use a coarse aluminum-oxide "stone" (it's actually man-made), available at most hardware and department stores for around $10. A Larger stone, 3 inches by at least 6 inches, provides a safer and more efficient grinding surface. I wet the stone with water (never put any type of oil on an aluminum-oxide hone or it may be ruined forever, its porous surface clogged by non-abrasive varnish), and then grind a blade hard against it in a back-and-forth motion, toward the edge then away from it. This motion permit's a forceful push against the hone that maximizes the amount of metal ground off, and quickly "sets" its edge. I repeat the back-and-forth motion up and down both sides of the blade until the beveled cutting edges are even on either side and the blade feels sharp, but rough. It doesn't matter if the bevels are a little rough, so long as they are even, because a finer hone can polish a rough edge better than it can create a new one.

In actual trials, Smith's Edge Pro manual knife sharpener enabled men and women who had no skill with conventional honing stones to apply hair-shaving edges to a broad range of blade styles.

An improvement on a time-honored method, Smith's Diamond Tri-Hone Sharpening system can put surgical edges on knives and scissors for many years.

A keen edge drags against a thumb dragged crosswise over it—never run your thumb lengthwise with the edge, because a sharp blade literally splits skin with only slight pressure. Finally, you can "strop" a good edge to hair-shaving sharpness by polishing it with the edge against a wide leather belt or strap to stand it up and create a surgically-sharp blade.

Sharpening Tools

Many attempts have been made to create a sharpening tool that enables anyone to put a shaving edge on a knife, but only recently have a few succeeded at making almost everyone nearly as good at sharpening knives as the best honemasters. The latest generation manual sharpeners are typically pull-through designs with two V-shaped notches comprised of two intersecting blades that form each notch; the carbide side mills nice, even bevels onto the dullest straight-edge knives, while the ceramic side does a bang-up job of polishing straight- or serrated-blade knives to a keenness that might raise your eyebrows.

Using the latest sharpeners is endearingly simple: Place the blade being sharpened in the appropriate notch, starting at the choil, and draw the knife backward smoothly toward its tip. Light downward pressure is best, especially in the aggressive carbide notch; if the blade chatters and catches as you pull it through, ease up on the pressure being applied. Try to keep the blade at right angles to the sharpener to ensure even cutting on either side, and raise the handle upward as you round the blade's belly, toward the point. Notch blades are ambidextrous to accommodate left- or right-handed users, and blades are reversible to extend their lives. Blades can also be replaced when (if) they wear out. Replacement carbide or ceramic blades are available, but the originals are likely to last several years with regular use.

If you prefer the control and versatility of traditional honing stones, it's hard to go wrong with a simple round (knife) or rectangular (axe) aluminum-oxide honing stone double-sided with coarse and medium grits, and priced at about $10 to start. About twice as expensive are crystalline diamond-impregnated hones. Some hones are rods, which can sharpen strap-cutter and gut hooks, some are flat like conventional honing stones; all are touted to last forever.

Smith's Diamond Tri-Hone Sharpening System is an example of how sharpening tools have improved in recent decades. The Tri-Hone's 2.5"x8" Coarse (325-grit) and Medium (750-grit) diamond stones, and a Fine (800-1,000-grit) Arkansas oilstone mounted onto a rotating triangular spindle make it simple to take a knife from completely dull to razor-sharp with one convenient tool. An advantage of the Tri-Hone design over conventional honing stones or ceramic-rod sharpeners is that it offers superior stability and angle control—critical for tough, hard-to-sharpen steels like ATS-34 or D2. The Tri-Hone's stand holds whichever stone is used 5 inches above the surface it rests on, the ideal height for a kitchen table or counter top. Rubber feet help to keep the unit from sliding as blade is worked against stone. TDiamond Tri-Hone is priced at $99.99.

For field sharpening there are now pocket-size sharpening tools that are ideal for anglers and hunters who might dull their knives in places where the bulk and weight of conventional sharpeners is inconvenient or prohibitive. Two of the easiest to use and most effective go-everywhere sharpeners are Lansky's Quick-Fix and Smith's Pocket Pal. The Quick-Fix uses two notched guides with a coarse carbide bevel-cutter on one side of a large easy-to-grip tab, and ceramic polishing blades in the other notch. The Quick-Fix retails for $6.

Smith's Pocket Pal uses coarse carbide and 600-grit ceramic blades set into V-shaped notches to quickly repair dulled or damaged cutting edges, then polish them to deer-skinning sharpness. The blades are reversible and replaceable, but it's not likely

An ability to negotiate shallow, twisting waterways, submerged logs, and rock-strewn rapids turns the craft into an angler's dream. Isolated holes that are beyond the reach of conventional fishing boats are easily within a kayaker's grasp, as are the unmolested lunker-size fish that inhabit them. Waterfowl hunters can also benefit, slipping silently into marshy shallows where ducks and geese wouldn't expect them, then retrieving downed birds without the assistance of a dog.

Unlike a sports car, a typical kayak in the 12- to 14-foot lengths preferred by backcountry paddlers

most of us will ever need to replace them. Adding to the sharpener's usefulness is a 2-inch long 400-grit tapered rod, set jackknife-fashion into the opposite side, for sharpening straight or serrated edges. The Pocket Pal retails for $10.

The Ultimate Survival Boat

For centuries the best-known boat for getting away from it all was a canoe. Conventional V-bottom rowboats draw too much water to get over half-submerged logs and mud flats. A canoe, the pickup truck of frontier trappers, is top-heavy and unstable, especially when lightly loaded, and real skill is needed to keep it upright in whitewater rapids. A flat-bottom riverboat, or John boat, is stable and it has a shallow draft, but its handling is sluggish, and so is its speed over water.

Then along came the plastic, then fiberglass, and now carbon-fiber kayaks, and exploring the back-country by water became dramatically easier. If the canoe is a pickup truck, a kayak is a mid-engine sports car. Easily the fastest muscle-powered boat, a kayak can cover more miles in less time, which can be important to part-time adventurers who have to be back to work by Monday.

These qualities make the kayak a fun high-performance boat, but it has a practical side as well.

A kayak is also the most maneuverable personal watercraft. Unlike a canoe, a kayak paddler is seated amidships, with legs extended and most of his weight actually below the waterline. This gives the boat a low center of gravity, like a racing car, which provides excellent stability, and causes the kayak to pivot from its center, rather the turning from the stern. Covered decks fore and aft keep water out of the boat, and watertight integrity can be made complete with an optional "spray skirt" that seals the cockpit from its rim to the paddler's waist. Fully outfitted, a kayak is the only boat that can roll 360 degrees (an "Eskimo roll"). Olympic and whitewater kayakers exploit their boats' handling performance to the max, tipping them literally onto their sides to hang turns as tightly as possible, much the same as a road motorcycle.

has plenty of trunk space. Most will carry their operator plus at least 100 pounds of gear stashed in watertight deck storage hatches and behind the seat. Backpackers who are used to counting ounces and sacrificing comfort to keep gear weight down will rejoice at the cornucopia of luxuries that can be fitted into a kayak. Kayakers can carry extra camp stove fuel, a radio, night-vision and camera equipment, and much more that is denied to their sweaty weight-conscious terrestrial counterparts.

Or you may opt to outfit your kayak as a hardcore survival system, with modern lightweight high-efficiency camping gear that turns it into a "bug-out" boat. The ease with which a kayak's double-blade paddle causes it to slice through water means you don't have to be an athlete to cover 15 miles in a day even upstream and fully laden with supplies. Handling performance and watertight integrity enable a kayak to tackle stormy seas that would be too rough for a canoe or rowboat (always wear a Personal Flotation Device). Rugged polyethylene hulls make the boats nearly indestructible, and built-in flotation keeps a kayak on the surface no matter what. Accessories like a deck compass, bilge pump, watertight deck and dry bags, and a "leash" that keeps your paddle attached to the boat further enhance a kayak's seaworthiness

Whether you're on a lonely mountaintop road or in a cul-de-sac in a subdivision, a fallen tree can be a trap if you don't have the tools to remove it.

in country where self-reliance is a necessity. We middle-aged outdoorsmen can also appreciate that a 14-foot kayak weighs about 15 pounds less than a canoe of the same length.

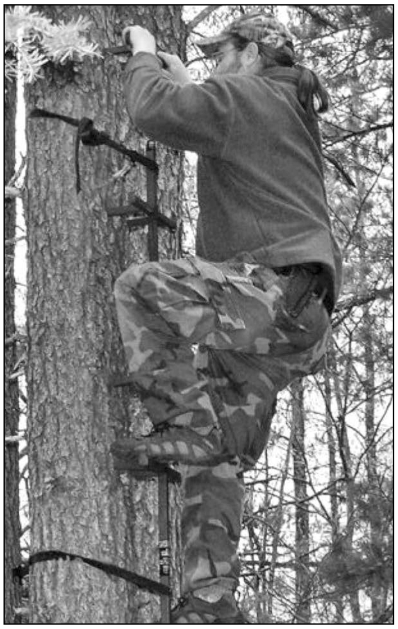
Don't take my word for it; rent or borrow a kayak and see for yourself why kayaks have been outselling canoes more than three to one since 2001. With a blend of proven Inuit design, high-strength but lightweight materials, and computer-aided engineering today's kayak just may be the ultimate backcountry survival vehicle.

Lumberjacking 101

American trees are under assault; some pests, like the jackpine budworm, are native, while many harmful insects and fungi have arrived from other states—even other continents—as a result of human commerce. The introduction of alien parasites has devastated whole forests, and it isn't a question of whether a dead tree will fall, but of when, and in which direction. During stormy weather, weakened wind-felled trees can block roads, knock down power lines, strand travelers and cut off entire communities for days at a time. Being most likely to fall in the direction of least resistance (open areas), wind-felled trees seem attracted to yards and driveways, and the damage a falling 2-ton tree can inflict on a building or vehicle is impressive.

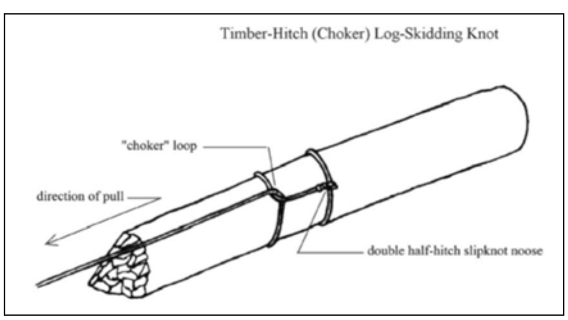
A few resort property owners have hired local talent, sometimes learning the hard way that not every resident of the big woods is an accomplished lumberjack. Many fell problem trees themselves, and some do the job well, but there has been tale or two of woe from those who flattened the very possessions they were trying to protect.

The secret to dropping a tree where you want it to land is to make sure that it has no alternative, particularly when the trunk is next to a structure that cannot be moved, and especially if the tree is already leaning in an undesired direction. That means anchoring the tree under force in the direction it



Putting down a tall, heavy tree right where it needs to go demands a few simple lumberjacking tools, like these telescoping scaling ladders.

needs to fall, which requires a simple winching outfit. Basic components include a quality "come-along" hand winch (about $70), 50 feet of climbing rope ($50), and 10-plus feet of vinyl-coated cable ($20) or nylon tow strap ($15), all of them rated to work under loads of no less than 2 tons. You'll also need a way to attach the pulling outfit at least 10 feet high on the trunk (higher is better because it provides more leverage); a step-ladder can suffice, but many deer hunters already have more portable, and safer, tree-scaling ladders.



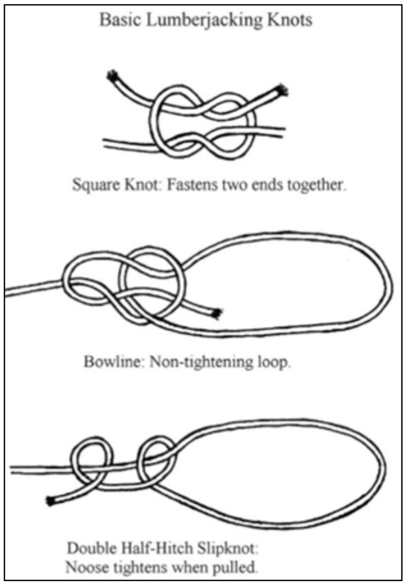
The "choker" knot used by lumberjacks to haul smooth-sided logs through a forest: a slipknot noose locked in place by a hfigalf-hitch.

Most critical is to be absolutely certain that every component is in top condition, because a 10-pound winch that snaps free under tons of force can break any body part it hits. Besides being certain that every component is rated for the job, it pays to be compulsive about frayed ropes and straps, broken cable wires, and anything that looks worn. Work gloves, eye protection, and even a hard hat are always good ideas because some mistakes can be made only once.

While direction of fall is dictated by safety, a falling tree's path to the ground should be as free of obstructions as possible; a half-fallen tree suspended from the branches of another standing tree can be extraordinarily dangerous. The potential for a "widow-maker" is much less with a ton or so of force helping to pull the tree down, but a clear path to the earth is essential. In most instances, hangers can be freed by shifting the winch's anchor point to one side, using the rope already tied around its trunk, and pulling the stuck tree loose from a safe distance.

How the winching components are connected is important: Try to keep the anchor tree directly in line with your desired impact site, and farther away than the tree being felled is tall. The anchor cable or strap is looped down low on the trunk of an anchor tree, and the loose end hooked to the cabled end of the winch. Release the come-a long's locking pawls to allow the reel to turn freely, and extend the cable to its full length by pulling the winch away from the anchor.

Pull the climbing rope—already tied ten feet up the trunk of the tree being felled with a "choker" timber-hitch—through the fixed hook at the winch's opposite end, and tie it off as tautly as you can. Some knot work is required, so it helps to bone-up on the basics (the Boy Scout Handbook is a great start). Knots that are winched against can pull very tightly, and tying them with a doubled rope makes them easier to untie. With the anchored winch tied off as tautly as you can get it (the winch should be



Three of the most useful lumberjacking knots

suspended in air), take up the remaining slack with the come-along, but do not pull hard against the tree yet Do be sure that your ladder is out of the way at this point.

Next, chainsaw a felling wedge from the trunk facing the place you want the tree to land. Like a right triangle, the flat bottom of the wedge is made by cutting horizontally into the trunk to a depth of slightly less than half its diameter. Do not cut more than halfway through the trunk as this can cause the tree's mass to shift and pinch your chainsaw bar like a vise. The second cut angles downward at roughly 4–5 degrees to meet the first cut at the trunk's center. When the wedge is free, push it off to one side, knocking it loose with an axe if you need to. Next, winch the lines tight between notched tree and anchor, just until the top branches of the notched tree move when you pull the winch handle.

The final, felling cut is made from the opposite side, angling downward from about 6 inches above the apex of the wedge notch; this creates a step to help prevent the tree from falling in any direction except forward. Begin by making certain that all tripping hazards are removed from the surrounding area before making this cut, because you'll want to step back several feet from the falling tree's butt. Depending on how it lands (steep hills are especially dangerous), trunks have bounced 10 feet into the air, sometimes coming to rest many feet from their stumps, so it pays to be farther away than you think is necessary. Normally, a tree will give plenty of warning as it begins to fall, cracking and creaking as it slowly leans toward the winch. At the first sign of a lean, disengage your chainsaw and begin moving away, because the tree is falling. Resist the urge to rush backward; remember that you have a running chainsaw in your hands, and that it will take several seconds for the tree to fall.

Being cushioned by branches, no winch has yet suffered from being under a falling tree, and a

Tying off the winch that will pre-load tall tree's direction of fall to ensure that it impacts precisely where it was meant to go

Cutting the felling notch

Making the final felting cut after the felling wedge has been removed from the opposite side.

Stepping away as a 2-ton tree heads for earth

Everything about lumberjacking is hard, heavy, or sharp.

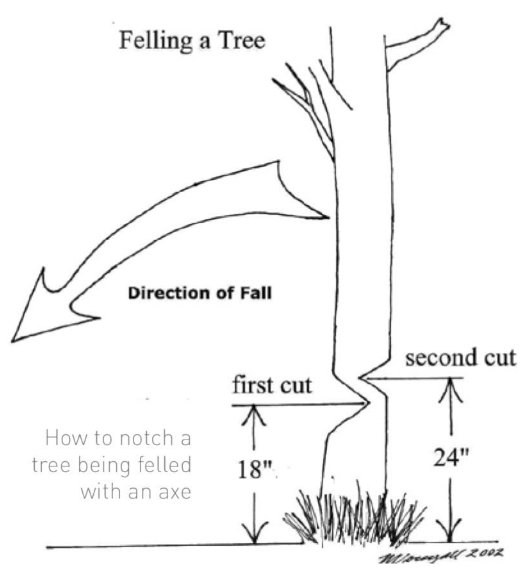
typical outfit can pull down dozens of trees before any components need replacement. Besides a chainsawing kit, other lumberjacking necessities include a good single-bit axe ($15), with a flat back that can be used as a sledge. A pruning-type handsaw (about $15) is handy for de-limbing trunks where a chainsaw is too clumsy, or might kick back. And it never hurts to have an extra strap or cable, in case the nearest anchor point is far away.

The jackpine budworm, emerald ash borer, gypsy moth, and a growing roster of other native and alien timber pests have shown that they are with us to stay. Probably none will wipe out the woods they feed on, but many of them kill large trees, which are then guaranteed to fall over at an unpredictable time in an unforeseeable direction. The same trouble occurs with fast-growing, short-lived trees, like aspen, cottonwood, and birches As long as humans and trees live together, and in places where use of large machines is prohibited, there will be a need for old-fashioned lumberjacking. If possible, hire a reputable (and insured) professional to fell problem trees. If that isn't feasible, never attempt to fell any tree without help, and approach the task with slightly-obsessive forethought and caution. Never cut any tree within touching distance of a power line; that is always one for the pros. As one old-timer put it, "Everything about lumberjackin' is hard, heavy, or sharp, and that's all you really need to know."

Cutting Wood With An Axe

Cutting wood with an axe has a method. Nothing about it is easy, but there is definitely an easier way and a hard way. Begin with your master (strongest) hand gripping the axe handle about halfway up, knuckles pointed in the same direction as the blade's cutting edge. The other, weaker, hand grasps the lower end of the axe handle, where it flares outward into a "toe" that helps to prevent the hand from slipping off of the end.

With hands positioned on the axe's handle, cock the head back over your right shoulder (if you're right-handed) like a baseball bat. With the



Cutting through a downed log with an axe

axe's cutting edge angled slightly inward (the desired angle changes), swing the head from your shoulder toward the log to be cut. Apply power to the axe handle with your master hand, driving the head in a smooth arc while the weak hand anchors the toe of the axe handle with a firm grip. As the axe head draws closer to its target, allow your master hand to slide easily down its handle, stopping when it reaches the opposite hand. The objective is to allow the heavy steel head to accelerate smoothly and steadily toward the point of impact, so that the cutting edge is driven home not by the force of your muscle, but from the energy of the axe head's own inertia.

When the cutting edge drives into wood and stops, give the axe handle a hard twist either upward or downward, whichever direction best splits the largest shingle of wood of wood from the main body. On the next hit, come in at the opposite inward angle, cutting (ideally) the layer of wood you've split free of the log in a single large chip. Tricks include saving yourself work by starting your cutting notch extra wide, so it doesn't need to be widened because the notch became too narrow before you'd chopped through the log.

When chopping down a standing tree, first determine the direction in which you want it to fall, and tie the trunk off if possible (as described above), to help ensure that it can only fall in that direction. The next step is to "set" the felling notch; the first stroke makes a cut that is perpendicular to the trunk, about 2 feet above the earth; this sets the bottom of the cutting notch. The second stroke is applied downward at a 45 to 50-degree angle, at a distance above the first cut that equals roughly two-thirds the diameter of the trunk being cut. This width insures that there will be sufficient room to remove chips as the notch becomes narrower toward the trunk's center. A hard outward twist of the embedded axe's handle helps to loosen both its head and large chunks of wood.

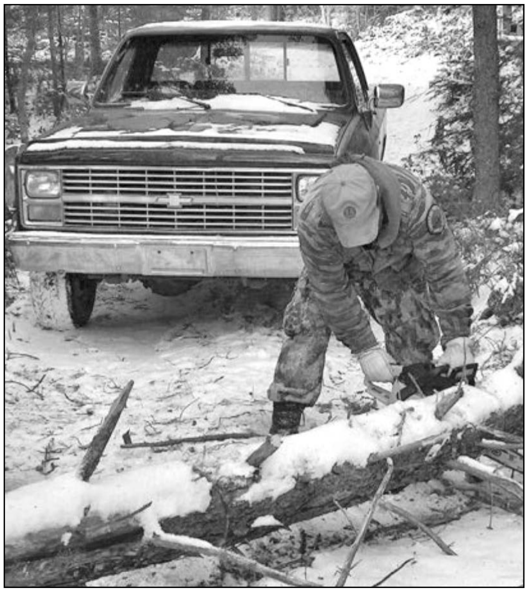
When the initial notch, which faces the direction of the intended fall, has been opened to a depth that eguals about two-thirds of the trunk's diameter, the axe wielder moves to the opposite side, away from the direction of the fall, and cuts the felling notch. This second notch is centered about 6 inches above the apex of the first, creating a ledge of sorts that prevents the tree from falling backward. This keeps you opposite the direction in which the tree will fall. I should take no more than a few good chops before the trunk cracks and begins to lean. Step back a dozen feet at this point, because it is not unheard of for butt ends to bounce ten feet into the air when a large tree impacts the ground.

Chopping a downed tree in two is a bit different than felling it, because there may be no getting around to cut from the opposite side. The initial cuts need to be nearly as wide as the log is thick to keep the V-shaped notch from coming to a point before the length has been severed. Unlike a felling cut, in which the bottom of the notch is kept generally perpendicular to the trunk both cuts are angled inward from the opposite sides to remove as much wood as possible per swing.

Clearing the Road

The hunting party had become trapped in a mountaintop lodge when high winds and heavy snow literally flattened large tracts of mature pine forest. When fair weather returned, the group found its road back to civilization impassable to vehicles, and nearly so to a man on foot. Even armed with chainsaws, the stranded hunters and the rescue party that was coming up the mountain toward them, found the going slow and the manual labor prohibitively exhausting. In the end, it took the mechanical muscle of log-skidders and bulldozers to break a trail through the toppled tree trunks.

This incident illustrates a problem that has afflicted many a backcountry camper. Roads leading



Downed trees and branches are a feature of many natural disasters, and it could be mperative to have a means of clearing streets and roads.

Pocket-size and able to tear through even tough-knotted jackpine, Ultimate Survival Technologies' SaberCut manual chainsaw has earned a place in disaster survival kits.

into the most remote and interesting places are by nature unpaved two-tracks, usually bordered by trees, and occasionally leading through places where it would be surprising to see another person. Frequently in such places, high winds will weaken the root system of a large tree enough for it to be uprooted and topple over, or sometimes a top will snap off and if the place they land is across the road that leads out, even a relatively small spruce or aspen can stop the gnarliest 4x4.

If you've already humped a full pack a half-dozen miles getting back to your vehicle, finding its only route to a paved road blocked by a couple of tons of green wood can be downright depressing. The logistics of safely cutting through a 24-inch diameter poplar trunk at both sides of the road, dropping a 2-ton log that's suspended a foot off the ground from either end by roots and branches, then moving that log out of the way requires tools not generally found in the backs of highway vehicles.

Storm-downed trees can strand you whether you're in the forest or the suburbs.

A chainsaw is great for this job, but the machine, its 2-stroke gas, bar oil, chain sharpener, bar wrench, spark plug wrench, and tensioning screwdriver are items most folks who aren't lumberjacks don't habitually carry in their vehicles. If you know your road may lead into a place so distant that you'll rely on driving to get back, it's not a bad idea to have a chainsawing outfit.

Even more dependable and convenient to carry are hand tools, and the first and most reliable mainstay of any lumberjacking chore has always been the axe. A bit of practice is needed to achieve accuracy and skill swinging an axe, but no tree trunk, branch, or root is too thick to be halved by this chopping tool.

It doesn't take a large tree lying across a road to stop even rugged 4x4 trucks; if you can't remove the tree, you might be stranded for a long time before someone else does.

Most versatile and usually easiest to master among axe designs is the single edge Collins-type axe, with a 3.5-pound head (5-pound heads are available), and a flat side opposite the cutting edge that works well as a heavy hammer. Available with hickory or fiberglass handles, a good axe can be found at most hardware stores for under $20, but its real value at a backcountry roadblock can make it priceless.

Next in line in terms of importance is an efficient handsaw, because springy smaller trunks and branches that bounce under an axe blow are often parted most safely with a saw. The old traditional bowsaw can still be found in the boxes of rural pickup trucks everywhere, but modern manufacturing technology has created toothed cutting edges that surpass anything a lumberjack of old had available. This increase in cutting efficiently is due in large part to continuously improving steel alloys and hardening processes but better tools also enabled creation of a very sharp opposing-teeth design that literally shreds wet or dry wood fibers. Known by names like "Razortooth," and available in blade sizes ranging from Corona's 18-inch pruning saw to Gerber's folding backpack saws, even Stanley's "Sharktooth" carpenter-style saw has proved able to zip through 12-inch green logs with surprising ease. Retail for any of these averages around $20, depending on blade length, which again belies the value that a good saw might have in the boondocks.

Most portable is the SaberCut manual chainsaw from Ultimate Survival Technologies (www.ultimatesurvival.com). Weighing in at 6 ounces with its ballistic-nylon belt case, this unit is essentially the cutting chain of a motorized chainsaw, but with nylon strap handles that loop over a user's wrists. Its 24-inch chain cuts and clears accumulated sawdust in both directions, without twisting or binding, and my own field trials prove that it will handle hard woods like maple and oak. Cutting teeth require little maintenance beyond occasional lubrication and sharpening with a standard chain saw blade sharpener. This tool has become a permanent part of my backwoods driving and ATV survival kits. At this time the SaberCut retails for $30.

After separating a fallen tree into pieces, you'll need to move those sections out of the road, and if the fallen tree is a large one, even a four-foot section of trunk can weigh hundreds of pounds. For this, you'll need a good come-a-long hand winch rated to exert at least two tons of pulling force (about $50), a 12" steel extension cable ($12), and at least fifty feet of quality three-quarter-inch nylon marine rope (under $20). With 4,000 pounds of mechanical muscle, a secure anchor point (sometimes your own vehicle), and 12 feet of pull, a lone camper has the power to drag all but the heaviest trees out of the way, and also the option of exerting that force from the side opposite his vehicle.

Conveniently contained in a duffle bag, along with leather work gloves and safety goggles, all of these tools take up surprisingly little space in even a small car's trunk. With this winching outfit, knowledge of a few basic knots (square knot, half-hitches, timber hitch, and bowline), and a modicum of ingenuity, virtually no passenger vehicle cannot be pulled out of a snowy ditch, muddy washout, or loose sand, which only adds to its potential value as a permanent part of the two-tracker's survival kit.

Although my own experience has been mostly limited to clearing truck-wide passages through wind-felled timber, it seems likely that a few tree removal tools might also prove handy for urban residents. Every year, tornadoes, hurricanes, and ice storms topple or break apart large trees in residential neighborhoods, separating people who live there from medical and other critical services until the way has been cleared. Most folks already know that they should never even approach a downed power line, but nearly any tree or branch that isn't lying against high voltage can be moved out of the street.

With a total cost of less than $120, and taking up less space than a spare tire, a good winching outfit is hard to overrate when big trees block a road you need to take. Whether in the suburbs or a vast wilderness, it beats standing there feeling helpless.

Getting Unstuck

You're bouncing slowly along a remote 2-track road, enjoying the serenity of a vast wilderness, when suddenly one front tire falls into the grassed-over hole left by a log skidder during the wet season. You slip the transmission to 4-low and try to back up, but even before you press the accelerator, you know your vehicle's weight is setting on the undercarriage, not the tires. Afraid of digging yourself in deeper, you get out to survey the problem, confirming that the front end is "high-centered," and neither front tire is getting traction.

Your cell-phone can't get a signal out here. It's a 10-mile hike to the nearest paved road, 20 miles to the nearest town, and the woods will be dark in an hour With sunset, a surprising coolness settles into the forest, forcing you to cover your bare goose-pimpled arms with a jacket, as well as to protect your torso from hordes of whining mosquitoes that fill the air from sunset to dawn. Judging from

No land vehicle is immune to getting stuck, and in some environments spending a night stranded on the road can be downright dangerous.

Any vehicle can get stuck; the question is, can you get it unstuck and back underway?

Getting stuck is a contingency that should be prepared for in vehicle-carried disaster survival kits across the board.

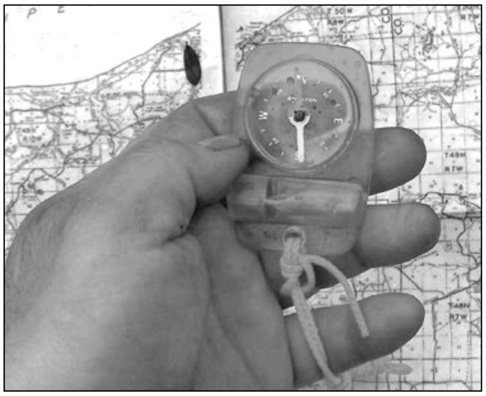
previous tire tracks, you aren't likely to meet with anyone else on this stretch of truck trail for days, maybe weeks. That cold feeling in your belly is more than an evening chill.

Generations of two-trackers can relate to the trials of getting waylaid by a stuck vehicle far from home. It can happen to anybody, and it will happen to every boondocker sooner or later. Where I live, anyone who claims to have never been stuck in snow, sand, or mud is either under sixteen years of age or lying. The pertinent question is, how long will you sit there, immobilized in an environment that will probably be less than comfortable?

Just as motocross and mountain bikes are equipped differently than their paved-road counterparts, so too does a backcountry 4x4 require accessories not normally found in highway vehicles. For these, a two-track vehicle extrication outfit is essential. Basic components include a manual come-along winch, a pair of tow straps, a single-blade axe, and a long-handled pointed shovel. The come-along, attached by cables between a stuck vehicle and a solid anchor point, provides up to 3 tons of pulling muscle from any direction. The axe and shovel are invaluable tools for manipulating the environment to better suit your needs; dead, broken sticks wedged under a tire help to increase traction in mud, a shovelful of sand is great for ice, and sometimes getting unstuck from deep snow is as simple as knocking down the hard-pack under your vehicle's chassis.

The price of a quality cable-type come-along, rated to pull two tons, averages about $70; nylon tow straps rated to match cost about $15 each; a shovel is around $12; a single-bit Collins axe, with a flat back that can serve as a hammer, retails for about $15. I also carry one-hundred feet of 2-ton braided climbing rope—about $45—to extend the reach of the winch, and to secure the vehicle from rolling backward while I reset the come-along. For less than $175, you can have the means to pull your car ortruck out of almost any place it gets stuck, to drag wind-felled trees from across roads or to help others to get unstuck. The winch and straps fit neatly into a large gym bag. The entire outfit takes up little space, so it can always be handy in the trunk of the smallest car for dragging wind-felled trees and debris from suburban and city streets after a storm.

Before using your winching outfit in a genuine situation, familiarize yourself with its workings, especially how to back-off tension from the come-along. Determine where the winching points on your vehicle are beforehand, and never pull directly against the bumper of any car ortruck. Be certain that all components are in good working condition because having any part of the outfit suddenly give way under several tons of force can result in serious,



The ideal pocket compass is liquid-filled to help its indicator settle quickly, but with a movement that turns smoothly, without sticking or jerking. Beware any new compass with a bubble of any size nside the indicator capsule. Small bubbles may occur after prolonged use afield, but a bubble in a new compass points to a leaky indicator capsule. If a bubble grows large enough, it can trap the indicator and prevent it from turning freely, or at all.

even fatal, injury. Wear work gloves whenever possible, and replace any strap or cable as soon as it begins to fray.

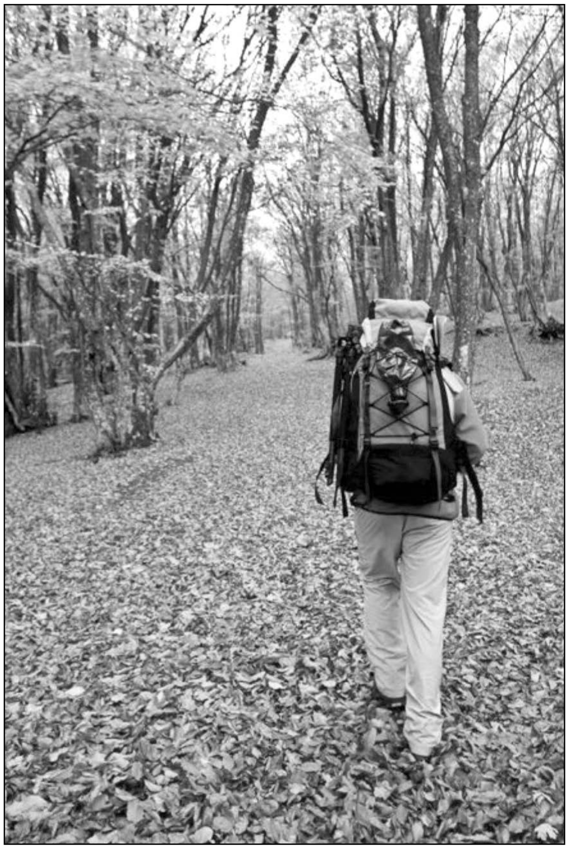
ABCs of Orienteering

Human beings don't have a sense of direction, and anthropologists claim we most likely never did. The ferric deposit that acts as a compass in the beaks and noses of "lower" animals is present in our own noses, but we lack the sensory connections that permit them to feel the pull of earth's magnetic north pole. Because our species has no sense of direction, we need a compass to find our way through untracked wilderness. In prehistory, our nomadic ancestors depended on reliable natural indicators, like the sun, moon, and stars prevailing winds, tall pines whose north-facing branches had been killed by winter winds and the direction faced by some plants.

Creation of the first magnetic compass is credited to early Egyptians, who discovered that a free-floating magnet will always align itself with earth's magnetic north pole. With a single constant point of reference, travelers could always know which direction they were heading, making it possible to maintain a straight course across vast areas of land or water, regardless of weather. The beauty of a compass has always been its simplicity and almost absolute reliability. All the needle or dial of the most sophisticated compass really does is point toward magnetic north, all the time, without batteries or parts that need replacing. A magnet at the north end of the needle or dial is attracted toward our planet's magnetic north pole when the compass is held flat in the user's palm, parallel to the ground. By turning the compass body or rotating dial (bezel) so that the northern half of the indicator is in agreement with the N on the compass dial, you know east is to the right, west to the left, and south directly to your rear. (Putting the first letters of those four directions together also spells NEWS—information from all four directions).

Just knowing where the four directions lie is enough to keep hikers from making the very common mistake of wandering in circles. But if you want to use your compass to get back out of the woods in a place at least close to where you came in, you'll need to take a "bearing" before you start. That means aligning your compass with north as described above, then using the information it provides to determine which direction you'll be taking into (and back out of) the forest.

For example, if you're about to enter thick swamp from a two-track road, you need to know in which direction that road lies once it's out of sight. Landmarks like roads, trails, railroad grades, and power lines are the best targets for a "back-bearing" (the direction that leads out) because they span large areas and are difficult to miss. If you leave the road and walk eastward into a woods, then finding that road again is as simple as walking west until you hit it. For most situations, that's all the orienteering you'll need to know.



Likewise, most campers, fishermen, and hunters don't need the complexity and expense of precision navigation instruments like Brunton's 8099 prismatic compass ($80). Compasses like this are designed to precisely navigate through many miles of untracked wilderness, but fully exploiting their potential demands more advanced orienteering techniques than are generally needed for getting to and from a camp or deer blind.

The compass I use religiously for informal day hikes is a simple "pocket" compass, like Silva's Type 7 ($8), worn around my neck on a string and carried tucked inside the shirt. Don't get the idea that simple has to mean low quality, however, because a good pocket compass is as serious an orienteering tool as its more sophisticated counterparts; it just lacks the precision sights and other accessories that most day hikers don't need anyway.

Even better is a compass made for use with a map, like Coleman's Map Compass ($7) which has a see-through base with a ruler and map scales etched into the plastic. By laying the compass on top of a map and orienting both to north, you have a preview of the surrounding terrain. Even if you can't see it, that lake the map shows to be west of your position is there, and all you have to do to reach it is hike west over the distance shown on your map.

Whichever compass you use, it's a good idea to include a map of the area you'll be traveling. Detailed area maps are available from Department of Natural Resources field offices and most local bookstores for about $2, depending on the size of the area they cover. Even more precise topographical maps can be purchased from United States Geographical Survey (www.usgs.gov) for $4 each, plus $4 shipping and handling per order.

Advanced Orienteering

While a typical outdoorsman seldom needs his compass to do more than show the way to a nearby road, situations can arise that demand more advanced orienteering methods. Dodging new beaver floodings or broken bridges, making forced course changes to avoid hostile weather, or cutting cross-country to get medical help for an injured companion are all real-life possibilities.

More advanced navigation techniques require using a map and compass together, and here is where map compasses come into their own. Map compasses—including the prismatic sighting models—have see-through bases that allow you to place the instrument directly onto a map and read the two together. This makes course calculations faster and more precise than is possible with metal-body compasses.

The first step is to align both map and compass to magnetic north. To do this, place the map flat on the ground, away from metal objects that

might deflect the compass indicator, and lay the compass on top of it. Orient the compass to north, as if you were taking a bearing, and rotate the map beneath it until the two are in agreement. With both instruments aligned to north the map becomes a microcosm of the surrounding country side; a mountain shown to your left (west) on the map will indeed be visible to your left, and the same applies to all other mapped landmarks.

It's also important to understand that there are two norths: true north, the one your map will probably be oriented to, and magnetic north, the one your compass points to. Depending on your geographic location, the difference between these two norths—called declination— in North America can range from 0 degrees in Ishpeming, Michigan to a whopping 35 degrees along Alaska's Pacific shoreline. The 0-Declination line, where compass and map agree, is a narrow strip of land extending in an irregular line from Florida's tip through Michigan's Keweenaw Peninsula. The farther east or west you travel from the 0-declination line, the greater the difference between map north and compass north, and the more important it becomes to take this difference into account when plotting a course.

Compensating for declination is easy, though. Locate your position as closely as possible using the declination chart, and if you're left (west) of the 0 line, subtract the number of degrees shown from the heading you arrived at with compass and map. If your position is right (east) of the 0 line, add the value indicated. For example, if you were in daho, which has a negative declination of 20 degrees, and wanted to follow a bearing of 270 degrees, the compass heading you'd follow would be at 250 degrees. Failure to compensate for declination would result in your being off course by % mile after traveling just 2 miles in any direction, magnetic declination can thus have serious consequences if you're trying to reach a remote cabin in blinding snow, fog, or torrential rain.

A surprisingly common and potentially serious mistake made by hikers crossing country where identifiable landmarks are hidden by weather or terrain is not trusting their compasses. Not too long ago one of my backpacking companions, who should have known better, had to walk to the 2 miles he'd missed our rendezvous by because he'd decided his compass was lying. It can be unnerving to spend hours crossing trackless wilderness with only compass and map to show you the way, but always remember that a compass cannot give a false reading or be off by any amount (so long as it isn't being deflected by ferric metals). A compass either works all the time, or it's obviously broken.

A fairly rare exception to this rule occurs in iron country, when ferric ore deposits prove more attractive to your compass than the magnetic north pole. I've encountered this problem in Michigan's iron-rich Huron Mountains, but such places are generally small enough to merely inconvenience hikers, and if you've been minding your course the effect on your compass will be noticeable immediately. You can change course to escape these effects, but in most cases a map and the surrounding terrain will provide enough information to keep you on course until your compass reads true again.

There will be many times when traveling from one place to another requires breaking your trip into sections, or legs, each of which requires a new compass bearing. Ironically, this is easier in untracked wilderness, because the first trail intersection you come to might not be the same intersection shown on your map, but a new trail created after the map was printed. For this reason, it's imperative to have the means to calculate distances traveled with a workable degree of accuracy.

The most common map scales are 1:25,000 (1 inch equals 25,000 inches, or 694.44 yards); 1:50,000 (1 inch equals 50,000 inches, or 1,388.88 yards) and 1:62,000, which means 1 inch

is equivalent to 1,722.22 yards, or just shy of a mile. All map compasses have at least two of these scales printed along the edges of their see-through bases, and most also have inch and millimeter scales for making conversions.

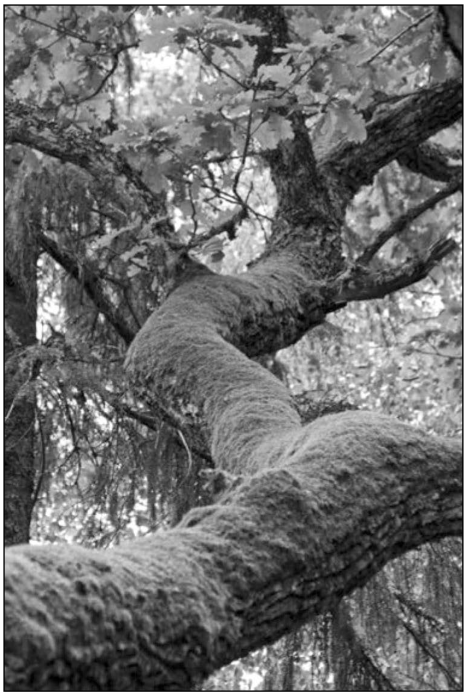
But hikers sometimes need a way to measure actual distances on the ground for correlation with map distances. An average adult covers about 3 miles in an hour of walking—a good guideline to remember—but when circumstances demand the precision necessary to locate a cabin, mountain pass, or the correct trail, you'll need a place counter.

The best such counter is the military model, which is essentially a heavy string with tight-fitting beads strung along its length. Unfortunately, every manufactured pace counter I've seen is calibrated to kilometers, while most maps are scaled in miles. remedy this problem by threading 23 "beats" made from ¼-inch sections of plastic tubing with a ⅛-inch inside diameter onto a doubled shoelace. A simple overhand knot in the doubled end prevents the beads from sliding off. Another knot in the middle of the shoelace separates the beads into groups of 5 and 18, while a knot in the free ends holds them all together as a unit. Leave the shoelace at least an inch too long in either group so that you can clearly separate beads from the rest of the group by sliding them to the opposite knot. It's important to have enough friction to make the beads stay wherever you slide them.

Using the completed pace counter is simple. Starting with all the beads pushed to the inside, determine how many paces, on average, it takes you to cover 100 yards (the military says 62 paces, but I personally find that 100 steps equals 100 yards). If, for example, you determine that 75 of your paces equals 100 yards, then you'd slide one bead from the large group down to the end for each set of 75 paces. When all 18 have been pushed to the end indicating 1,800 yards of travel, you know you've traveled approximately one mile (1,760 yards). At this point slide one bead from the smaller group to its outer end and reset all the beads in the larger group by sliding them back to the center. The process continues until all five beads in the smaller group have been pushed to the end, indicating 5 miles of travel it's a good idea to now stop and mark your position on the map before you start the entire process over. For all its simplicity, the pace counter is surprisingly accurate, and I consider it an indispensable component of any orienteering kit.

Once, after we'd spent a whole day four-wheeling along an ancient, unmapped mountain trail, one of my companions asked me to show him our location on the map. He seemed a bit disconcerted when I told him I had no idea where we were. Sooner or later, everyone who explores the wilderness encounters this problem—you don't have to be lost to not know where you are. The solution, as I demonstrated to my anxious companion the new morning, is an orienteering exercise called triangulation, a complex-sounding technique that's actually quite simple to perform. The only requirements are two positively identifiable terrain features, a good map to reference them against, and a sighting compass that allows you to read precise bearings from these landmarks. Triangulation is of little or no use in deep forest where tall trees obscure vision, but in any open country where distant landmarks are visible, it's possible to determine within 100 yards your exact location on a map. That's important because if you don't know where you are right now—if you don't have a solid anchor upon which to base map headings—there's no way you can plot an intelligent course to anywhere else.

The first step is to find a place where you can visually identify two distant landmarks that are also identified on your map. The points should be as far away from one another as possible. Orient your map and compass to magnetic north, making certain to compensate for magnetic declination, and sight a bearing from either point, jotting down both forward bearings and back bearings in the margins for use



in the next step. Any compass can be used for triangulating, but the more precise the instrument's sighting system, the more accurate will be your calculations This is where a prismatic (mirrored) compass shines.

Next, use the compass's protractor and straightedge to draw a line through each landmark on the map, extending these lines on the same angles as their back bearings. If your compass isn't equipped with a protractor, center its indicator post exactly on top of either reference point and use its bezel as a protractor.

You'll note that as you extend the back-bearing lines on the map back toward yourself, they draw closer together. The point where these lines intersect is your position.

Night Navigation

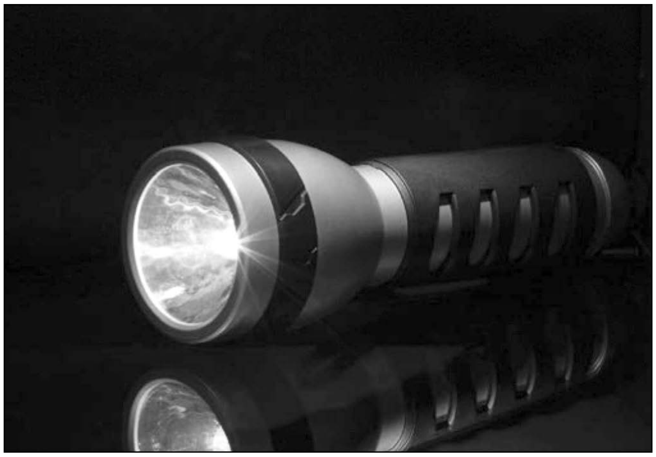
As much as we try to convince ourselves otherwise, few of use are unafraid to be alone in the woods at night. There are many reasons behind this fear: humans have perhaps the lowest perception of ultraviolet light of any species, which means we can't see at night; the forest is already an alien environment where most civilized folks feel somewhat insecure in daylight; worse, all of us have been taught from childhood to fear what could be lurking in the darkness. The logical part of our brains may know that such fear is unfounded, but each of us carries a burden of childhood terror left over from tales about werewolves, vampires, and all sorts of sharp-clawed predators that wait to rend and tear unsuspecting humans in the darkness. While these stories probably sprang from an era when our distant ancestors huddled around a fire for protection from now-extinct predators that sometimes did eat them, almost every species on the planet has learned to avoid humans, none more so than in North America.

The trick to traveling at night is learning to rely less on your eyesight and more on your other senses. Your eyes will adjust better than you might think, but you must learn to use the hardness of a trail underfoot to guide your steps on moonless or cloudy nights Condition yourself to step higher than normal to clear protruding roots and other tripping hazards. Learn to "see" movement around with your ears, not your eyes, listening for the rushing of water, the rustling of leaves, and other audible clues. Feel for minute changes in air currents with your extremely sensitive facial skin, and learn to recognize how these tactile differences relate to changes in terrain.

Night orienteering requires a small flashlight for map reading and taking bearings, but as with any battery-powered device, you'll want to use is sparingly. I recommend using a recognizable star as a bearing point—a fixed point that you can see and follow without the aid of artificial light.

Other Orienteering Tricks

One persistent myth among outdoor lovers of all disciplines is the belief that moss prefers to grow



on the northern sides of trees. The truth is that moss grows wherever conditions most favor it, regardless of direction. In fact, in the North Woods mosses actually tend toward the southern side of their hosts, away from winter's killing north wind, but always keeping to shade.

In this same vein hikers in northern and mountain states can use the tallest spruce hemlock, or other pine tree to find their way. Since this tree will rise above the surrounding forest to face winter's full fury, any buds that sprout on its northern side will literally be frozen to death each winter. Thus the branches growing on its opposite side will always point generally south.

If you can see it, the sun is a reliable indicator of direction because, as every kid from my generation knew, east is the land of the rising sun, and cowboys always ride west into the sunset. But it's also true that our sun is directly overhead only at the planet's equator. The farther north you travel from the sun, the more southerly becomes its east-to-west arc across the sky. The opposite is true in the southern latitudes.

Chronograph-type wristwatches can also serve as compasses in a pinch, but they too rely on a visible sun to work. In the morning, point the watch's hour hand at the sun, and at the point where the angle between it and the number 12 is bisected will be south. The same procedure applies when you're taking a bearing in the afternoon, except that A.M. bearings are always taken from the left (6-12) half of a watch, while P.M. bearings are read from the right (12-6) half. This method is neither accurate or reliable enough to replace a dedicated compass-changes in latitude and cloudy days can pose problems—but if something happens to your compass, a good watch can actually help you get home There are also a few miscellaneous tips I can give you about using terrain features to find a route through the wilderness. For example, it's good to know that most rivers flow southward generally, and that if you follow the flow of water downstream to its outlet, sooner or later you'll run across civilization. Also, prevailing winds across North America blow generally west to east, and downhill usually leads to water.

Natural Disasters

It is impossible to predict exactly when a storm will come your way, or how severe it will be. However, you can be prepared. There are many steps you can take to help ensure your safety, as well as that of your family, pets, and property.

If there's time before a storm hits, remember to moor your boat securely.

Hurricanes

If you live in an area particularly prone to hurricanes, taking precautions is especially important. However, hurricanes can form anywhere, so don't assume that just because you're not in the tropics, you're not at risk. Thinking ahead will, at the very least, give you greater peace of mind.

What to Do Before a Hurricane

If you live in a hurricane-prone area, you may want to take the following precautions:

Hurricanes occur more frequently in coastal areas, but they can happen anywhere.

- Install permanent shutters to protect your windows. Or you can board up windows with ⅝-inch marine plywood. Have the plywood cut to fit and ready to install.
- Install straps or additional clips to fasten your roof securely to the frame structure. This will reduce roof damage.
- Be sure trees and shrubs around your home are well-trimmed.
- Clear loose and clogged rain gutters and downspouts.
- Determine how and where to secure your boat, if you have one.

Shutters will help to protect your windows during wind storms.

Watch the sky for warning signs of a serious storm approaching.

If you are aware of a hurricane approaching, you should:

- Listen to the radio or TV for information.
- Secure your home, close storm shutters, and secure outdoor objects or bring them indoors.
- Turn off utilities if instructed to do so. If you leave the electricity on, turn the refrigerator thermostat to its coldest setting and keep its doors closed so the food will stay colder longer if the electricity goes out.
- Turn off propane tanks. Avoid using the phone, except for serious emergencies.
- Moor your boat if time permits.
- Draw fresh water in jugs or in your bathtub or sink for use in drinking, bathing, and flushing toilets if the electricity goes out.

What to Do During a Hurricane

You should evacuate if:

- You are directed by local authorities to do so. Be sure to follow their instructions.
- You live in a mobile home or temporary structure—such shelters are particularly hazardous during hurricanes no matter how well-fastened to the ground.
- You live in a high-rise building—hurricane winds are stronger at higher elevations.
- You live on the coast, on a floodplain, near a river, or on an inland waterway.
- You feel you are in danger.

If you are unable to evacuate, go to a basement or underground shelter. If you do not have one, follow these guidelines:

- Stay indoors during the hurricane and away from windows and glass doors.
- Close all interior doors—secure and brace external doors.
- Keep curtains and blinds closed. Do not be fooled if there is a lull; it could be the eye of the storm—winds will pick up again.
- Take refuge in a small interior room, closet, or hallway on the lowest level.
- Lie on the floor under a table or another sturdy object.

Floods

Floods are one of the most common hazards in the United States. However, not all floods are alike. Some floods develop slowly, sometimes over a period of days. Flash floods can develop quickly, sometimes in just a few minutes and without any visible signs of rain. Flash floods often have a dangerous wall of roaring water that carries rocks, mud, and other debris and can sweep away most things in its path. Overland flooding occurs outside a defined river or stream, such as when a levee is breached, but still can be destructive. Fooding can also occur when a dam breaks, producing effects similar to flash floods.

Be aware of flood hazards no matter where you live, but especially if you live in a low-lying area, near water, or downstream from a dam. Even very small streams, gullies, creeks, culverts, dry streambeds, or low-lying ground that appears harmless in dry weather can flood. Every state is at risk of this hazard.

What to Do Before a Flood

To prepare for a flood, you should:

- Avoid building in a flood-prone area unless you elevate and reinforce your home.
- Elevate the furnace, water heater, and electric panel if susceptible to flooding.
- Install “check valves” in sewer traps to prevent floodwater from backing up into the drains of your home.
- Contact community officials to find out if they are planning to construct barriers (levees, beams, or floodwalls) to stop floodwater from entering the homes in your area.

If your home is by a river, lake, or canal, you are at a higher risk for flooding.

In some areas particularly prone to flooding, homes are built on stilts.

- Seal the walls in your basement with waterproofing compounds to avoid seepage.

If a flood is likely in your area, you should:

- Listen to the radio or television for information.
- Be aware that flash flooding can occur. If there is any possibility of a flash flood, move immediately to higher ground. Do not wait for instructions to move.
- Be aware of streams, drainage channels, canyons, and other areas known to flood suddenly. Flash floods can occur in these areas with or without such typical warnings as rain clouds or heavy rain.

What to Do During a Flood

If you must prepare to evacuate, you should do the following:

- Secure your home. If you have time, bring in outdoor furniture. Move essential items to an upper floor.

TIP

The following are important points to remember when driving in flood conditions:

- Six inches of water will reach the bottom of most passenger cars, causing loss of control and possible stalling.
- A foot of water will float many vehicles.
- Two feet of rushing water can carry away most vehicles, including sport utility vehicles and pickup trucks.

- Turn off utilities at the main switches or valves if instructed to do so. Disconnect electrical appliances. Do not touch electrical equipment if you are wet or standing in water.

If you have to leave your home, remember these evacuation tips:

- Do not walk through moving water. Six inches of moving water can make you fall. If you have to walk in water, walk where the water is not moving. Use a stick to check the firmness of the ground in front of you.
- Do not drive into flooded areas. If floodwaters rise around your car, abandon the car and move to higher ground if you can do so safely. You and the vehicle can be quickly swept away.

What to Do After a Flood

After a flood, you should:

- Listen for news reports to learn whether the community's water supply is safe to drink.
- Avoid floodwaters; water may be contaminated by oil, gasoline, or raw sewage. Water may also be electrically charged from underground or downed power lines.

TIP

Familiarize yourself with these terms to help identify a flood hazard:

Flood Watch: Flooding is possible. Tune in to NOAA Weather Radio, commercial radio, or television for information.

Flash Flood Watch: Flash flooding is possible. Be prepared to move to higher ground; listen to NOAA Weather Radio, commercial radio, or television for information.

Flood Warning: Flooding is occurring or will occur soon; if advised to evacuate, do so immediately.

Flash Flood Warning: A flash flood is occurring; seek higher ground on foot immediately.

- Avoid moving water.
- Be aware of areas where floodwaters have receded. Roads may have weakened and could collapse under the weight of a car.
- Stay away from downed power lines, and report them to the power company.
- Return home only when authorities indicate it is safe.
- Stay out of any building if it is surrounded by floodwaters.
- Use extreme caution when entering buildings; there may be hidden damage, particularly in foundations.
- Service damaged septic tanks, cesspools, pits, and leaching systems as soon as possible. Damaged sewage systems are serious health hazards.
- Clean and disinfect everything that got wet. Mud left from floodwater can contain sewage and chemicals.

Dry grass or other vegetation will encourage fire to spread quickly.

Wildfires

The threat of wildfires for people living near wild-land areas or using recreational facilities in wilderness areas is real. Dry conditions at various times of the year and in various parts of the United States greatly increase the potential for wildfires.

Stucco homes are less vulnerable to fire than homes made of wood.

Advance planning and knowing how to protect buildings can lessen the devastation of a wildfire. There are several safety precautions that you can take to reduce the risk of fire losses. Protecting your home from wildfires is your responsibility. To reduce the risk, you'll need to consider the fire resistance of your home, the topography of your property, and the nature of the vegetation close by.

If you are considering moving to a home or buying land in an area prone to wildfires, consider having a professional inspect the property and offer recommendations for reducing the wildfire risk. Determine the community's ability to respond to wildfires. Are roads leading to your property clearly marked? Are the roads wide enough to allow firefighting equipment to get through?

What to Do Before a Wildfire

To prepare your home for a wildfire you should:

- Create a 30-foot safety zone around the house. Keep the volume of vegetation in this zone to a minimum. If you live on a hill, extend the zone on the downhill side. Fire spreads rapidly uphill. The steeper the slope, the more open space you

Learn and Teach Safe Fire Practices

- Build fires away from nearby trees or bushes.
- Always have a way to extinguish the fire quickly and completely.
- Install smoke detectors on every level of your home and near sleeping areas.
- Never leave a fire—even a cigarette—burning unattended.
- Avoid open burning completely, especially during dry season.

will need to protect your home. Swimming pools and patios can be a safety zone and stonewalls can act as heat shields and deflect flames.

- Remove vines from the walls of the house and move shrubs and other landscaping away from the sides of the house. You should also prune branches and shrubs within 15 feet of chimneys and stovepipes, remove tree limbs within 15 feet of the ground, and thin a 15-foot space between tree crowns.
- Replace highly flammable vegetation such as pine, eucalyptus, junipers, and fir trees with lower growing, less-flammable species within the 30-foot safety zone. Check with your local fire department or garden store for suggestions. Also replace vegetation that has living or dead branches from the ground level up (these act as ladder fuels for the approaching fire). Cut the lawn often, keeping the grass at a maximum of 2 inches. Watch grass and other vegetation near the driveway, a source of ignition from automobile exhaust systems. Finally, clear the area of leaves, brush, evergreen cones, dead limbs, and fallen trees.
- Create a second zone at least 100 feet around the house. This zone should begin about 30 feet from the house and extend to at least 100 feet. In this zone, reduce or replace as much of the most flammable vegetation as possible. If you live on a hill, you may need to extend the zone for several hundred feet to provide the appropriate level of safety.
- Remove debris from under sun decks and porches. Any porch, balcony, or overhang with exposed space underneath is fuel for an approaching fire. Overhangs ignite easily by flying embers and by the heat and fire that get trapped underneath. If vegetation is allowed to grow underneath or if the space is used for storage, the hazard is increased significantly. Clear leaves, trash, and other combustible materials away from underneath sun decks and porches. Extend a ½-inch mesh screen from all overhangs down to the ground. Enclose wooden stilts with non-combustible material such as concrete, brick, rock, stucco, or metal. Use non-combustible patio furniture and covers. If you're planning a porch or sun deck, use non-combustible or fire-resistant materials. If possible, build the structure close to the ground so that there is no space underneath.
- Enclose eaves and overhangs. Like porches and balconies, eaves trap the heat rising along the exterior siding. Enclose all eaves to reduce the hazard.
- Cover house vents with wire mesh. Any attic vent, soffit vent, louver, or other opening can allow embers and flaming debris to enter a home and ignite it. Cover all openings with ¼ inch or smaller corrosion-resistant wire mesh. If you're designing louvers, place them in the vertical wall rather than the soffit of the overhang.
- Install spark arresters in chimneys and stovepipes. Chimneys create a hazard when embers escape through the top. To prevent this, install spark arresters on all chimneys, stovepipes, and vents for fuel-burning heaters. Use spark arresters made of 12-gauge welded or woven wire mesh screen with openings ½ inch across. Ask your fire department for exact specifications. If you're building a chimney, use non-combustible

Do not attempt to go back inside a house that is already burning.

Handling Combustibles

- Install electrical lines underground, if possible.
- Ask the power company to clear branches from power lines.
- Avoid using bark and wood chip mulch.
- Stack firewood 100 feet away and uphill from any structure.
- Store combustible or flammable materials in approved safety containers and keep them away from the house.
- Keep the gas grill and propane tank at least 15 feet from any structure. Clear an area 15 feet around the grill. Place a ¼-inch mesh screen over the grill. Always use the grill cautiously and refrain from using it at all during high-risk times.

materials and make sure the top of the chimney is at least 2 feet higher than any obstruction within 10 feet of the chimney. Keep the chimney clean.

- Use fire-resistant siding such as stucco, metal, brick, cement shingles, concrete, or rock. You can treat wood siding with UL-approved fire retardant chemicals, but the treatment and protection are not permanent.
- Choose safety glass for windows and sliding glass doors. Windows allow radiated heat to pass through and ignite combustible materials inside. The larger the pane of glass, the more vulnerable it is to fire. Dual- or triple-pane thermal glass and fire-resistant shutters or drapes help reduce the wildfire risk. You can also install non-combustible awnings to shield windows and use shatter-resistant glazing such as tempered or wire glass.
- Prepare for water storage; develop an external water supply such as a small pond, well, or pool.
- Always be ready for an emergency evacuation. Evacuation may be the only way to protect your family in a wildfire. Know where to go and what to bring with you. You should plan several escape routes in case roads are blocked by a wildfire.

Safety Measures for New Construction or Remodeling

- Choose locations wisely; canyon and slope locations increase the risk of exposure to wildfires.
- Use fire-resistant materials when building, renovating, or retrofitting structures.
- Avoid designs that include wooden decks and patios.
- Use non-combustible materials for the roof.
- The roof is especially vulnerable in a wildfire. Embers and flaming debris can travel great distances, land on your roof, and start a new fire. Avoid flammable roofing materials such as wood, shake, and shingle. Materials that are more fire-resistant include single-ply membranes, fiberglass shingles, slate, metal, clay, and concrete tile. Clear gutters of leaves and debris.

What to Do if a Wildfire is Approaching

- Evacuate your pets and all family members who are not essential to preparing the home. Anyone with medical or physical limitations and the young and the elderly should be evacuated immediately.
- Wear protective clothing.
- Remove combustibles. Clear items that will burn from around the house, including woodpiles, lawn furniture, barbecue grills, tarp coverings, and so on. Move them outside of your defensible space.
- Close outside attic, eave, and basement vents, and windows, doors, and pet doors. Remove flammable drapes and curtains. Close all shutters, blinds, or heavy non-combustible window coverings to reduce radiant heat.

- Close inside doors and open damper. Close all doors inside the house to prevent draft. Open the damper on your fireplace, but close the fireplace screen.
- Shut off any natural gas, propane, or fuel oil supplies at the source.
- Connect garden hoses and fill any pools, hot tubs, garbage cans, tubs, or other large containers with water.
- If you have gas-powered pumps for water, make sure they are fueled and ready.
- Place a ladder against the house in clear view.
- Back your car into the driveway and roll up the windows.
- Disconnect any automatic garage door openers so that doors can still be opened by hand if the power goes out. Close all garage doors.
- Place valuable papers, mementos, and anything you "can't live without" inside the car, ready for quick departure. Any pets still with you should also be put in the car.
- Just before evacuating, turn on outside lights and leave a light on in every room to make the house more visible in heavy smoke.
- Leave doors and windows closed but unlocked. It may be necessary for firefighters to gain quick entry into your home. The entire area will be isolated and patrolled by police.

If Caught in the Open

- The best temporary shelter is in a sparse fuel area. On a steep mountainside, the back side is safer. Avoid canyons, natural "chimneys," and saddles.
- If a road is nearby, lie face down along the road cut or in the ditch on the uphill side. Cover yourself with anything that will shield you from the fire's heat.
- If hiking in the back country, seek a depression with sparse fuel. Clear fuel away from the area while the fire is approaching and then lie face down in the depression and cover yourself. Stay down until after the fire passes!

What to Do After a Wildfire

- Check the roof immediately. Put out any roof fires, sparks, or embers. Check the attic for hidden burning sparks.

Survival in a Vehicle

- This is dangerous and should only be done in an emergency, but you can survive the firestorm if you stay in your car. It is much less dangerous than trying to run from a fire on foot.
- Roll up windows and close air vents. Drive slowly with headlights on. Watch for other vehicles and pedestrians. Do not drive through heavy smoke.
- If you have to stop, park away from the heaviest trees and brush. Turn headlights on and ignition off. Roll up windows and close air vents.
- Get on the floor and cover up with a blanket or coat.
- Stay in the vehicle until the main fire passes.
- Stay in the car. Do not run! The engine may stall and not restart. Air currents may rock the car. Some smoke and sparks may enter the vehicle. Temperature inside will increase. Metal gas tanks and containers rarely explode.

- If you have a fire, get your neighbors to help fight it.
- The water you put into your pool or hot tub and other containers will come in handy now. If the power is out, try connecting a hose to the outlet on your water heater.
- For several hours after the fire, maintain a "fire watch." Re-check for smoke and sparks throughout the house.

Earthquakes

One of the most frightening and destructive phenomena of nature is a severe earthquake and its terrible aftereffects. Earthquakes strike suddenly, violently, and without warning at any time of the day or night. If an earthquake occurs in a populated area, it may cause many deaths and injuries and extensive property damage.

Although there are no guarantees of safety during an earthquake, identifying potential hazards ahead of time and planning appropriately can save lives and significantly reduce injuries and property damage.

What to Do Before an Earthquake

- Check for hazards in the home. Fasten shelves securely to walls, place large or heavy objects on lower shelves, and store breakable items such as bottled foods, glass, and china in low, closed cabinets with latches. Hang heavy items such as pictures and mirrors away from beds, couches, and anywhere people sit. Brace overhead light fixtures. Repair defective electrical wiring and leaky gas connections and secure a water heater by strapping it to the wall studs and bolting it to the floor. Repair any deep cracks in ceilings or foundations, getting expert advice if there are signs of structural defects. Store weed killers, pesticides, and flammable products securely in closed cabinets with latches and on bottom shelves.
- Identify safe places indoors and outdoors. Safe places include under sturdy furniture such as a

It is best to store china and other breakables in closed, latched cabinets.

Even a relatively minor earthquake can leave a home in shambles.

heavy desk or table; against an inside wall; away from where glass could shatter around windows, mirrors, pictures, or where heavy bookcases or other heavy furniture could fall over; or in the open, away from buildings, trees, telephone and electrical lines, overpasses, or elevated expressways.

- Educate yourself and family members. Contact your local emergency management office or American Red Cross chapter for more information on earthquakes. Teach children how and when to call 911, police, or fire department and which radio station to tune to for emergency information. Teach all family members how and when to turn off gas, electricity, and water.
- Have disaster supplies on hand, including a flashlight and extra batteries, portable battery-operated radio and extra batteries, first aid kit and manual, emergency food and water, non-electric can opener, essential medicines, and sturdy shoes.
- Develop an emergency communication plan. In case family members are separated from one another during an earthquake, develop a plan for reuniting after the disaster. Ask an out-of-state relative or friend to serve as the "family contact." After a disaster, it's often easier to call long distance. Make sure everyone in the family knows the name, address, and phone number of the contact person.

What to Do During an Earthquake

Be aware that some earthquakes are actually fore-shocks and a larger earthquake might occur. Minimize your movements to a few steps to a nearby safe place and stay indoors until the shaking has stopped and you are sure exiting is safe.

If indoors:

- Drop to the ground, take cover by getting under a sturdy table or other piece of furniture, and hold on until the shaking stops. If there isn't a table or desk near you, cover your face and head with your arms and crouch in an inside corner of the building.
- Stay away from glass, windows, outside doors and walls, and anything that could fall, such as lighting fixtures or furniture.

- Stay in bed if you are there when the earthquake strikes. Hold on and protect your head with a pillow, unless you are under a heavy light fixture that could fall. In that case, move to the nearest safe place.
- Use a doorway for shelter only if it is in close proximity to you and if you know it is a strongly supported, load-bearing doorway.
- Stay inside until shaking stops and it is safe to go outside. Research has shown that most injuries occur when people inside buildings attempt to move to a different location inside the building or try to leave.
- Be aware that the electricity may go out or the sprinkler systems or fire alarms may turn on.

If outdoors:

- Stay outside.
- Move away from buildings, streetlights, and utility wires.
- Once in the open, stay there until the shaking stops. The greatest danger exists directly outside buildings, at exits, and alongside exterior walls. Many of the 120 fatalities from the 1933 Long Beach earthquake occurred when people ran outside of buildings only to be killed by falling debris from collapsing walls. Ground movement during an earthquake is seldom the direct cause of death or injury. Most earthquake-related casualties result from collapsing walls, flying glass, and falling objects.

If in a moving vehicle:

- Stop as quickly as safety permits and stay in the vehicle. Avoid stopping near or under buildings, trees, overpasses, and utility wires.
- Proceed cautiously once the earthquake has stopped. Avoid roads, bridges, or ramps that might have been damaged by the earthquake.

If trapped under debris:

- Do not light a match.
- Do not move about or kick up dust.
- Cover your mouth with a handkerchief or clothing.
- Tap on a pipe or wall so rescuers can locate you. Use a whistle if one is available. Shout only as a last resort. Shouting can cause you to inhale dangerous amounts of dust.

What to Do After an Earthquake

- Expect aftershocks. These secondary Shockwaves are usually less violent than the main quake but can be strong enough to do additional damage to weakened structures and can occur in the first hours, days, weeks, or even months after the quake.
- Listen to a battery-operated radio or television. Listen for the latest emergency information.
- Open cabinets cautiously. Beware of objects that can fall off shelves.
- Stay away from damaged areas unless your assistance has been specifically requested by police, fire, or relief organizations. Return home only when authorities say it is safe.
- Be aware of possible tsunamis if you live in coastal areas. These are also known as seismic sea

A Inspect your utilities after an earthquake to be sure there are no leaks or other damage.

An excavator cleans up debris after an earthquake.

waves (mistakenly called "tidal waves"). When local authorities issue a tsunami warning, assume that a series of dangerous waves is on the way. Stay away from the beach.

- Help injured or trapped persons. Remember to help your neighbors who may require special assistance, such as infants, the elderly, and people with disabilities. Give first aid where appropriate. Do not move seriously injured persons unless they are in immediate danger of further injury. Call for help.
- Clean up spilled medicines, bleaches, gasoline, or other flammable liquids immediately. Leave the area if you smell gas or fumes from other chemicals. Inspect the entire length of chimneys for damage. Unnoticed damage could lead to a fire.
- Inspect utilities. Check for gas leaks. If you smell gas or hear a blowing or hissing noise, open a window and quickly leave the building. Turn off the gas at the outside main valve if you can and call the gas company from a neighbor's home. If you turn off the gas for any reason, it must be turned back on by a professional. Second, look for electrical system damage. If you see sparks or broken or frayed wires, or if you smell hot insulation, turn off the electricity at the main fuse box or circuit breaker. If you have to step in water to get to the fuse box or circuit breaker, call an electrician first for advice. Finally, check for sewage and water line damage. If you suspect sewage lines are damaged, avoid using the toilets and call a plumber. If water pipes are damaged, contact the water company and avoid using water from the tap. You can obtain safe water by melting ice cubes.

Coping with Disasters

BY LEN MCDOUGALL

While many aspects of survival are generic—like the need to eat drink, and sleep—different situations can demand different responses. Following are some of the disasters that are most anticipated by FEMA and DHL.

Floods

Flooding is the most common natural disaster in every U.S. state, a statistic that has proved itself repeatedly in recent years. Some floods occur during heavy rains, some during a heavy snowmeLt. Flash floods can strike quickLy in mountain country, often from rains that fall many miles away, because even a light rain can run into rivulets that form into rivers that become torrents as they rush downhill over nonabsorbent rock. It is especially important to be prepared for flooding if you are in low-level terrain, near a river or creek, or downstream from a dam.

According to the Department of Homeland Security, the first step in safeguarding against any type of flood is to “Get a Kit.” DHS recommends an Emergency Supply Kit that includes a 3-day supply of nonperishable food water, a battery-powered or hand-crank radio receiver, flashlights, and spare batteries.

DHS also suggests assembling a second kit for the car. This kit is more critical than a household emergency kit because there are fewer alternatives—if you don’t have a 4-by-4 bandage, you can’t go to the linen closet to make bandages from a sheet. This kit should contain photocopies of prescriptions so that you can get refills more easily when normalcy returns. It should include copies and photocopies of deeds titles, and identification documents, as well as pertinent medical information—blood type, heart or other organ problems—medications being taken, and copies of financial records, all sealed in a watertight lockbox. A change of clothing warm sleeping bag(s) and pillows sealed inside garbage bags help to ensure

Next, create a Family Emergency Plan. Members of your family might not be together when a disaster occurs, and it could be vital to have a strategy for contacting one another, a place where everyone will go to meet the others, and discuss contingency plans, in case things don’t go as expected. Bear in mind that when phone lines or towers are down at ground-zero, it might be easier to make a telephone call long-distance than locally. Ask about emergency plans at your workplace, and at schools or daycare facilities attended by your children, and don’t be embarrassed to share your own emergency plan with the staff there. And of course, pets should be included in any emergency strategy. If you’d like to become more involved, DHS sponsors Community Emergency Response Team (CERT) classes from local Citizen Corps chapters.

a restful night's sleep. You should have bottled water sufficient to provide each person in your family or intended group with at least one gallon of drinking water, and a water filter that enables you to make more from any ditch. An LED flashlight or headlamp with spare batteries provides cheap night-vision and can be used to signal for help from passing vehicles or aircraft at night. A battery-operated shortwave radio often provides international news that is more current and accurate than local broadcasts from a disaster area; Coleman's StormBeam incorporates a nice LED flashlight, an FM receiver, and multiple cell-phone adapters into a palm-size unit that seems made for automobile survival. An NOAA Weather Radio is also an asset.

Flood Warnings

- Flood Watch: Flooding is possible. Tune in to NOAA or local weather broadcasts for the most current information.
- FLash Flood Watch: FLash flooding is possible; be ready to move to the highest elevation available; listen to NOAA and local weather broadcasts.
- FLood Warning: A flood is happening or is imminent; prepare to evacuate when advised to do so.
- FLash Flood Warning: Aflash flood is occurring; do not attempt to drive, but seek out the highest elevation immediately.

Frequent Causes of Flooding

Tropical Storms and Hurricanes: Hurricanes bring powerful winds, pounding rain, and dangerous flying debris. They can submerge coastlines and cause monsoon-like rains hundreds of miles inland DHS claims that all coastlines are at risk, but some low-lying cities are especially vulnerable and could suffer damages even greater than those caused by Hurricane Katrina in 2005. When hurricanes slow

to become tropical storms, their loss of impetus can concentrate copious amounts of rain onto a single area—like the 30 inches that Tropical Storm Allison dumped onto Houston, Texas, in 2001, flooding more than 70,000 homes.

Snowmelt: During the spring melt in snow country, frozen earth prevents water from being absorbed into the ground. Like a Rash flood in mountain country, the melted rivulets run together to form increasing larger streams that join on their way to the lowest geographical point. The result can be overflowing streams, rivers, and lakes, especially when meltwater is joined by spring rains.

Heavy Rains: Several areas of the country are at heightened risk for flooding due to heavy rains. The Northwest is at high risk due to La Niña conditions, which include an increased risk of extreme snowmelts, heavy rains, and wildfires. And The Northeast is at high risk due to heavy rains produced from Nor'easters. This excessive amount of rainfall can happen throughout the year, putting your property at risk.

West Coast Threats: The West Coast rainy season usually lasts from November to April, bringing heavy flooding and increased flood risks with it; however, flooding can happen at any time. Large wildfires have dramatically changed the landscape and ground conditions, causing fire-scorched land to become mudflows under heavy rain. Experts say that it might take years for

vegetation, which will help stabilize these areas, to return. The West Coast also has thousands of miles of levees, which are meant to help protect homes and their land in case of a flood. However, levees can erode, weaken, or overtop when waters rise, often causing catastrophic results.

Levees and Dams: Levees are designed to protect against a certain level of flooding. However, levees can and do decay over time, making maintenance a serious challenge. Levees can also be overtopped or even fail during large floods, creating more damage than if the levee wasn't even there. Because of the escalating flood risks in areas with levees, especially in the Midwest, FEMA strongly recommends flood insurance for all homeowners in these areas.

Flash Floods: Flash floods are the number one weather-related killer in the United States; they can roll boulders, tear out trees, and destroy buildings and bridges. A flash flood is a rapid flooding of low-lying areas in less than six hours, which is caused by intense rainfall from a thunderstorm or several thunderstorms. Flash floods can also occur from the collapse of a man-made structure or ice dam.

New Development: Construction and development can change the natural drainage and create brand-new flood risks. That's because new buildings, parking lots, and roads mean less land to absorb excess precipitation from heavy rains, hurricanes, and tropical storms.

Know Your Risks, Know Your Saftey

Find out if your home is at risk for flood and educate yourself on the impact a flood could have on you and your family. FEMA's Flood Insurance Study compiled statistical data on river flows, storm tides, hydrologic/hydraulic analyses, and rainfall and topographic surveys to create flood hazard maps that outline your community's different flood risk areas.

Most homeowners insurance does not cover flood damage. Talk to your insurance provider about your policy and consider if you need additional coverage. The National Flood Insurance Program (NFIP) can help provide a means for property owners to financially protect themselves if additional coverage is required. The NFIP offers flood insurance to homeowners, renters, and business owners if their community participates in the NFIP. To find out more about the NFIP visit www.FloodSmart.gov.

Prepare your Home

- Elevate the furnace, water heater, and electric panel in your home if you live in an area that has a high flood risk.
- Consider installing "check valves" to prevent floodwater from backing up into the drains of your home.
- If feasible, construct barriers to stop floodwater from entering the building and seal walls in basements with waterproofing compounds.
- Find out how to keep food safe during and after an emergency by visiting www.foodsafety.gov/keep/emergency/index.html.

Prepare Your Business

- Plan to stay in business, talk to your employees, and protect your investment.
- Carefully assess how your company functions, both internally and externally, to determine which staff, materials, procedures and equipment

are absolutely necessary to keep the business operating.

Identify Operations Critical to Survival And Recovery

- Plan what you will do if your building, plant, or store is not accessible.
- Consider if you can run the business from a different location or from your home.
- Develop relationships with other companies to use their facilities in case a disaster makes your location unusable.
- Learn about programs, services, and resources at the U.S. Small Business Administration.

Listen to local officials

Learn about the emergency plans that have been established in your area by your state and local government. In any emergency, always listen to the instructions given by local emergency management officials.

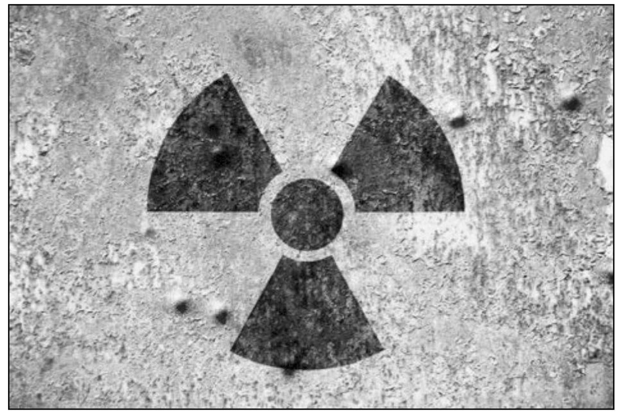
Federal and national resources

Find additional information on how to plan and prepare for floods, learn what to do during and after a flood, and explore other available resources by visiting the following:

Federal Emergency Management Agency
NOAA Watch
American Red Cross
U.S. Environmental Protection Agency
U.S. Department of Health and Human Services, Center for Disease Control
USA Freedom Corps Website
www.FloodSmart.gov

Man-made disasters

A radiation threat, commonly referred to as a "dirty bomb" or "radiological dispersion device (RDD)," is the use of common explosives to spread



radioactive materials over a targeted area. It is not a nuclear blast. The force of the explosion and radioactive contamination will be more localized. While the blast will be immediately obvious, the presence of radiation will not be clearly defined until trained personnel with specialized equipment are on the scene. As with any radiation, you want to try to limit exposure. It is important to avoid breathing radiological dust that may be released in the air.

If there is a radiation threat or "dirty bomb":

- If you are outside and there is an explosion or authorities warn of a radiation release nearby, cover your nose and mouth and quickly go inside a building that has not been damaged. If you are already inside, check to see if your building has been damaged. If your building is stable, stay where you are.
- Close windows and doors; turn off air conditioners, heaters, or other ventilation systems.
- If you are inside and there is an explosion near where you are or you are warned of a radiation release inside, cover nose and mouth and go outside immediately. Look for a building or other shelter that has not been damaged and quickly get inside.
- Once you are inside, close windows and doors; turn off air conditioners, heaters or other ventilation systems.
- If you think you have been exposed to radiation, take off your clothes and wash as soon as possible.

- Stay where you are, watch TV, listen to the radio, or check the Internet for official news as it becomes available.
- Remember: To limit the amount of radiation you are exposed to, think about time, distance, and shielding:
  - Time: Minimizing time spent exposed will also reduce your risk.
  - Distance: The farther away you are away from the blast and the fallout, the lower your exposure.
  - Shielding: If you have a thick shield between yourself and the radioactive materials, more of the radiation will be absorbed, and you will be exposed to less.

As with any emergency, local authorities may not be able to immediately provide information on what is happening and what you should do. However, you should watch TV, listen to the radio, or check the Internet often for official news and information as it becomes available.

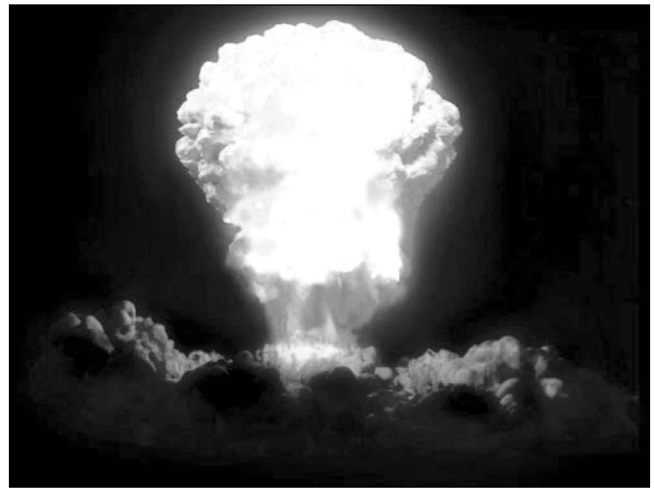
Nuclear Blast

A nuclear blast is an explosion with intense light and heat, a damaging pressure wave and widespread radioactive material that can contaminate the air, water, and ground surfaces for miles around. During a nuclear incident, it is important to avoid radioactive material, if possible. While experts may predict at this time that a nuclear attack is less likely than other types, terrorism by its nature is unpredictable.

If there is advanced warning of an attack, Take cover immediately, as far belowground as possible, though any shield or shelter will help protect you from the immediate effects of the blast and the pressure wave.

If there is no warning:

- Quickly assess the situation.
- Consider if you can get out of the area or if it would be better to go inside a building to limit the amount of radioactive material you are exposed to.



- If you take shelter, go as far belowground as possible close windows and doors, and turn off air conditioners heaters, or other ventilation systems. Stay where you are, watch TV, listen to the radio, or check the Internet for official news as it becomes available.
- To limit the amount of radiation you are exposed to think about shielding, distance, and time:
  - Shielding: If you have a thick shield between yourself and the radioactive materials, more of the radiation will be absorbed, and you will be exposed to less.
  - Distance: The farther away you are away from the blast and the fallout the lower your exposure.
  - Time: Minimizing time spent exposed will also reduce your risk.

Use available information to assess the situation. If there is a significant radiation threat, health care authorities may or may not advise you to take potassium iodide. Potassium iodide is the same stuff added to your table salt to make it iodized. It may or may not protect your thyroid gland, which is particularly vulnerable, from radioactive iodine exposure. Plan to speak with your health care provider in advance about what makes sense for your family.

For more information, see “Potassium Iodide” from the Centers for Disease Control.

For more general information, see “Are you Ready?” from the Federal Emergency Management Agency.

Biological Threats

A biological attack is the deliberate release of germs or other biological substances that can make you sick. Many agents must be inhaled, enter through a cut in the skin, or be eaten to make you sick. Some biological agents, such as anthrax, do not cause contagious diseases. Others, like the smallpox virus, can result in diseases you can catch from other people.

If there is a biological threat:

Unlike an explosion, a biological attack may or may not be immediately obvious. While it is possible that you will see signs of a biological attack, as was sometimes the case with the anthrax mailings, it is perhaps more likely that local health care workers will report a pattern of unusual illness or there will be a wave of sick people seeking emergency medical attention. You will probably learn of the danger through an emergency radio or TV broadcast or some other signal used in your community. You might get a telephone call, or emergency response workers may come to your door.

In the event of a biological attack, public health officials may not immediately be able to provide information on what you should do. It will take time to determine exactly what the illness is, how it should be treated, and who is in danger. However, you should watch TV, listen to the radio, or check the Internet for official news including the following:

- Are you in the group or area authorities consider in danger?
- What are the signs and symptoms of the disease?
- Are medications or vaccines being distributed?
- Where? Who should get them?
- Where should you seek emergency medical care if you become sick?

During a declared biological emergency, if a family member becomes sick, it is important to be suspicious.

- Do not assume, however, that you should go to a hospital emergency room or that any illness is the result of the biological attack. Symptoms of many common illnesses may overlap.
- Use common sense, practice good hygiene and cleanliness to avoid spreading germs, and seek medical advice.
- Consider if you are in the group or area authorities believe to be in danger.
- If your symptoms match those described, and you are in the group considered at risk, immediately seek emergency medical attention.

If You Are Potentially Exposed:

- Follow instructions given by doctors and other public health officials.
- If the disease is contagious expect to receive medical evaluation and treatment. You may be advised to stay away from others or even deliberately quarantined.

- For noncontagious diseases, expect to receive medical evaluation and treatment.

If You Become Aware Of An Unusual And Suspicious Substance Nearby:

- Quickly get away.
- Protect yourself. Cover your mouth and nose with layers of fabric that can filter the air but still allow breathing. Examples include two to three layers of cotton such as a T-shirt, handkerchief or towel. Otherwise, several layers of tissue or paper towels may help.
- Wash with soap and water.
- Contact authorities.
- Watch TV, listen to the radio, or check the Internet for official news and information including what the signs and symptoms of the disease are, if medications or vaccinations are being distributed, and where you should seek medical attention if you become sick.
- If you become sick, seek emergency medical attention.

Chemical Threats

A chemical attack is the deliberate release of a toxic gas, liquid or solid that can poison people and the environment.

Possible signs of chemical threat:

- Many people suffering from watery eyes, twitching choking, having trouble breathing or losing coordination.
- Many sick or dead birds, fish, or small animals are also cause for suspicion.

If You See Signs of Chemical Attack: Find Clean Air Quickly

- Quickly try to define the impacted area or where the chemical is coming from, if possible.

- Take immediate action to get away.
- If the chemical is inside a building where you are get out of the building without passing through the contaminated area, if possible.
- If you can't get out of the building or find dean air without passing through the area where you see signs of a chemical attack, it may be better to move as far away as possible and shelter in place.
- If you are outside, quickly decide what is the fastest way to find clean air. Consider if you can get out of the area or if you should go inside the closest building and shelter in place.

If You Think You Have Been Exposed To a Chemical:

- If your eyes are watering, your skin is stinging, and you are having trouble breathing, you may have been exposed to a chemical.
- If you think you may have been exposed to a chemical, strip immediately and wash.
- Look for a hose, fountain, or any source of water, and wash with soap if possible being sure not to scrub the chemical into your skin.
- Seek emergency medical attention.

For more information, see "Are you Ready?" from the Federal Emergency Management Agency.

Influenza Pandemic Info

You can prepare for an influenza pandemic now. You should know both the magnitude of what can happen during a pandemic outbreak and what actions you can take to help lessen the impact of an influenza pandemic on you and your family. This list will help you gather the information and resources you may need in case of a flu pandemic.

Plan For a Pandemic:

- Store a two-week supply of water and food. During a pandemic, if you cannot get to a store, or if stores are out of supplies, it will be important for you to have extra supplies on hand. This can be useful in other types of emergencies, such as power outages and disasters.
- Periodically check your regular prescription drugs to ensure a continuous supply in your home.

- Have any nonprescription drugs and other health supplies on hand, including pain relievers, stomach remedies, cough and cold medicines, fluids with electrolytes, and vitamins.
- Talk with family members and loved ones about how they would be cared for if they got sick, or what will be needed to care for them in your home.
- Volunteer with local groups to prepare and assist with emergency response.
- Get involved in your community as it works to prepare for an influenza pandemic.

Limit the Spread of Germs And Prevent Infection:

- Avoid close contact with people who are sick. When you are sick, keep your distance from others to protect them from getting sick too.
- If possible, stay home from work, school, and errands when you are sick. You will help prevent others from catching your illness.
- Cover your mouth and nose with a tissue when coughing or sneezing. It may prevent those around you from getting sick.
- Wash your hands often; this will help protect you from germs.
- Avoid touching your eyes, nose, or mouth. Germs are often spread when a person touches

something that is contaminated with germs and then touches his or her eyes, nose, or mouth.

- Practice other good health habits. Get plenty of sleep, be physically active manage your stress, drink plenty of fluids, and eat nutritious food.

For more information on preparing for and responding to an influenza pandemic, visit the U.S. Department of Health and Human Service's website at www.pandemicflu.gov.

Tsunamis

Tsunamis, also known as seismic sea waves, are most common along the Pacific coast, but can strike anywhere along the U.S. coastline. Tsunamis are enormous waves caused by an underground disturbance such as an earthquake. They can move hundreds of miles per hour and hit land with waves topping 100 feet in height.

Understand the difference between the terms that identify a tsunami hazard: advisory, watch and warning. For a detailed explanation of these terms, see www.fema.gov/areyouready/tsunamis.shtm.

Plan To Act Quickly.

- If you are in coastal waters and notice a dramatic recession of water from the shoreline you should heed nature's warning that a tsunami is approaching.
- Move inland immediately and do not return to the flooded and damaged areas until officials say it is safe to do so.
- Visit NOAA for more weather-related information.
- Find out how to keep food safe during and after and emergency by visiting www.foodsafety.gov/keep/emergency/index.html

Stay informed. Local authorities may not immediately be able to provide information on what is happening and what you should do. However, you should listen to NOAA Weather Radio, watch TV, listen to the radio, or check the Internet often for official news and instructions as they become available.

Volcanoes

Potentially active volcanoes in the United States exist mainly in Hawaii, Alaska, and the Pacific Northwest. When pressure builds up within a volcano's molten rock it has the potential to erupt, sending forth lava flows, poisonous gases, and flying rack and ash that can sometimes travel hundreds of miles downwind.

- Follow the instructions given by local emergency officials.
- Know your community's warning systems and disaster plans, including evacuation routes.
- Plan to evacuate quickly and to take your portable emergency supply kit with you.
- Plan ahead by adding extra goggles and something to cover your nose and mouth to your

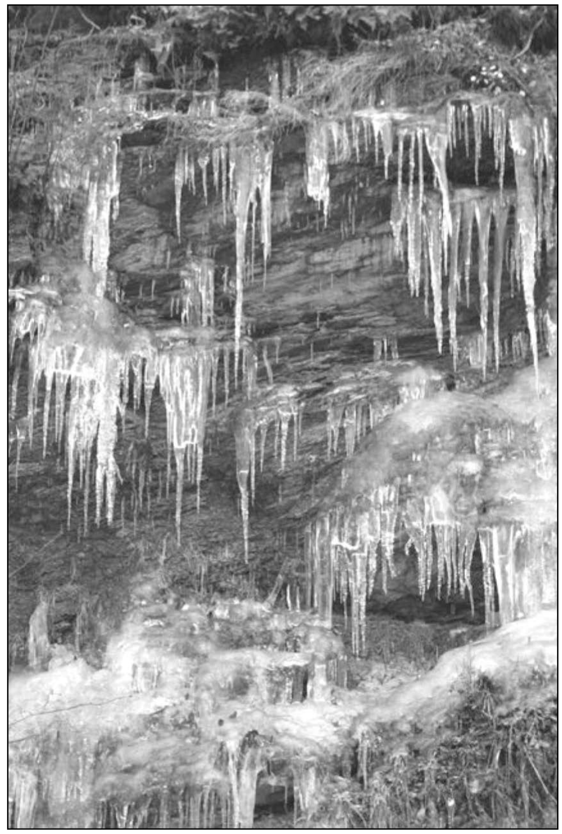
emergency supply kit. Include something to cover your nose and mouth for every member of your family.

- If you are unable to evacuate, and in order to protect yourself from falling ash, you should remain indoors with doors, windows, and ventilation closed until the ash settles.

Stay informed. Local authorities may not immediately be able to provide information on what is happening and what you should do. However, you should listen to NOAA Weather Radio, watch TV, listen to the radio or check the Internet often for official news and instructions as they become available

For additional information on dealing with volcanic eruptions, please see: www.redcross.org/www-files/Documents/pdf/Preparedness/AreYou-Ready/PublicInformationVolcanoes.pdf and/or www.fema.gov/areyou-ready/volcanoes.shtm.

Winter Storms And Extreme Cold



While the danger from winter weather varies across the country, nearly all Americans, regardless of where they live, are likely to face some type of severe winter weather at some point in their lives. That could mean snow or subfreezing temperatures, as well as strong winds or even ice or heavy rainstorms. One of the primary concerns is the winter weather's ability to knock out heat, power, and communications services to your home or office, sometimes for days at a time. The National Weather Service refers to winter storms as the "Deceptive Killers" because most deaths are indirectly related to the storm. Instead, people die in traffic accidents on icy roads and of hypothermia from prolonged exposure to cold. It is important to be prepared for winter weather before it strikes.

Step 1: Get A Kit

- Get an Emergency Supply Kit that includes items like nonperishable food, water, a battery-powered or hand-crank radio, extra flashlights, and batteries.

- Thoroughly check and update your family's Emergency Supply Kit before winter approaches, and add the following supplies in preparation for winter weather:
  - Rock salt to melt ice on walkways
  - Sand to improve traction
  - Snow shovels and other snow removal equipment
  - Adequate clothing and blankets to keep you warm

Step 2: Make A Plan

Prepare Your Family

Make a Family Emergency Plan. Your family may not be together when disaster strikes, so it is important to know how you will contact one another, how you will get back together, and what you will do in case of an emergency.

- Plan places where your family will meet, both within and outside your immediate neighborhood.

- It may be easier to make a long-distance phone call than to call across town, so an out-of-town contact may be in a better position to communicate among separated family members.
- You may also want to inquire about emergency plans at places where your family spends time: work, day care and school. If no plans exist, consider volunteering to help create one.
- Take a Community Emergency Response Team (CERT) class from your local Citizen Corps chapter. Keep your training current.

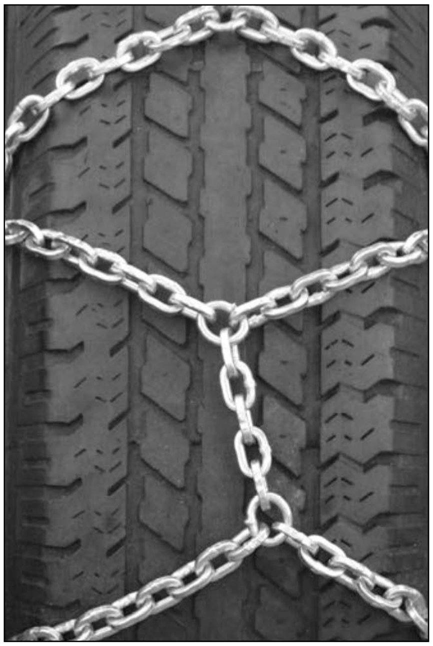
Step 3: Be informed

Prepare Your Home

- Make sure your home is well insulated and that you have weather stripping around your doors and windowsills to keep the warm air inside.
- Insulate pipes with insulation or newspapers and plastic and allow faucets to drip a little during cold weather to avoid freezing.
- Learn how to shut off water valves (in case a pipe bursts)
- Keep fire extinguishers on hand, and make sure everyone in your house knows how to use them. House fires pose an additional risk as more people turn to alternate heating sources without taking the necessary safety precautions.
- Know ahead of time what you should do to help elderly or disabled friends, neighbors, or employees.
- Hire a contractor to check the structural stability of the roof to sustain unusually heavy weight from the accumulation of snow—or water, if drains on flat roofs do not work.

If you have a car, fill the gas tank in case you have to leave. In addition, check or have a mechanic check the following items on your car:

- Antifreeze levels—ensure they are sufficient to avoid freezing.



- Battery and ignition system—should be in top condition, and battery terminals should be clean.
- Brakes—check for wear and fluid levels.
- Exhaust system—check for leaks and crimped pipes and repair or replace as necessary. Carbon monoxide is deadly and usually gives no warning.
- Fuel and air filters—replace and keep water out of the system by using additives and maintaining a full tank of gas.
- Heater and defroster—ensure they work properly.
- Lights and flashing hazard lights—check for serviceability.
- Oil—check for level and weight. Heavier oils congeal more at low temperatures and do not lubricate as well.
- Thermostat—ensure it works properly.
- Tires—make sure the tires have adequate tread. All-weather radials are usually adequate for most winter conditions. However, some jurisdictions require that to drive on their roads, vehicles must be equipped with chains or snow tires with studs.
- Windshield wiper equipment—repair any problems and maintain proper washer fluid level.

Familiarize Yourself With The Terms That Are Used To Identify Winter Weather:

- Freezing rain creates a coating of ice on roads and walkways.
- Sleet is rain that turns to ice pellets before reaching the ground. Sleet also causes roads to freeze and become slippery.
- Winter Weather Advisory means cold, ice, and snow are expected.
- Winter Storm Watch means severe weather such as heavy snow or ice is possible in the next day or two.
- Winter Storm Warning means severe winter conditions have begun or will begin very soon.
- Blizzard Warning means heavy snow and strong winds will produce a blinding snow, near zero visibility, deep drifts, and life-threatening windchill. Frost/Freeze Warning means below-freezing temperatures are expected.

When a Winter Storm Watch Is Issued:

- Listen to NOAA Weather Radio, local radio, and television stations, or cable television such as The Weather Channel for further updates.
- Be alert to changing weather conditions.

- Avoid unnecessary travel.
- When a Winter Storm WARNING is issued.
- Stay indoors during the storm.
- If you must go outside, several layers of lightweight clothing will keep you warmer than a single heavy coat. Gloves (or mittens) and a hat will prevent loss of body heat. Cover your mouth to protect your lungs.
- Walk carefully on snowy, icy walkways.
- If the pipes freeze, remove any insulation or layers of newspapers and wrap pipes in rags. Completely open all faucets and pour hot water over the pipes, starting where they were most exposed to the cold (or where the cold was most likely to penetrate).
- Maintain ventilation when using kerosene heaters to avoid buildup of toxic fumes Refuel kerosene heaters outside and keep them at least 3 feet from flammable objects.

Avoid traveling by car in a storm, but if you must...

- Carry an Emergency Supply Kit in the trunk.
- Keep your car's gas tank full for emergency use and to keep the fuel line from freezing.
- Let someone know your destination, your route, and when you expect to arrive. If your car gets stuck along the way, help can be sent along your predetermined route.
- Eat regularly and drink ample fluids, but avoid caffeine and alcohol.
- Conserve fuel, if necessary, by keeping your residence cooler than normal. Temporarily close off heat to some rooms.

Listen to local officials

Learn about the emergency plans that have been established in your area by your state and local government. In any emergency, always listen to the instructions given by local emergency management officials. For further information on how to plan and prepare for winter storms as well as what to do during and after a winter storm, visit the websites for the Federal Emergency Management Agency, NOAA Watch, or American Red Cross.

How to Recognize the Arrival of Day One

BY KATE AND JIM ROWINSKI

To some, Day One means the mushroom cloud on the horizon, the choking in the Tokyo subway, or trekking across subarctic areas in running shoes while the temperature plummets to -40°F. Wrong, that is *Day Two*. By that time, you should have been in a fallout shelter, avoiding the subway, or wearing insulated clothing and pulling a cargo toboggan.

To recognize Day One, you must be an armchair general, keeping abreast of the news and having the knowledge and equipment to muddle through Day Two. The only way to survive in style is to have a plan and the knowledge to carry it through. Day One can be anywhere from one day to ten years long, depending on the disaster scenario you are facing. In the individual scenarios, we will try to focus on their estimated duration.

Similarly, Day Two or Day Three are not necessarily of a twenty-four-hour duration. Perhaps it would have been more precise to call them phases. However, it is easier to think of them as days. When you look back upon an interesting phase of your life, you think of specific days while skipping over other intervening ones when nothing much happened. So it is with this book.

Day One is critical to your well-being. This is when you plan, prepare, accumulate supplies, and learn new skills to carry you through the following days. What you do on Day One determines whether you will live through any of the scenarios detailed in this book in style. Some people will survive without preparation by sheer Luck, but that is not the way to bet. What you are betting is your existence and the existence of those you love.

Day One is unusual in that if you do not prepare for it, unless you are very lucky, you have lost the battle. Your planning starts when you realize that things can happen to you. Day One is the day when many people will ridicule you if they know that you are preparing for something. On the other hand, if you do not prepare, you are not likely to have any descendants. As the old saying goes, "If your parents did not have any children, you are not likely to have any either."

At the very least have your passport and other important papers up to date and close to you. What should you keep in your safety deposit box? Your fire insurance policy, copies of important papers, a copy of your last will, and similar documents. Do not keep cash, gold, firearms, or like items in your safety deposit box. Under many circumstances, they will get you into trouble. Even in a nonemergency situation, think what the IRS, the ATF, or the FBI would make of them.

Where should you keep the originals of your papers and your valuables? The answer depends on where you live. If your home is one room in a boardinghouse and your landlord regularly pokes around your place, the best solution is to carry your valuables with you, wherever you go. On the other hand, if you own a house in the suburbs, there are many more places to hide your valuables and supplies.

There is a tendency among us to brag a little about the preparations we make. I can't repeat it often enough—keeping a low profile is very important in this business. You may have an impromptu show-and-tell session with a neighbor, who doesn't believe there could be hard times. Once something does happen, he will turn on you for your supplies. His lack of preparedness is partially due to the government-encouraged belief that "it can't happen here." It will and you better be prepared for it, even if your neighbor isn't.

Except in a few cases, Day One will not arrive with large neon signs and sound effects proclaiming that it is here. In most cases, Day One arrives like a thief in the night. Sometimes it is only on Day Two that many will realize that Day One was yesterday. As a general piece of advice, assume that Day One is on hand now. Lay in supplies, learn new skills, and keep informed on what is happening in the world. Accumulate stocks of food that you eat now, and rotate those stocks. Do not rely too much on your freezer and refrigerator. Electricity is one of the first

things to go in an emergency. Rely on canned foods, dehydrated sachets of soup and pasta dishes, canned meats, stews, and other nonperishables.

Day One has already come for some scenarios, and it is very close to many others. We are living at the edge, and given the current state of affairs, we should be on guard. Once a scenario unfolds, it can progress at a frightening pace. Be prepared at all times.

What to do:

- Take stock of what you are eating, and take stock of what you have on hand. That will tell you how long you could survive if the stores close tomorrow.
- Where do you get your water? Find what other sources you have, and have those sources tested.
- What happens to your sewage? How would you cope if your system is disrupted?
- Are you on medications? How long could you last without them? Do you have an alternate source for them? Always refill your prescriptions ahead of time. If questioned, just say that you are taking a trip. Have at least a month's supply on hand.
- Is your vehicle ready to roll in case of an emergency? How much gas do you have? What about lubricants, brake fluid, spare parts?
- Do you have a place to go? Do you know the topography of the area between your home and your place of retreat?
- Do you have the knowledge to deal with emergencies? Do you have the skills to put the knowledge into practice?
- How can you make your home harder to break into by criminals and looters?
- Can you handle firearms for self-defense? Do you have the firearms along with ammunition and spare parts to maintain them? Can you reload ammunition?
- Have you taken a first-aid course in the last five years? Do you have the supplies and instruments to give first aid?
- Are you aware of what is happening in your community, your country, and in the world? Do you have radios, communication devices, and newsletters to keep you informed?
- Do you have the financial or barter assets to start all over again?

A lot of hard questions are raised above. Yet, unless you sit down and answer them in the hard light of honesty, your chances of surviving even a temporary interruption in your present mode of life will be reduced.

Then there is the question of security while you are preparing to survive. The ten commandments of security are:

1. Do not discuss personal or family business with anyone not directly involved.
2. Do not trust a politician or bureaucrat's word or promise.
3. Never give your real name or address when purchasing survival supplies.
4. Never let strangers into your home.
5. Do not turn your back on an unlocked door or window.
6. Do not have your street address on any of your IDs or mail. Use a P.O. box as much as you can.
7. Do not keep all your money or valuables in the same bank. Have several bank accounts under different names.
8. Never rely on someone else doing anything correctly or on time.
9. Do not have important mail sent to your home.
10. Always set the alarm and lock your garage when leaving your home.

Contributors and Their Works

All short stories, articles, recipes, and other works appearing in this compendium have been reprinted courtesy of the authors listed below. To buy any of their books, go to the websites indicated.

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Trout Fishing the Southern Appalachians

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*A Skyhorse publication

Barn Records and Forms

CHICKEN
cheat sheet and fast facts

* based on 25 chickens *

Birth Date	Breed	Class	Expected Leave
/ /			/ /

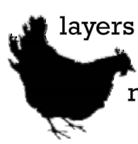
Week 1	Week 4	Week 6	Week 18-22	Weeks 23+
90-92°F	75°F	45-80°F →		
15 sq. ft	50 sq. ft.	100 sq. ft. →		

← water: 2 to 4 gallons per day →

starter crumble 25 lbs/wk → layer grower → pre-layer 50 lbs/wk → laying ration

layers start laying - increase light
if raising dual-purpose,
cull the roosters

↑ layers / dual-purpose



meat birds ↓

Week 1	Week 4	Week 8	Week 16
	75°F	45-80°F →	
15 sq. ft	100 sq. ft. →		

← water: 2 to 4 gallons per day →

starter crumble 25 lbs/wk; grower pellets 50 lbs/wk → finishing grain →; 100 lbs/wk →

Date	Notes / Worming / Feed & Medication Changes
/ /	
/ /	
/ /	
/ /	

GOAT
breeding and birth record

Doe's Name

Reg. No.

Registry

Date of Breeding / /

Buck's Name

Buck's Reg. No.

Buck's Registry

Buck's Owner Name

Address

Buck's Owner Signature

Expected Kid Date / /

Actual Birth Date / /

Name / ID Kid #1

Sex

Weight

Descriptive features and notes:

Name / ID Kid #2

Sex

Weight

Descriptive features and notes:

Name / ID Kid #3

Sex

Weight

Descriptive features and notes:

GOAT
health docket for

Birth Date / /	Tag/Tattoo/Reg	Registry

Sex	Sire	Dam

Vaccinations:

Date	Vaccination	Veterinarian
/ /		
/ /		
/ /		
/ /		

Worming:

Date	Medication Used	Dosage
/ /		
/ /		
/ /		
/ /		

Weight:

Date	Weight	Feed Changes?
/ /		
/ /		
/ /		
/ /		

Date	Notes / Milk Record / Grain Changes
/ /	
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GOAT
purchase agreement

Use of this form is at your own discretion and should not be considered legal counsel.

Birth Date / /	Tag/Tattoo/Reg	Registry

Sex	Sire	Dam

Seller's Name	Seller's Address
Buyer's Name	**Buyer's Address**

Today's Date / /	Amount Received	Goat's Veterinarian

Worming / Medications / Vaccination / Castration / Breeding

Date		Particulars
/ /		
/ /		
/ /		
/ /		

Seller's Disclaimer and Buyer's Responsibilities

____________________ , (hereinafter referenced as "Seller"), is making the goat referenced above available to ________________ (Buyer) on a "where is, as is" basis, and other than guaranteeing Buyer that said goat is in good health, are free of injury or disease at the date of sale, and that same will breed if provided with the propoer care, environment, and nutrition, Seller makes no other guarantees or warranties, either expressed or implied. Any subsequent claims by Buyer, contesting Seller's representation as to the health, physical condition, or breeding soundness of the subject goat at date of sale must be fully substantiated by a physical examination and applicable medical tests performed by a licensed veterinarian and provided in writing to the Seller.

Applicable registration certificates or registration applications will be provided to Buyer if applicable, within fifteen (15) days of Seller's payment-in-full for the subject purchase, and Seller has confirmed that said payment is in valid funds.

All expenses pertaining to the transportation of the purchased goat from or to the facilities of ________________________ to or from the Buyer's facilities are the responsibility of the Buyer.

/ / ____________ ____________

Seller's Name **Seller's Signature**

/ / ____________ ____________

Buyer's Name **Buyer's Signature**

PIG
cheat sheet and fast facts

Although we do not discuss the following animals in this book, the information can be helpful for keeping or making your own records.

Birth Date / /	Sex	Name	Expected Leave / /

40 pounds	60	75	125	220 pounds
85-90°F	65-70°F			
20 sq. ft	40 sq. ft.		75 sq. ft	100 sq. ft.

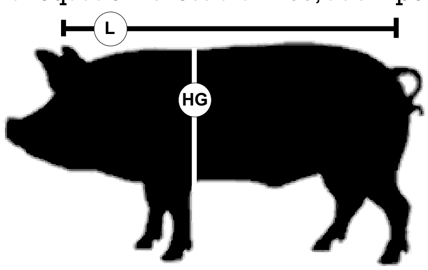
← train to electric fence ↔ worm at 10 and 14 weeks

← water: 2 to 4 gallons per day →

starter feed	grower feed	finisher feed
3 lbs / day	5 ½ lbs / day	7+ lbs / day

HG X HG X L / 400 = WEIGHT

Where HG = Heart Girth and L = Center of Head to Base of Tail
If final equation is less than 150, add 7 pounds.



Date	Notes / Worming Dates / Feed Changes
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HEIFER / COW
health, breeding and milk

Birth Date	Tag / Name	Breed / Color
/ /		

Birth Weight	Expected Mature Weight	Sire	Dam

Vaccinations/Medications:

Date	Vaccination	Vet / Clear date
/ /		
/ /		
/ /		
/ /		

Breeding and Calving History:

Heat	Breeding	Expected	Actual Calf	Notes
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Milking Records:

Date	Quantity	Date	Quantity	Date	Quantity
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SHEEP
health and maintenance

Birth Date	Tag / Name	Breed / Color
/ /		

Sex	Birth Weight	Sire	Dam

Vaccinations:

Date	Vaccination	Veterinarian
/ /		
/ /		
/ /		
/ /		

Worming:

Date	Medication Used	Dosage
/ /		
/ /		
/ /		
/ /		

Lambing History:

Exposure Date	Lambing Date	Ear Tag Numbers of Lambs
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/ /	/ /	

Date	Notes / Weight / Grain Changes
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