Chapter 17
Composting Processes

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Composting Processes

Taken from the 1993 King County, WA Master Recycler Composter Training Manual
Edited and revised by Nancy E. Adams, University of New Hampshire Cooperative Extension

In this chapter we will examine the potential for recycling organic debris through natural processes of decomposition. This includes the biological processes that transform organic materials into compost, the uses for compost, and the benefits of compost for soils and plant growth. We will focus on composting of yard debris and food scraps.

Introduction to Composting

Yard debris and food "wastes" are valuable resources. They are also the most economical and practical materials suited for composting, because they are large, easily separated parts of our waste stream. We will look at home composting options as well as centralized composting operations.

Terms introduced in this chapter include:

- Organic wastes
- Carbon:Nitrogen ratio
- Vermicompost
- Holding unit
- Turning unit
- Mulch
- Fertilizer
- Soil amendment
- Compost
- Humus
- Bacteria
- Soil structure
- Soil aggregates
- Micronutrients
- Macronutrients
- Grasscycling

What is "Organic"?

Anything that is alive or was once alive is "organic." All plants and animals, and anything made from plants or animals, is organic. Any wastes generated by plants and animals, or remaining after we use products made from a plant or an animal, are also organic. Organic products are an important part of our economy and of our lives. Some of the common organic materials that we use and dispose of daily are listed in *Figure 1.*

As *Figure 1* illustrates, organic materials account for much of what we consume and throw away every day. Paper products alone make up over one third of our waste. Yard debris comprises an estimated 17 percent of our garbage, and food wastes another 7 percent. Due to the sheer volume of organic wastes produced, the way that we choose to handle these materials is one of the most important waste management decisions that we face today.

Figure 1.

Common Organic Materials

Food — Fruits, vegetables, grains, eggs, dairy products, meat, and fish.

Clothing and Furnishings — Cotton, wool, burlap, leather, feathers, and down.

Building Materials — Lumber, plywood, and other wood-based materials.

Paper Products — Paper, newsprint, cardboard, and tissues

By-products — Food processing wastes, sawdust, blood, bones, and fur.

Animal Wastes — Manure, sewage, and hair.

Yard Debris — Grass clippings, leaves, prunings, fallen branches, and trees.

Decomposition: a Problem and a Solution

Organic materials have many different qualities and uses, but all organic materials have a common trait which sets them apart from other waste materials: organic wastes naturally break down into a rich, soil-like material called compost. Decomposition is inevitable. When organic wastes are separated from trash and allowed to decompose with an adequate air supply, they can be turned into a valuable soil amendment which helps plants grow better, protects soil from erosion, and conserves other resources.

In some situations, particularly landfills, decomposition can create serious problems. When buried, organic materials decompose in the absence of air, or anaerobically, and produce methane gas. This can create a problem if the methane gas migrates into nearby buildings, creating a danger of explosion. As rain or groundwater percolates through a landfill, weak acids are produced by decaying organic matter. As these acids wash through the landfill they react with other trash, creating a potentially toxic leachate which can contaminate groundwater, lakes, and streams.

Landfilling and Burning of Leaf & Yard Waste

NH RSA 266:3 VI

Beginning July 1, 1993, NH RSA 266:3 VI takes effect. It states that "no leaf or yard waste shall be disposed in a solid waste landfill or incinerator including any waste to energy facility. This paragraph shall not apply to municipalities organized under RSA 53-A, RSA 53-B, or 1986, 139, if application of the paragraph would cause the municipality to violate or incur penalties under legal obligations existing on the effective date of the paragraph. Any generator or transporter who violates this paragraph shall be subject to the penalties and enforcement provisions of RSA 149-M:12."

266.4 Effective Date. This act shall take effect January 1, 1993.

(Approved May 18, 1992)

(Effective Date January 1, 1993).

Composting: Nature's Recycling System

The natural processes of decomposition are the basis for recycling systems for many types of organic materials. Some of the organic waste composting systems currently being promoted as solutions to our solid waste problems include:

- Backyard composting of yard debris and food scraps.
- Mulching organic wastes to protect soil from erosion and help establish new plantings on disturbed lands.
- Centralized composting of yard debris, such as local curbside collection.
- Mixed waste composting of soiled paper, food wastes, and other organic materials.
- Co-composting of sewage sludge with sawdust or shredded yard debris.

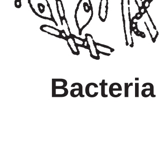
Each of these composting systems has advantages and disadvantages. Which system is preferred for a given situation depends on the convenience and availability of transportation and markets, and the volume and type of organic waste to be handled, whether the waste generators involved are large or small, concentrated or dispersed. Yet all of these systems operate on the same biological principles which are described in the following sections.

Compost Flora and Fauna

Bacteria: Powerhouse of the Compost Pile

The most numerous organisms in a compost pile are bacteria. Too small to be seen individually, the effects of bacterial activity are easy to detect. Bacteria generate the heat associated with composting, and perform the primary breakdown of organic materials, setting the stage for larger decomposers to continue the job.

Bacteria don't have to be added to compost. They are present virtually everywhere, and enter the compost pile with every single bit of added organic matter. Initially, their numbers may be modest, but given the proper conditions (proper moisture, air, a favorable balance of carbon and nitrogen, and lots of surface area to work on) bacteria can reproduce at a remarkable rate.



Bacteria

Bacteria are unicellular micro-organisms which reproduce by division: simply growing a wall through the middle of their cells and dividing into two. Then they do it again and two cells become four, then four cells become eight, and so on. This might not be as impressive if it didn't happen so fast. One gram of the common bacteria *Escherichia coli* would become a pound in three hours, and a mass the size of the earth in one and a half days if sufficient food and proper conditions were available.

Many types of bacteria are at work in the compost pile. Each type thrives on special conditions and different types of organic materials. Even at temperatures below freezing some bacteria can be at work on organic matter. These psychrophilic bacteria (a grouping of bacterial species that includes all those working in the lowest temperature range) do their best work at about 55 ^{0}F, but they are able to carry on right down to 0 ^{0}F. As these bacteria eat away at organic wastes, they give off a small amount of heat. If conditions are right for them to grow and reproduce rapidly, this heat will be sufficient to set the stage for the next group of bacteria, the "mesophilic," or middle-temperature-range, bacteria.

Like us, mesophilic bacteria thrive at temperatures from 70 to 90 ^{0}F, and just survive from 40 to 70^{0}F, or from 90 to 110^{o}F. In many compost piles, these efficient mid-range bacteria do most of the work. However, given optimal conditions, they may produce enough heat to kick in the real hot shots, the "thermophilic," or heat-loving, bacteria.

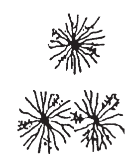
Thermophilic bacteria work fast, in a temperature range of 104 to 200 ^{0}F. Unless the compost pile is turned at strategic times or new materials are added to the pile, the bacteria will work for only four to seven days until their activity peaks and the pile cools down below their optimum range. But what activity in those four to seven days! In that short time, they turn green, gold, and tan organic material into a uniform deep brown. If the pile is turned to let more air in, the thermophilic bacteria will feast for another four to seven days. (Large compost piles with a volume of several yards or more can retain enough heat to keep thermophilic bacteria alive for several weeks or longer).

In all of this work, the bacteria are not alone — though at first they are the most active decomposers. Other microbes, fungi, and a host of invertebrates take part in the composting process. Some are active in the heating cycle, but most organisms prefer the cooler temperatures of slow compost piles or proliferate only when hot piles start to stabilize at lower temperatures.

Nonmicrobial Composters

A compost pile is a real zoo. Besides the many types of bacteria, a multitude of larger organisms, many of them feeding on the spent bacteria and their by-products, add diversity to the compost pile. The following is just a sampling of some of the more common organisms in this diverse group. (Much of this information about nonmicrobial composters is quoted from Dr. Daniel L. Dindal's slide show, *The Decomposer Food Web*).

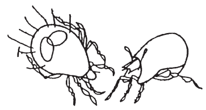
Actinomycetes are a type of primary decomposer common in the early stages of the decomposition of the pile. Actinomycetes produce greyish cobwebby growths throughout compost that give the pile a pleasing, earthy smell similar to a rotting log. They are frequently seen in drier parts of compost piles and survive a wide range of temperatures and conditions.



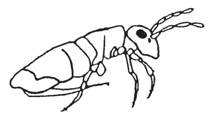
Fungi also perform primary decomposition in the compost pile. Fungi send out thin mycelial fiber-like roots, far from their spore-forming reproductive structures. The most common of the reproductive structures are mushrooms that sometimes pop up on a cool pile. Though they are major decomposers in the compost pile, fungal decomposition is not as efficient as bacterial decay. The growth of fungi, even more than bacteria, is greatly restricted by cold temperatures. Since they have no chlorophyll, fungi must obtain their food from plants and animals. Parasitic fungi exist on living plants or animals. Most fungi are saprophytic, living on decayed vegetable and animal remains.

Nematodes, or roundworms, are the most abundant invertebrates in the soil. Typically less than 1 millimeter in length, they prey on bacteria, protozoa, fungal spores, and each other. Though there are pest forms of nematodes, most of those found in soil and compost are beneficial.

Fermentation mites, also called mold mites, are transparent-bodied creatures that feed primarily on yeasts in fermenting masses or organic debris. Literally thousands of these mites can develop into a seething mass over a fermenting surface. Their presence in a compost pile is a good sign.

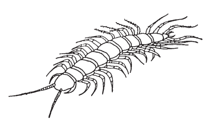


Springtails, along with nematodes and mites, share the numerical dominance among soil invertebrates. They feed principally on fungi, although they also eat nematodes and small bits of organic detritus. They are a major population controlling factor on fungi.

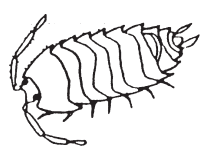


Wolf spiders are truly "wolves" of the soil and compost microcommunities. They don't build webs, but merely run freely hunting their prey. Depending on the size of the spider, their prey can include all sizes of arthropods, invertebrate animals with jointed legs and segmented bodies.

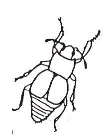
Centipedes are found frequently in soil and compost microcommunities. They prey on almost any type of soil invertebrate near their size or slightly larger.



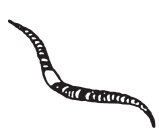
Sow bugs feed on rotting woody materials and highly durable leaf tissues, such as the veins comprised of woody xylem tubes. Sow bugs that roll up like an armadillo are known as pill bugs or roly polys.



Ground beetles have many representatives lurking through litter and soil spaces. Most of them feed on other organisms, but some feed on seeds and other vegetable matter.



Redworms play an important part in breaking down organic materials and in forming finished compost. As worms process organic materials, they coat their wastes with a mucus film that binds small particles together into stable aggregates and helps to prevent nutrients from leaching out with rainwater. These stable aggregates give soil a loose and well-draining structure.



Unwanted Guests: Pests of the Compost Pile

Given a comfortable or nourishing environment, pest species will be attracted to the action in the composting pile. Common pests in compost systems include house and fruit flies, rodents, raccoons, and domestic animals such as cats and dogs. Rats are probably the least-wanted guests of all. In a hospitable environment with plenty of food, their numbers increase quickly and they may become transmitters of disease. Although pests may take residence in any compost pile, they are especially attracted to the same high-quality foods that humans and our pets like to eat. So it is important to keep kitchen scraps, including vegetable and fruit scraps, meat, fish, dairy products, grains, and pet food out of yard debris compost piles. Safe methods for composting many food wastes will be discussed in this chapter.

Basic Compost Farming

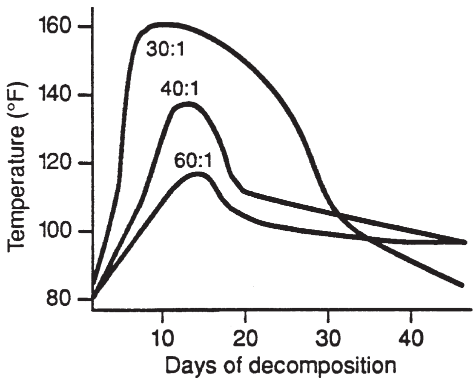
Put a pile of leaves, an old cotton rag, or a freshly cut board out in the environment, and decomposition is bound to occur. How long the process takes depends on a number of factors: the makeup of the materials, the amount of surface area exposed, the availability of moisture and air, and the presence of insulating materials around the decomposing object.

It is useful to think of composting as growing microorganisms. Just as a farmer keeps in mind the basics of fertility, cultivation, irrigation, and the season when growing a crop; a good composter focuses on the materials being composted, their preparation, and their moisture content to ensure a healthy compost crop. Fortunately, as composters we can do much more to control the conditions in a compost pile than a farmer can do to control the weather.

Understanding how to create the ideal composting conditions described here will allow you to make compost quickly and help you to diagnose and solve other peoples' composting problems. But remember that provided sufficient time, perfectly good compost can be made without the preparations described here.

Figure 2.

Carbon: Nitrogen Ratio Effects on Composting



Materials: "Greens" and "Browns"

All living organisms need relatively large amounts of the element carbon (C) and smaller amounts of nitrogen (N). The balance of these elements in a material is called the carbon-to-nitrogen ratio (C:N). This ratio is an important factor determining how easily bacteria are able to decompose an organic material. The microorganisms in compost use carbon for energy and nitrogen for protein synthesis, just as we use carbohydrates for energy and protein to build and repair our bodies. The optimal proportion of these two elements used by the bacteria averages about 30 parts carbon to 1 part nitrogen. Given a steady diet at this 30:1 ratio, bacteria can decompose organic material very quickly *(see Figure 2)*.

It helps to think of materials high in nitrogen as "greens," and woody, carbon-rich materials as "browns." There is often a visual correlation between high nitrogen content in green plant material, and high carbon content in brown materials. *Figure 3* lists the C:N ratios for several common organic wastes.

As the chart illustrates, most materials available for composting don't have the ideal carbon to nitrogen ratio. One way to speed-up composting is to combine nitrogen-rich "green" materials (such as grass clippings) with carbonaceous "brown" materials (such as autumn leaves) to create a mix having a 30:1 carbon-to-nitrogen ratio. This works best on a weight, rather than volume, basis. For instance, a mixture of one-half brown tree leaves (40:1 ratio) could be used with one-half fresh, green grass clippings (20:1 ratio) to make a pile with the ideal 30:1 ratio.

The C:N ratios listed in *Figure 3* are only guidelines. For instance, brown grass clippings from an unwatered lawn will have far less nitrogen content than green clippings from an abundantly fertilized lawn. Similarly, the leaves from different types of trees vary in the C:N balance. There are also some confusing exceptions to green-nitrogen, brown-carbon correlations. For instance, evergreen leaves are low in nitrogen, and brown-colored animal manures are often high in nitrogen.

The best way to become familiar with C:N balancing is to try to be specific about it for a while, then relax into an intuitive assessment of what a pile needs. Think like a chef varying the ingredients for a recipe. Be curious, write down the type and quantity of materials used, and take note of the temperature your pile reaches and the quality of the finished compost. After a while, the process becomes as intuitive as cooking.

Figure 3.

Average Carbon:Nitrogen Ratios

Food scraps	15:1	
Grass clippings	19:1	**Greens**
Rotted manure	25:1	
	30:1	**Ideal**
Corn stalks	60:1	
Leaves	40 – 80:1	
Straw	80:1	
Paper	170:1	**Browns**
Sawdust, wood chips	500:1	

Surface Area

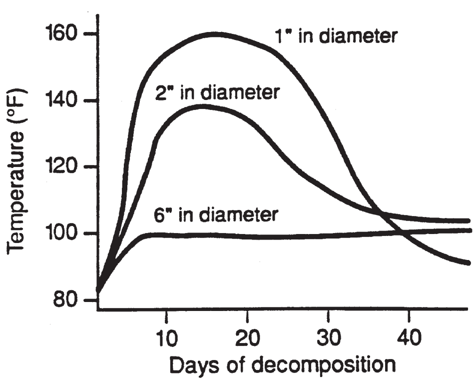
A melting block of ice provides a good analogy for how surface area affects the speed of decomposition. A large block of ice melts slowly, but when it is broken into smaller pieces the surface area increases, and the ice melts more quickly.

Similarly, when large, coarse, or woody organic materials are chopped or shredded into smaller pieces, the composting process speeds up *(see Figure 4)*. With more surface area exposed, bacteria have greater access to easily available food, so they can reproduce and grow quicker, producing more heat.

While breaking organic materials into smaller pieces speeds up the decomposition process, it isn't essential in order to compost them. In some instances, such as when using organic wastes as mulches, slow decomposition is advantageous. The less surface area that is available on a mulch, the slower it decomposes and the longer it will continue to control weeds, slow evaporation, and stop soil compaction and erosion.

Figure 4.

Particle Size Effects on Composting



Moisture and Aeration

All compost organisms need a certain amount of water and air to survive. The amounts of air and water in a compost pile form a delicate balance that must be maintained for rapid decomposition to take place. Too much air circulating in the pile can make the pile too dry for bacteria to function. At less than 40 percent moisture, the bacteria are slowed by the lack of water. At greater than 80 percent moisture, there is not enough air for "aerobic" decomposition to continue. Anaerobic bacteria, which thrive in the absence of oxygen, can take over the pile. Anaerobic decomposition is slow and can produce unhealthy by-products, including an odor similar to rotten eggs.

Optimal moisture levels for composting occur when materials are about as moist as a wrung-out sponge. It should be obviously moist to the touch, but yield no liquid when squeezed. This level of moisture provides organisms with a thin film of water on materials, while still allowing air into their surroundings.

If a compost pile is too wet, it should be turned (pulled apart and restacked) to allow air back into the pile and loosen up the materials for better drainage. Mixing materials of different sizes and textures also helps to provide a well-drained and well-aerated compost pile. *Figure 5* shows the effect of turning.

If an undecomposed pile of yard debris becomes dry it needs to be pulled apart and watered as it is restacked. Watering an intact pile from above is not effective as dry organic materials often shed water. Dry materials must be gradually wetted and mixed until they glisten with moisture. Prolonged exposure to winter rains can effectively soak a dry compost pile. It is best to cover a pile once materials are uniformly moist to retain moisture and to prevent the pile from becoming anaerobic.

Compost should be about as moist as a wrung-out sponge. It should be obviously moist to touch, but yield no liquid when squeezed.

Figure 5.

Turning Frequency Effects on Composting Temperature

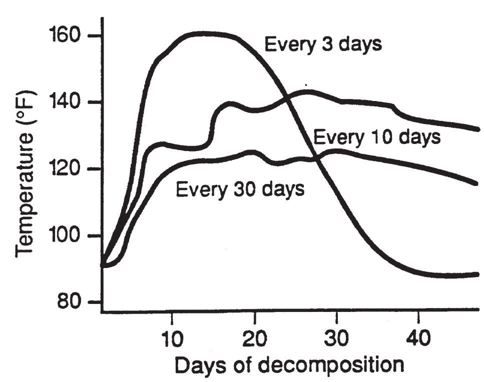
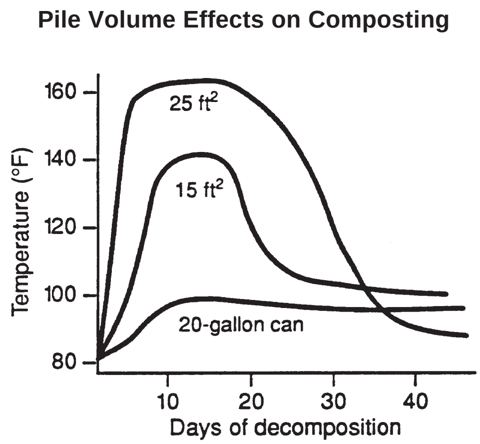


Figure 6.

Troubleshooting Compost Piles

Symptom	The heap is **wet and smells** like rotten eggs.
Problem	Not enough air; pile too wet.
Solution	Turn it; add coarse, dry wastes such as straw or corn stalks.
Symptom	The **center is dry** and contains tough, woody wastes.
Problem	Not enough water in pile. Too woody.
Solution	Turn and moisten; add fresh green wastes; chop or shred.
Symptom	The heap is damp and warm right in the **middle, but nowhere else.**
Problem	Pile is too small, or too dry.
Solution	Collect more material and mix into a new pile; moisten.
Symptom	The heap is damp and sweet-smelling, but **will not heat up**.
Problem	Lack of nitrogen in pile. Compost is done!
Solution	Mix in fresh grass clippings or nitrogen fertilizer.

Figure 7.



Volume

For fast, efficient composting, a compost pile must be large enough to hold heat and moisture, and small enough to admit air to the center. As a rule of thumb, compost piles need to be a minimum size of 3 ft. by 3 ft. by 3 ft. (1 cubic yard).

A smaller pile will dry out easily, and cannot retain the heat required for quick composting. However, by insulating the sides of smaller piles, higher temperatures and moisture can be maintained.

The upper size limits for a compost pile are about 5 ft. by 5 ft. by any length. Larger piles must be turned frequently or have "ventilation stacks" placed throughout the pile to allow air into the interior to prevent anaerobic conditions from forming. *Figure 7* shows the effect pile volume can have on decomposition.

Time and Temperature

The hotter the pile, the faster the composting process. As we've seen, temperature is dependent on how we manage our microorganism farm. A home compost pile built with proper consideration of carbon to nitrogen ratios, surface area, volume, moisture, and aeration, can produce stabilized compost in as little as three weeks. A commercial composting operation, which thoroughly shreds materials and turns or aerates piles, may require six to 12 weeks to produce finished compost. The smaller particle sizes and increased pile volumes of larger systems reduce aeration in the interior of piles, slowing down the process.

With less attention to the details of materials used and the environment provided for them, a cooler, slower pile can be built. Low-maintenance methods of composting will still create an excellent compost, but may take six months to two years to yield finished compost.

Compost Benefits and Uses

Whether a compost pile is quick and hot or slow and cool, when the decomposer organisms have completed their work, the contents of the pile have been transformed into an entirely new material. Most of the wastes that made up the pile are no longer recognizable in the finished compost — with the exception of some persistent, woody parts. What remains is dark, loose, crumbly material that resembles rich soil. The volume of the finished compost has been reduced because of biochemical breakdown and water respiration to about 30 to 50 percent of what went into the pile. The compost is now ready to use for growing new plants, and begin the cycle over again.

Beneficial Properties of Compost

Compost will improve the quality of almost any soil. The main benefit is to improve the "structure" of the soil. The structure of a soil determines its ability to drain well, store adequate moisture, and meet the many needs of healthy plants. Although compost provides important nutrients, it is not a substitute for fertilizers. More important than the nutrients supplied by compost is its ability to make existing nutrients more easily available to plants.

Soil Structure

The value of compost as a soil amendment is suggested by its appearance. Even a casual observation of soil amended with compost shows that it is made up of many round, irregular "aggregates." Aggregates are groups of particles loosely bound together by the secretions of worms and compost bacteria. If these aggregates are rubbed between a finger and thumb, they break down into smaller aggregates. In between and within the aggregates themselves are many small air channels like the empty spaces left in a jar of marbles.

A well-structured soil with lots of small aggregates stays loose and easy to cultivate. The channels that aggregates create through the soil allow plant roots and moisture to penetrate easily. The smaller pores within the aggregates loosely hold moisture until a plant needs it. The larger pore spaces between the aggregates allow excess water to drain out and air to circulate and warm the soil.

By encouraging the formation of aggregates, compost improves the structure of every type of soil: silt, sand, or clay. In loose sandy soils, compost helps to bind unconsolidated particles together to retain water and nutrients that would normally wash right through. Added to a clay or silt soil, compost breaks up the small tightly bound particles and forms larger aggregations, which allow water to drain and air to penetrate.

Figure 8.

pH Levels of Soil

Material	pH
Recycled yard debris compost	5.5 – 7.5
Sphagnum peat moss	3.5
Douglas fir bark	3.6 – 3.8

Nutrient Content

Dark, loose compost *looks* like it should be rich in nutrients. Indeed, compost contains a variety of the basic nutrients that plants require for healthy growth. Of special importance are the micronutrients present in compost, such as iron, manganese, copper, and zinc. They are only needed in small doses, like vitamins in our diet, but without them plants have difficulty extracting nutrients from other foods. Micronutrients are often absent from commercial fertilizers, so compost is an essential dietary supplement in any soil.

Compost also contains small amounts of the macronutrients that plants need in larger doses. Macronutrients include nitrogen, phosphorous, potassium, calcium, and magnesium. These nutrients are usually applied in measured amounts through commercial fertilizers and lime. The three numbers listed on fertilizer bags (e.g., 10-10-10) refer to the percentage of the three primary macronutrients — nitrogen, phosphorous, and potassium (N-P-K) — available in the fertilizer.

Although compost generally contains small amounts of the these macronutrients, they are typically present in forms that are not readily available to plants. When applied in four to six inch layers, compost may provide significant amounts of these nutrients. However, due to the variability and slow release of major nutrients, compost is considered a supplement to fertilization with more reliable nutrient sources.

Nutrient Storage and Availability

To understand how compost is able to store nutrients and make them available when needed by plants requires a closer look. When viewing compost through a microscope that enlarges things 1,000 times, individual compost particles resemble the aggregates that are observed with the unaided eye. Like the aggregates, individual particles of compost contain many porous channels. Just as the channels in the aggregates provide space to store water, these spaces in the compost particles provide spaces to store nutrients.

The sides of the channels provide vast surfaces inside the particles where individual ions of minerals and fertilizers can cling. These ions are given up to plant roots as the plants require them. Thus, compost is able to store nutrients that might otherwise wash through a sandy soil or be locked up in the tight spaces of a clay soil.

The ions clinging to the surfaces of our compost particles tend to be those that give soil a “neutral” pH. A measure of soil acidity or alkalinity is its pH. The acidity or alkalinity of a soil affects the availability of nutrients to plants. Most important plant nutrients are relatively easily available to plants at a pH range of 5.5 to 7.5. At pH levels above this range (alkaline) or below this range (acid), essential nutrients become chemically bound in the soil and are unavailable to plants. Recycled yard debris compost typically has a pH range of 5.5 to 7.5. When mixed into soil, this compost will help keep the pH at optimum levels for nutrient availability. The pH levels of some common soil amendments are compared in *Figure 8*.

Beneficial Soil Life

Taking a step back from the microscopic view, another beneficial characteristic of compost is evident. The presence of redworms, centipedes, sow bugs, and others shows that compost is a healthy, living material.

The presence of decomposer organisms means that there is still some organic material being slowly broken down which is releasing nutrients. They are also indicators of a balanced soil ecology, which includes organisms that keep diseases and pests in check. Many experiments have shown that the rich soil life in compost helps to control diseases and pests that might otherwise overrun a more sterile soil lacking natural checks against their spread.

Compost Uses

Compost is a much needed resource. It is not only useful to the home gardener, but is essential to the restoration of landscapes where topsoil has been removed or destroyed during construction or mining operations. Compost is increasingly being applied to agricultural and forest lands depleted of their organic matter. The most common use of compost today is probably in topsoil mixes used in the landscape industry.

Compost is typically applied in three ways:

1. To mulch or “top dress” planted areas
2. To amend soil prior to planting
3. To amend potting mixes

Mulching

Gardeners and landscapers use mulches and top dressings over the surface of the soil to suppress weeds, keep plant roots cool and moist, conserve water, maintain a loose and porous surface, and prevent soil from eroding or compacting. Compost serves all of these purposes and also gives plantings an attractive, natural appearance. Compost can be used to mulch around flower and vegetable plants, shrubs, trees, and ground covers.

To prepare any area for mulching, first clear away any visible grass or weeds that might grow up through the mulch. Make sure to remove the roots of any weedy plants which spread vegetatively, such as quack grass, ivy, and buttercup. Different types of plants benefit from varying application rates and grades of mulch. Recommended uses of compost as mulch and top dressings are shown in Figure 9.

Figure 9.

Using Compost as Mulch

On flower and vegetable beds:

Screen or pick through compost to remove large, woody materials. They are less attractive, and will compete for nitrogen if mixed into the soil.

Apply ½ to 1 inch of compost over the entire bed, or place in rings around each plant extending as far as the outermost leaves. Always keep mulches a few inches away from the base of the plant to prevent damage by pests and disease.

On lawns:

Use screened commercial compost, or sift homemade compost through a ½ inch or finer mesh. Mix with an equal amount of sand or sandy soil.

Spread compost / sand mix in 1/4 to ½ inch layers after thatching or coring, and before reseeding.

On trees and shrubs:

Remove sod from around trees and shrubs as far as branches spread. If this is impractical, remove sod in a circle a minimum of 4 feet in diameter around plants.

Use coarse compost or material left after sifting. Remove only the largest branches and rocks.

For erosion control:

Spread coarse compost, or materials left after sifting, in 2 to 4 inch deep layers over entire planting area or in rings extending to the drip line.

Mulch exposed slopes or erosion prone areas with 2 to 4 inches of coarse compost.

Soil Amendment

Compost can be used to enrich garden soils before planting annuals, ground covers, shrubs, and trees. Many commercial topsoil mixes contain composted yard debris or sewage sludge as a major component, along with sand, sandy soil removed from construction sites, peat moss, and ground bark.

Amend soils by mixing compost or topsoil mixes thoroughly with existing soil. If a rich compost or topsoil mix is laid on top of the existing soil without mixing, the zone where they meet can become a barrier to penetration by roots and water. In this condition, plantings often develop shallow roots and eventually blow over or suffer from lack of water and nutrients. Recommended applications for different situations are shown in *Figure 10*.

Figure 10.

Using Compost as Soil Amendment

In flower and vegetable beds and ground covers:

Dig or till base soil to a minimum 8 to 10 inch depth.

Mix 3 to 4 inches of compost through the entire depth. For poor soils, mix an additional 3 inches of compost into the top 3 inches of amended soil. In established gardens, mix 2 to 4 inches of compost into top 6 to 10 inches of soil each year before planting.

Planting lawns:

Till base soil to 6 inch depth.

Mix 4 inches of fine textured compost into the loosened base soil.

Planting trees and shrubs:

Dig or till base soil to a minimum 8 to 10 inch depth throughout planting area, or an area 2 to 5 times the width of the root ball of individual specimens.

Mix 3 to 4 inches of compost through the entire depth. For poor soils, mix an additional 3 inches of compost into the amended topsoil. Do not use compost at the bottom of individual planting holes or to fill the holes. Mulch the surface with wood chips or coarse compost.

Potting and Seedling Mixes

Sifted compost can be used to make a rich, loose potting soil for patio planters, house plants, or for starting seedlings in flats. Compost can be used to enrich purchased potting mixes or to make your own mixes.

Plants growing in containers are entirely reliant on the water and nutrients that are provided in the potting mix. Compost is excellent for container growing mixes because it stores moisture effectively and provides a variety of nutrients not typically supplied in commercial fertilizers or soil-free potting mixes. However, because of the limits of the container, it is essential to amend compost-based potting mixes with a “complete” fertilizer to provide an adequate supply of macronutrients (N-P-K). Simple “recipes” for making your own compost mixes are shown in *Figure 11*.

Figure 11.

Using compost in potting mixes

For starting and growing seedlings in flats or small containers:

Sift compost through a ½ inch or finer mesh.

Mix 2 parts sifted compost, 1 part coarse sand and 1 part Sphagnum peat moss. Add ½ cup of lime for each bushel (8 gallons) of mix. Use liquid fertilizers when true leaves emerge.

For growing transplants and plants in larger containers:

Sift compost through 1 inch mesh or remove larger particles by hand.

Mix 2 parts compost; 1 part ground bark, Perlite or pumice; 1 part coarse sand and 1 part loamy soil or peat moss. Add ½ cup of lime and ½ cup of 10-10-10 fertilizer for each bushel (8 gallons) of mix. (An organic fertilizer alternative can be made from ½ cup blood or cottonseed meal, 1 cup of rock phosphate, and ½ cup of kelp meal.)

Managing Organic Materials at Home

With an understanding of the value of finished compost and the biological processes that transform organic materials, it is easy to see why people would want to compost organic materials at home. Home composting not only provides a free soil amendment, but also reduces the cost of garbage collection and landfilling. Composting at home is a winning proposition.

Many of the common organic materials identified earlier are materials we generate at home and are candidates for home composting. These include yard debris, kitchen scraps, sawdust, soiled paper and cardboard, hair, pet wastes, and natural fiber fabrics. However, just because a waste *could* be composted at home does not mean that it *should* be. Some of these organic materials, including many yard clippings, are better managed by not producing them in the first place. Others, such as meat and other animal or fatty food wastes, invite so many problems that we are better off putting them into the trash.

Part of your role as a Master Gardener may be to help people decide which approaches are most appropriate for their unique situation. The decision depends on what materials are available, how much time and effort a person is willing to spend, the space available, costs, aesthetic considerations, and what options are available. To guide these decisions you must be familiar with the entire range of home composting methods and the types of materials and maintenance styles best suited to each of these systems.

The first step in selecting a management strategy for organic materials generated at home is to understand what options are available. When we apply solid waste management priorities to organic materials, we create the following hierarchy of options:

1. **Reduction** — Landscaping strategies and practices that reduce the amount of yard debris.
2. **Reuse** — Composting of materials for reuse on-site.
3. **Recycling** — Collection of organic materials for processing and marketing by centralized composting facilities.

The following sections examine the specific practices involved in each of these options.

Source Reduction

Source reduction principles should be applied to purchases of organic products as they are to any other. But how can we be selective about the wastes that come out of our yards and gardens? When autumn comes we cannot decide that the leaves won't fall. And we can't very well selectively cut the grass, can we?

In fact, we can choose to reduce organic materials generated at home. The choices are fewer than the multitude of choices we can make at the supermarket, but the process is the same and the results can be just as impressive.

Determine Needs

There are three main questions that we can ask ourselves about how we generate yard debris to determine if we "need" to be producing so much waste.

1. *How do you use your yard?* These uses affect the amount of space devoted to high-maintenance/high-waste-producing components, such as lawn and annual flower beds, as opposed to low-maintenance plantings or paved areas.
2. *Is the level of maintenance you provide essential for plant health and the reasonable appearance of the yard?* Yard debris can be reduced by less pruning, mowing, watering, and fertilization without sacrificing appearance and health.
3. *Are there materials that can be put to use at home that are currently being disposed?*

Identify Alternatives

A number of steps can be taken to reduce the amount of organic wastes generated in our landscapes. The alternatives range from simple changes in maintenance procedures to complete re-landscaping of yards to create self-sustaining composting systems. Several source reduction options are described here, starting with the simplest and moving to more involved strategies.

Grasscycling

Grass clippings are the largest single component of landscape waste in most yards. Yet it is actually healthier for the lawn to leave the clippings on the lawn than to remove them. Letting the clippings remain on the ground returns nutrients to the lawn, adds organic matter to rejuvenate the soil, conserves moisture, and saves time and money on bagging. Grasscycling does not contribute to build-up of "thatch," which is an accumulation of dead roots and stems.

It helps to have a lawn mower that is designed to "mulch" grass clippings back into the turf. Mulching mowers, now widely available, recirculate the clippings through the blades, chopping them into tiny pieces and blowing them down into the grass. Reel-type mowers are also effective at cutting the clippings small enough so that they are not conspicuous when left on the lawn. Other mowers may be adapted by modifying the outlet spout to direct clippings down rather than out.

During periods of fast growth and wet weather, grasscycling may require more frequent cuttings, to avoid heavy deposits of clippings. But without bagging the clippings, each mowing can take half the time.

Mulching

Many common yard clippings make excellent mulches or soft "paving" for paths and play areas. Grass clippings, leaves, and pine needles are all suitable for mulching landscapes. Wood chips from pruning and removing trees are a natural looking substitute for "Beauty Bark." This material can often be obtained for free by calling a tree service.

Yard debris mulches can be applied following the same methods described for using compost as mulch *(see Figure 9)*. Mulch annual flower and vegetable gardens with nonwoody materials that break down quickly and can be tilled under without competing with plants for nitrogen. If woody materials, such as sawdust or wood chips, are used in an annual garden they must be pulled aside before tilling, or they must be balanced by adding a high-nitrogen fertilizer such as blood meal when tilling them in.

Trees and shrubs can be mulched with one-half to one inch layers of grass clippings, or with two to four inch layers of wood chips, twigs or pine needles. Avoid making thick layers of fine green materials, as they can mat down, becoming anaerobic and acting as impenetrable barriers to air and water.

Selective Fertilization and Watering

Selective use of fertilizers and water, applied at the correct time in proper amounts, actually makes lawns healthier and more tolerant of stress, and produces less waste. Lawns should be fertilized in spring and early autumn to encourage strong root development. For more information on lawn fertilization, see the chapter on lawns in this handbook.

Turn In Crop Wastes

At harvest time, chop or till crop wastes from annual vegetable and flower gardens into the soil. Spring crops will decompose quickly if cut when they are still succulent, or you can add nitrogen fertilizer to speed decomposition. Fall crop wastes can be turned in or left cut roughly on the surface to protect soil from erosion and compaction, then tilled in with fertilizers a few weeks before spring planting.

Alternatives to Lawns

Reducing the size of one's lawn can produce less debris and conserve fertilizer, water, labor, and other resources. Many low-maintenance ground covers can be used to replace grass in low-traffic areas. In many cases, ground covers will be healthier and more attractive than lawns grown in less than optimum conditions, and they certainly require less work to stay attractive. Many low, spreading shrubs also provide interesting alternatives to lawns.

Areas used heavily as paths or play areas can be replaced by wood chips. To create a low-maintenance, long-lasting path or play area, remove the sod and lay down two or three overlapping layers of corrugated cardboard to suppress weed growth. Cover the cardboard with four to six inches of chip; it will compact as it is walked on.

Natural Landscapes

Many people are replacing high-maintenance lawns and shrubs with more natural-looking wooded areas (with native and other understory plantings and shade-loving ground covers) or wildflower meadows. An initial thick layer of wood chip or other yard debris will help create the woodland look and reduce watering, weeding, and other maintenance. These woodlands also provide areas to reduce grass clippings, leaves, needles, and other trimmings by using them as mulches. Meadow areas (probably away from the street or borders with neighbors) can be seeded with wildflowers and pasture grasses with attractive seed heads. These meadows are attractive when left unwatered and unmowed, or only mowed once each summer after flowering.

Selection

Sometimes major changes in the layout of a garden or maintenance plan are not possible. In these cases, it is important to carefully select landscaping practices to reduce waste. Here are some general criteria to use in selecting yard debris management options.

1. Reduce or reuse as many materials as possible at home (or on-site at public facilities). On-site reuse or composting is the most efficient landscape waste management option.
2. Use organic materials diverted from other sites whenever possible to meet landscape needs. Consider trading unwanted plants or plant divisions with neighbors and friends. Always try to reuse wastes, such as wood chips and animal manures, before purchasing new materials that would provide the same service.
3. Buy compost and mulch products made from recycled yard debris whenever possible for potting mixes, soil amendments, and other garden needs.

Reusing Organic Materials: Home Composting

Composting at home is an easy way to reuse yard debris. Home composting methods range from “no work” techniques that require maintenance once or twice a year, to active turning methods that are maintained weekly. Composting systems can be categorized by the type of materials they process: yard debris, food wastes, or pet wastes. In addition to considering the materials to be composted, the composting method chosen depends on how much space is available, the time and effort that the composter is willing to spend, and how quickly the compost is desired. The following sections review common home composting systems and discuss their advantages and drawbacks. *Figure 12* lists the brochures available from New Hampshire to help people choose and use a home composting system.

Composting Yard Debris

Yard debris can be composted in simple holding units where it will sit undisturbed for slow decomposition, or in turning bins, which produce finished compost in as little as a month. Not all yard debris is appropriate for home composting. *Figure 13* lists the types of debris considered appropriate for home composting and materials to avoid.

Holding Units are simply bins used to keep decomposing materials in an organized way while they break down. Using a holding unit is the easiest way to compost. It requires no turning or other labor, except for placing the debris into the bin as it is generated.

Non-woody materials, such as grass clippings, crop wastes, garden weeds, and leaves, work best in these systems. Decomposition can take from six months to two years. The process can be reduced to just a few months by chopping or shredding wastes, mixing green and brown materials, and maintaining proper moisture.

Since materials are added continuously, they decompose in stages. Generally, the more finished compost is located inside and at the bottom of the pile, while partially decomposed materials are near the top. Once or twice a year, remove the finished compost and return the undecomposed materials to the holding bin.

Some examples of holding units include circles of snow fencing or stiff hardware cloth (not poultry wire), old wooden pallets lashed together, and stacked cinder blocks. There are also a variety of commercially available bins made from wood, molded plastic, or metal.

Figure 12.

NH Composting Brochures

UNH Cooperative Extension offers a number of brochures and workbooks about composting.

Titles include:

Backyard Composting (a flyer prepared with the NH Governor’s Recycling Program especially for backyard composters. Cost: Free)

Composting: Wastes to Resources (designed for adult volunteers, leaders, camp counselors, and teachers who want to set up composting projects with youth. Cost: $8.00)

Composting to Reduce the Waste Stream (a guide to small scale food and yard waste composting. Cost $7.00)

Municipal Leaf & Yard Waste Composting (a planning guide for New Hampshire communities. Cost: Free. Contact: Governor’s Recycling Program; 271-1098)

Turning Units are typically a series of bins used for building and turning hot, fast compost piles or for slowly accumulating debris in cool piles that are turned occasionally for aeration. Barrels or drums are also used as turning units, mounted either vertically or horizontally for easy turning. Turning units allow wastes to be conveniently mixed for aeration on a regular basis. This speeds composting by providing bacteria with the air they need to break down materials. Given the proper mix and preparation of materials, turning piles will also generate the heat required to kill weed seeds, insect pests, and plant diseases.

Turning units can be expensive to buy or build, and hot composting requires substantial effort (see *Figure 15*). However, the effort and expense is rewarded with high-quality compost produced in short periods of time.

Hot composting must be done in batches using enough material to fill a 3 ft. by 3 ft. by 3 ft. bin, or about two-thirds of a barrel composter. Materials should be chopped, moistened, layered, and mixed as described in *Figure 16*. Hot piles should be monitored and turned after temperatures peak and begin to fall. Compost prepared in this way can be ready for use in three to four weeks.

Composting in rotating barrel units requires the same attention to balancing of carbon and nitrogen, chopping, and moisture control. If the materials are properly prepared and the barrel is rotated every two to four days, compost can be ready to use in two to three weeks.

Figure 13. **Composting Materials**

Yard Debris Acceptable for Home Composting

Grass clippings: Our most common organic waste at home.

Yard Trimmings: Old plants, wilted flowers, small prunings from shrubs and trees.

Leaves: Deciduous leaves are ideal for composting. Evergreen leaves are slow to decompose and may need to be shredded before composting.

Weeds: Weeds make fine compost, if seed heads, rhizomes, and other vegetative reproducing parts are kept out.

Plant-derived food scraps: Vegetable and fruit waste can be composted with yard debris in a properly prepared hot compost pile or worm bin.

Wood chip: Wood chip is a product resulting from tree trimming. Tree services will gladly leave some from work in your neighborhood.

Sawdust: Sawdust from unpainted, untreated wood without glues (i.e., no plywood) can be composted in worm bins or in yard debris piles in small amounts.

Cardboard and paper: Soiled cardboard and paper are not acceptable for recycling, but they can be torn up and composted with yard debris, or used under wood chip paths to suppress weeds.

Organic Materials That Should Not Be Composted At Home

Everything that was once alive will compost, but not everything belongs in your compost pile. Some materials that create problems and should be kept out of home compost systems include:

Plants infected with a disease or a severe insect attack: Insect eggs and disease spores can be preserved or the insects themselves could survive in most home compost piles (examples are apple scab, aphids, and tent caterpillars). These materials should be composted in large commercial systems which uniformly reach high, pasteurizing temperatures.

Ivy, succulents, and certain pernicious weeds: Plants which spread by rhizomes; such as Morning glory, Buttercups, Quack grass, and Comfrey may not be killed even in a well built hot pile in a home compost system. They can choke out other plants when compost is used in the garden. These plants should be composted in large commercial systems which uniformly reach high, pasteurizing temperatures.

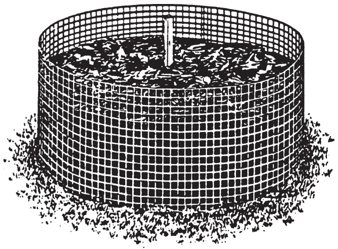
Cat and dog manures: Even though you find these in your yard, they are not yard wastes. Pet wastes can contain pathogens harmful to people. These wastes should be buried in ornamental areas of the garden, or flushed down the toilet.

Waxy leaves: The waxy leaves of plants such as Rhododendron, English Laurel, and Pine needles break down very slowly. Try composting small amounts of these mixed with other materials, or shred them for use as mulch. Large amounts of these leaves should be composted in large commercial systems which uniformly reach high temperatures and involve mechanical shredding processes.

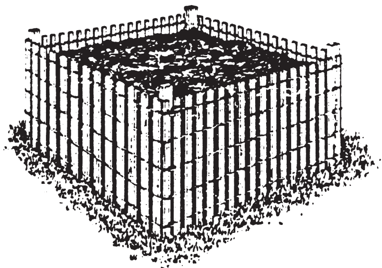
Figure 14.

Compost Holding Units

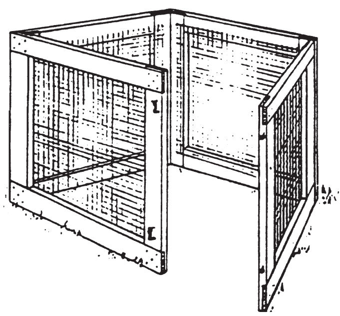
Moveable holding units constructed from:



Wire

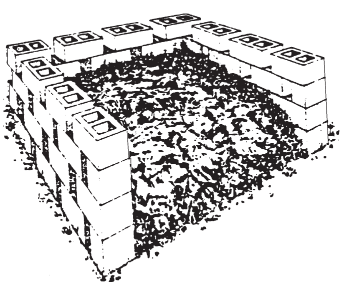


Snow fencing

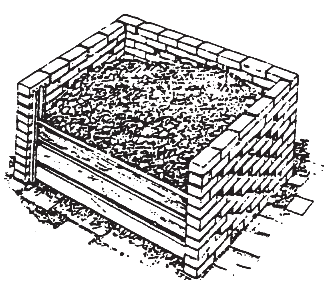


Wood-and-wire

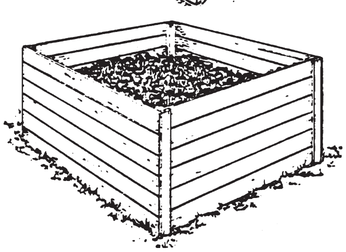
Stationary holding units constructed from:



Cinder blocks



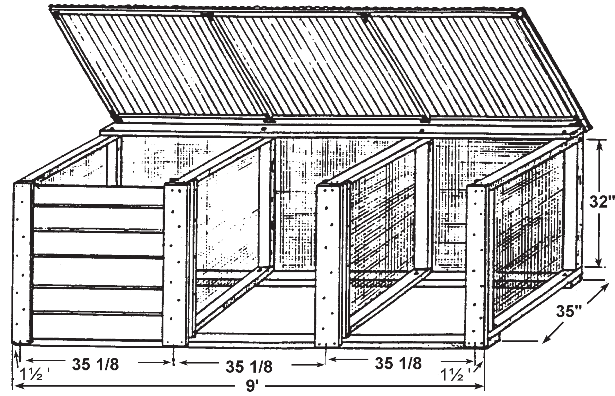
Mortared bricks



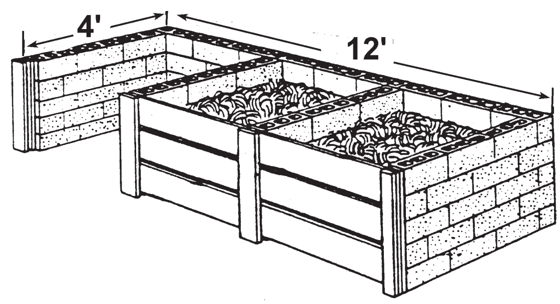
Wood

Figure 15.

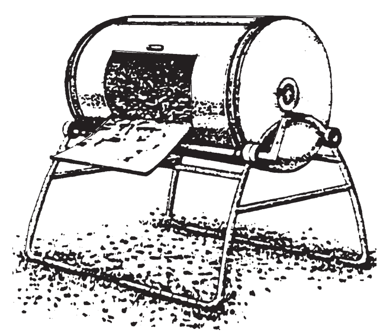
Compost Turning Units



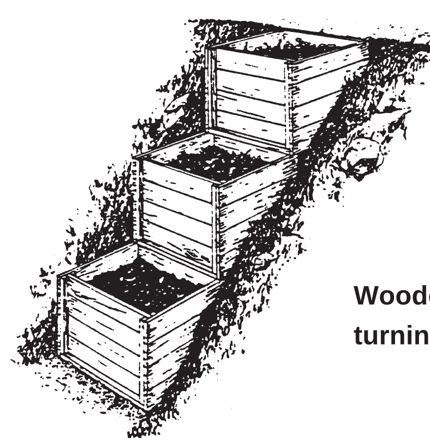
Wood slat three-bin turning system



Cinder block and wood turning unit.



Rotating barrel composting unit



Wooden stair-step turning unit

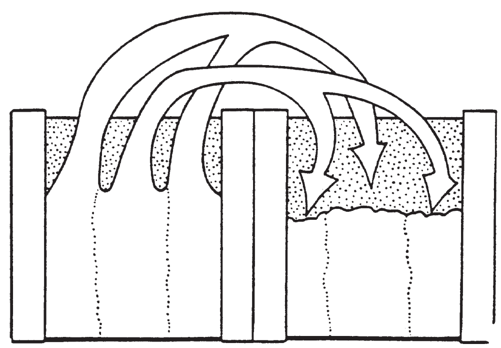
Figure 16.

Building a Hot Compost Pile

Hot compost piles are the only effective way to compost food and yard wastes together without pest problems. They can also kill plant diseases and weed seeds and will produce compost in a short period of time. Unfortunately, many home compost piles, even when built carefully, do not attain the high temperatures needed to kill diseases and pests uniformly throughout the pile. Diseased or insect-infested plant materials are best composted in large commercial operations where high temperatures are uniformly produced throughout the compost pile.

To Build a Hot Compost Pile:

1. **Gather enough green and brown materials** to make at least a 3 ft. by 3 ft. by 3 ft. pile (1 cubic yard) and to approximate a 30:1 carbon to nitrogen balance.
2. **Shred or chop coarse and woody materials** to increase their surface area. Semi-woody yard wastes like corn stalks can be cut up with a pair of pruners, or chopped with a machete or square point spade on a block of wood. Even some pounding with the back of a hatchet will create entry ways for decomposer organisms. A wide range of shredders and chippers are available for yard debris, or a rotary lawn mower can be used to shred leaves on a hard surface such as a driveway.
3. **Start building the pile with a 4 to 6 inch base of the coarser, brown wastes** (small branches, corn stalks, straw) to help air circulate from below. Moisten each layer.
4. **Add a 4 to 6 inch layer of nitrogen materials.** If the greens are not very fresh, sprinkle a small amount of blood meal or cottonseed meal, high nitrogen fertilizer such as ammonium sulfate, vegetative food scraps, or poultry manure over this layer. Food wastes may make up a part of this layer. High-nitrogen materials such as fresh grass clippings or vegetative food wastes should be used in thinner layers. Moisten and mix the green and brown layers together, so bacteria can feed on both layers simultaneously.
5. **Continue alternating and mixing layers of green and brown materials,** adding water and extra nitrogen-rich materials as needed, until the bin is full.
6. **Close the lid or cover the pile,** and wait.
7. **Monitor the temperature of the interior** of the pile on a regular basis. It should peak between 120 to 160°F in 4 to 7 days.
8. **When the temperature begins to decrease, turn the pile.** Take materials from the outer edges and top of the pile and place them at the base and middle of the new pile; those from the middle should be on the outside edges and top of the new pile.
9. **Continue monitoring the temperature** in the pile.
10. **About one week later, turn the pile again after the temperature of the pile peaks.** After another week the compost should be finished.



Turning a compost pile

Composting Sod and Weeds

Weeds that spread through roots or rhizomes and sod stripped from a lawn require special, covered compost piles. The roots of these plants — including Quack Grass, Buttercup, and Morning Glory — will sprout and spread through compost piles unless light is completely excluded. Small volumes of these weeds can be composted in any system that effectively excludes light and prevents their spread into soil. A covered garbage can or extra thick black plastic bag can be used as a "weed holding pile."

To compost large quantities of stripped sod, simply pile the fresh cut sod, (roots up/grass down), in a square or rectangle up to three feet high. Make sure each layer is thoroughly wet, and cover the entire pile (including the sides) with black plastic or a tarp. Sod piles may take one to three years to completely decompose. Decomposition of sod piles can be shortened to as little as six months by sprinkling each layer with a high-nitrogen fertilizer, such as cottonseed meal or ammonium sulfate.

Do not put flowers and seed heads of any weeds into sod piles or any other home compost system. Weed seeds can only be killed by the high uniform temperatures of a large compost pile.

Composting Food Scraps

Although non-fatty food scraps can be composted with yard debris in properly maintained hot piles, it is difficult for most people to maintain the conditions required for successful hot piles. Improperly composted food wastes can attract pests, create unpleasant odors, and make the compost unhealthy to handle. As Master Gardeners, encourage people to practice two other methods for safely composting food scraps:

1. To incorporate them into the soil where they will decompose and fertilize established or future plantings,
2. To compost them in worm bins which produce rich "castings" and use the castings as a mulch or soil amendment.

Figure 17 lists the types of food scraps appropriate for home composting and those that are inappropriate.

Soil Incorporation. This is the simplest method for composting kitchen scraps. Dig a hole one foot deep. Chop and mix the food wastes into the soil, then cover with at least eight inches of additional soil. Depending on soil temperature, the supply of microorganisms in the soil, and the carbon content of the wastes, decomposition will occur in one month to one year.

Food waste burial can be done randomly in fallow areas of the garden, or in an organized system. One such system is to bury scraps in holes dug around the drip line of trees or shrubs.

An English system, known as "pit and trench" composting *(Figure 18)* maintains a three-season rotation of soil incorporation and crop growth. The garden includes three rows: a trench in which to bury food wastes, a row for growing crops, and a third row to use as a path. In the next season, the fertile soil of the former compost trench is used to grow crops, the former crop row is left fallow and used as a path, and the compacted path is loosened and dug as a new trench to bury food wastes. After a third season of rotation, the cycle starts over again. This form of composting keeps the garden perpetually fertile with little organizational effort.

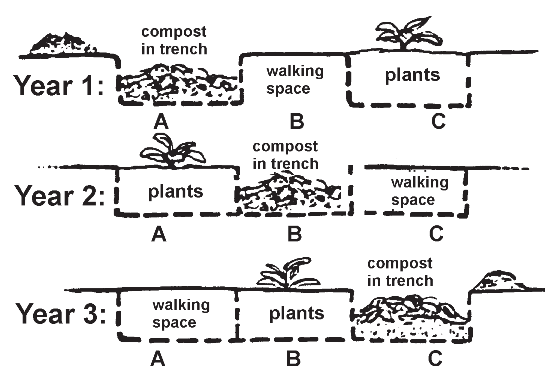
Figure 17.

Compostable Food Wastes

Can Be Used	Cannot Be Used
Apples	Butter
Apple peels	Bones
Cabbage	Cheese
Carrots	Chicken
Celery	Fish scraps
Coffee grounds, filters	Lard
Egg shells	Mayonnaise
Grapefruit	Meat scraps
Lettuce	Milk
Onion peel	Peanut butter
Orange peel	Sour cream
Pears	Vegetable oil
Pineapple	Yogurt
Potatoes	
Pumpkin shells	
Squash	
Tea leaves and bags	
Tomatoes	
Turnip leaves	

Figure 18.

Pit and Trench Composting



Worm Composting

Worm composting systems use "redworms" (not earthworms) to compost food scraps. Redworms can be purchased, found in leaf or manure piles, or taken from another worm bin. Worm bins are usually wood boxes with tightly fitting lids that provide redworms with a dark and moist environment, while excluding rodents and other pests. (*See Figure 19*) Surface area is more important than depth in sizing a worm system; generally, one square foot of surface is required for every pound of food waste to be composted per week. Drainage must be provided by drilling small holes in the bottom of the bin.

The worms live in moist "bedding" made from shredded newsprint, corrugated cardboard, sawdust, fall leaves, or other high-cellulose materials. Scraps are buried in this bedding, and the worms turn the food wastes and bedding into a high-quality soil amendment suitable for use on house plants, vegetable seedlings, and flowers. With a basic understanding of worms, these vermicomposting systems are simple to maintain.

Two or three times a year, when most of the contents of the bin have become dark "worm castings," the compost may be harvested. The finished compost will be greatly reduced in volume from that of the original materials, and should only fill one half or less of the bin. The compost may be harvested by moving it all to one side of the bin and adding fresh bedding to the empty side. Then you begin burying food waste in the new bedding. The worms will finish decomposing the old bedding and then migrate to the fresh bedding and food scraps, allowing the finished compost to be harvested.

Worm bins are fun and interesting. Mary Appelhof's book *Worms Eat My Garbage* is the best single source of information about these "living" garbage disposals.

Figure 19.

Worm Composting Bin

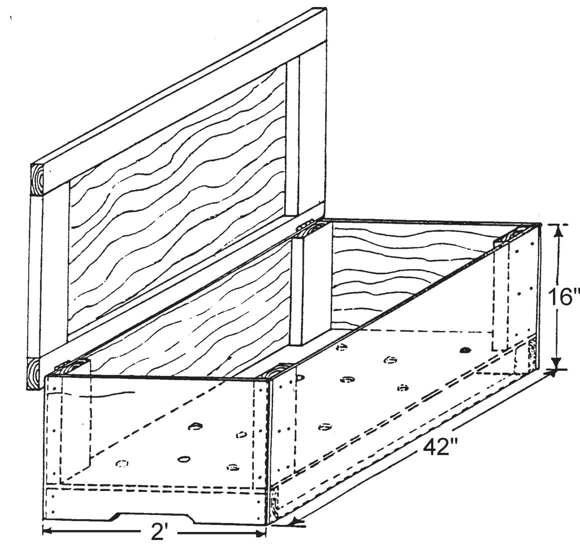


Figure 20.

Composting Criteria

Materials
Types of organic materials to be composted.

Cost
Amount of money required to buy or build a particular system.

Labor
Amount of time and energy needed to maintain the compost system.

Aesthetics
Types of materials and construction that are attractive and fit into a particular backyard. Also, how neatly the system organizes the compost.

Efficiency
Amount of time and space required to make compost, and the desired quality and quantity of the finished product.

Pest Control
How well pests are excluded.