Backyard Composting

Objectives

1. Understand the role composting plays in diverting food waste from the landfill.
2. Define compost and composting.
3. Understand aerobic decomposition, including the role of various organisms.
4. Discover what makes a pile heat up and what the temperature curve means.
5. Understand the five control factors of a compost pile (SMART)
6. Backyard compost bins and systems

Terms Defined in this Chapter:

Actinomycetes
Aerobe
Anaerobe
Biologic decomposition
Browns
C:N Ratio
Cellulose
Compost
Compost Food Web
Composting
Controlled conditions
Dicamba
Enzyme
Greens
Juglone
Lignin
Mesophile
Psychrophile
Saprophyte
Soil amendment
Thermophile

Study Materials

Why compost?

Clark County produces about 58,000 tons of food waste each year. Our waste is hauled to local transfer stations where it is packed onto barges and carried 160 miles upriver to Finley Buttes Regional Landfill, in Morrow County, OR.

In addition to taking up landfill space and costing money and energy to transport, food waste and other organic material in a landfill decomposes anaerobically and releases methane, a gas contributing to climate change.

Composting is simply ***organic recycling***. But, unlike cans, bottles and paper that can only be reformed into similar products, yard and food wastes can be converted into a ***valuable soil amendment.*** As a soil amendment, finished compost improves soil texture, increases the water holding capacity of soil, nourishes plants, and reduces our need for petrochemical fertilizers.

Another asset that is too precious to waste is good, edible food. We know that recycling, although valuable, is the least effective tool in our waste reduction kit, we should always look to reduce and reuse materials first. Composting can be similar for certain items, most notably edible food. When we compost, we should be sure what we are adding to our pile is truly at the end of its useful life. We want to do everything we can to use them for their highest calling (feeding people and animale before we add them to the compost pile.

Decomposition Happens!

Since the dawn of life on earth, and long before our need for solid waste disposal, nature has been decomposing her dead and returning the nutrients to start another cycle of life. A walk through the forest demonstrates natural decomposition. As the stumps, branches, twigs, needles, leaves, animal wastes and dead animals break down, they become unrecognizable as plants and animals and begin to resemble rich, fertile soil. No unpleasant smells, no intervention required. When human beings lived in small, nomadic hunter-gatherer groups, solid waste disposal was not a problem. When more complex agricultural societies developed, man began producing significant quantities of waste. He also recognized the need to maintain the fertility of cultivated soil.

The "Father of modern composting" is Sir Albert Howard, a British government agronomist. Sir Howard spent 29 years in India studying various scientific methods to make compost. His landmark book, *An Agricultural Testament* (1943), generated renewed interest in organic methods of agriculture and gardening.

In North America, J.I. Rodale carried Howard's work further. He established the Farming Research Centre and "Organic Gardening" magazine. Now, organic methods in gardening and farming are becoming increasingly popular. Even farmers who rely on chemical fertilizers recognize compost's value for plant growth and soil restoration. Today, farmers, gardeners and scientists continue to refine composting (ref. Hanson, *Easy Compost* p.11).

What is composting?

Composting is a method of solid waste management whereby the ***organic component*** of the solid waste stream is ***biologically decomposed under controlled conditions*** to produce a ***valuable end product*** (Goldstein, ed., *Biocycle Guide to the Art & Science of Composting*, p.14).

Let's break down this definition.

What exactly is the *"**organic component of the waste stream?***"

Organic refers to materials that were once living. Therefore, plant and yard wastes, wood and paper wastes, animal waste, manure and food scraps make up the organic component of the waste stream. As you will learn later, not all organic waste is appropriate for backyard composting.

What does the term *"**biologically decomposed under controlled conditions***" mean?

Biologic decomposition refers to the breakdown of organic materials by bacteria, fungi and other ***living organisms***. In contrast, incineration is a non-biologic method of decomposition that breaks down wastes, but will not produce compost.

What do we mean by ***controlled conditions***?

Unlike the natural decomposition that "happens" on the forest floor, composting systems can be manipulated to encourage specific organisms and discourage others. Yard waste composting is designed to encourage oxygen breathing microorganisms (primarily bacteria, fungi and actinomycetes) to dominate the system. Composting produces a ***valuable end product***. That end product can be directly applied to the land as a beneficial ***soil amendment***.

What is compost?

Compost is defined by the Washington Organic Recycling Council (WORC) as ***"a product produced from the controlled decomposition*** **of** ***organic matter.***" As materials in the compost bin decay, they undergo the same biological and chemical transformations as natural organic litter. When we apply stable, mature, finished compost to the soil, it ultimately functions in the same manner as natural humus.

Compost Biology 101

Biologic decomposition is primarily the work of thousands of microscopic species of bacteria, fungi and a special group of organisms related to fungi called ***actinomycetes***. Microorganisms that feed on dead organic material are called ***saprophytes***. The ***saprophytic microbes*** can be divided into two basic groups, ***aerobes*** and ***anaerobes***.

Aerobes require oxygen to live. Aerobic, saprophytic bacteria, fungi and actinomycetes rapidly degrade organic matter and give off heat, water and carbon dioxide as by-products. Aerobic decomposition is odorless, therefore yard waste and vermicomposting systems are designed to encourage aerobic organisms.

Anaerobes do NOT require oxygen to live, in fact, oxygen is toxic to them. Anaerobic organisms are found in nature on swamp bottoms and in other oxygen-poor environments. They work slowly, produce no heat, and give off methane (sewer gas), hydrogen sulfide (rotten egg aroma), alcohols, phenols, terpines, putresines and cadaverines (their names suggest their offensive smells!). Many of the byproducts of anaerobes are toxic to earthworms, insects and plants. Anaerobes begin to function when oxygen concentrations drop below about 15%. When oxygen levels drop below approximately 8%, distinctive odors are generated.

Decomposition can occur by two basic processes, ***aerobic*** and ***anaerobic*****.**

- ***Aerobic decomposition*** requires oxygen.
- ***Anaerobic decomposition*** occurs in the absence of oxygen.

Because aerobic organisms give off heat as a by-product of degradation, ***an aerobic yard waste compost pile gets hot during the most active phase of aerobic activity***. The internal temperature of an active compost pile can range from 0ºF to over 160ºF. ***This heat is totally independent of outside weather conditions and is solely the result of microbial activity***. No one species of bacteria, fungi or actinomycetes can survive this wide temperature range. Rather, each species is best adapted to a relatively narrow temperature range. Scientists classify species into three broad groups:

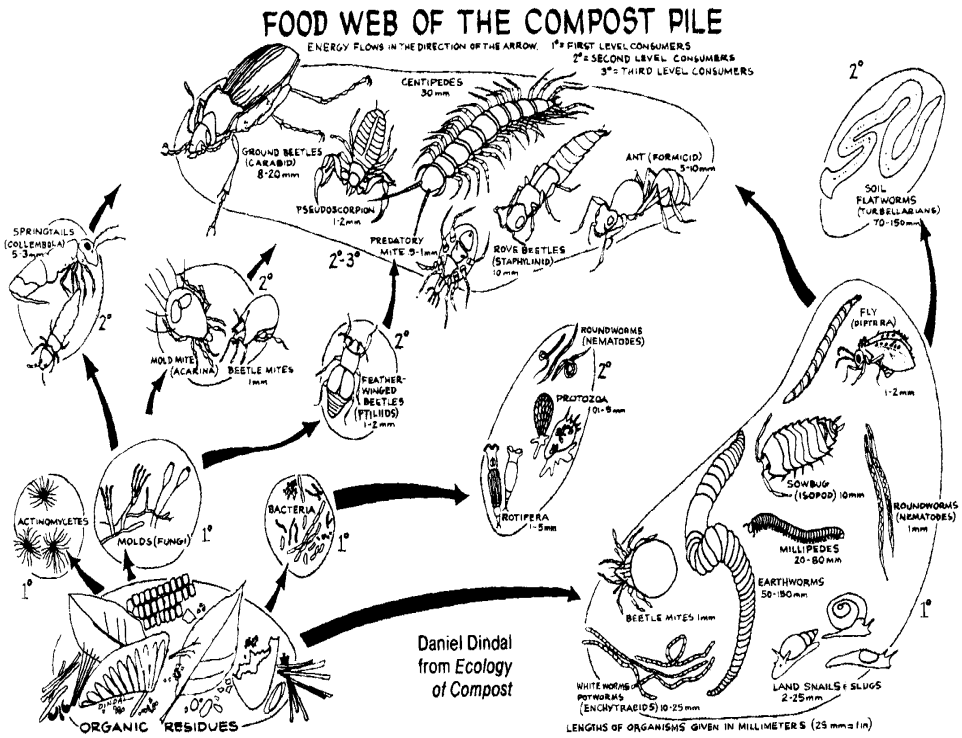
Psychrophiles: Microorganisms that thrive at temperatures ranging from 0ºF to 55ºF.
Mesophiles: Microbes that live in temperatures between 40ºF and 115ºF. The optimal range for many mesophiles is 90ºF to 115ºF. Actinomycetes and most fungi are mesophiles.
Thermophiles: Microorganisms adapted to temperatures ranging from 110ºF to 160ºF. Temperatures above 160ºF kill even the thermophiles and effectively sterilize the compost pile.

Yard waste compost systems are designed to encourage species from all three groups to be present at all times in a compost pile, ready to take advantage of whatever environment they encounter. Bacteria reproduce very rapidly; many have doubling times of 20 minutes or less. Under optimal conditions, in one hour, 100 microbes divide to become 200, then 400, then 800, etc. Because every individual in this huge population gives off heat as it decomposes organic wastes, the pile gets hotter and hotter. The psychrophiles are replaced by the mesophiles who are replaced by the thermophiles. The microbes that die contribute organic matter to the compost pile. Their spores (seed-like reproductive bodies) generally survive high temperatures and will give rise to new individuals when the temperature cools sufficiently.

Compost Food Web

Microscopic bacteria, fungi and actinomycetes are the real workers in the compost pile, but they are just one part of a complex and fascinating ecosystem we call the "Compost Food Web".

Figure 2-1. Compost Food Web. From Dindal 1971, *Ecology of Compost*.



Primary layer:

Bacteria, fungi and actinomycetes are at the bottom or primary layer (1º) of the Compost Food Web. These organisms feed directly on decomposing waste. Thousands of species of these organisms exist, and it is not fully understood which species are most active in the compost process. Nonetheless, they all feed on decaying organic matter by secreting ***enzymes***. Enzymes are specialized proteins that break down carbohydrates, proteins or fats into simple molecules that can be used by the microorganism. These simple food molecules are then digested by the bacteria and fungi and utilized for building and maintaining cell structure, reproduction and energy. The only byproducts of this metabolic process are carbon dioxide (CO_2), water (H_2O), and heat. Bacteria do the lion's share of work in a compost pile. They are the primary degraders of organic waste. There are species of aerobic bacteria that thrive in all temperature ranges. Actinomycetes and most fungi are mesophilic. They generally appear on the outside layer of the pile as a gray or green powdery coating. Both actinomycetes and fungi are most active in degrading ***cellulose*** and ***lignins***, components of paper and woody materials (ref. Goldstein, ed. *Biocycle Guide to the Art & Science of Composting*, p.18).

Flies, sowbugs, pot worms, ***earthworms*** and ***snails*** can also feed directly on wastes, but unlike the microbes, they produce a "manure" that can be further metabolized. In addition, some also feed on bacteria, fungi and actinomycetes, thereby acting as both 1º and 2º consumers. Earthworms are sensitive to light, temperature and moisture and will only visit a compost pile that is dark, cool and moist. Although they play a role in backyard composting, they are not usually present in large numbers.

Secondary layer:

Bacteria, fungi and actinomycetes have enemies lurking in the compost pile. They are fed upon by a group of organisms that comprise the second layer (2º) of the food web. These organisms include:

Protozoa: Microscopic single cell organisms capable of self-propelled movement that feed on bacteria. Protozoa help regulate bacterial populations and serve as a food source for organisms higher in the food web.

Nematodes or Roundworms*:* Microscopic, unsegmented worms with a long cylinder-shaped body. They feed on plants, bacteria, fungi and other nematodes.

Rotifers*:* Single cell organisms, usually found in water that move using rings of tiny hairs on its front end and feed on bacteria.

Springtails **(Colembola**): Tiny, white insects that feed on fungi.

Mites **(Acarina):** Arachnid (8 legged, spider-like) insects that feed on fungi.

Beetles: Large group of insects that feed on fungi.


Adult

Black Soldier Fly Larva: Black soldier fly larva are voracious decomposers. Don't be fooled, many see these "maggots" in their compost and get concerned, but these larva are actually a sign of a healthy pile. Larva typically appear in piles that have relatively high moisture, so one way to control them is by adding dry carbon material. When flies hatch, they typically live for only a few days. They are not aggressive nor annoying and have no mouth parts with which to eat or bite. More info on this fascinating and beneficial creature can be found here: http://tinyurl.com/p7guwu.


Larva

Tertiary or Top layer:

The predators occupy the third and highest level of the Compost Food Web. These include:

Ground Beetles: Fairly large, feed on insects.

Pseudoscorpions: Rarely seen predator that feeds on insects.

Centipedes (Chilopoda): Fast moving, many legged predators that can bite humans and will eat beneficial worms. Not a welcome member of the compost pile.

Millipedes (Diploda): Round, hard-shelled, slow moving, many-legged beneficial vegetarian.

Ants: Many species, feed on insects.

All the organisms in the Compost Food Web are necessary to completely degrade organic waste and produce finished compost. In nature, the process of decomposition is erratic, depending on temperature, moisture levels and the types of decaying materials. Unlike natural decomposition, compost is biologically decomposed under controlled conditions, and ***well-managed yard waste composting favors aerobic microorganisms***. It is our job as composters to create and maintain an environment that encourages these organisms to thrive 24 hours a day. The **Five Control Factors**, described in detail below, are the keys to optimal performance.

Five Yard Waste Compost Control Factors - SMART

Control Factor 1: Size

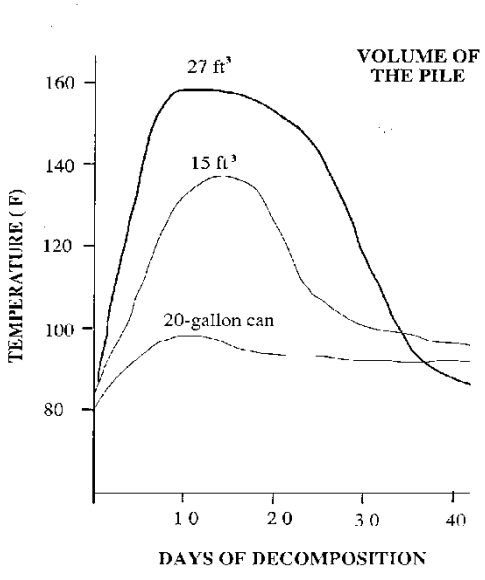


Figure 2-2. Effect of Volume.

As you know, aerobic decomposition generates heat as a byproduct. As compost goes from the psychrophilic to mesophilic to thermophilic temperature range, the rate of decomposition increases. The most active breakdown occurs in the thermophilic range. An ideal compost pile must be well insulated to retain the heat generated by microbial action and encourage the proliferation of thermophilic organisms.

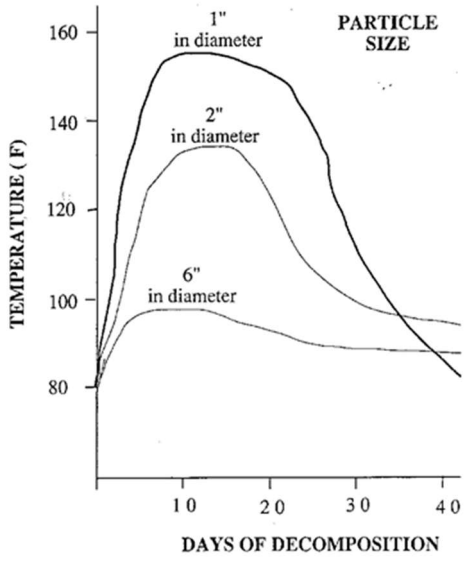
The most efficient volume for a home compost pile is 27 cubic feet (one cubic yard). A pile measuring 3feet high x 3feet wide x 3 feet deep and contains six-and-a-half, 32-gallon trashcans full of shredded organic material. As the figure demonstrates, reducing the pile size to 15 cubic feet or to 20 gallons dramatically reduces efficiency.

Is a pile greater than one cubic yard more efficient? Yes and no. Commercial composters generally handle piles greatly exceeding one cubic yard. These piles have such huge mass that they often reach temperatures exceeding 160ºF (sterilization temperature) and require vigilant monitoring to keep the beneficial organisms aerated and alive. Commercial operations use heavy machinery and many man-hours to move and turn the piles. For the homeowner, piles larger than one cubic yard become difficult to turn and aeration suffers. Like its commercial counterpart, a large home pile can become so hot that beneficial microbes will die. The largest manageable home compost pile is about 5ft x 5ft x 5ft. If a homeowner has large amounts of compostable materials, it is more prudent to advise several smaller piles rather than one big pile.

Particle Size

We have all witnessed the dramatic effect particle size has on the rate of organic decomposition. A tree stump may take 20 years to break down, while grass clippings are unrecognizable within 24 hours. The difference is due to the amount of surface area available to microscopic organisms at the bottom of the Compost Food Web; the more surface area available, the faster the rate of breakdown. In addition, most plants have a protective outer "skin" that naturally resists bacteria and fungi. Breaking or chipping the plant exposes the vulnerable inner surfaces to microbial action.

Figure 2-3. Effect of Particle Size.



As the figure demonstrates, in an ideal system, in which materials are 1"-2" in diameter, the pile heats quickly and evenly, reaching the thermophilic temperature range within 10 days. If particle size is increased to 6" in diameter, the pile never leaves the mesophilic range and degradation is slow. The simplest way to achieve ideal particle size is by running over the materials with a lawn mower, chopping them with a machete or by using a chipper/shredder. Shredded materials not only increase the rate of decomposition, a pile composed of uniformly sized organic materials has greater insulating value, sheds rainwater, resists excessive drying, and is easier to turn and harvest. Particles smaller than 1" in diameter tend to compact more easily, squeezing out air molecules and fostering the proliferation of anaerobic organisms.

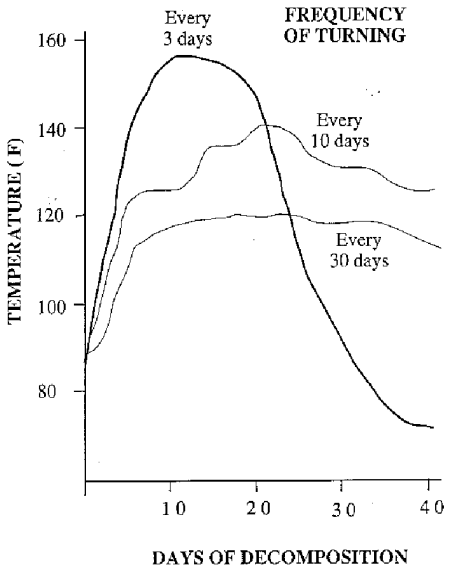
In practice, it is not necessary to achieve total uniformity. In fact, the addition of a few larger chunks of material (pine cones, small branches, etc.) may improve aeration by providing avenues for oxygen to move through the system. This is especially important when large amounts of grass (particle size less than 1") or very wet materials are added to the compost pile.

Control Factor 2: Moisture

Water is essential for all living organisms. The microorganisms in a compost system rely on water, not only for their metabolic functions, but also as a medium through which they move to all parts of the pile. Many microbes can travel only through water. Moisture and aeration are closely related. Too little moisture cannot sustain microbial life and too much squeezes out oxygen and encourages proliferation of anaerobes. The ideal moisture level is ***45%–60%, the consistency of a wrung out sponge***. A handful of compost should feel moist but should produce no water drops when squeezed. When moisture levels exceed about 70%, water molecules fill the oxygen pores between particles and anaerobes are favored.

Control Factor 3: Aeration

Figure 2-4. Frequency of Turning.



Aerobic decomposition cannot take place without oxygen. Remember, both aerobes and anaerobes are present in the compost pile; their relative numbers depend solely on oxygen concentration. In the absence of oxygen, anaerobic organisms and their unpleasant odors will take over. Oxygen can penetrate passively about 18". Once the oxygen in the thermophilic center of the pile is depleted, the pile will cool off and the dormant anaerobes will repopulate the compost. How to maintain adequate oxygen and encourage aerobic organisms? Turn the pile! The graph shows the effect of turning the pile on the rate of decomposition as measured by temperature change. As the graph illustrates, a pile turned **every three days** will decompose far more quickly than a pile turned every 10 or 30 days. If turning every three days is good, would turning the pile every day be better? NO! Fungi and actinomycetes are extremely sensitive to temperature and oxygen concentrations and thrive only in the cool, oxygen rich, outermost layer (4" to 6") of a compost pile (ref. Goldstein, ed. *Biocycle Guide to the Art & Science of Composting* p.19). If a pile is turned too frequently, fungi and actinomycetes populations cannot reach critical mass and cellulose degradation suffers.

Table 2-2. C:N Ratio of Organic Waste Materials.
(adapted from Appendix A: On-Farm Composting Handbook, 1992, NRAES).

Material	C:N Ratio	Brown or Green?
Manure (Farm animals)	6-19:1	Green
Vegetable waste	11-19:1	Green
Hay	15-32:1	Green
Shrub/garden trimmings	16:1	Green
Grass Clippings	17:1	Green
Coffee Grounds	20:1	Green
Fruit waste	20-49:1	Green
Corn stalks	60-73:1	Brown
Dried leaves	40-80:1	Brown
Pine Needles	60-110:1	Brown
Straw	80:1	Brown
Saw dust	125-600:1	Brown
Newspaper	398-852:1	Brown
Bark dust	560-641:1	Brown
Cardboard	563:1	Brown
Chipped branches	~600:1	Brown

Control Factor 4: Ratio

All living organisms require Carbon (C) and Nitrogen (N) to live. Carbon is used for both cell structure and energy while nitrogen is used primarily in building cell proteins. The relative concentrations of the two elements are expressed as the ***C:N Ratio*** (Carbon to Nitrogen Ratio). A material containing 10 times more C than N is said to have a C:N Ratio of 10:1. A material containing half as much C as N would have a C:N ratio of 0.5:1.

Cells need more carbon than nitrogen. In fact, ***most organisms use 30 parts of carbon to each part of nitrogen (C:N ration of 30:1)***. When the carbon and nitrogen content of a compost pile approaches a C:N of 30:1, it provides an ideal food source for compost organisms.

Table 2-2 lists the C:N Ratios of many commonly composted materials. These ratios were determined by chemical analysis. ***Nitrogen-rich*** materials have C:N ratios of less than 50:1. Nitrogen-rich materials are referred to as "***greens***" because they are often (though not always) green or brightly colored. "Greens" tend to be soft-structured and rich in moisture. ***Carbon-rich*** materials have C:N ratios above 50:1. Carbon-rich materials are considered "***browns***." Browns often have a brown or golden color and tend to be dry, bulky and fibrous. If carbon content greatly exceeds nitrogen (high C:N, ratio greater than 50:1), bacteria will rapidly use all the

available nitrogen and die. As they die, they release their cellular nitrogen, allowing another round of bacterial growth. Because nitrogen is limiting, each round of growth will be short and degradation will be slow. If nitrogen concentrations are too high (low C:N, ratio less than 30:1), bacteria will release unused nitrogen as ammonia. In addition to its nasty aroma, ammonia is toxic to beneficial worms and insects. Compost high in soft structured, nitrogen-rich materials can squeeze out oxygen and encourage anaerobic organisms.

How do we blend our diverse organic wastes to achieve a C:N of 30:1 in our compost pile? Equations exist to calculate compost C:N ratios (http://compost.css.cornell.edu/calc/cn_ratio.html), but unless solving page long mathematical formulas is your idea of fun, follow this simple rule of thumb: ***Mixing an equal volume of brown and green materials will result in a C:N of 30:1.*** In other words, for every shovel-full of browns, add a shovel-full of greens and mix well. No need to even dust off the old calculator!

Control Factor 5:

As Master Composters, we strive for the ideal, but most homeowners don't always want to dedicate themselves to composting. What happens to a neglected pile? Remember, COMPOST HAPPENS! Idealizing the 5 Control Factors will simply increase the ***rate of decomposition.*** An ideal "thermal" pile will produce finished compost in as little as 4-6 weeks, whereas a "passive" pile may take a year or more to complete the degradation process. A passive pile rarely reaches the thermophilic temperature range and most decomposition is carried out by psychrophilic and mesophilic microorganisms. There is some evidence that passive compost can retain more nutrients than thermal compost, but finished passive compost has no greater or lesser value than finished thermal compost. One important difference exists. Many weed seeds and plant pathogens will not be destroyed unless they are exposed to temperatures in the thermophilic range. In fact, ***to kill weeds and pathogens, compost must reach 135ºF-160ºF for 6 hours/day for 3 consecutive days***. When the temperatures begin to drop after the third day, the pile must be turned and heat up to 135ºF–160ºF for 3 more days. After a second turning and 3-day heating cycle, most weeds and pathogens will be killed. It is virtually impossible for a home compost system to sustain temperatures hot enough to kill weeds and pathogens. Therefore, ***to avoid inoculating your garden with weeds or diseases, do not add weeds or diseased plants to a home compost pile.***

Materials that belong in a Yard Waste Compost Pile
For quick reference, see Table 2-3 for a summary of the following information.

Bread scraps
Avoid butter or margarine.

Chipped branches
Use in moderation, slow to degrade. May be useful to create air channels.

Farm animal manure
Excellent N source, may be odor problem. Mix well with browns**.**

Fruit peels, wastes

Bury well to avoid attracting fruit flies. May be better used in a Worm Bin (see Vermicomposting).

Grass clippings

Excellent N source; mix well with browns to avoid compaction. May be better left on the lawn - grasscycling.

Hair

Pet and human hair are good sources of N.

Moss

Moss will fully decompose. Finished compost from a moss-containing pile does NOT spread moss.

Pinecones

A few pinecones are beneficial to create air channels, but they degrade very slowly.

Shredded fresh or dried deciduous leaves

Excellent source of C.

Shredded newsprint or cardboard

Probably better in the recycling bin, but can serve as a C source. Make sure to shred and spread well to avoid compaction.

Shredded, dried broad-leaved evergreen leaves

These include rhododendron, azalea, laurel, holly, Oregon grape, and salal leaves. Drying and shredding will break down protective waxy cuticle and allow microbial access. Good source of C.

Shredded pine needles

Use in moderation, tough protective coat makes them slow to break down. Pine needles are acidic as they break down. May be more useful as mulch for acid-loving plants. Good source of C both fresh or dried.

Straw/Hay

Good source of C, make sure to mix well and watch particle size.

Shredded natural fabrics and dryer lint

Cotton, wool, and silk scraps, if well shredded will decompose in a compost pile. Polyester, on the other hand, lasts forever!

Sod

Break up and shake off as much soil as possible before adding (large quantities require a specialized method of composting, see page 65 below).

Spent flowers

N source.

Urine

It is high in nitrogen and can sometimes be used as a fertilizer for crops (this is true of humans or any other animal). Since we know that compost piles crave nitrogen, a little urine can add a boost of this essential nutrient. This isn't to say that you should use the compost pile as your new alternative to a toilet, but that you could if you wanted to from time to time without any negative effects.

Vegetable peels, wastes, coffee grounds

Excellent N source. Avoid any vegetable waste contaminated with grease or oil. Check particle size. May be better used in a Worm Bin (see Vermicomposting).

Materials that DO NOT belong in a Home Compost Pile

For quick reference, see Table 2-3 for a summary of the following information.

Black walnut leaves, nuts

Leaves, nuts and roots of the **black walnut** contain a chemical called ***juglone***, a persistent herbicide that when present in finished compost can kill sensitive garden plants. **Black walnut** leaves can be added to a Waste Reduction Pile (see Chapter 5) where the toxin will eventually break down. English walnut leaves are not toxic and may be added to a home compost bin.

Chemically treated wood

Creosote or chemically treated woods leach toxic chemicals into the compost pile that kill beneficial organisms. Best hauled to a company that handles wood waste (see Appendix II, Resources).

Commercial Compost Starters, Activators or Fertilizers

Many composting books advise adding a commercial "Compost Starter" or "Activator" to increase the rate of decomposition. These products generally contain ammonium sulfate, which acts as a nitrogen source. Unlike organic nitrogen, ammonium sulfate releases a burst of nitrogen. So much nitrogen is available that microbes cannot use most of it and the excess is released as ammonia. Locally high concentrations of ammonia kill many microbes, worms and insects. In addition to being a waste of money, there is no sound biochemical reason to add compost starters, activators or fertilizers to a home compost pile. Mixing materials to give a 30:1 C:N ratio will facilitate healthy, sustained microbial activity, without wasting nitrogen or money.

Fresh broad-leaved evergreen leaves

Rhododendrons, azaleas and other broad-leaved evergreen leaves have a thick, waxy cuticle, which breaks down very slowly. They will eventually degrade, but it is better to add dried, shredded leaves.

Glossy paper

Some glossy magazine photos contain toxic heavy metals and are best added to the recycle bin.

Human Waste

Never add human manure – also known as "humanure" – to backyard compost or food crops, because of the disease potential. Residents seeking a way to compost their humanure can explore myriad resources such as the guide at http://humanurehandbook.com/manual.html to find the method that works best for them.

Invasive Weeds

These include our favorite blackberries, Morning glory, Quack grass, ivy and mint. These plants grow by rhizomes (root-like stems that give rise to new plants) and will not be reliably killed in a home compost system. These are best managed by taking them to a commercial or municipal composting company (see Appendix II, Resources).

Lime

Like wood ash, lime is very basic and will alter the pH of the pile and kill beneficial organisms. Lime is better used elsewhere in the garden.

Meat and Dairy

Avoid all meat, bones and dairy products. In addition to being a favorite food source of Salmonella, they attract flies and vermin. Meats also tend to decompose anaerobically by putrefaction. One alternative to throwing away meat scarps is **deep pit or trench composting**.

Oily or Greasy Food Wastes

Kitchen oils and greases may attract flies and vermin to the pile.

Pet Waste

The feces of cats, dogs, pot-bellied pigs and exotic birds can contain pathogens or parasites that are transmissible to humans. Dog feces may transmit hookworm, cat feces are a source of salmonella and toxoplasmosis, and bird droppings can carry salmonella or Chlamydia psittaci (causes a severe respiratory illness called psittacosis). None of these pathogens or parasites are reliably killed in a home compost system. **Do not compost pet waste and never bury it in an area where food will ever be grown!** The best way to dispose of pet waste and kitty litter is to bag it and put it in the garbage. Pet waste should not be included in a backyard compost pile, but there are a few alternative composting methods, including deep pit composting and pet waste digesters. Ask the Program Coordinator for specific information on any of these methods.

Poisonous Plants

Toxins produced by plants such as Nightshade (cardio-toxic) are not reliably killed in a home compost system. Handle these plants with caution. Poisonous plants are best managed by taking them to a commercial or municipal composting company.

Produce Stickers

A common casualty of fruit and vegetable peels, these stickers are plastic and will never decompose in a compost pile. They do not pose any health risk, but can be a nuisance if mixed in with all your other compostable materials. The best thing to do is remove stickers and put them in the garbage.

Sand

There is absolutely no reason to add sand to a pile. Sand is an inert substance; it cannot be composted. Like soil, sand will simply add weight to the pile.

Soil

Some composting "Bibles" recommended adding soil to compost to "inoculate" it with beneficial microbes. Inoculation is **NOT necessary**. The surfaces of all plants are covered with saprophytic microbes just waiting for the plant to die so they can get to work. In addition, air currents carry microbial spores, and worms and insects will find their way in. Large quantities of soil will make the pile heavy and may increase the potential for compaction.

Weed Seeds and Diseased Plants

Home composting rarely achieves the temperatures necessary to kill weeds and plant pathogens. It is best to either compost these separately (see Chapter 5) or take them to a commercial or municipal composting company (see Appendix II, Resources).

Weed & Feed Type Products

Weed & Feed Products contain a toxic broad-leaf herbicide called ***Dicamba***. Dicamba degrades very slowly. If a Weed & Feed Product is applied to lawn grass, the grass must be cut *twice* after application and the clippings either left on the lawn, placed in a Waste Reduction Pile or bagged and taken to a commercial or municipal composting company. Only the *third* and subsequent clippings are safe to add the compost pile.

Wood Ash

Wood ash is a good source of calcium and potash, but it is very alkaline and will dramatically alter the acid-base balance (pH) of the compost pile, killing many organisms and slowing the rate of decomposition. Many plants benefit from a top dressing of wood ash. Contact a Master Gardener for specific uses.

Table 2-3. Do and Do Not Compost.

 DO Compost	 Do NOT Compost
Bread scraps	Black walnut leaves
Chipped branches	Chemically treated wood
Farm animal manure	Compost starter/activator/fertilizer
Fruit peels, wastes	Fresh broad-leaf evergreens
Grass clippings	Glossy paper
Hair	Highly invasive weeds
Moss	Human waste
Pinecones	Lime
Shredded broad-leaf evergreens	Meat and dairy
Shredded natural fabrics/dryer lint	Oily/Greasy kitchen waste
Shredded newspaper/cardboard	Pet waste
Shredded or dried leaves	Poisonous plants
Shredded pine needles	Produce stickers
Sod	Sand
Spent flowers	Soil
Straw/hay	Weed seeds/diseased plants
Vegetable peels, coffee grounds	“Weed and Feed” products
	Wood ash

Tricks of the Trade: Troubleshooting a Yard Waste Compost Pile

The following are some common questions you may encounter when dealing with the public.

Q: I don't have anything to compost, why should I do it?

A: Remember, coffee grounds, vegetable and fruit scraps and houseplant clippings are compostable. Also, consider helping neighbors and friends by composting some of their excess garden waste.

Q: I live in an apartment or condo with virtually no yard. Can I still compost?

A: Absolutely! Vermicomposting and bokashi are options.

Q: With all this talk about bacteria and fungi, is there any danger in handling a compost pile?

A: Although some fungi pose a theoretical risk to immunosuppressed people, there have been no reports of disease due to compost. The best prevention is the simplest: WASH YOUR HANDS WITH SOAP after handling compost and wear a mask if sensitive to molds.

Q: Help, I haven't turned my pile in a while and it's beginning to smell.

A: In the absence of adequate oxygen, anaerobes and their nasty byproducts have taken over your pile! Luckily, it's easy to fix by turning the pile to introduce more oxygen. Turn the pile until it reaches the thermophilic range (110ºF –160ºF) and all offensive odors are gone.

Q: How can I keep my compost pile from getting waterlogged in the winter and too dry in the summer?

A: Weather in the Pacific Northwest presents some challenges to the home composter. The good news is that our mild winters allow decomposition to take place year round. The bad news in the winter is excessive rain. Simply covering your compost pile with a tarp or piece of scrap plywood is effective.

Q: **What is the best time of year to start a compost pile?**

A: Browns are abundant in the fall, greens in the spring. A good suggestion is to collect and store browns in the fall (make sure to keep them dry), and use them to start a pile in the spring. Alternatively, shredded paper or straw can be obtained year round as a substitute for fall leaves.

Q: Do I need to buy a chipper/shredder?

A: NO! Gas powered chippers are noisy, dangerous and polluting. Unless you have vast quantities of materials, manual methods are preferable.

Q: If I keep adding fresh material to my compost pile, it will never be finished. Do I need two piles?

A: No, the next time you turn your pile, simply remove the finished compost and return the unfinished material to the pile.

Backyard Compost Bins & Systems

Objectives

1. To become familiar enough with various composting systems to advise a prospective composter.
2. What is a Waste Reduction Pile and to whom would you recommend one?
3. To understand special situations such as sod and pet waste composting.

Terms Defined in this Chapter:

Chicken Wire Bin
Concrete Block Bin
Earth Machine
FreeGarden 82 gal. Enviro World
Open Pile
Three Bin Turning Unit
Tumbler
Waste Reduction Pile
Windrow
Wooden Pallet Bin

Study Materials

Helping People Choose the Right System

Many people come to Composter Recyclers for advice on how to start backyard composting. Before recommending a system, you may want to ask:

- What materials do you have or want to compost?
- How much space do you have in your yard for a compost pile?
- How much time do you want to spend working with your compost?
- What aesthetic criteria do you have? Does it have to look attractive, or just be functional?
- How much time and money would you be willing to invest in a bin?
- How quickly do you want finished compost?

Armed with the answers to these questions, you can guide each individual to the system best suited to his or her needs. Remember, a happy composter is a lifelong composter!

Best Location for a Compost Pile

Responsible backyard composting requires consideration of others. Although a well-managed compost pile will not emit nasty odors, it is best to build the compost pile in a visually secluded area downwind of neighbors. This advice is most applicable to large, open, unconfined piles; most commercially available home compost systems are designed to be relatively small and attractive. It is also important to build the compost pile near the source of waste materials and in a spot convenient to the user.

Social considerations aside, weather dictates the best location for a compost pile. In the Pacific Northwest, the winters are relatively mild and wet, and the summers are dry. Locating the pile in

an area that receives morning sun and afternoon shade and covering the pile during the rainy season is probably the best advice. It is also best to avoid excessively windy areas because too much air circulation could dry the pile. Selecting a spot with good drainage will prevent the area around the compost bin from becoming a muddy mess in wet weather. Some composting books recommend placing a pile under a tree. Be aware of the species of tree, avoiding black walnuts, pines and bay laurels (ref. Harmonious Tech., *Backyard Composting*, p.25).

Tools and Gadgets

Few tools are truly required for composting. A sturdy pitchfork and wheelbarrow will serve the average composter for decades. Handy additions include a mulching lawn mower, blower-vac or machete to shred materials. Although a minimalist can get by with an old shovel, the "compostophile" may invest in a host of specialized tools including compost thermometers, compost turners, and compost sifters (see Figure 8).

Open Pile or Windrow

An open pile is simply unconfined compost. Open piles generally require a significant amount of space and distance from neighbors. They can be actively managed to produce compost quickly or left to decay naturally. Open piles should measure approximately 3ft x 3ft x 3ft (1 cubic yard) for peak efficiency.

Simple Homemade Enclosures and Bins

Examples of these simple systems are on display at the MCR Program Demo Sites (for addresses, see Appendix II, Resources). Figure 8 illustrates many systems and the advantages and disadvantages of each system are summarized in Table 8.

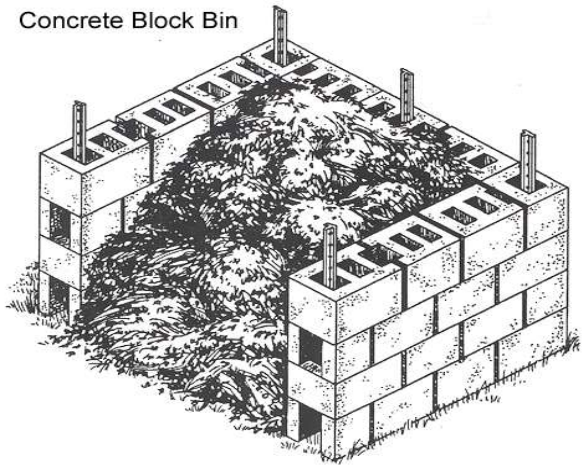
- **Wire or plastic mesh enclosure**

  Wire and plastic mesh are inexpensive and readily available and can be used to form a simple circular enclosure of any diameter. They are easy to open or disassemble when the compost needs turning, but unfortunately, both materials are flimsy and tend to distort easily and tip. In addition, unless the bins are covered, they are prone to rain or excessive dryness, inquisitive pets, birds and rodents. ***Wire or plastic mesh enclosures may be best suited as a corral to stockpile browns in the fall.***

- **Wooden pallet bin**

  Wooden pallets are readily available and can be assembled into an almost perfect cubic yard bin by nailing or wiring the sides together. With a bit more work, one can make one side a "hinged" door for easy access when turning or harvesting. Placing a pallet on the bottom of the cube helps provide aeration. Unfortunately, pallet bins are heavy, unattractive, and prone to decay.

- **Concrete block bin**



Concrete blocks offer a modular approach to compost bin building. They can be used to build a single or multi-bin unit. Concrete blocks are relatively inexpensive, and their design allows good ventilation. Generally, concrete bin systems require a lot of space and are heavy and difficult to move.

- **Homemade Three Bin Turning Unit**

The Three Bin Turning Unit is attractive and can handle a large amount of waste, but it requires a bit of woodworking skill to build.

In this system, mixed organic waste is added to the first bin. After the first heating cycle, the partially composted materials in the first bin are turned into the second bin and fresh wastes are added to the first. The fresh materials in Bin 1 and the newly turned materials in the second bin will go through a second heating cycle. At that time, the material from Bin 2 is turned into Bin 3, material from Bin 1 moves to Bin 2 and fresh waste is added to Bin 1. When the compost in Bin 3 is finished, it is removed for use and the cycle starts again.

- **Commercially Available Compost Bins**

Many commercially produced compost bins are advertised to the public.
Every system has advantages and disadvantages (see Table 8).

FreeGarden

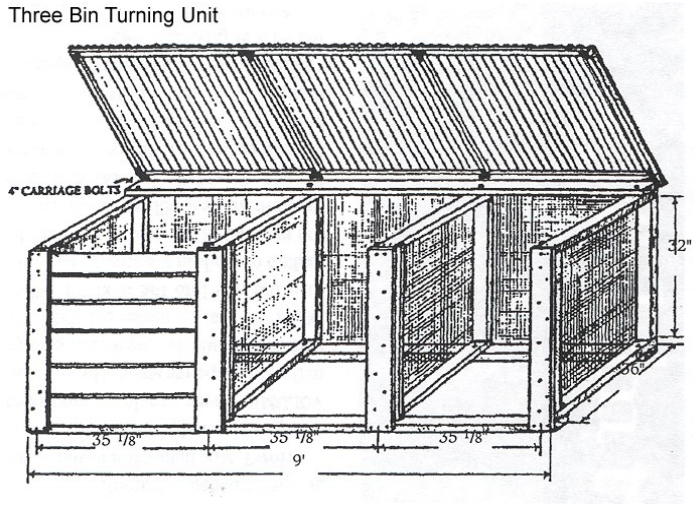
The FreeGarden is a black, plastic inverted cone (34" at base, 33" tall) made of 50% recycled plastic. It holds 82 gallons of material, has air vents and a sliding door at the bottom. It is currently available at no cost through the CR Program.

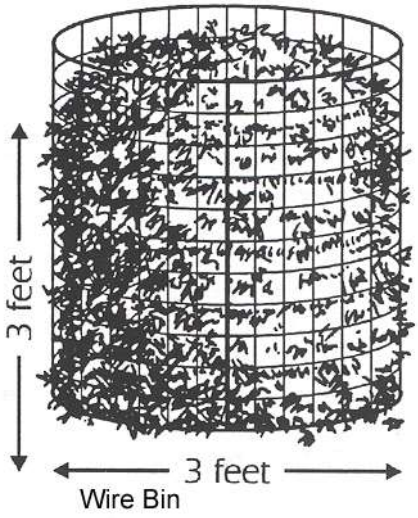
Misconceptions about this system abound. First, the black color DOES NOT cause the compost to heat up! As you know, compost heat is totally independent of outside weather conditions and is *solely* the result of microbial activity. Second, well-seasoned, finished compost is unlikely to pour from the convenient sliding door at the bottom of the Earth Machine, though pictures make it look so! The *center* of the compost pile is the most active; materials from the outside edges will degrade more slowly. Unless the contents are turned frequently, materials harvested from the sliding door will tend to be incompletely decomposed.

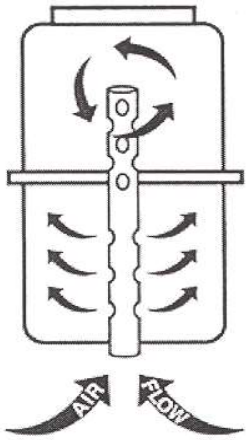
- **Compost Tumblers**

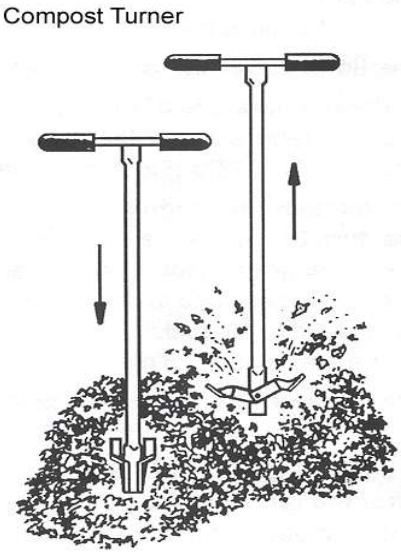
These systems work best when filled.

Figure 2-5. Compost Bins & Systems.









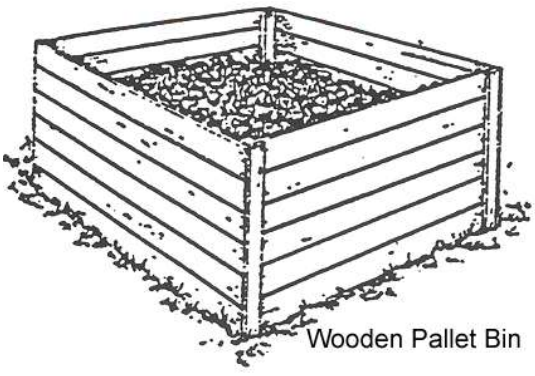


Table 2-4. Compost Bins & Systems: Advantages and Disadvantages.

Bin or System	Advantages	Disadvantages
Open Pile or Windrow	1. Simple, no container. 2. Good for large quantities.	1. Requires significant space. 2. Pile spreads, untidy.
Chicken wire or plastic mesh	1. Inexpensive or free. 2. Simple to make. 3. Can be built to any diameter. 4. Easy to disassemble for turning or harvesting. 5. Great system to stockpile browns in the fall.	1. Flimsy, prone to distortion and tipping. 2. Unattractive. 3. No cover, susceptible to weather. 4. Vulnerable to rodent and other pests.
Wooden Pallet Bin	1. Free or inexpensive; pallets are a good use of recycled materials. 2. Easy to make. 3. Can make one side a “hinged” door for easy access. 4. Pallet cube is almost a perfect cubic yard.	1. Unattractive. 2. If uncovered, it is susceptible to weather. 3. Vulnerable to rodent and other pests. 4. Heavy, difficult to move.
Three Bin Compost System	1. Attractive, relatively easy to build. 2. Free construction plans. 3. Each compartment 1 cubic yard. 4. Easy to turn compost. 5. Covered, protected from weather.	1. Requires woodworking skill. 2. Requires large area. 3. Heavy, difficult to move. 4. Wood will eventually decompose.
FreeGarden	1. Neat, affordable through MCR. 2. Made of recycled materials. 3. Easy to assemble. 4. Relatively inaccessible to rodents, pests.	5. Small volume. 6. Hard to turn compost. 7. Sliding door difficult to operate.
Urban Compost Tumbler	8. Neat. 9. Made of recycled materials. 10. Easy to turn. 11. Produces finished compost rapidly. 12. Inaccessible to rodents, pests.	1. Relatively expensive. 2. Small volume. 3. Must be set on solid, level surface. It may tip. 4. We do not recommend manufacturer’s suggestions.

Tricks of the Trade: Which system is best?

Q: How do I decide on the best compost system?

A: The most important consideration is "What materials are you planning to compost?" Second, "How much compostable material do you think you will generate in a season?" Armed with the answers to those two questions, consider price, convenience and attractiveness when evaluating alternatives.

Q: I've got so many leaves that I can't compost them all. What should I do with the excess?

A: Dried leaves make excellent mulch. In addition, your neighbors may appreciate a bag of "browns". Another excellent alternative is taking your yard wastes to a local compost facility like H&H Wood Recyclers (call for rates). These facilities often offer free leaf disposal during the **Fall Leaf Coupon Program.** Free leaf disposal coupons are available for Vancouver and Clark County residents each fall, and are good from October 1 to December 31. Coupons allow for free disposal of up to 5 yards of leaves at designated drop-off sites.

Q: I have a large yard. When I add my grass clippings to the compost pile, it gets slimy and begins to smell. What should I do?

A: The answer is two-fold. Grass has high moisture content and soft structure, making it prone to anaerobic decomposition. Leaving the clippings on the lawn has many benefits. If you wish to compost clippings, make sure to mix them with an equal volume of those dried "browns" you stockpiled last fall, or with straw or shredded paper. Grass is a great nitrogen source, and when properly mixed, will rapidly decompose without odor.

Q: My finished compost does not look like the bagged variety at Fred Meyer. What is the difference?

A: Commercial composts are usually screened before bagging. Screening assures uniform size. Although your irregularly sized compost is fine for most purposes, you can make a simple compost screen by stretching machine cloth (available at home centers) over a 2" x 4" wooden frame. Alternatively, you can buy a compost screen.