chapter 3

Composting

In a nutshell...

- Compost happens. Just give it time.
- You don't have to have a yard to compost. Vermicomposting can be done in an apartment or office.
- Check the resources at **hort.extension.wisc.edu** for issues not covered in this chapter.

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Introduction

Nature recycles organic matter slowly on forest floors, in prairies, and in your yard. This decomposition process returns valuable nutrients and builds soil. You can recycle organic materials faster than nature by controlling the conditions needed to change leaves, garden debris, paper, food waste, and manure into a rich, soil-like material.

This controlled process is composting, and the end product is a humus-rich soil amendment called **compost**. This chapter covers the basics of compost and how to recycle kitchen, lawn, and garden wastes by home composting and vermicomposting.

Learning objectives

1. Explain the benefits of composting, how to tell when compost is done, and how to use it.
2. Know about different types of compost systems and what materials should and should not be composted.
3. Understand the carbon and nitrogen balance needed for successful composting and the role of micro and macro organisms.
4. Know the components of a worm bin, how to manage and harvest finished vermicompost, and how to use the finished product.

Why compost?

Composting offers many economic, environmental, and biologic benefits.

Save money: Composting is the most economical way to handle yard materials at home or work. Municipalities spend thousands of dollars picking up yard trimmings at the curb or maintaining drop-off sites. Gardeners can save tax dollars as well as the cost of plastic bags by composting. Composting also means you'll spend less money on costly fertilizer and soil amendments such as peat moss.

Improve soil structure and water management: Compost consists of irregularly shaped aggregates of particles loosely bound together by secretions from worms and bacteria. Inside and between the aggregates are many small air spaces that improve soil structure, texture, and aeration. As a result, compost improves drainage in clay soils and helps retain water in sandy soils. It also helps reduce water runoff. In addition, plant roots are better able to penetrate compost-amended soil.

Promote plant growth: Compost contains a variety of nutrients that plants need for healthy growth. Small amounts of nitrogen, phosphorous, potassium, calcium, magnesium, and sulfur are present in a slow-release form. It's also an important way to supply micronutrients—such as iron, manganese, copper, and zinc—often absent in commercial fertilizers. Compost usually supplements fertilizer rather than completely replacing it.

Hold nutrients longer: Compost is able to hold onto nutrients that might otherwise be washed through sandy soil or locked up in tight clay soil. Nutrients are stored inside the porous particles of compost aggregates. As organic matter, compost enhances the release of minerals and nutrients to plant roots by increasing the **cation exchange capacity** of the soil (see chapter 2, Soils). And the generally neutral pH of finished compost helps keep soil in the optimal 5.5 to 7.5 pH range needed to release nutrients to plants.

Benefit the environment: Recycling organic materials by composting returns valuable nutrients to the earth and saves landfill space. It eliminates the need to burn leaves, which can pollute the air and aggravate heart and respiratory conditions. Many of the organisms found in compost can help suppress some diseases and control pests that might otherwise take over a more sterile soil.

Yard and food waste: Wisconsin law

In 1993, Wisconsin law banned yard materials from landfills and most incinerators. Yard materials banned include leaves, grass clippings, garden debris and twigs, brush, and branches smaller than 6 inches in diameter. Because yard and garden materials cannot be placed in landfills, residents, towns, and cities have had to find other ways to handle yard materials. Composting at home or work is the most cost-effective way to handle these materials.

A small but growing number of cities in the U.S. are requiring households and businesses to compost food scraps. Restaurants, grocery stores, and institutions are showing an increased interest in composting food as well. Composting food and yard waste conserves valuable nutrients that would otherwise be lost. Check with your municipality to find out if curbside composting is available or if there are any home compost ordinances you should be aware of.

How to use compost

Mix compost into the soil

Compost can help improve the texture, moisture retention, and fertility of sandy or clay soil. To do so, you must mix compost or topsoil/compost blends into the top 6 inches of existing soil. Unmixed, compost can create a barrier layer that roots and water may not penetrate. This leads to shallow-rooted plantings that may blow over or suffer from lack of water and nutrients.

- Mix 2 inches of compost into the top 6 to 8 inches of lawn soil before seeding grass.
- Mix 2 inches of compost into the top 6 to 8 inches of garden soil before planting (fall is the best time for this).
- Mix compost into soil of exposed sloping areas to help fight erosion.
- DON'T mix any compost into the soil when planting trees. Doing so may cause roots to stay within the hole instead of spreading out properly.

Use compost as mulch

Spread up to a 3-inch layer of compost around flowers, vegetables, shrubs, trees, and groundcovers to:

- Discourage weeds.
- Slowly release nutrients when it rains or the garden is watered.
- Keep roots cool and moist.
- Reduce erosion.
- Conserve water.
- Maintain a loose, porous surface and reduce compaction.

Spread compost on lawns

Sift compost through ½-inch hardware cloth screen and spread a thin layer over your lawn to enhance the soil and add nutrients in a slow-release manner. This is called **topdressing** with compost.

Make compost tea

Compost tea is a liquid infusion made from compost that may contain nutrients beneficial for plant growth. Using compost and consistent watering may be just as effective.

Use in potting mixes

Compost can be added to potting medium used for transplants and containers. There are many different recipes (see box). Before using it, sift compost through 1-inch hardware cloth screen or remove larger particles by hand. Compost should not exceed 25% of the mix for good plant growth.

Potting mix recipe 1

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 lime and ½ cup 10-10-10 fertilizer for each bushel (8 gallons) OR replace 10-10-10 with an organic blend of ½ cup blood meal or cottonseed meal, 1 cup rock phosphate, and ½ cup kelp meal.

—Cornell University's Master Composter Manual, 1998

Potting mix recipe 2

Mix 1 part compost, 2 parts peat moss, and 1 part perlite or pumice.

— Various sources

Compost basics

What makes compost?

Microorganisms

Microbes are the workhorses of the compost pile. They are present on leaves, grass, and other yard materials—and even in the air. Bacteria, fungi, and **actinomycetes** (a gray, cobwebby growth with an earthy smell) generate heat as they multiply and start the process of breaking materials down. Keep these organisms happy and they will make compost faster for you.

You don't need to add compost additives or boosters to get your compost cooking. Although adding bacteria in these ways is not harmful, you already have plenty of bacteria on your yard materials to start your pile. You can also add a shovel or two of mature compost or garden soil.

Bacteria in compost piles thrive at different temperatures.

- From 0 to 55˚F, the low-temperature bacteria multiply and give off heat.
- Around 40˚F, the mid-temperature bacteria begin to increase and peak at 70 to 90˚F.
- As the pile heats up more, the high-temperature bacteria thrive from 104 to 170˚F.

A well-built home compost pile can reach 130 to 140˚F for 7 to 10 days, which will kill most weed seeds, many plant disease-causing organisms, and dangerous *E. coli* and *Salmonella* bacteria. To heat all parts of the pile, turn it once or twice during those first 10 days. Peak temperatures should not exceed 150 to 160˚F, or the microbes will die.

Food, oxygen, water

Microbes need the same things people do to live: food, water, and oxygen.

Food

Bacteria need carbon for energy and growth and nitrogen for making proteins and reproduction (see table 1). The ideal mix is 30:1, or 30 parts carbon to one part nitrogen.

TABLE 1. Food balance needed to make compost

Carbon	+	Nitrogen
Brown, dried plant materials		Green plant material or other nitrogen

Charts in compost books and online list the average carbon:nitrogen ratio of most organic materials: for example, dried leaves are 40 to 80:1 and green grass clippings are 19:1. For home composting, the rule of thumb is mix 2 parts brown with 1 part green. (When using manures, use only a couple inches of manure for each foot of brown material.)

Oxygen

Turning your compost pile fluffs it up to increase the flow of oxygen. This helps oxygen-loving **aerobic** bacteria multiply and break down organic materials faster. Reduce the oxygen and **anaerobic** bacteria begin to multiply, producing unwanted odors reminiscent of rotten egg or ammonia.

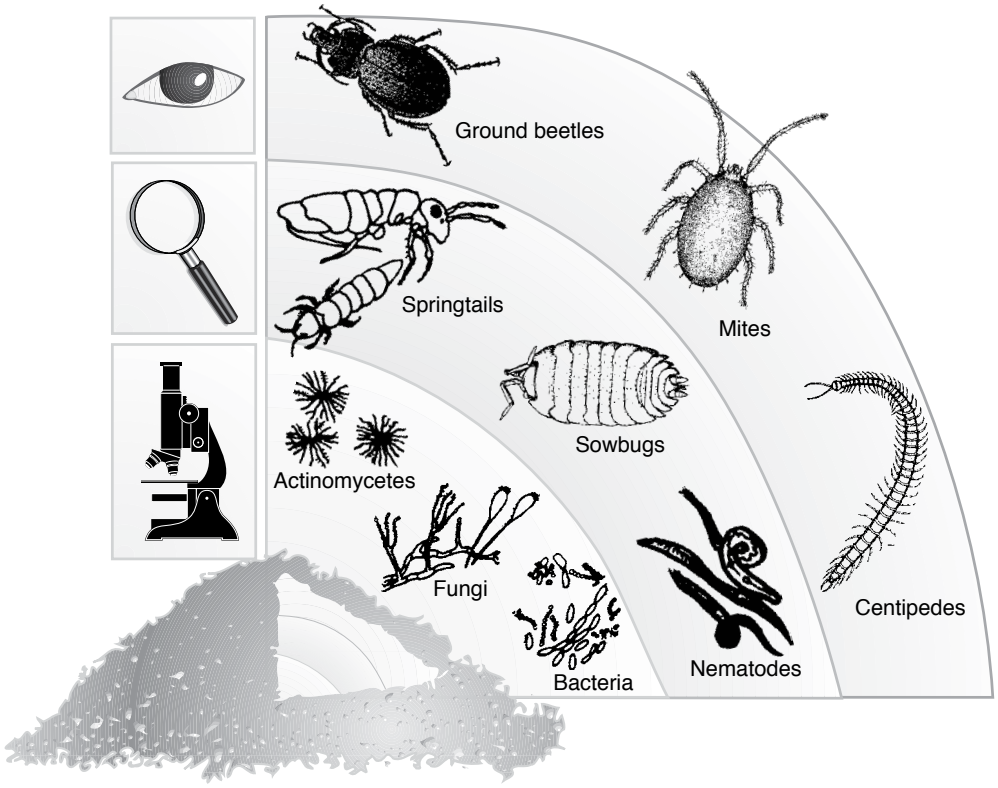
Water

Microbes in a compost pile live in a layer of moisture around particles of organic matter. If a pile is too dry, bacteria cannot function. If it's too wet, the oxygen is pushed out of the compost pore spaces, allowing anaerobic bacteria to take over.

Macro-organisms

Nematodes, mites, springtails, centipedes, sow bugs, ground beetles, and earthworms are just some of the normal critters found in a healthy compost pile (see figure 1). Some are active during the heating cycle, but most move in to help finish decomposition as the pile cools down.

FIGURE 1. Organisms at work in the compost pile



How to compost

Much of the average household's waste, including material generated during routine landscape maintenance and scraps from the kitchen, is suitable for composting. Different materials contribute different components to the compost pile. Table 2 lists materials for composting and whether they are brown or green (or both). Don't include items in the NO list (see box), as these can cause to problems during composting or with the finished compost.

Particle size

Chopping or shredding woody, large, or coarse materials can speed up the compost process. This exposes more food surface area to microbes. If pieces are too small, however, they compact, excluding oxygen. A mixture of large and small particles is best.

Moisture and turning

Keep your pile damp, between 50 and 60% moisture. It should feel as damp as a wrung-out sponge. Water your pile well as you build it, as you turn it, and whenever it begins to dry out. The shape of your pile can also affect moisture levels. A compost pile with a rounded top is likely to shed rain, while a pile with a dip in the top can collect moisture. Rainwater helps, but it may not provide enough moisture for a dry pile.

Turning shifts the outside of a pile to the inside, breaks up clumps, and mixes brown and green materials. Turning is most easily accomplished with multiple bins: simply lift the materials with a pitchfork or other tool from one bin to the next. With a portable bin, remove the bin from the pile and set it up again next to the pile. Transfer the composting material into the now empty bin. Unfortunately, stirring within a bin or pile can be frustrating and does not tend to mix materials well.

TABLE 2. Materials that can be composted

Organic materials	Carbon	Nitrogen	Other
Leaves	Brown	Green	
Grass clippings	Brown	Green	
Weeds/garden debris*	Brown	Green	
Small brush, twigs	Brown		
Fruit & vegetable food scraps		Green	
Untreated, unpainted sawdust or wood chips	Brown		
Egg shells			Calcium
Coffee grounds, tea leaves		Green	
Coffee filters, paper, cardboard	Brown		
Hay	Brown	Green	
Manure from herbivores (plant eaters)**		Green	
Aquatic weeds		Green	
Fur, hair, natural fibers, feathers	Brown		

* Persistent weeds (e.g. quackgrass and chickweed) need to be "cooked" to kill the weed seeds before you add them. Place the weeds in a sealed black plastic bag set in the sun for 2 to 3 weeks.

**Only by hot compost method. Do not add droppings from tropical birds—they may contain diseases.

Do NOT compost

- Meat, bones, fat
- Cat, dog, or human waste
- Dairy products
- Charcoal briquettes, fireplace ash
- Oils—cooking and salad
- Thorny branches
- Whole branches, logs
- Diseased plants*
- Sawdust from treated wood
- Some persistent weeds (quackgrass, bindweed)**

Poison ivy

Weeds with seeds*

*Unless hot composted

**Unless "cooked" first

Heaps, bins, or trenches?

Gathering your materials into a pile or heap is the simplest way to compost. You don't need to use a compost bin, but may prefer to do so. Compared to simply piling your compost in a heap, bins are more attractive, use vertical space better, and keep you more organized. And it's generally easier to turn compost from bin to bin than tackling a big heap.

Whether you use a bin or not, your compost pile should be:

- At least 3 x 3 x 3 feet in size (smaller bins will not hold heat well) and no larger than 5 x 5 x 5 feet.
- Near a water source so you can easily keep the pile damp.
- Convenient for you—near the house or garden.
- In the sun or shade—both work.
- Located where you have space to turn the bin (or turn your compost on to a tarp and then return it to bin).
- At least 2 feet from any buildings to allow air circulation.

Bins

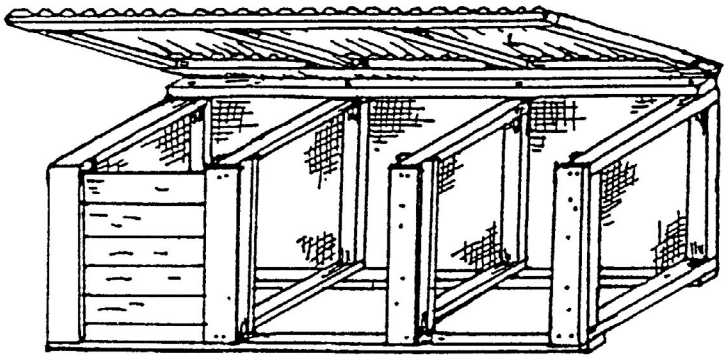
Many commercial or home-built bins work well. Choose a bin based on how well it functions, its appearance, and your budget.

Many commercial bins are made from recycled plastic. Choose one that is good sized, durable, and easy to set up and turn. Lids are optional: they can help retain moisture and keep pets and other critters out, but they also keep out the rain. To find affordable bins, check with your municipal or county recycling program to see if they sponsor a bulk bin sale. Also check garden centers, hardware stores, and online sources for bins.

Home-built bins can be as simple as a ring of chicken wire or a more elaborate wooden unit. There are many plans available for a variety of do-it-yourself bins (see figure 2) in portable or permanent styles, single or multiple bins, and using various construction materials.

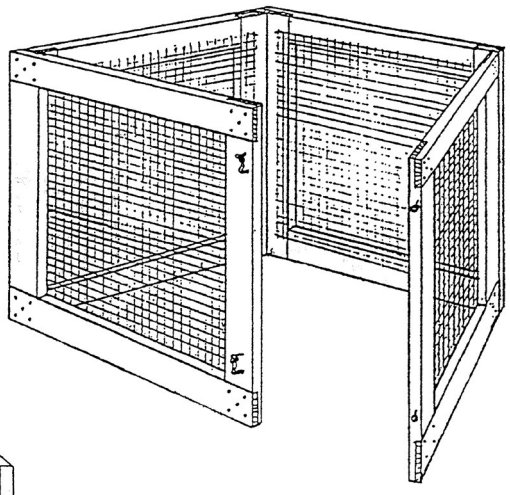
If you are building a wooden bin, use cedar or plain wood. Never use lumber treated with CCA (chromium, copper, and arsenic) or other wood preservatives, as the early stages of composting are acidic and can leach the arsenic into the compost.

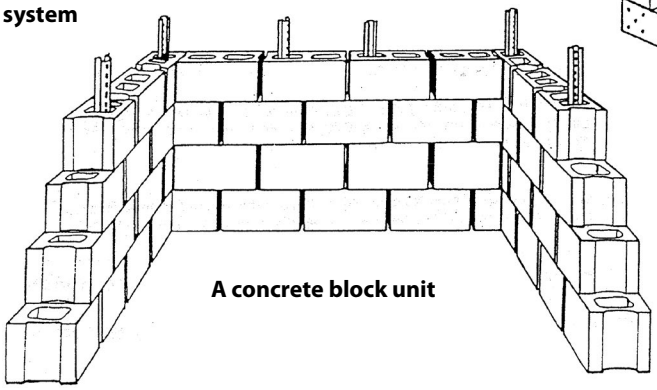
FIGURE 2. Compost bin styles



A home-built three-bin system

A portable wood-and-wire bin





A concrete block unit

Trench composting

Trench composting allows you to dig organic materials right into the ground; George Washington did trench composting to feed his tobacco plants. Fruit and vegetable scraps and garden waste can be dug into a trench or hole and covered up. You may need to add extra nitrogen if you are trenching lots of carbon-rich dried plants.

Compost recipes

There are two main ways to make compost. The method you choose will depend on the amount of time you have to devote to maintenance and how quickly you need the compost to use in your garden.

Fast composing

Fast composting (hot) creates a hot pile that makes finished compost in 12 weeks to 6 months (see sidebar). The length of time depends on how often you turn and water your pile. Giving the microbes two parts brown to one part green will also speed up the process.

Slow composting

With slow composting (cool) you build your pile a little at a time, so it never really heats up (see sidebar). The finished compost is ready to use in 12 to 24 months. The bottom or center of the pile may produce finished compost sooner. Any uncomposted material can be used to start a new pile.

Be careful what you add to this slow compost method. Do not add weeds that have gone to seed, diseased plants, or manure, as the pile will not heat up enough to kill seeds or diseases.

When is compost done?

Immature compost still needs nitrogen to finish decomposition and will compete with plants for nitrogen if used too soon. Let your compost rest—or **cure**—and become stable for at least 1 month before you use it in your garden.

Your compost is done if it meets the following conditions:

- It looks done—particles of leaves, weeds, and grass all look alike (but you still may see eggshells, small twigs, and pine needles).
- It smells done—earthy, like a greenhouse.
- It feels done—crumbly, not slimy.
- It doesn't reheat—it stays cool for a month.

A finished batch of compost will be half the volume of the original materials. So, a cubic yard of green and brown materials will reduce to approximately a half a cubic yard of finished compost. Tarp or cover finished compost to keep the rain from leaching nutrients and weed seeds from blowing in.

For help with common composting problems, refer to table 3.

Making hot compost

1. Make a thin layer of coarse organic materials such as small sticks or corn stalks (optional).
2. Layer or mix approximately two parts brown (carbon) materials and one part green (nitrogen). Water each layer as the pile is built. Finish off the pile with a brown layer of dried plant material.

Hint: Chopping materials will speed up composting. Use a lawnmower, shredder, or machete.

Some recipes add an inch of soil or finished compost after each layer of brown and green. This will add extra microorganisms, but it's not necessary. There are enough microbes already present on yard materials to inoculate the pile.

3. Turn the pile at least two times during the first 7 to 10 days to heat the entire pile to 130 to 140˚F, then every week or two to fluff it up and let in oxygen. Water the layers of the pile as it's turned. Keep the pile as damp as a wrung-out sponge.

Making cool compost

1. Make a thin layer of coarse organic materials such as small sticks or corn stalks (optional).
2. Add yard materials as they accumulate, but maintain a proper mix of two parts brown materials to one part green.
3. Water the pile as you build it. Keep it as moist as a wrung-out sponge.
4. Turn the pile occasionally or not at all.

TABLE 3. Common compost problems

Problem	Observation	Solution
Too dry	Dry, crackles to the touch.	Add water; keep the pile as damp as a wrung-out sponge.
Too slow	Doesn't heat up.	Add more green materials (nitrogen), check the moisture.
Too wet	Soggy, may smell.	Turn pile to fluff and increase oxygen and add dry brown materials. Stop watering until the pile is just damp.
Smelly	Pile matted, especially if grass clippings were used. Smells bad.	Turn the pile and mix in more brown material.

Other ways to manage organic material

Grass-cycling

Golf courses leave grass clippings on the fairways because it is free fertilizer. Recycling nitrogen-rich grass clippings back to your lawn throughout the season equals one fertilizer application.

- To recycle grass clippings back to your lawn, use a mower with a mulching blade or a regular lawnmower (a few passes may be needed).
- Grass-cycling does not create **thatch**. Thatch is made up of grass stems and roots—not grass blades—and is more often a result of over-fertilization.
- Encourage others to grass-cycle to reduce the volume of yard materials at municipal drop-off sites and curbside.

Grass clippings can also be added to the compost bin or used as mulch. If your lawn has been treated with herbicides, the herbicide may transfer with the clippings and could kill flowers, vegetables, and even trees. DO NOT use treated clippings as mulch until you've mowed at least three to four times.

Mowing leaves

Leaves can be recycled right on the lawn if the leaf layer is not too deep. Run your lawnmower across leaves several times until the pieces are small and fall between the grass blades.

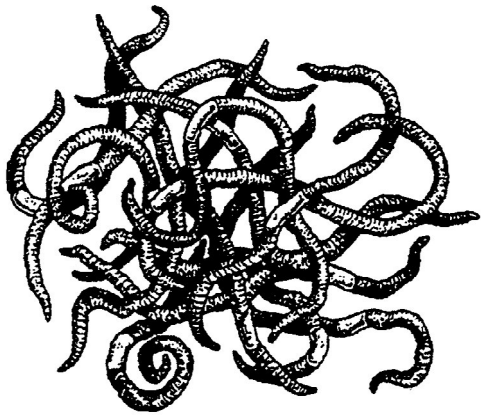
Worm composting

You can compost in your house, apartment, or office with red worms, or *Eisenia fetida*. The finished **vermicompost**—or worm castings—are digested bedding and food scraps.

- Vermicompost is great for improving soil and feeding houseplants, flowers, fruits, and vegetables.
- Worm bins are fun, educational tools for kids at school or home.
- Red worms eat half their weight a day and especially favor watermelon, cantaloupe, and pumpkin. They also eat other fruits, vegetables, coffee grounds, eggshells, and houseplant leaves.
- Red worms are also good pan fish bait or food for pet salamanders.

Red worms live for 1 to 4 years, if well cared for. They reach maturity in 60 to 90 days, then breed and lay two to three eggs in cocoons. Red worms thrive in highly organic, moist conditions: they can live at temperatures from 32 to 100˚F, but prefer 55 to 77˚F.

Red worms are available at bait shops in small quantities or mail order businesses by the pound. **Note:** Do not use night crawlers in these higher-moisture bins, as they will die.



Worm bins

A well-managed bin will have an earthy smell and should not smell bad. Bad odors result from adding too much food or the wrong foods (e.g., meat, dairy) or foods like onions and broccoli that can have a strong odor while decomposing.

To create a worm bin (see figure 3), start with a 10-gallon plastic bin with a lid. Then:

- Wash the bin with hot soapy water.
- Drill 25 to 30 small holes in the bottom for drainage.
- Set the bin on 1- to 2-inch blocks on a plastic tray.
- Fill the bin with damp bedding—shredded newspaper or office paper.
- Add ½ cup peat moss (for moisture control) and ¼ cup sand (which helps grind food in worm gizzards).
- Dig in one gallon of food/plant scraps and cover with bedding. Add one pound of red worms (about 1,000).
- Put several whole sheets of newspaper on top of the bedding to help keep it moist.
- Leave the lid off and a light on for the first night (to keep the worms in the bin).
- After the first night, ALWAYS leave the lid ajar for ventilation.

Feed your worms one gallon of kitchen scraps every week or when the food disappears. You shouldn't need to add water—the food usually provides enough moisture. A family of three will need one or two 10-gallon bins to handle all their food scraps. Worms are easy to care for and can be left for a couple of weeks if you are away. Add new bedding, peat moss, and sand as needed.

Harvesting and using vermicompost

The **light method** of harvesting vermicompost works well. Worms turn away from light, which will help you harvest. Take the lid off your bin in a lit place and the worms will move down. Scrape off a layer of the wormless castings, wait 15 minutes, and then continue to harvest. Repeat the process until done.

The **side-to-side method** is even easier. Push the vermicompost to one side; put new bedding and food on the other. Wait a week and the worms will move to the new food side, leaving the wormless castings behind.

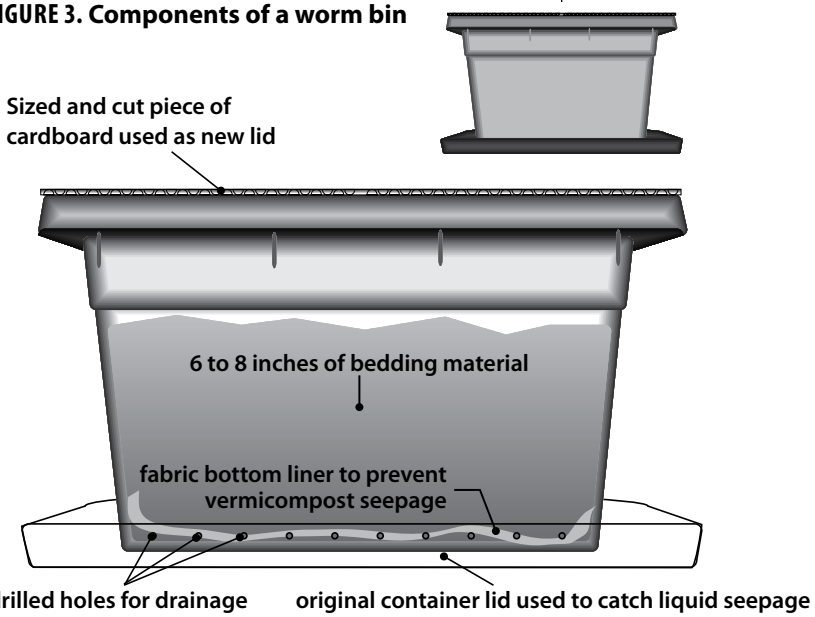
Vermicompost also needs to cure before you use it. Let it sit for a few weeks to stabilize. Keep a towel or sheets of newspaper on top of the bucket of castings to prevent the vermicompost from drying out. Dry vermicompost is very hydrophobic and difficult to remoisten.

Use worm castings sparingly. They are richer than regular compost and contain a higher concentration of salts from the worm's digestive system.

Conclusion

The process of composting turns kitchen, lawn, and garden wastes into a humus-rich soil amendment. Home composting can reduce the use of water and synthetic fertilizers while improving the health of your soil and plants. Vermicomposting affords homeowners and apartment dwellers an opportunity to compost food scraps year-round. And all forms of composting keep nutrient-rich, reusable yard and food waste out of the landfill.

FIGURE 3. Components of a worm bin



Source: Lori Marsh, Extension Engineer, Biological Systems Engineering Department, Virginia Tech. *Composting Your Organic Kitchen Wastes with Worms* (Publication 442-005).

Resources

Wisconsin Horticulture publications are available at hort.extension.wisc.edu.

FAQs

Won't composting kitchen scraps attract pests?
Don't add meats or fats to your compost pile. Bury any scraps 6 to 8 inches deep in the compost pile so you don't attract unwanted guests. Never just dump them on top and leave them uncovered.

Can I add pine needles?
Yes, up to 10% by volume can be added to a compost pile. They break down very slowly due to the lignin and waxy coating of the needles. And they do little (or nothing) in changing soil pH.

Can oak leaves be composted?
Yes. Although they are acidic to start with, microbes break them down to a neutral pH. Oak leaves take longer to break down than most other leaves, so shred them to speed the process.

Should I add lime?
No. The microbes do the neutralizing. Adding lime may shift the pH too high, slow microbial activity, and create odors.

Where do I get brown materials in July?
Save bags of brown leaves from the fall; use straw, marsh hay, dried weeds (no seeds) or grass; or add shredded newspaper.

Can I compost in winter?
Composting will slow to a stop as the weather cools. Building a hot pile in the fall will give you a jump-start in spring. Keep a few bags of leaves next to your bin to cover the kitchen scraps you add to the pile.

Can I add wood chips?
Yes, but not too many. They break down slowly but do serve as a bulking agent to keep piles loose and let in more oxygen.

What about pesticides?
Most turf and garden chemicals break down in the composting process, but some residual materials can affect sensitive plants. Be careful when adding treated materials to the pile.

Composting, practice exam questions

1. Adding compost to a clay soil helps
- a. Decrease the release of minerals and nutrients
- b. Decrease air spaces between aggregates
- c. Improve drainage
- d. Supply large amounts of nitrogen

2. Compost can be used:
- a. Mixed into the soil when planting trees
- b. Spread up to 3 inches deep as a mulch around flowers
- c. Spread up to 3 inches deep on lawns to add nutrients
- d. All of the above

3. When building a compost pile, you should always:
- a. Add compost additives or boosters
- b. Keep it soaking wet
- c. Add 2 parts browns (dried materials) to 1 part greens (fresh materials)
- d. Add 30 parts browns (dried materials) to 1 part greens (fresh materials)

4. Things that should never be composted include:
- a. Cat, dog, or human waste
- b. Dairy products and oils
- c. Diseased plants and weeds with seeds
- d. all of the above

5. A compost pile or bin should be:
- a. At least 5 x 5 feet
- b. At least 2 feet from any buildings to allow air circulation
- c. Located in the shade
- d. Made from recycled materials

6. Compost is done:
- a. When it feels crumbly and smells earthy
- b. About a month after the pile was made
- c. It is warm to the touch
- d. All of the above

7. Vermicomposting
- a. Uses red worms to digest organic matter
- b. Can be done in the house, apartment, or office
- c. Is a good educational tool for kids at school or home
- d. All of the above

Answer key
1. (c) 2. (b) 3. (c) 4. (d) 5. (b) 6. (a) 7. (d)