

Composting

A T H O M E



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Introduction

Composting is a simple, rewarding way to recycle yard trimmings and food scraps at home while creating compost, a valuable soil amendment for gardens and lawns.

Food scraps and yard trimmings, such as leaves, grass clippings, garden debris, and brush, make up over 20% of a typical household's solid wastes. When treated as trash, these materials increase the cost of collecting and handling community solid wastes. In the landfill, they consume valuable space and create potential pollutants such as leachate and methane gas. By composting at home, you help to reduce the cost and environmental risks of managing solid waste materials.

But equally important, yard trimmings and food scraps contain valuable soil-building nutrients and organic compounds which nature normally recycles through the decay process. By composting organic materials, you can accomplish the same thing. Compost is easy to handle and rich in organic matter. It is prized by gardeners and landscapers as a soil amendment, mulch, and source of plant nutrients.

Composting at Home explains the benefits and basics of backyard composting. It covers the composting process, the ingredients and methods for building a compost pile, how to manage it, and how to use compost. You will find enough information here to start and

manage a composting pile. A list of suggested reading and Web sites is included if you wish to learn more about this simple and beneficial process.



COMPOSTING FOR NON-GARDENERS OR IN SMALL SPACES *Nearly anyone can practice composting—it is not just for gardeners. In fact, you do not need to use compost yourself to benefit from composting. As long as you have food scraps or yard trimmings, and you enjoy recycling, you will find composting rewarding. Furthermore, composting can be done in small spaces, as small as the corner of an apartment patio. Here are some composting ideas for people who don't have a garden or large area for composting.*

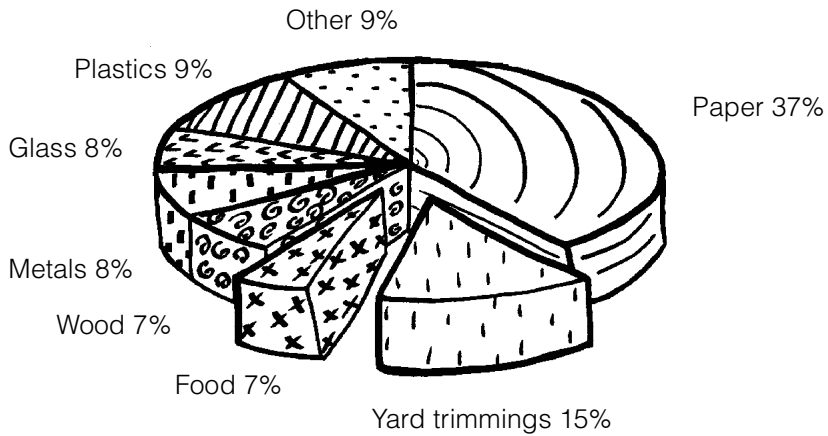


Figure 1. Components of solid waste, percentage by weight (1993)

If you do not have a garden:

- *Reduce the amount of organic material to be composted by practicing grass recycling, mulching, or another form of source reduction.*
- *Use your compost in the potting soil for your potted plants.*
- *Apply compost to your lawn as a topdressing. A thin layer of screened compost spread evenly over the lawn surface will work its way into the soil and improve the turf.*
- *Use your compost to make “compost tea” to fertilize your house plants or lawn.*
- *Give compost away to your gardening friends and neighbors, or donate it to a community gardening project.*

If you have little space for composting:

- *Reduce the amount of organic material to be composted by practicing grass recycling, mulching, or another form of source reduction.*
- *Use a composting bin or tumbler that holds the material in a compact area.*
- *Manage the composting process closely, and turn the material frequently, to produce compost in the minimum time possible. Faster composting will reduce the amount of the space needed.*
- *If you have many food scraps but few yard trimmings, try worm composting. A worm bin uses less space than a conventional composting bin and generally produces less compost.*
- *Give some or all of the organic materials from your household to a neighbor or friend who composts, or work with your neighbor or friend to produce compost together, sharing materials, labor, and space.*

Compost Happens

Understanding the composting process

Composting is a natural biological process carried out by a vast number and variety of decomposer organisms. Naturally occurring microorganisms, such as bacteria and fungi, account for most of the decomposition. Larger organisms, including insects and earthworms, also break down the materials, especially in the later stages of the process. The organisms responsible for composting consume organic materials and oxygen in order to grow and reproduce. In the process, they produce carbon dioxide, water vapor, and heat. From start to finish, the composting materials change from a diverse mixture of individual ingredients, such as leaves, stems, and fruit, to a uniform soil-like material called compost (sometimes referred to as humus).

People intervene in this natural decay process to create and maintain a good environment for the decomposer organisms, and thereby accelerate the process. How well or how much you manage the process influences the composting time, the qualities of the compost, and what problems may or may not develop. Therefore, it is helpful to understand the factors that affect composting.

Factors that affect composting

Aeration and oxygen Composting is an aerobic process; that is, it requires oxygen. The desired decomposers need oxygen to work their magic. The oxygen consumed during composting must

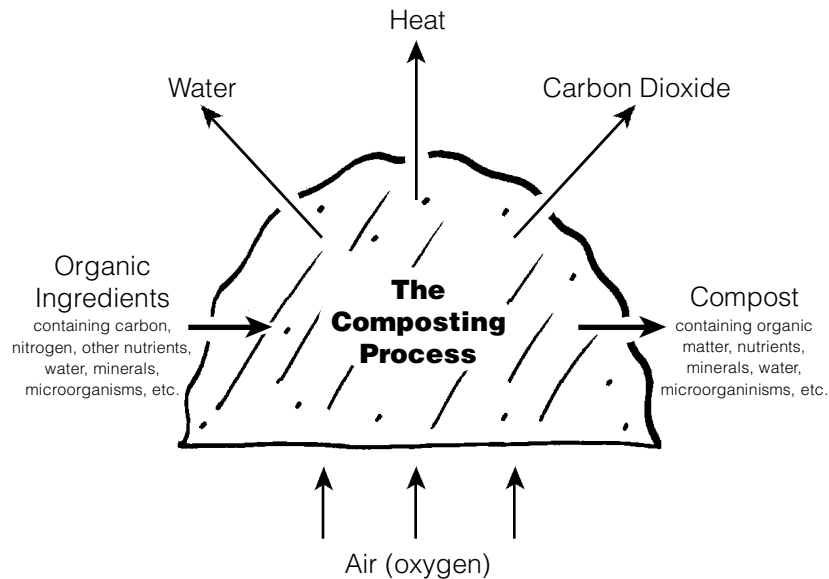


Figure 2. *Basics of the composting process*

be continually replaced by aeration (air flow through the materials). Good aeration is encouraged by placing bulky composting ingredients in the pile to create pathways for air movement, and by “turning” the materials to loosen and mix them. If oxygen becomes scarce, anaerobic decomposition takes place. Anaerobic decomposition is undesirable in a compost pile because it is slower, creates unpleasant odors, and produces little heat.

Nutrients The decomposer organisms obtain many nutrients from the composting ingredients, but carbon (C) and nitrogen (N) are particularly important. A well-balanced proportion of carbon and nitrogen usually ensures a good supply of all nutrients and allows composting to proceed rapidly. A balance of carbon and nitrogen can be achieved by combining carbon-rich or “brown” materials with nitrogen-rich or “green” materials (see “Recipes for Success”).

Degradability The speed at which composting occurs is largely determined by the degradability of the materials, that is, how easily they decompose. Microorganisms easily digest materials containing a high proportion of sugars, starches, and proteins, such as

food scraps, manure, and green vegetation. Straw, plant stems, and, especially, woody materials take longer to decompose and may even pass through the composting process with little change. You will notice that many nitrogen-rich materials (greens) tend to decompose quickly, while the carbon-rich materials (browns) are less degradable. The degradability of a material is enhanced by shredding and by ensuring that adequate amounts of nitrogen and water are available.

Moisture Microorganisms need moisture to carry out their work. If the materials are dry, the process slows down. On the other hand, too much water makes the compost pile soggy and dense, which hinders aeration. Composting materials should be moist but not dripping wet.

Surface area The decomposer organisms work on the surface of particles. Because smaller particles offer more surface area, composting is generally faster when materials are chopped, shredded, or cut into pieces. However, a pile with only fine particles is dense and therefore does not aerate well. Particles in the range of 1/4 to 2 inches usually compost well. As decomposition progresses, particles shrink in size and tend to compact. Turning helps to loosen the compacted particles and improves aeration.

Temperature Heat generated by the microorganisms during composting raises the temperature of the composting materials. The temperatures in a compost pile often rise above 120°F and sometimes exceed 160°F. High temperatures (above 140°F) have the advantage of killing pathogens (microorganisms that cause disease) and weed seeds. Because backyard composting piles are small, they may only sustain elevated temperatures for one or two days. That's OK. Good compost can also be produced by moderate temperatures. Unless the material being composted is diseased or contains many seeds, achieving high temperatures is not important.

Time Depending on the ingredients and conditions in a pile, it can take several weeks to over a year to produce compost. Compost is typically ready for use in three to six months, given regular turning, adequate moisture, and a good mixture of materials. With daily turnings and highly degradable ingredients, the composting time can be reduced to less than one month. Methods that involve little or no turning usually require more than a year to produce compost that is ready to use.

What to Compost, What Not to Compost

While most natural organic materials will decompose in time, not everything belongs in the backyard compost pile (see Table 1). Many readily available organic materials are good candidates for the backyard compost pile. Garden vegetation, landscape trimmings, and most plant-derived food scraps can generally be composted without concern. In moderation, you can also add manure from livestock and poultry.

Avoid composting plant material that is diseased or that carries an abundance of seeds and insects. You should also avoid composting grass clippings that have been treated with persistent herbicides (see “Managing Grass Clippings in the Compost Pile”). Certain invasive weeds, such as morning glory (bindweed) and quack grass, are best left out of the compost pile. Backyard compost piles do not reliably produce enough heat to destroy plant pathogens, rhizomes, and seeds. For the same reason, cat and dog feces, which can carry pathogens, should not be added to compost piles. Fatty and oily foods should be avoided because they are more likely to generate odors and attract animal pests, such as flies, dogs, and rodents.

Table 1. *Materials that can be composted, and materials that should not be composted*

(Adapted from *Composting to Reduce the Waste Stream*)

Can be composted

Aquatic plants
Bread
Branches, chipped
Brush, chipped
Coffee grounds
Compost recycled from previous batches
Corn husks, stalks, and cobs
Cut flowers
Eggshells
Evergreen needles
Fruit
Fruit peels and rinds
Garden trimmings
Grass clippings
Leaves
Manure—cattle, horse, chicken, rabbit, etc.
Paper
Sawdust
Soil, garden and potting
Straw
Sod
Tea leaves and tea bags
Vegetables
Vegetable tops and trimmings
Weeds without seeds
Wood ash
Wood chips and shavings

Should not be composted

Materials that produce odors or attract pests (oily foods)

- Butter
- Bones
- Cheese and other dairy products
- Fish scraps
- Lard
- Mayonnaise
- Meat and poultry
- Peanut butter
- Salad dressing
- Sour cream
- Vegetable oil

Possible sources of weeds and disease

- Cat manure
- Dog manure
- Diseased plants
- Plants with spreading rhizomes and invasive roots,
such as quack grass and bindweed
- Weeds that have gone to seed

Possible sources of toxins

- Plants or grass treated with persistent herbicides
- Treated or painted wood, shavings, or sawdust
- Walnut leaves



MANAGING GRASS CLIPPINGS IN THE COMPOST PILE *The easiest way to manage grass clippings is to leave them on the lawn to decompose and recycle their nutrients (see “Alternatives to Composting”). However, when clippings are collected, they can still be recycled by composting.*

Generally, grass is a good ingredient for a backyard composting pile. Grass clippings decompose rapidly and add needed moisture and nitrogen. Compost piles begin to heat soon after grass clippings are added. The resulting higher pile temperatures destroy more weed seeds and plant diseases and generally speed the composting process.

There are a few cautions to observe when composting grass clippings. Grass quickly consumes oxygen in the compost pile. Also, grass clippings tend to stick together, forming clumps and mats which air cannot penetrate. Unpleasant odors could develop if a large amount of grass is composted. The remedy is to mix grass clippings with other materials that are bulky and decompose more slowly. In general, grass clippings should make up no more than one-third (by volume) of the material in the pile. A compost pile containing a large proportion of grass should be watched and then turned if the pile begins to compact or emit an odor.

Another concern is herbicide. Most herbicides and other pesticides decompose in the compost pile, but certain long-lasting herbicides used on grass can remain in the compost (see Table 2). Sensitive plants may be damaged by herbicide residue in the compost. To be cautious, avoid putting grass clippings from lawns treated with long-lasting herbicides in the compost pile. Leave herbicide-treated clippings on the lawn. If you do add herbicide-treated grass to the compost pile, use the compost as a topdressing for the lawn or extend the composting time. After 12 months of composting, herbicide residue should not pose a problem. If you use a lawn care company, find out what chemicals they use on your lawn. Contact your local Cooperative Extension System office for questions about herbicides or other pesticides.

Table 2. *Persistence of common herbicides in soil*

(Reprinted with permission from *Composting to Reduce the Waste Stream*)

Common name	Trade name	Longevity in soil* (months)
Benefin	Balan, Balfin	4–8
DCPA	Dacthal	4–8
Bensulide	Betasan, Prefar	6–12
Glyphosate	Roundup, Kleenup	<1
2,4-D	many formulations	1–2
MCPP	many formulations	1–2
Dicamba	Banvel	3–12

* The speed at which herbicides decompose depends on the soil conditions, including temperature, moisture, and aeration. Herbicides last longer if soils are cold, dry, dense, or compacted. Decomposition will probably be faster in the compost pile than in soil.

Recipes for Success

Combining ingredients for faster composting

Composting can succeed with a wide range of materials. In fact, once you start piling any moist organic materials, composting will start on its own. But by paying attention to the combination of materials that you add to the pile, you can make composting happen faster, or hotter, or you can avoid occasional problems (see “Troubleshooting”).

The mix of materials or ingredients used for composting is often referred to as a recipe. Composting recipes attempt to provide a balanced amount of carbon (C) and nitrogen (N). If there is too little nitrogen, composting takes place slowly. However, too much nitrogen creates ammonia gas, leading to nitrogen loss. A ratio of 20 to 50 parts of carbon to 1 part of nitrogen usually results in relatively rapid composting. You can achieve the desired balance by combining the right amounts of carbon-rich and nitrogen-rich ingredients.

In backyard composting, it is not practical to follow a precise recipe. Perhaps the easiest approach is to think of organic carbon sources as “browns” and organic nitrogen sources as “greens,” and then combine brown and green ingredients in rough proportions. A mix of 2 to 3 volumes of browns to 1 volume of greens often produces a C:N ratio in the 20:1 to 50:1 range. Examples of brown materials are dried leaves, straw, corn stalks, and woody materials

Table 3: *Examples of browns and greens: typical carbon to nitrogen ratios of selected backyard composting ingredients*

		C:N Ratio*
Browns <i>Carbon-rich</i>	Dry leaves	60:1
	Corn stalks	60:1
	Straw	80:1
	Shrub trimmings	50:1
	Waste paper	400:1
	Wood	500:1
	(sawdust, shavings, etc.)	
Greens <i>Nitrogen-rich</i>	Grass clippings	17:1
	Kitchen scraps	15:1
	Vegetable culls	12:1
	Horse stable manure	25:1
	Cattle manure	18:1
	Chicken manure	8:1

* Note: The C:N ratio of all materials varies considerably from one source to the next and as the materials age.

such as paper, sawdust, wood shavings, branches, and shrub trimmings. Commonly available green materials include grass clippings, green vegetation, food scraps, and livestock manures (horse, cattle, chicken, rabbit, etc.).

Inorganic additives, such as lime and wood ash, are rarely helpful to composting, though moderate use will not hurt. Because backyard composting piles often lack nitrogen, adding synthetic chemical fertilizers or organic nitrogen sources, such as manure or blood meal, can speed the process and increase pile temperatures. However, such fertilizers are not necessary. Microbial inoculants, activators, or compost starters are also unnecessary. Yard trimmings, food scraps, compost, soil, and the general environment contain ample quantities of the desired composting organisms.

Finally, don't worry about following the right recipe. Almost any combination of organic ingredients will compost well if moisture is available. In general, composting happens faster as the ingredients become more diverse.



Some composters follow well-defined recipes with the goal of consistently producing compost that is rich in nutrients, or exceptionally high in organic content, or that has particular qualities for particular uses. A few popular approaches include the biointensive, biodynamic, and Rodale methods of composting. Typically, these methods prescribe specific ingredients along with procedures for building and managing the compost pile. Several recipes call for the addition of soil, compost, inoculants, specific herbs, manure, or minerals. There are advantages in adding certain ingredients. For example, soil contributes microorganisms and nutrients and adds bulk to the finished compost. Returning compost to a pile improves aeration and supplies microorganisms. However, composters disagree about the benefits of some recommendations, such as supplying inoculants and herbal mixtures. Nevertheless, close attention to what goes into the compost pile and how the process is managed usually results in high-quality compost. The trade-off, of course, is that gourmet composting recipes require more effort from the composter.

**GOURMET
COMPOSTING**

If your goal is to make a superior-quality compost or compost with particular attributes, learn more about the various approaches to composting. The Rodale Book of Composting (see “Suggested Reading”) provides a good review of several methods. Talk to other composters, and don’t be afraid to experiment with composting ingredients and techniques yourself. You may discover a valuable technique, yet you are unlikely to fail at composting.

Finally, remember that gourmet composting recipes and procedures are merely attempts to fine-tune the composting process and product. They are not necessary! You can make excellent compost simply by gathering together your yard trimmings and following the basic principles related to aeration, moisture, and time.

Backyard Composting Methods

Heaps, bins, and tumblers

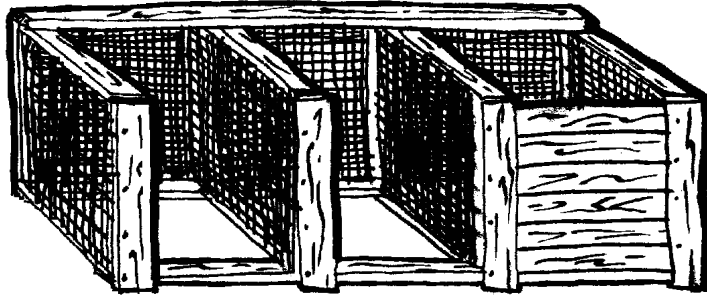
Backyard composting involves mixing ingredients together, keeping them moist, and turning the materials occasionally to improve aeration. What differs from one method to the next is how the materials are contained and turned. Options include heaps, bins, ventilated containers, and rotating tumblers.

Heaps, or freestanding piles, are the simplest form of composting, and they work very well. Materials can be added to the pile as they become available, or stockpiled until you get enough to make a good-sized heap. Either way, it is helpful to have two or three piles, one for fresh ingredients, another in the active composting stage, and possibly a third for maturing the compost. The pile is typically turned with a pitchfork, although you can use any tool that helps to lift and loosen the pile.

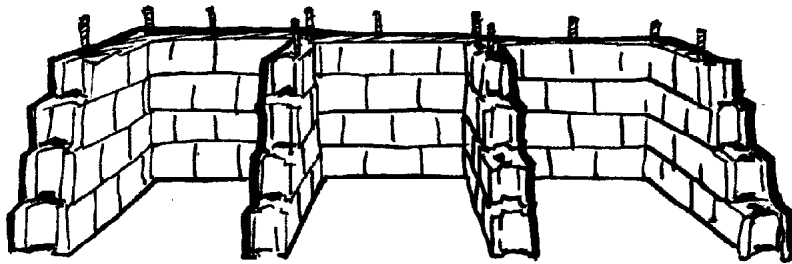
Composting bins work in nearly the same manner as heaps. However, bins more neatly confine the composting materials and allow them to be stacked higher. Certain types of bins also shelter the materials from the weather and animal pests. Just as it is helpful to have two or three compost heaps, using more than one composting bin can help you manage the progression of materials.

A variety of bins can be used. You can make bins from circles of wire fencing, wooden pallets, snow fencing, or wire mesh framed in wood. These enclosures can be taken apart and reassembled

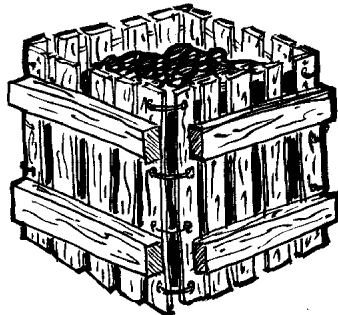
Figure 3a-g. *Examples of composting bins*



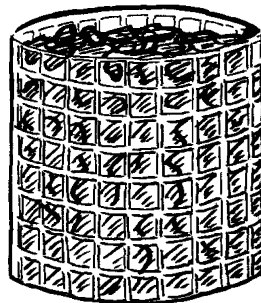
a. Wood and hardware screen three-bin composting unit.



b. Cement block three-bin composting unit.



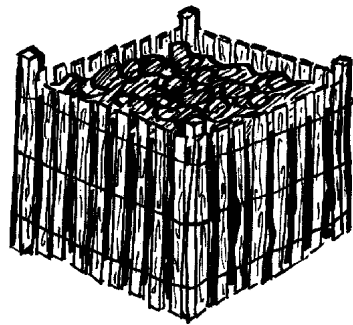
c. Wooden pallet composting bin.



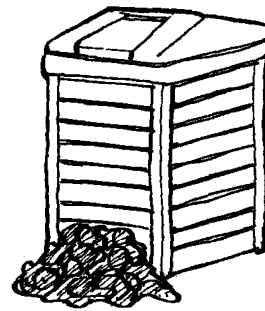
d. Wire-fencing composting bin.

when you are turning or harvesting the compost. Stationary bins can be made with wooden posts and planks, or by stacking landscape timbers, concrete blocks, or rocks. All bins should allow air flow through the sides and back.

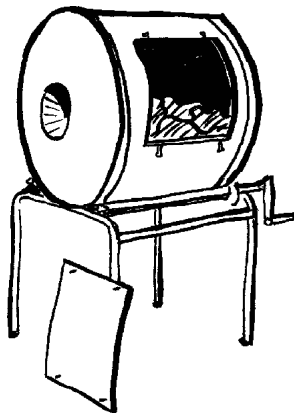
If you plan to turn your composting materials frequently, use a bin that provides easy access to the materials, such as those shown in Figure 3a, b, and c. Bins that are convenient for turning are often referred to as turning units. If you simply want to contain the materi-



e. Snow-fence composting bin.



f. Commercially manufactured composting bin.



g. Drum-type compost tumbler.

als and turn them only occasionally, then an enclosed type of bin, often called a holding unit, will work as well (Figure 3d, e, and f). The distinction between turning units and holding units is merely in ease of access. Bins considered as turning units do not have to be turned. Similarly, holding units can be turned frequently, if you wish.

Some bins are essentially closed containers with air vents in the bottom and top of the bin. Many are designed especially to compost food scraps. Fresh ingredients are added at the top and compost is removed from the bottom. Little or no turning takes place. These bins are not intended to maintain fully aerobic conditions. They control odors by enclosing the materials, and the odor, inside the container.

Tumblers are rotating barrels or drum composters which turn the materials inside as they spin like a clothes dryer via a hand crank, or are tumbled end-over-end. The idea behind tumbling composters is to make turning easier so the materials will be turned more frequently and consequently compost faster. Some drums and multi-sided tumblers are designed to be rolled along the ground. Several manufactured models of tumblers are available, though you can also build your own rotating barrels. All of these composting units include some means of ventilation, along with loading/unloading features. Because the barrels must be loaded in batches, you will either have to store fresh materials or use two drums, one for composting while the other is being loaded.



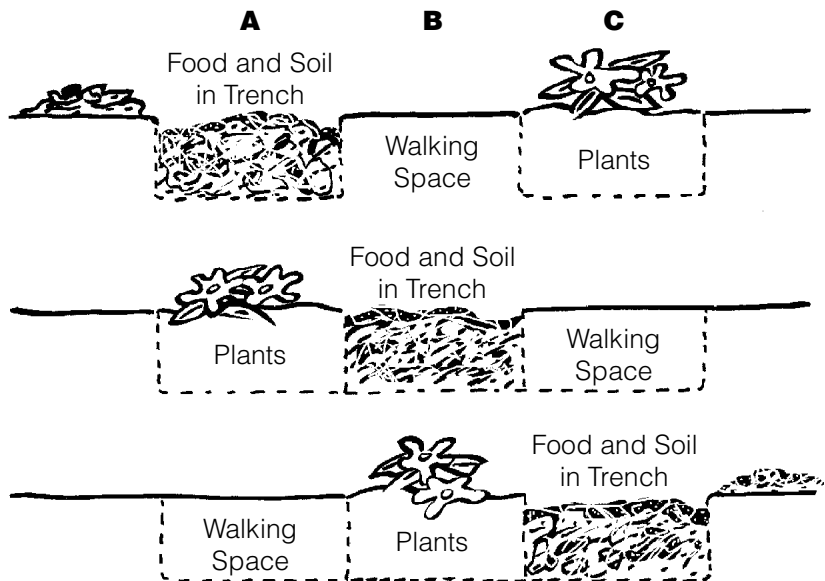
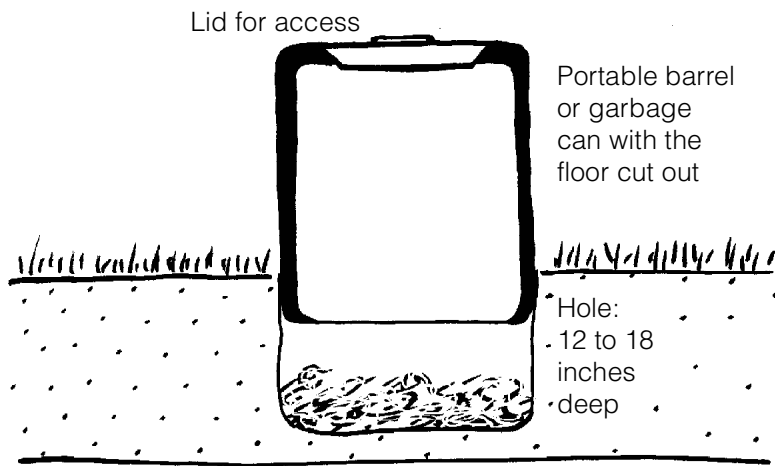
ALTERNATIVES TO COMPOSTING *Composting is not the only way to make good use of kitchen and garden residues. Grass recycling, mulching, and soil incorporation recycle garden and food residues without the management demands of composting. Worm composting produces a high-quality soil amendment through a different biological process*

Grass recycling *Usually, the compost pile is not the best destination for grass clippings. The simplest way to recycle grass clippings is to leave them on the lawn, which benefits from the nutrients and organic matter returned to the soil. This alternative also keeps herbicide-treated grass out of the compost pile. Grass recycling works best with proper mowing, fertilizing, and watering practices (see CIS 1016, Don't Bag It!).*

Mulching *Organic mulches placed on the soil surface control weeds, reduce evaporation and erosion, and keep the soil cooler in the summer and warmer in the winter. Grass clippings, leaves, pine needles, chipped branches, and shrub trimmings are all suitable for surface mulching around trees, shrubs, and other perennial plantings, with a few precautions. Large branches and other shrub trimmings must be chipped or shredded. Leaves should be shredded, because unshredded leaves tend to mat, preventing water and oxygen from moving into the soil. Fresh grass clippings should be applied in layers 1-inch thick or less. Otherwise, they become slimy, stick together, and limit air movement.*

Soil incorporation *Mixing food scraps deep into the soil is an alternative way to recycle non-fatty foods (Figure 4). Within one month to one year, the food material will decompose and fertilize the neighboring plants. Food scraps should be chopped, mixed with the soil at the bottom of an 8- to 12-inch deep hole or trench, and completely covered with clean soil. You can work the trench into the garden rotation by shifting its location. Food scraps can also be deposited in a container with the bottom cut out and set over a hole in the ground. When the hole is full, cover it with soil. The container can then be moved to another location. Soil incorporation is difficult, if not impossible, during the winter when the ground is frozen or snow-covered.*

Worm composting *Worm composting, or vermicomposting, relies on specific types of earthworms to digest food scraps, paper, manure, and vegetation. In the process the worms leave behind castings, which form a high-quality soil amendment called vermicompost. Red worms, rather than common nightcrawlers, are used in vermicomposting. Because worms need a dark, cool, moist, and aerobic environment, mixtures of food and bedding are composted in shallow layers in closed boxes or bins. The bedding provides an airy habitat for the worms. Typical bedding materials include shredded paper, straw, peat moss, and sawdust. Worms work best at temperatures between 50° and 70°F, which makes a basement a good year-round location for a worm bin. If the bin freezes or gets too hot, the worms die. The compost can be used after several months, when the bin contents become fairly uniform, dark, and soil-like in texture.*



24 **Figure 4.** Soil incorporation of food scraps with covered container

Composting Management

Making it work for you

Composting will happen almost by itself. Nevertheless, good management helps the process along and minimizes nuisances. Your level of management also determines how soon the compost will be ready for use. Things to pay attention to include where to place the pile and how to build it, when to turn it, preventing odors, and troubleshooting various ailments. Managing moisture is particularly important.

Location, location, location

The ideal location for your compost pile or bin provides sunlight in the winter, shade in the summer, and as much shelter from the wind as possible. Wind robs the composting materials of heat and precious moisture. Direct sunlight provides needed warmth in the winter but it otherwise dries the pile. In arid climates, open bins and piles that are exposed to summer sunlight will require diligent management of moisture. An area of the yard shaded by a deciduous shrub or the canopy of a deciduous tree can be a good site, providing both summer shade and winter sunlight. Shelter from sunlight and wind are less important if you are using closed composting bins.

The location should also provide easy access to water. Even shaded piles will need water during the summer. The piles are more

likely to be kept moist if the water source is convenient; for instance, if they are within reach of a garden hose. With open piles and bins, you may also wish to choose a spot that is shielded from view. Finally, the location should provide enough space to turn the pile and to stockpile raw materials and finished compost. In locating your compost pile, avoid:

- poorly drained spots that gather standing water.
- contact with trees, wooden fences, and buildings, since moist composting materials hasten decay and corrosion.
- close proximity to buildings and combustible materials—spontaneous combustion (a self-ignited fire) within a backyard composting pile is a remote yet possible danger.
- areas near neighbors who might object to the sight or smell of a compost pile.

Building and feeding the pile

The most important task in constructing a pile is blending the ingredients, including water. Brown and green ingredients should be well distributed within the pile. Usually, materials are added without mixing and then blended by subsequent turnings. Some composters place brown and green materials in alternating layers, 3 to 6 inches thick, sometimes interspersed with layers of fertilizer or manure. Although layering provides an easy way to proportion materials, the layers actually make a poor blend of materials. Turning is necessary to mingle the brown and green layers together.

Compost piles can be constructed gradually from the ground up by adding materials as they become available, or by stockpiling ingredients until the desired amount accumulates, or by a combination of both. Adding fresh ingredients in large quantities is more likely to produce high temperatures, but it increases the chance of odors. In many cases, brown ingredients, such as dry leaves, are scarce when green materials, such as grass clippings, become available. You can mix the greens into the existing composting pile, or stockpile brown ingredients and use them gradually as the green ingredients are generated. When adding food scraps or other materials that might attract flies and pests, bury them 6 inches beneath the surface of open piles and bins or cover them with several inches of soil or compost. If the pile is not dry or frozen, the material will partially decompose in about one to two weeks and the

pile can then be turned. If food materials are added in large quantities, they should be mixed into the pile, covered, and then turned a week or so later.

A pile or bin should be large enough to generate and hold in heat, yet small enough to allow air to reach its center. As a rule of thumb, the pile or bin should be at least 3 feet by 3 feet at the base and 3 feet high. Larger piles lose less heat in the winter, but piles larger than 5 feet high or 8 feet wide are a challenge to turn and aerate. Place a layer of dry leaves, straw, wood chips, compost, or other coarse material at the base of piles and bins. This layer enhances aeration, insulates materials from the cold ground, and absorbs liquids which may drain from above. You can improve air circulation by placing aeration aids such as pallets under piles and bins, or by inserting branches, perforated pipes, or tubes of rolled-up wire mesh into the composting materials.

The whys and whens of turning

Turning the compost pile gives you a window into the composting process. You get to see what is happening inside the pile—if the material is too wet or too dry, what ingredients are or are not decomposing, and how well composting is progressing. Turning performs several functions. It charges the pile with fresh air. It improves aeration by fluffing the materials and creating air channels. It blends together materials, breaks apart particles, and removes heat, water vapor, and other gases contained in the pile. Turning exchanges material at the cool, dry, oxygen-rich pile surface with the material at the warmer and moister core. Overall, turning speeds the composting process and helps manage temperature, moisture, and odors.

Few hard-and-fast rules exist for turning composting materials. The pile can be turned on a regular schedule, weekly, for example; or occasionally at the composter's convenience; when fresh materials are added; or in response to conditions in the pile. The following guidelines may help you decide when to turn your pile.

To speed the process Generally, the more often a pile is turned, the faster it composts. However, turning has only a limited effect on materials that naturally decompose slowly, such as wood.

To promote high temperatures Frequent turning leads to faster composting, which increases the pile temperature.

To blend materials Turn piles when materials are poorly mixed, or when different sections of the pile differ in consistency, color, moisture, temperature, or odor.

To cool the materials Turn piles if temperatures rise above 140°F, the point at which the microorganisms begin to suffer.

To aerate materials Turn piles when odors begin to develop or when other signs of anaerobic conditions appear, such as compacted, matted, or slimy-looking materials.

To add moisture Turn piles when adding water. Repeatedly wet and then turn the material. Water is otherwise difficult to distribute throughout the pile.

To drive off moisture Turn piles when the materials become saturated from rain or the addition of wet materials.

Preventing odors

Although most backyard composting materials present little risk of odor, odors can still occur through neglect or from the wrong combination of ingredients and conditions. The best way to manage odors is to avoid anaerobic conditions—keep the pile from becoming overly wet, turn it at the first hint of odors, and maintain a mix with at least as many brown ingredients as green. Highly degradable materials like grass, manure, and food scraps require particular attention. These materials should be thoroughly mixed within the pile. If they are added in large quantities, the pile should be turned regularly.

Troubleshooting

The most common problem in backyard composting is slow decomposition. The first suspected cause should be excessive drying of piles, followed closely by a lack of nitrogen (not enough fresh green material). Poor aeration due to wet or compacted materials can also hinder the composting rate. In this case, the problem may be accompanied by odors. Other occasional difficulties include pests, ammonia-like odors, and extremely high temperatures. Table 4 provides general guidance for troubleshooting these conditions.

Judging when composting is finished

Composting does not stop at a particular point. Biological decomposition of the raw materials and the compost continues almost

indefinitely. However, the compost becomes usable, and the process is considered finished, when decomposition slows to the point where odors are no longer a concern and plants will not be harmed (see the following section, “Using Compost at Home”). Judging when compost has reached this point is part of the art of composting. Signs of finished compost include:

- You would expect the compost to be finished by now—a sufficient amount of time has passed since materials were last added to the pile (see “Factors That Affect the Composting Time”).
- The pile of compost has developed a dark brown color, consistent crumbly texture, and earthy odor.
- There should be no ammonia or rotten odor in the compost.
- Except for pieces of wood, the compost shows very little evidence of the original yard trimmings and food scraps added to the pile.
- The moist pile remains cool and does not become warmer after turning.
- Moist compost, stored in a closed plastic bag at room temperature for one week, does not develop offensive, stale, or ammonia-like odors.

Some of these properties can be seen in unfinished compost, so several of these signs should be evident before the compost is harvested—the more, the better.



In arid regions, a dry compost pile is the most common problem that backyard composters encounter. Without adequate moisture, the composting process slows to a crawl and eventually stops. In the absence of regular soaking rains, water must be added to the pile frequently to replace the moisture lost to drying winds, sunlight, natural evaporation, and the pile’s own heat.

How much moisture is right? Generally, the composting material should feel moist to the touch but not dripping wet. The “squeeze” test is an easy way to gauge the moisture level of composting materials. Squeeze a handful of composting material. If no water oozes out, the pile is too dry. If water drips without squeezing, the pile is too wet.

**MANAGING
COMPOST
PILE
MOISTURE
IN ARID
CLIMATES**

Table 4. *Troubleshooting guidelines for home composting piles*

Problem	Possible Causes
Rotten odor	Anaerobic conditions due to excess moisture or food scraps Anaerobic conditions due to poor porosity and compaction
Ammonia odor	Too much nitrogen (greens); not enough carbon.
Slow decomposition	Not enough moisture Not enough nitrogen; OR slowly degradable materials Not enough oxygen (anaerobic conditions) Pile is cold; small volume Pile is totally frozen Compost is mature
Pile does not reach high temperatures (over 120°F)	Small volume Not enough nitrogen Cold weather
Pile is too hot (over 140°F)	Pile is too large Not enough air flow (poor ventilation) Pile is becoming too dry. Not enough evaporative cooling
Pile attracts pests (flies, bees, dogs, cats, rodents, skunks, etc.)	Exposed food scraps Meat, fish, or oily foods in the pile

Clues	Remedy
Pile feels and looks soggy	Turn pile and/or mix in dry materials
Pile looks dense, matted, or slimy. Few or no large, rigid particles	Turn pile and/or mix in coarse brown materials (straw, chipped wood, etc.)
More grass, food, and manure visible than brown ingredients	Mix in more brown, carbon-rich ingredients (leaves, straw, etc.)
Pile is barely damp to dry inside	Add water and/or wet materials and turn pile
Abundance of brown materials in the pile (wood, leaves, etc.); AND the pile is not dry	Add green material or nitrogen fertilizer; OR shred materials; OR be patient—it will happen
Pile is dense, looks matted or slimy. Hint of rotten odor	Turn pile. Add coarse or dry material as needed
Pile is less than 3 ft high and the weather is near freezing	Add fresh material and turn pile Increase pile size
Frozen clumps within the pile	Wait for spring, and then turn
Pile conditions are good	None needed
Pile is less than 3 ft high	Increase pile size
Pile is more than 3 ft high and outdoor temperature is above freezing	Add green material or nitrogen fertilizer
Pile is more than 3 ft high and outdoor temperature is above freezing	Insulate surface of pile with compost, straw, leaves, etc.
Pile is more than 5 ft high	Divide into smaller piles
Pile is less than 5 ft high but fairly dense and moist	Turn pile; decrease pile size
Pile is less than 5 ft high and only slightly damp	Add water and turn pile
Food scraps at or near the pile surface	Bury food 6 inches beneath the pile surface
Evidence of digging in the pile	Remove food from pile, or turn into the pile center; OR use a pest-proof composting bin

How often should water be added, and how much? In the summer, when moisture loss is greatest, water should be added at least weekly to keep the process going. The amount of water needed depends primarily on the pile size and how dry it has become. For a typical 3 ft wide x 3 ft long x 3 ft high pile, an average of 5 gallons of water per week is a reasonable estimate to start with. This is about the amount of water provided by 1 inch of rain. More water will be needed if the pile is frequently turned or exposed to sunlight and wind. Less water will be needed for sheltered piles, and for compost contained in composting bins with small ventilation openings.

Tips for maintaining pile moisture

- *Check the moisture level of the pile frequently. The surface of piles will nearly always appear dry but the material a few inches below should look and feel damp. Use the squeeze test to determine if water should be added. Meters designed for measuring soil moisture have not been widely used for compost, but you might find them convenient if you can obtain meter readings that consistently match the squeeze test results.*
- *If the pile needs water, add it with a bucket, hose, trickle hose, or sprinkler. However, because water moves slowly through the mass of composting materials, it is best to turn the materials while adding water to distribute it throughout the pile.*
- *Make sure the pile has easy access to a water source—locate it within reach of a garden hose, for instance. Piles are more likely to be kept moist if water is convenient. If possible, locate the pile in an area that is also sheltered from wind and summer sunlight.*
- *To conserve fresh water, routinely add “used” water from certain household and garden activities, for example, water from washing or cooking vegetables or water used to rinse the bucket holding kitchen scraps for the compost pile.*
- *Add high-moisture ingredients to the compost pile such as kitchen scraps, fresh grass clippings (if you collect them at all), and leaves from gutters and storm drains. Collect and add leaves and other yard trimmings before they dry.*

- *Too much water is a less common problem in arid climates. In the winter, or during periods of frequent precipitation, prevent the pile from getting saturated by rain or snow by using a covered bin or a plastic tarp over the pile. Be aware that the tarp will decrease aeration. Piles that are too wet should be turned both to distribute water within the pile and to encourage evaporation.*

The Payoff

Using compost at home

Compost makes a good soil amendment, mulch, and topdressing for many gardening applications. When mixed with a sandy soil, compost increases its ability to retain nutrients and moisture. In heavy clay soil, compost particles bind with clay particles to form loose pellets of soil which drain better and resist surface crusting and erosion. Compost contains minor and major plant nutrients which will become available to plants gradually over several growing seasons. Annual or regular additions of compost will increase the organic matter and fertility level of your soil and help sustain the long-term productivity of your garden.

Although most composts will greatly benefit plants, unfinished compost or compost stored under anaerobic conditions can harm seedlings or sensitive plants. Anaerobic conditions and the continued decomposition of unfinished compost can create partially decomposed compounds, some of which may injure plants. An unfinished compost may also tie up nitrogen in the soil as it continues to decompose. Therefore, pay attention to the quality and condition of the compost that you use. It should look, feel, and smell like rich soil, with absolutely no ammonia or sour, garbage-like odor.

Because compost is not a concentrated source of plant nutrients, it is commonly used as a soil amendment or mulch, rather than a

primary fertilizer, though the nutrients provide a valuable bonus. To use compost as a mulch or topdressing for gardens and lawns, apply it uniformly in thin layers. The organic matter and nutrients will gradually work their way into the soil. When using compost as a soil amendment, add it during preparation of the garden bed or lawn surface before planting. As a rough rule, mix the compost with soil to a depth equaling at least three times the thickness of the layer of compost applied. For example, a 1-inch thick layer of compost should be mixed into the top 3 to 4 inches of soil; a 2-inch layer should be mixed to a depth of 6 inches or more; and so on. Small amounts of compost can be mixed into seed furrows or transplant holes, again following the rule of 1 volume of compost to 3 volumes of soil. In a potting mix, compost should not make up more than one-third of the mix by volume. A popular compost-based mix is 1 part peat moss, 1 part vermiculite or perlite, and 1 part compost, by volume.

Compost contains only moderate quantities of major nutrients, and only a portion of these are usable to plants in the first year. If you wish to use compost as the main source of nutrients for your plants, you will need a large amount, at least in the first few years. Eventually, as you continue to add compost to the garden, the soil fertility will build to a fairly constant level. At that point, less compost will be required annually. The amount of compost needed to supply adequate nutrients depends greatly on the compost ingredients, the crops grown, the soil, and the climate. The book *How to Grow More Vegetables* (see "Suggested Reading") provides guidance for using compost as the sole source of fertility.

Another way to use compost is to make "compost tea," a liquid nutrient source for your plants. There are many recipes for making compost tea, ranging from directly mixing compost with water to continuously passing water through a container of compost. One common method involves filling a burlap bag with five to six shovelfuls of compost and then soaking the bag in a 50-gallon drum of water for two to three days. The water becomes the compost tea. The spent compost from the burlap bag can be still used as a soil amendment. As a general guide, apply the tea to the base of your plants every one to two weeks. However, using compost tea can be tricky. Its nutrient content and strength will vary, depending on the compost used and how the tea is made. Recommendations for using compost tea come from individual experience, so experiment with it before using it extensively on your plants.

General guidelines for using compost are given in Table 5. Vary the amount of compost you add as a soil amendment according to the current condition of the soil. As a general rule, use more compost for poorer soils.

Table 5. *Guidelines for using compost*

Use	Approximate Application Rate (lb/1000 sq ft)	Thickness of Compost	Comments
Soil amendment for establishing gardens and lawns	3000 to 9000	1 to 3 inches	Mix with soil to a depth of about 4 to 9 inches. Use more compost for poor soils.
Soil amendment for planting trees and shrubs	3000 to 9000	1 to 3 inches	Mix with soil over an area of 2 to 5 times the root ball width and to a depth of 6 to 10 inches. Use more for poor soils.
Topdressing for lawns	400 to 800	1/8 to 1/4 inch	Broadcast evenly over lawn surface. Best applied after thatching or core aeration.
Topdressing for gardens and shrubs	400 to 1500	1/8 to 1/2 inch	Spread evenly then lightly work into the soil.
Landscape or garden mulch	1500 to 6000	1/2 to 2 inches	Spread evenly over surface. Use the higher rate with coarse, woody composts.
Potting mix	Not more than 1/3 by volume is generally a safe amount.		Blend with peat moss, sand, perlite, vermiculite, or bark.

Helpful numbers: A 1 inch layer covering 1000 square feet requires about 3 cubic yards of compost. Most compost weighs 30 to 40 pounds per cubic foot, or about 800 to 1000 pounds per cubic yard.

Enjoy It

If you are a beginner at composting, don't be intimidated by the many techniques and tips for composting. Remember that composting is easy. Once you gather organic ingredients together, composting will happen on its own. With only a little attention to the basic needs for aeration, moisture, and time, you will become a successful composter. You can help the composting process along, but you can hardly hurt it or stop it.

You should also find composting to be enjoyable and rewarding, well worth the effort. Composting benefits your community and the environment by keeping organic materials out of the landfill. Composting benefits you by producing a useful soil amendment and nutrient source for your lawn and garden. Moreover, to many people composting is educational—a lesson in biology and chemistry, and a backyard glimpse into nature's recycling methods.

Learn more!

Suggested reading about backyard composting

Backyard Composting. 1992. Harmonious Technologies Press, P.O. Box 1865-100, Ojai, CA 93024. 95 pages.

Composting To Reduce the Waste Stream. 1991. N. Dickson, T. Richard, R. Kozlowski. Northeast Regional Agricultural Engineering Service, 152 Riley-Robb Hall, Ithaca, NY 14853-5701; phone 607-255-7654. 44 pages.

Don't Bag It! Recycle Your Grass Clippings, CIS 1016. 1994. University of Idaho Cooperative Extension System, Moscow, ID 83844-2240.

Easy Composters You Can Build, Bulletin A-139. 1995. Storey Publishing, Pownal, VT 05261.

How to Grow More Vegetables, 5th edition. 1995. John Jeavons. Ten Speed Press, P.O. Box 7123, Berkeley, CA 94707. 201 pages.

Let It Rot. 1990. S. Campbell. Storey Publishing, Pownal, VT 05261. 152 pages.

The Mulch Book. 1991. S. Campbell. Storey Publishing, Pownal, VT 05261. 117 pages.

The Rodale Book of Composting. 1992. D. Martin and G. Gershunny (editors). Rodale Press, Book Reader Service, 33 East Minor St., Emmaus, PA 18009. 278 pages.

Urban Home Composting, Rodent-Resistant Bins and Environmental Health Standards. City Farmer, Canada's Office of Urban Agriculture, Suite 801-318 Homer St., Vancouver, B.C., V6B 2V3.

Worms Eat My Garbage. 1982. M. Appelhof. Flower Press, 10332 Shaver Rd., Kalamazoo, MI 49002. 100 pages.

Composting information on the Internet (as of 1997)

The Internet houses a mind-boggling amount of information about composting. Try conducting a search using the words "backyard" and "composting" or "compost." You will be amazed. But don't believe everything that you read—anyone can put anything on the web. Still, there are many good websites with helpful information about composting, including the following. Check'em out!

Composting Resource Page: <http://www.oldgrowth.org/compost>

Cornell Composting: <http://www.cals.cornell.edu/dept/compost/>

Rot Web: http://net.indra.com/~topsoil/Compost_Menu.html

Urban Agriculture Notes: <http://www.cityfarmer.org>

Backyard Magic: <http://www.gov.nb.ca/enviro/m/comucate/compost/comworks.htm>

The Composting Council: <http://www.composter.com/composting/compccouncil>

Notes

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