COMPOSTING: THE BASICS

The art of composting has been part of our global culture since ancient times. The basic principles are quite simple, and adhering to them will result in an efficient and successful outcome. Studies have shown that home composting can divert an average of 700 lbs. of material per household per year from the waste stream. Municipal composting carries a greater environmental cost, but not nearly as high as if leaf and yard waste are disposed by conventional means. Composting is an excellent way to avoid both wasting useful, natural resources and creating environmental problems, while at the same time producing a high quality and inexpensive soil amendment.

Composting is the transformation of organic material (plant matter) through decomposition into a soil-like material called compost. Invertebrates (insects and earthworms), and microorganisms (bacteria and fungi) help in transforming the material into compost. Composting is a natural form of recycling, which continually occurs in nature.

An ancient practice, composting is mentioned in the Bible several times and can be traced to Marcus Cato, a farmer and scientist who lived in Rome 2,000 years ago. Cato viewed compost as the fundamental soil enhancer, essential for maintaining fertile and productive agricultural land. He stated that all food and animal wastes should be composted before being added to the soil. By the 19th century in America, most farmers and agricultural writers knew about composting.

Today there are several different reasons why composting remains an invaluable practice. Yard and food wastes make up approximately 30% of the waste stream in the United States. Composting most of these waste streams would reduce the amount of Municipal Solid Waste (MSW) requiring disposal by almost one fourth, while at the same time provide a nutrient-rich soil amendment. Compost added to gardens improves soil structure, texture, aeration, and water retention. When mixed with compost, clay soils are lightened, and sandy soils retain water better. Mixing compost with soil also contributes to erosion control, soil fertility, proper pH balance, and healthy root development in plants.

The standard means of disposal for most yard and food waste include landfilling and incineration. These practices are not as environmentally or economically sound as composting. Yard waste is landfilled, breaks down very slowly due to the lack of oxygen. As it decomposes, it produces methane gas and acidic leachate, are both environmental problems.

Landfilling organic wastes also takes up landfill space needed for other wastes. Incinerating moist organic waste is inefficient and results in poor combustion, which disrupts the energy generation of the facility and increases the pollutants that need to be removed by the pollution-control devices. Composting these wastes is a more effective and usually less expensive means of managing organic wastes. It can be done successfully on either a large or small scale, but the technique and equipment used differ.

Decomposition

Decomposition occurs naturally anywhere plants grow. When a plant dies, its remains are attacked by microorganisms and invertebrates in the soil, and it is decomposed to humus. This is how nutrients are recycled in an ecosystem. This natural decomposition can be encouraged by creating ideal conditions. The microorganisms and invertebrates fundamental to the composting process require oxygen and water to successfully decompose the material. The end products of the process are soil-enriching compost, carbon dioxide, water, and heat.

Composting is a dynamic process which will occur quickly or slowly, depending on the process used and the skill with which it is executed. A neglected pile of organic waste will inevitably decompose, but slowly. This has been referred to as “passive composting,” because little maintenance is performed. Fast or “active” composting can
be completed in two to six weeks. This method requires three key activities: 1) "aeration," by turning the compost pile, 2) moisture, and 3) the proper carbon to nitrogen (C:N) ratio. Attention to these elements will raise the temperature to around 130°-140°, and ensure rapid decomposition.

The success with which the organic substances are composted depends on the organic material and the decomposer organisms involved. Some organic materials are broken down more easily than others. Different decomposers thrive on different materials as well as at different temperature ranges. Some microbes require oxygen, and others do not; those that require oxygen are preferable for composting.

A more diverse microbial community makes for a more efficient composting process. If the environment in the compost pile becomes inhospitable to a particular type of decomposer, it will die, become dormant, or move to a different part of the compost pile. The transforming conditions of the compost pile create a continually evolving ecosystem inside the pile.

**Factors Affecting The Composting Process** All organic material will eventually decompose. The speed at which it decomposes depends on these factors:

**Carbon-to-Nitrogen Ratios** Carbon and nitrogen are the two fundamental elements in composting, and their ratio (C:N) is significant. The bacteria and fungi in compost digest or "oxidize" carbon as an energy source and ingest nitrogen for protein synthesis. Carbon can be considered the "food" and nitrogen the digestive enzymes.

The bulk of the organic matter should be carbon with just enough nitrogen to aid the decomposition process. The ratio should be roughly 30 parts carbon to 1 part nitrogen (30:1) by weight. Adding 3-4 pounds of nitrogen material for every 100 pounds of carbon should be satisfactory for efficient and rapid composting. The composting process slows if there is not enough nitrogen, and too much nitrogen may cause the generation of ammonia gas which can create unpleasant odors. Leaves are a good source of carbon; fresh grass, manures and blood meal are sources of nitrogen.

**Surface Area** Decomposition by microorganisms in the compost pile takes place when the particle surfaces are in contact with air. Increasing the surface area of the material to be composted can be done by chopping, shredding, mowing, or breaking up the material. The increased surface area means that the microorganisms are able to digest more material, multiply more quickly, and generate more heat. It is not necessary to increase the surface area when composting, but doing so speeds up the process. Insects and earthworms also break down materials into smaller particles that bacteria and fungi can digest.

**Aeration** The decomposition occurring in the compost pile takes up all the available oxygen. Aeration is the replacement of oxygen to the center of the compost pile where it is lacking. Efficient decomposition can only occur if sufficient oxygen is present. This is called aerobic decomposition. It can happen naturally by wind, or when air warmed by the compost process rises through the pile and causes fresh air to be drawn in from the surroundings. Composting systems or structures should incorporate adequate ventilation.

Turning the compost pile is an effective means of adding oxygen and brings newly added material into contact with microbes. It can be done with a pitchfork or a shovel, or a special tool called an "aerator," designed specifically for that purpose. If the compost pile is not aerated, it may produce an odor symptomatic of anaerobic decomposition.

**Moisture** Microorganisms can only use organic molecules if they are dissolved in water, so the compost pile should have a moisture content of 40-60 percent. If the moisture content falls below 40 percent the microbial activity will slow down or become dormant. If the moisture content exceeds 60 percent, aeration is hindered, nutrients are leached out, decomposition slows, and the odor from anaerobic decomposition is emitted. The
“squeeze test” is a good way to determine the moisture content of the composting materials. Squeezing a handful of material should have the moisture content of a well wrung sponge. A pile that is too wet can be turned or can be corrected by adding dry materials.

**Temperature** Microorganisms generate heat as they decompose organic material. A compost pile with temperatures between 90°F and 140°F (32°C–60°C) is composting efficiently. Temperatures higher than 140°F (60°C) inhibit the activity of many of the most important and active organisms in the pile. Given the high temperatures required for rapid composting, the process will inevitably slow during the winter months in cold climates. Compost piles often steam in cold weather. Some microorganisms like cool temperatures and will continue the decomposition process, though at a slower pace.

**Backyard vs. Large-Scale Composting** Backyard composting can be done using a variety of different systems, enclosures, or containers. Composting systems or bins can be constructed at home or purchased commercially. Depending on where you live, you may have a problem with rodents if vegetative food wastes are combined with yard wastes. If so, an enclosed space or bin is advisable. The methods employed will vary somewhat depending on the system you choose, but the principles and purpose remain the same. This is true for large-scale composting projects as well.

Some municipalities collect yard waste at the curbside similar to the way recyclables are collected. It is taken to a central location and formed into windrows, triangular-shaped rows from 5 to 8 feet high and as long as necessary. Turning for aeration is done about once a month using a front-end loader or other type of heavy equipment made specifically for that purpose. The temperature and moisture are checked twice a week. The finished compost may be sold, given away, or used by the municipality in public works projects. Backyard composting eliminates the environmental and economic costs of the heavy equipment used to bring yard waste to a composting site and turn the windrows.

**In Your Backyard** All organic matter eventually decomposes. Composting speeds the process by providing an ideal environment for bacteria and other decomposing microorganisms. The final product, humus or compost, looks and feels like fertile garden soil. This dark, crumbly, earthy-smelling stuff works wonders on all kinds of soil and provides vital nutrients to help plants grow and look better.

Decomposing organisms consist of bacteria, fungi, and larger organisms such as worms, sow bugs, nematodes, and numerous others. Decomposing organisms need four key elements to thrive: nitrogen, carbon, moisture, and oxygen. For best results, mix materials high in nitrogen (such as clover, fresh grass clippings, and livestock manure) and those high in carbon (such as dried leaves and twigs). If there is not a good supply of nitrogen-rich material, a handful of general lawn fertilizer will help the nitrogen-carbon ratio. Moisture is provided by rain, but you may need to water or cover the pile to keep it damp. Be careful not to saturate the pile. Turning or mixing the pile provides oxygen. Frequent turning yields faster decomposition.

**Getting Started** Many materials can be added to a compost pile, including leaves, grass clippings, straw, woody brush, vegetable and fruit scraps, coffee grounds, livestock manure, sawdust, and shredded paper. Do not use diseased plants, meat scraps that may attract animals, and dog or cat manure which can carry disease. Composting can be as simple or as involved as you would like, and depends on how much yard waste you have, how fast you want results, and the effort you are willing to invest.

**Cold or Slow Composting** With cold or slow composting, you can just pile grass clippings and dry leaves on the ground or in a bin. This method requires no maintenance, but it will take several months to a year or more for the pile to decompose. Cold composting works well if you are short on time needed to tend the compost pile at least every other day, have little yard waste, and are not in a hurry to use the compost. Keep weeds and diseased plants out of the mix since the temperatures reached with cold composting may not be high enough to
kill the weed seeds or disease-causing organisms. Add yard waste as it accumulates. Shredding or chopping speeds up the process. To easily shred material, run your lawn mower over small piles of weeds and trimmings. Cold composting has been shown to be better at suppressing soil-borne diseases than hot composting. Cold composting also leaves more undecomposed bits of material, which can be screened out if desired.

**Hot Composting**  Hot composting requires more work, but with a few minutes a day and the right ingredients you can have finished compost in a few weeks depending on weather conditions. The composting season coincides with the growing season. When conditions are favorable for plant growth, those same conditions work well for biological activity in the compost pile. However, since compost generates heat, the process may continue later into the fall or winter.

Hot piles do best when high-carbon material and high-nitrogen material are mixed in a 1 to 1 ratio. A pile with the minimum dimensions of 3’ x 3’ x 3’ is needed for efficient heating. For best heating, make a heap that is 4 or 5 feet in each dimension. As decomposition occurs, the pile will shrink. If you don’t have this amount at one time, simply stockpile your materials until a sufficient quantity is available for proper mixing.

Hot piles reach 110 to 160 degrees Fahrenheit, killing most weed seeds and plant diseases. Studies have shown that compost produced at these temperatures has less ability to suppress diseases in the soil since these temperatures may kill some of the beneficial bacteria necessary to suppress disease.

**Steps:**

1. Choose a level, well-drained site, preferably near your garden.
2. There are numerous styles of compost bins available depending on your needs. These may be as simple as a moveable bin formed by wire mesh or a more substantial structure consisting of several compartments. There are many commercially available bins. While a bin will help contain the pile, it is not absolutely necessary. You can build your pile directly on the ground. To help with aeration, you may want to place some woody material on the ground where you will build your pile.
3. To build your pile, either use alternating layers of high-carbon and high-nitrogen material or mix the two together and then heap into a pile. If you alternate layers, make each layer 2 to 4 inches thick. Some composters find that mixing the two together is more effective than layering. Use approximately equal amounts of each. If you are low on high-nitrogen material, you can add a small amount of commercial fertilizer containing nitrogen. Apply at a rate 1/2 cup of fertilizer for each 10-inch layer of material. Adding a few shovels of soil will also help get the pile off to a good start; soil adds commonly found decomposing organisms.
4. Water periodically. The pile should be moist but not saturated. If conditions are too wet, anaerobic microorganisms (those that can live without oxygen) will continue the process. These are not as effective or as desirable as the aerobic organisms. Bad odors also are more likely if the pile is saturated.
5. Punch holes in the sides of the pile for aeration.
6. The pile will heat up and then begin to cool. Start turning when the pile’s internal temperature peaks at about 130 to 140 degrees Fahrenheit. You can track this with a compost thermometer, or reach into the pile to determine if it is uncomfortably hot to the touch.
7. During the composting season, check your bin regularly to assure optimum moisture and aeration are present in the material being composted.

8. Move materials from the center to the outside and vice versa. Turn every day or two and you should get compost in less than 4 weeks. Turning every other week will make compost in 1 to 3 months. Finished compost will smell sweet and be cool and crumbly to the touch.

Common Problems

Composting is not an exact science. Experience will tell you what works best for you. If you notice that nothing is happening, you may need to add more nitrogen, water, or air. If things are too hot, you probably have too much nitrogen. Add some more carbon materials to reduce the heating. A bad smell also may indicate too much nitrogen.

Cold composting often proceeds faster in warmer climates than in cooler areas. Cold piles may take a year or more to decompose depending on the materials in the pile and the conditions.

Adding kitchen wastes to compost may attract flies and insects. To prevent this problem, make a hole in the center of your pile and bury the waste. Do not compost meat scraps, dead animals, pet manure, diseased plant material, or noxious weeds.

Check on any local or state regulations for composting in urban areas--some communities may require rodent-proof bins.

Vermicomposting Vermicomposting uses worms to compost. This takes up very little space and can be done year-round in a basement or garage. It is an excellent way to dispose of kitchen wastes.

Steps:

1. You need a plastic storage bin. One 1’ x 2’ x 3.5’ will be enough to meet the needs of a family of 6.
2. Drill 8 to 10 holes, approximately 1/4” in diameter, in the bottom of the bin for drainage.
3. Line the bottom of the bin with fine nylon mesh to keep the worms from escaping.
4. Put a tray underneath to catch the drainage.
5. Shredded newspaper works well as bedding. Rip into pieces and water well so that it is thoroughly moist. Place on one side of your bin. Do not let it dry out.
6. Add worms to your bin. Redworms are recommended for best composting, but other species can be used. Redworms are the common small worms found in most gardens and lawns. You can collect them from under a pile of mulch or order them from a garden catalog.
7. Provide worms with food wastes such as vegetable peelings. Do not add fat or meat products. Limit feed -- too much at once may cause the material to rot.
8. Keep the bin in a dark location away from extreme temperatures.
9. In about 3 months the worms should have changed the bedding and food wastes into compost. At this time add fresh bedding and more food to the other side of the bin. The worms should migrate to the new food supply.
10. After a couple of weeks, open your bin in a bright light. The worms will burrow into the bedding. Scoop out the finished compost and apply to your plants or save for use in the spring.

**Using Compost** Compost can be used for all your planting needs. Compost is an excellent source of organic matter to add to your garden or potted plants. It helps improve soil structure which contributes to good aeration and moisture-holding capacity. Compost is also a source of plant nutrients.

Compost can also be used as a mulch material. Studies have shown that compost used as a mulch, or mixed with the top one-inch layer of soil, can help prevent some plant diseases, including some of those that cause damping of seedlings.

**On the Farm** On the farm, potential waste is turned into a resource that saves money and helps the environment. Producers use livestock manure to fertilize crops. When manure is properly handled, it can be safely applied to the land without the risk of polluting water. Composting is also practiced in some poultry operations. The compost is used as fertilizer on the farms and for lawns and gardens.

**More About Backyard Conservation**

The Natural Resources Conservation Service, National Association of Conservation Districts, and Wildlife Habitat Council encourage you to sign up in the “Backyard Conservation” program. To participate, use some of the conservation practices in your backyard that are showcased in this series of tip sheets -- tree planting, wildlife habitat, backyard pond, backyard wetland, composting, mulching, nutrient management, terracing, water conservation, and pest management. Then, simply fill in the Backyard Conservation customer response card, send a Backyard e-mail request to landcare@usda.gov, or call 1-888-LANDCARE.

Compost is organic material that can be used as a soil amendment or as a medium to grow plants. Mature compost is a stable material with a content called humus that is dark brown or black and has a soil-like, earthy smell. It is created by: combining organic wastes (e.g., yard trimmings, food wastes, manures) in proper ratios into piles, rows, or vessels; adding bulking agents (e.g., wood chips) as necessary to accelerate the breakdown of organic materials; and allowing the finished material to fully stabilize and mature through a curing process.

Natural composting, or biological decomposition, began with the first plants on earth and has been going on ever since. As vegetation falls to the ground, it slowly decays, providing minerals and nutrients needed for plants, animals, and microorganisms. Mature compost, however, includes the production of high temperatures to destroy pathogens and weed seeds that natural decomposition does not destroy.

**Did You Know That Compost Can...**

- Suppress plant diseases and pests.
- Reduce or eliminate the need for chemical fertilizers.
- Promote higher yields of agricultural crops.
- Facilitate reforestation, wetlands restoration, and habitat revitalization efforts by amending contaminated, compacted, and marginal soils.
- Cost-effectively remediate soils contaminated by hazardous waste.
- Remove solids, oil, grease, and heavy metals from stormwater runoff.
- Capture and destroy 99.6 percent of industrial volatile organic chemicals (VOCs) in contaminated air.
- Provide cost savings of at least 50 percent over conventional soil, water, and air pollution remediation technologies, where applicable.
**Organic Materials**  Yard trimmings and food residuals together constitute 23 percent of the U.S. waste stream, as documented by EPA. An estimated 56.9 percent of yard trimmings were recovered for composting or grasscycled in 2000, a dramatic increase from the 12 percent recovery rate in 1990. Accompanying this surge in yard waste recovery is a composting industry that has grown from less than 1,000 facilities in 1988 to nearly 3,800 in 2000. Once dominated by public sector operations, the composting industry is increasingly entrepreneurial and private-sector driven, led by firms that add value to compost products through processing and marketing. Compost prices have been as high as $26 per ton for landscape mulch to more than $100 per ton for high-grade compost, which is bagged and sold at the retail level.

While yard trimmings recovery typically involves leaf compost and mulch, yard trimmings can also be combined with other organic waste, such as food residuals, animal manure, and biosolids to produce a variety of products with slightly different chemical and physical characteristics. In contrast to yard trimmings recovery, only 2.6 percent of food waste was composted in 2000. The cost-prohibitive nature of residential food waste separation and collection is the primary deterrent to expanding food waste recovery efforts. Yet in many communities, edible food residuals are donated to the needy, while inedible food residuals are blended into compost or reprocessed into animal feed. In some areas, composting operations are working with high-volume commercial and institutional food producers to recover their food byproducts, saving these firms significant disposal costs.

For more information on organic materials, visit our Organic Materials Web site.

**What to Compost - The IN List**

- Animal manure
- Cardboard rolls
- Clean paper
- Coffee grounds and filters
- Cotton rags
- Dryer and vacuum cleaner lint
- Eggshells
- Fireplace ashes
- Fruits and vegetables
- Grass clippings
- Hair and fur
- Hay and straw
- Houseplants
- Leaves
- Nut shells
- Sawdust
- Shredded newspaper
- Tea bags
- Wood chips
- Wool rags
- Yard trimmings

**What Not to Compost - The OUT List**

Leaves Out/Reason Why
- Black walnut tree leaves or twigs
  - Releases substances that might be harmful to plants
Coal or charcoal ash
   Might contain substances harmful to plants
Dairy products (e.g., butter, egg yolks, milk, sour cream, yogurt)
   Create odor problems and attract pests such as rodents and flies
Diseased or insect-ridden plants
   Diseases or insects might survive and be transferred back to other plants
Fats, grease, lard, or oils
   Create odor problems and attract pests such as rodents and flies
Meat or fish bones and scraps
   Create odor problems and attract pests such as rodents and flies
Pet wastes (e.g., dog or cat feces, soiled cat litter)
   Might contain parasites, bacteria, germs, pathogens, and viruses harmful to humans
Yard trimmings treated with chemical pesticides
   Might kill beneficial composting organisms

NOTE: Finished compost can be applied to lawns and gardens to help condition the soil and replenish nutrients. Compost, however, should not be used as potting soil for houseplants because of the presence of weed and grass seeds.

Why Compost?

Composting makes sense. Instead of sending organic matter to a landfill, it can be transformed into a useful additive which can even be sold. See Environmental Benefits.

What Can Compost Be Used For?

- Farmers use compost for enhancing crops and for sod farms.
- Landscapers use compost as a soil amendment and for decorative purposes at properties, golf courses, and athletic fields.
- Landfill operators use compost to cover landfills and carry out reclamation projects.
- Nurseries use compost for enhancing plant and forest seedling crops in reforestation projects and to prevent certain plant diseases such as root rot.
- Public agencies use compost for landscaping highway median strips, parks, recreational areas, and other public property and remediating contaminated or eroded sites.
- Homeowners use mature compost to enrich gardens, improve the soil around trees and shrubs, use as soil additive for house plants and planter boxes and as a protective mulch for trees and shrubs.

How Do I Compost?

Composting is easy. Common materials like chicken wire, bricks, and buckets are all it takes to begin composting, which can be done either indoors or outdoors. Maintenance is not difficult either: regular mixing or turning and a little water can ensure success. Learn how to create your own compost pile.

Why Not Put Yard Wastes in Landfills?

Since these materials are relatively clean and biodegradable, disposal in landfills may be unnecessary and wastes space. In addition, as yard wastes decompose in landfills, they generate methane gas and acidic leachate.
Methane is a colorless, explosive greenhouse gas that is released as bacteria decompose organic materials in landfills. If methane is not controlled at a landfill, it can seep underground and into nearby buildings, where it has the potential to explode. Yard wastes also contribute acidity that can make other waste constituents more mobile and therefore more toxic.

A number of states across the nation have implemented yard waste composting programs. To learn how many composting programs are in your state, visit Municipal Solid Waste (MSW) State Data page.

Why Not Burn Leaves and Other Yard Wastes?

Burning leaves and other yard wastes pollutes the air and can lead to uncontrolled fires. Leaf smoke can make breathing difficult for people who suffer from asthma, emphysema, chronic bronchitis, or allergies. A number of states currently ban leaf burning, and some communities either ban leaf burning or restrict when and where it can take place. For more information, visit EPA’s Backyard Burning site.

Laws/Statutes

What regulations exist for organic materials and compost facilities?

Organic material management is regulated (i.e., siting, permitting, and management) at the state level, except for biosolids and animal manures.

States have assumed the lead role in regulating composting facilities. Composting facilities may need approval from the state before operating. The permit requirements for composting facilities vary among states. Examples of topics covered in the permitting process include: a detailed facility design, operating plans, a description of incoming materials, the amount and types of residue to be generated in the plant, monitoring plans, potential environmental releases, landfills to be used, and potential markets for the compost.

On the federal level, the Standards for the Use or Disposal of Sewage Sludge (40 CFR Part 503 under the Clean Water Act) was published in the Federal Register (58 FR 9248 to 9404) on February 19, 1993. This act pertains to land application (and biosolids composting), surface disposal, and combustion of biosolids sewage sludge. Many of the standards promulgated in this rule can be applicable to municipal solid waste compost. For more information about this regulation, please go to EPA’s Biosolids Page.

Regulations for Confined Animal Feed Operations (CAFOs)

Under Section 301 of the Clean Water Act (Title 33, Chapter 26, 1311, USC), EPA has the authority to regulate point source discharges (including CAFOs) into U.S. waters through the National Pollutant Discharge Elimination System (NPDES) permitting program.

Manure and wastewater from CAFOs have the potential to release pollutants such as nitrogen and phosphorus, organic matter, sediments, pathogens, heavy metals, hormones, antibiotics, and ammonia to the environment. Excess nutrients in water (i.e., nitrogen and phosphorus) can result in or contribute to low levels of dissolved
oxygen (anoxia), eutrophication, and toxic algal blooms. These conditions may be harmful to human health and, in combination with other circumstances, have been associated with outbreaks of microbes such as Pfiesteria piscicida. Decomposing organic matter can reduce oxygen levels and cause fish kills.

Pathogens, such as cryptosporidium, have been linked to impairments in drinking water supplies and threats to human health. Pathogens in manure can also create a food safety concern if manure is applied directly to crops at inappropriate times. In addition, pathogens are responsible for some shellfish bed closures. Nitrogen in the form of nitrate can contaminate drinking water supplies drawn from ground water.

For more information about CAFOs, see the National Agricultural Compliance Assistance Center's Animal Feeding Operations.

Environmental Benefits

Compost use can result in a variety of environmental benefits. The following are a few of the most important benefits:

**Compost enriches soils**

Compost has the ability to help regenerate poor soils. The composting process encourages the production of beneficial micro-organisms (mainly bacteria and fungi) which in turn break down organic matter to create humus. Humus—a rich nutrient-filled material—increases the nutrient content in soils and helps soils retain moisture. Compost has also been shown to suppress plant diseases and pests, reduce or eliminate the need for chemical fertilizers, and promote higher yields of agricultural crops.

**Compost helps cleanup (remediate) contaminated soil**

The composting process has been shown to absorb odors and treat semivolatile and volatile organic compounds (VOCs), including heating fuels, polynuclear aromatic hydrocarbons (PAHs), and explosives. It has also been shown to bind heavy metals and prevent them from migrating to water resources or being absorbed by plants. The compost process degrades and, in some cases, completely eliminates wood preservatives, pesticides, and both chlorinated and nonchlorinated hydrocarbons in contaminated soils.

**Compost helps prevent pollution**

Composting organic materials that have been diverted from landfills ultimately avoids the production of methane and leachate formulation in the landfills. Compost has the ability to prevent pollutants in stormwater runoff from reaching surface water resources. Compost has also been shown to prevent erosion and silting on embankments parallel to creeks, lakes, and rivers, and prevents erosion and turf loss on roadsides, hillsides, playing fields, and golf courses.

**Using compost offers economic benefits**
Using compost can reduce the need for water, fertilizers, and pesticides. It serves as a marketable commodity and is a low-cost alternative to standard landfill cover and artificial soil amendments. Composting also extends municipal landfill life by diverting organic materials from landfills and provides a less costly alternative to conventional methods of remediating (cleaning) contaminated soil.

Understanding the Composting Process

One of the most important steps for evaluating composting options is to become familiar with how the composting process works. Before you begin composting or start a composting program, you should understand the five primary variables that must be "controlled" during composting. These include the following:

**Feedstock and nutrient balance.** Controlled decomposition requires a proper balance of "green" organic materials (e.g., grass clippings, food scraps, manure), which contain large amounts of nitrogen, and "brown" organic materials (e.g., dry leaves, wood chips, branches), which contain large amounts of carbon but little nitrogen. Obtaining the right nutrient mix requires experimentation and patience and is part of the art and science of composting.

**Particle size.** Grinding, chipping, and shredding materials increases the surface area on which the microorganism can feed. Smaller particles also produce a more homogeneous compost mixture and improve pile insulation to help maintain optimum temperatures (see below). If the particles are too small, however, they might prevent air from flowing freely through the pile.

**Moisture content.** Microorganisms living in a compost pile need an adequate amount of moisture to survive. Water is the key element that helps transports substances within the compost pile and makes the nutrients in organic material accessible to the microbes. Organic material contains some moisture in varying amounts, but moisture also might come in the form of rainfall or intentional watering.

**Oxygen flow.** Turning the pile, placing the pile on a series of pipes, or including bulking agents such as wood chips and shredded newspaper all help aerate the pile. Aerating the pile allows decomposition to occur at a faster rate than anaerobic conditions. Care must be taken, however, not to provide too much oxygen, which can dry out the pile and impede the composting process.

**Temperature.** Microorganisms require a certain temperature range for optimal activity. Certain temperatures promote rapid composting and destroy pathogens and weed seeds. Microbial activity can raise the temperature of the pile’s core to at least 140 °F. If the temperature does not increase, anaerobic conditions (i.e., rotting) occur. Controlling the previous four factors can bring about the proper temperature.

Methods of Composting

Composting takes on many forms, from simple and inexpensive backyard or onsite composting methods to more expensive and high-tech methods such as in-vessel composting. Composting varies as much in its complexity as in the range of organic materials recovered. The most common composting methods are listed in order of increasing costs and levels of technology required and are described in greater detail on the following pages:
After reviewing the science of composting above, select an appropriate method or combination of methods that will best meet your needs. Will backyard composting suffice for reducing residential volume, or should you invest in equipment and labor for larger volumes from restaurants or other businesses? Selecting the right composting equipment at an affordable price also requires careful research. Hundreds of vendors sell composting equipment and there are many variations on each type of equipment.

**Composting Challenges**

Challenges for the composting industry as a whole include a lack of consistent product quality, market research and planning, investment, accepted national compost specifications, and sophisticated product marketing. In addition, compost end uses range from city and county landscaping to niche markets such as soil remediation. Government agencies could play a larger role by increasing purchases and promotion of compost products. New technologies allow compost companies to tailor their products to specific end-uses, increasing the market value of the material. In fact, more and more compost producers are engineering multiple compost products for applications as diverse as bioremediation of contaminated soil and erosion control at construction sites. Many composting companies are packaging and marketing compost in home repair, garden center, and other retail outlets. Some companies use compost to control odors through new process technologies such as biofilters, while still others are using compost as a filter in water treatment systems.

**Learn More About Environmentally Safe Ways to Compost**


**Open Bins or Containers**

There are two basic kinds of compost piles: open bins and enclosed containers.

Open bins can be constructed with wood, chicken wire, or recycled plastic. Of course, municipal large scale composting is often conducted in large open piles without the use of any bins at all. These compost heaps are often turned by bulldozers or other pieces of heavy equipment, so container walls are not practical.

Enclosed containers for composting usually consist of one of two designs: upright box-like containers, and rotating drums.

**Advantages of Open Bin Composting**

- Open bins easily collect rain water
- Open bins are very convenient for adding materials

**Disadvantages of Open Bin Composting**

- Open bins can attract rodents, flies, bees, and bears
- Open bins can become too wet, if not covered
Open bins may be more difficult to mix (more on that later)
Open bins may be an eyesore to your neighbors

Advantages of Compost Containers

- Compost containers will rarely attract pests
- Upright containers may be more aesthetically appealing
- Rotating drums are usually easier to mix or turn
- Rotating drums are easy to unload
- Rotating drums usually have “screening” options

Disadvantages of Compost Containers

- Enclosed containers usually require you to add water
- Upright containers may be very difficult to mix or turn

Two Chambers are Always Better than One

Whether you choose to use an open bin or a compost container, two chambers are always better than one. In fact, if you are really serious about composting, having two chambers is a necessity. Because the composting process takes at least several weeks under the best conditions, you cannot add additional materials to the heap without “resetting the clock” to day one (Mantis Makes a pretty good two chamber compost tumbler). To create an ideal batch of fully composted material, your mix needs to “cook” for at least several weeks; if you add additional material, you’ll have a mix of fully decomposed material, partially decomposed material, and fresh materials. It’s simply much easier, and much more desirable to use a consistent mixture of fully decomposed compost for gardening purposes. After all, you wouldn’t want to buy a bag of potting soil that contained a rotting tomato in it!

Tools You’ll Need

After you’ve built or bought a compost bin or container, there are only a few tools that you’ll need to make compost. If you’re already a gardener, you probably already have the tools that you need.

**Pitch fork, or turning fork** - The best hand tool for mixing and turning a working compost pile. The tines of the fork will penetrate layers of leaves and grass clippings, and make the mixing process much easier than using a shovel.

**Shovel** - The best tool for removing finished compost from a bin or heap, and for tossing compost onto the garden.

**Garden Cart** - the best tool for moving compost from the heap to the garden. Garden carts can also be very useful in “catching” compost from a rotating drum composter. The Mantis Loadumper cart is especially practical for moving compost; it’s cleverly balanced, and has big, easy rolling wheels. And, it’s designed to be very easy to dump.
Compost Thermometer – not essential, but you might be interested in checking the temperature of the “core.” A properly established mix will heat up to 160 degrees F., whether you have a compost thermometer or not. Having one just might be interesting.

Key Ingredients for Great Compost

One of the great aspects of composting is that the key ingredients are often things that you’d be tempted to throw away. So, with just a little effort, you can contribute less to the trash stream (good for the environment) and make great compost (good for your garden).

Compost is created when you provide the right mixture of key ingredients for the millions of microorganisms that do the dirty work. These microorganisms will eat, multiply, and convert raw materials to compost as long as the environment is right. The environment doesn’t have to be absolutely “perfect,” so you don’t need to be a microbiologist or chemist to have successful compost. You need to provide: food, water, and air.

The water and air are easy. The food is a little more complex. Food for your little micro friends consists of two classes of materials, simply referred to as “Greens” and “Browns.” Green materials are high in nitrogen, while brown materials are high in carbon. The green materials provide protein for the micro bugs, while the brown materials provide energy.

Typical green materials are:

- Fresh (green) Grass clippings
- Fresh manure (horse, chicken, rabbit, cow)
- Kitchen scraps (fruit, vegetables, coffee grounds, tea bags)
- Weeds
- Green leaves
- Leftover fruits from the garden

Typical brown materials include:

- Brown, dry leaves
- Dried grass
- Cornstalks (shredded)
- Straw
- Sawdust (in moderation; see below)

Just like us, the little microorganisms need a balanced diet, along with water and air. Too much, or too little of any ingredient significantly reduces their productivity. It is hard to have too much of the brown category. As noted earlier, leaves in the forest decompose without significant quantities of “green” components (although animal droppings do contribute to the green part of the mix) – but, the decomposition takes a little longer.
Too much green is usually the problem. A pile of kitchen garbage will never become useful compost; it simply becomes a smelly pile of garbage. Landfills are not composting sites. Most municipal composting operations begin with the huge quantities of dry leaves that are collected each fall.

A good mix of browns and greens also helps the pile maintain the right amount of moisture and air. A pile that is 100% grass clippings, for example, will quickly become a matted, soggy mess, with too much moisture and too little air. It will decompose, quickly at first, but then stall. Mix in some dry leaves, and you'll have a significantly more efficient mixture. The dry leaves help maintain air pockets within the pile and also provide a more balanced diet for the bacteria and fungi that cause the decomposition.

The Ideal Combination of Browns and Greens

The best combination of browns and greens is about 4 parts of "browns" to one part "greens" by volume. Of course, this is a rough approximation. If you have more browns, you'll still get compost. it'll just take a little longer. If you are on the side of too much green, you'll likely have a smelly garbage heap.

The best source of brown material is dry leaves. In many parts of the country, the annual fall clean-up of leaves from deciduous trees is seen as a necessary chore. I choose to see it as the harvest for next year's compost pile! Harvesting, shredding, and storing dry leaves is the best thing you can do to create great compost. Use a leaf vacuum or a lawn mower to shred the leaves, and collect them when they're dry, if at all possible. I like to store my stash of dry leaves in large plastic bags that I can hide under my deck or porch until I need them to keep the greens in my compost bin balanced.

Aerobic vs. Anaerobic (or Hot vs. Cold) Composting

As noted earlier, decomposition occurs naturally, and, except for extreme conditions, it's virtually impossible to stop it. But, decomposition doesn't necessarily occur efficiently.

When we provide the micro bugs with a good mixture of browns and greens, as well as some water and air, decomposition can be very efficient. This is known as aerobic or “hot” composting. The compost pile can attain temperatures as high as 160 degrees Fahrenheit, which will kill some weed seeds, make most of the microbes very active, but will deter worms and some other critters. As the pile cools, the worms will return to assist in the decomposition. Aerobic composting is fast, and a well maintained compost heap can fully decompose in several weeks. While some ads claim that you can make compost in 14 days, I've never experienced that phenomenon in over 25 years of careful composting.

Anaerobic composting is slower, primarily because the environment is hospitable to some of the micro bugs, but it's hardly ideal. This is the form of composting that almost always occurs in the forest, where the mix is often comprised of dry leaves and dead wood. It will decompose over time, but the temperature never gets very high, and the process can take years.

Our goal is to create a composting environment that is aerobic. At least during the late spring, summer, and early fall.

Getting Started - Activators, Worms, Microorganisms

You've built or bought a composter. You have some dry leaves and you'll be adding green materials (lawn clippings, kitchen waste, plant scraps) all summer. To some extent, you'll be layering these materials to provide both a balanced diet and the best mix for air and water penetration. Also if you want to try compost activators go ahead they won't hurt.
How can you be sure that the composting will start?

Do you need to buy a “compost activator” or a batch of worms?

What if there aren’t any microorganisms in the mix?

No. No. and, Don’t Worry.

The microorganism essential to composting are plentiful in nature. (That’s why mom always told us to wash our hands after playing outside!) If you’re starting with leaves and other natural materials, you’ve got bacteria and fungi that are eager to help you make compost. And, if you want to give the mix a little boost, one excellent and free additive is simply a shovel full of good garden soil. Assuming that it hasn’t been polluted with nasty chemicals, the soil is full of microbes that are eager to devour the goodies in your compost pile.

Compost activators won’t hurt, but they may not help enough to justify the cost. Mike McGrath, former editor of Organic Gardening magazine and host of the radio show “You Bet Your Garden,” says that compost activators can be more helpful when the compost heap is almost finished, vs. using them at the beginning of the cycle. Mike has written a lot about composting; you can see his articles on the Gardens Alive web site.

Worms can significantly improve your composting effectiveness, just as worms in the garden can improve soil tilth. My open bin compost piles have a healthy supply of worms, probably because I occasionally add a shovel full of good garden soil to my bins.

Worm composting, or Vermicomposting, is a separate form of composting, which is discussed later in this article.

Critical Mass – When is Enough Enough?

For efficient aerobic composting, you need to have a critical mass to generate a heat core. Most experienced composters agree that you need a minimum of 1 cubic foot of raw materials, of course, more is better.

As soon as decomposition begins, the volume of the pile will decrease. You might be tempted to add more materials; but, as previously mentioned, this resets the clock on that batch to “Day 1.” You’ll have much better success if you refrain from adding raw materials to your batch of working compost, and simply start a new batch with new raw materials. That’s why it’s essential to have at least two chambers, regardless of the type of composter you use. Single chamber composters are often called batch composters; don’t continuously add materials to a single chamber.

Size Matters – Smaller is Better

While it’s nice to have a larger pile, to develop a good heat core, and to produce a nice quantity of compost, the raw materials should be shredded whenever possible. Smaller particles are simply easier to mix and easier for the little microbes to digest. Of course, the micro bugs don’t eat the whole particle, but smaller particles of raw materials means that you’ll have more surface area for the millions of microbes to do their work.

So, in summary, you should aim for “big heap, small particles.”

Turn, Turn, Turn – with apologies to the Byrds

Those of us who were music fans in the 70’s will remember the great Byrds song “Turn, Turn, Turn... to everything there is a season...” a song that was based on verses from the Book of Ecclesiastes, in the Bible. And,
indeed, for most of us, composting is a seasonal activity. You’ll maximize your composting efforts if you continuously turn, or mix, the heap. Mixing your heap will help to keep the browns and greens in balance, will distribute moisture, and add essential air (oxygen) to the mixture. The core (the inside) of the compost heap is always hotter and is the center of activity. The outside is generally less active and much cooler. To increase the efficiency of the composting process, mix the heap to bring more of the raw materials from the outside to the core. Bring more food and water to the busy little micro bugs on the inside.

While the compost is working, or “cooking,” the best tool for turning is a pitch fork or garden fork. When the compost is completely, or almost completely done, I use my Mantis Tiller to mix the compost in my open bins. This final mix provides a great consistency, and makes removing the compost (by shovel) very easy.

Worm Composting (Vermicomposting)

Worm composting is the process of using worms in a container to digest kitchen vegetable scraps. The worms (red wigglers) eat the kitchen scraps and cast off their waste to produce a very rich fertilizer. Most worm composting is done indoors, usually in one’s basement. You’ll need to build or buy a worm composting “farm” if you want to dispose of your kitchen scraps by vermicomposting. You can buy a very effective worm composter and red worms from Gardens Alive! Search for “worm composting” in the search box.

Compost Tea – Yum!

Don’t drink it, unless you’re a houseplant or garden plant. Compost tea is simply the result of soaking a bag full of compost in a bucket full of water for an hour or so. The water soluble nutrients and beneficial microorganisms leach out of the compost, resulting in a brown liquid that can be used to water houseplants, your lawn, or garden plants. Compost tea will give your plants a boost of needed nutrients and help to prevent a lot of plant diseases, but, the tea won’t do as much to improve the soil structure as using fully decomposed compost.

What NOT to Do

Don’t add these ingredients to your compost pile:

**Meat, Fish, animal fats** - Unless you can completely bury them, you run the risk of attracting unwanted visitors to your compost. You might be able to add very small portions (remember the Native Americans used fish to fertilize their corn), but they must be completely buried, and adding them makes turning or mixing the working compost very problematic.

**Shredded Newspapers or Office Paper** - Recycle them instead. The paper very likely contains chemicals that are not good for your compost. Newspaper shredders were very popular years ago, but the risk of adding ink chemicals isn’t worth it. By all means, recycle your paper and save trees, but don’t put them in your compost pile.

**Ashes from Your BBQ Grill** - Another no-no. Wood ashes can be very useful in small quantities. And, wood ashes can be helpful for certain lawn applications. But, never put BBQ grill ashes into your compost pile.

**Dog and Cat Feces** - Are never good for your compost. There’s simply too much risk of adding nasty diseases, not to mention the unpleasant odor! Chicken, horse, cow, and rabbit manure is fine…in moderation. If you have access to these very high nitrogen sources, compost them. They’re too “hot” for most direct applications to the garden. But, remember your brown to green ratio of 4-to-1. And, chicken manure is green, in composting terms… even though it’s brown in appearance.

Be Careful When Adding These Ingredients!
**Sawdust** - Because of its very high carbon content, and its very small particle size, sawdust can overwhelm a compost pile. But, it can also be quite useful if you have an overload of green material. I add some from my woodworking shop when I have a lot of extra fruit in my pile at the end of the season. Avoid using sawdust that came from Black Walnut wood, as it contains a chemical that will stunt or prevent the growth of some plants, tomatoes in particular.

**Wood Shavings, Chips, and Bark** - Like sawdust, the carbon content can overwhelm, and shut down, an otherwise good compost mix. Set them aside, if possible, and let them decompose the old fashioned way, over time (anaerobic decomposition).

**When and How to Use Compost**

**Soil Building** - Compost is the single best additive for good, even great, garden soil. It improves tilth, fertility, water retention for sandy soils, water drainage for clay soils, and improves your soil's disease fighting characteristics. Add compost in spring and fall, and till it in.

**Garden Fertilizer** - Compost can be used throughout the season as a garden fertilizer. Simply side dress vegetables and flowers for a slow-release food source and improved disease prevention.

**Lawn Feeding** - Screened compost (compost that has been sifted to collect the smaller particles) can be applied as a lawn fertilizer throughout the season. It will provide a wonderful slow-release food as well as assist in lawn disease prevention. And, given that the nutrients aren't as concentrated as in chemical lawn foods, you'll avoid the stripes that can easily occur when incorrectly applying chemicals. You'll avoid chemical run-off, and you'll save money. Your lawn will be alive, with earthworms (nature's aerators) and beneficial microbes.

**Compost vs. Mulch** - Mulch is any material that is applied to the garden's surface to prevent weed germination and to reduce water evaporation. Compost will help build the soil, and it will help retain moisture; but, it won't do a lot to prevent weeds. It's an ideal growing medium; so, weeds are likely to be very comfortable in it. Use shredded leaves for mulch, or a combination of shredded leaves and lawn clippings. The combination of lawn clipping and shredded leaves creates an attractive mulch that won't blow away (as leaves alone tend to do) and allows water penetration (as grass clippings alone tend to mat and repel water).

**Potting Mix (seed starting, potted plants)** - Compost can be used to create a very good seed starting mix, or it can be added to potting soil to create a nutrient-rich mixture. Most commercial potting mix is made from Canadian peat moss, which is virtually void of nutrients, so the addition of good compost provides a real boost. Aerobic compost, which has been produced at higher temperatures, is less likely to contain a lot of weed seeds. However, some of the fungi in compost may contribute to “damping off” of seedlings when compost is used for seed starting. To be safe, you should consider “sterilizing” the compost before using it as a potting mix. You can sterilize compost by microwaving it, baking it in an oven, or pouring boiling water over it. Of the three methods, the boiling water treatment is the neatest and cleanest. Simply put the compost in a large flower pot and soak it with boiling water from a teapot or saucepan.

For more information on composting, go to [HowToCompost.org](http://HowToCompost.org).

**Composting Fundamentals**

Good composting is a matter of providing the proper environmental conditions for microbial life. Compost is made by billions of microbes (fungi, bacteria, etc.) that digest the yard and kitchen wastes (food) you provide for them. If the pile is cool enough, worms, insects, and their relatives will help out the microbes. All of these will slowly make compost out of your yard and kitchen wastes under any conditions. However, like people, these living things need air, water, and food. If you maintain your pile to provide for their needs, they’ll happily turn...
your yard and kitchen wastes into compost much more quickly. Keep in mind the following basic ideas while building your compost piles:

AIR

Composting microbes are \textit{aerobic} -- they can't do their work well unless they are provided with air. Without air, \textit{anaerobic} (non-air needing) microbes take over the pile. They do cause slow decomposition, but tend to smell like putrefying garbage! For this reason, it's important to make sure that there are plenty of air passageways into your compost pile. Some compost ingredients, such as green grass clippings or wet leaves, mat down very easily into slimy layers that air cannot get through. Other ingredients, such as straw, don't mat down easily and are very helpful in allowing air into the center of a pile. To make sure that you have adequate aeration for your pile and its microbes, thoroughly break up or mix in any ingredients that might mat down and exclude air. You can also \textit{turn} the pile to get air into it, which means completely breaking it apart with a spade or garden fork and then piling it back together in a more 'fluffed-up' condition.

WATER

Ideally, your pile should be as moist as a wrung-out sponge to fit the needs of compost microbes. At this moisture level, there is a thin film of water coating every particle in the pile, making it very easy for microbes to live and disperse themselves throughout the pile. If your pile is drier than this, it won't be very good microbial habitat, and composting will be slowed significantly. If your pile is a great deal wetter, the sodden ingredients will be so heavy that they will tend to mat down and exclude air from the pile, again slowing the composting process (and perhaps creating anaerobic odor problems). If you are using dry ingredients, such as autumn leaves or straw, you'll need to moisten them as you add them to the pile. Kitchen fruit and vegetable wastes generally have plenty of moisture, as do fresh green grass clippings and garden thinnings. Watch out for far-too-soggy piles in wet climates (a tarp may help to keep rain off during wet weather). In dry climates, it may be necessary to water your pile occasionally to maintain proper moisture.

FOOD

In broad terms, there are two major kinds of food that composting microbes need.

'Browns' are dry and dead plant materials such as straw, dry brown weeds, autumn leaves, and wood chips or sawdust. These materials are mostly made of chemicals that are just long chains of sugar molecules linked together. As such, these items are a source of energy for the compost microbes. Because they tend to be dry, browns often need to be moistened before they are put into a compost system.

'Greens' are fresh (and often green) plant materials such as green weeds from the garden, kitchen fruit and vegetable scraps, green leaves, coffee grounds and tea bags, fresh horse manure, etc. Compared to browns, greens have more nitrogen in them. Nitrogen is a critical element in amino acids and proteins, and can be thought of as a protein source for the billions of multiplying microbes.

A good mix of browns and greens is the best nutritional balance for the microbes. This mix also helps out with the aeration and amount of water in the pile. Browns, for instance, tend to be bulky and promote good aeration. Greens, on the other hand, are typically high in moisture, and balance out the dry nature of the browns. If you'd like specific information on different materials, check the 'What to Compost' section.

OTHER THINGS TO CONSIDER
If you live in a cold climate, your compost pile will probably go dormant in the winter. No problem -- it'll start back up again when the springtime thaw comes.

A common misunderstanding about compost piles is that they must be hot to be successful. This just isn’t true. If you have good aeration and moisture, and the proper ingredient mix, your pile will decompose just fine at temperatures of 50 degrees Farenheit or above.

Hotter piles will decompose a bit faster, however. One way to understand why this is so is to realize that the heat in a hot pile is the result of the collective body heat of billions of microbes that are busy digesting the ingredients in the pile. Generally speaking, a hotter pile means more microbes or conditions that allow the microbes to have faster metabolisms, and therefore a faster composting process. If you’d like to keep your pile as warm as possible, consider the following:

For a pile to get hot and stay hot for a long period of time, the typical minimum size for the pile is one cubic meter (a cube one meter, or about three feet, on a side). A pile this size has plenty of mass in which those billions of heat-generating microbes can live, yet is also large enough that the center of the pile is well-insulated by the material surrounding it. Smaller piles just cannot insulate themselves well enough to remain hot for long, if at all. You can also provide additional insulation to a pile by stacking bales of hay or straw, or bags of dry autumn leaves, around your bin system. Some people even used stacked hay bales to make bin systems (this kind of bin will slowly compost itself, of course).

_Composting Questions and Answers:_

**When is my compost finished?**

Finished compost is dark in color and has an earthy smell (like the smell of soil). Usually, it’s difficult to recognize any of the original ingredients, although bits of hard-to-decompose materials (such as straw) sometimes can be seen.

There is no single point at which compost is finished -- it’s a bit more subjective than that. For many outdoor garden applications, for instance, it can be fine to use compost that still has a few recognizable bits of leaves or straw -- it will finish rotting in the soil. If you plan to use compost in seed-starting mixes, though, you’re best off having a well-finished compost, because seedling roots may be attacked by decomposer microbes if the roots contact unfinished compost.

**How can I use my finished compost?**

To tell you the truth, well-finished compost looks so fine that I’m tempted to eat the stuff sometimes. However, there are several more common ways that compost can be used, on gardens, lawns, landscapes, and houseplants:
COMPOST AS SOIL AMENDMENT: Many people put compost into their garden soil by digging it in prior to spring planting. The image shows a potato harvest by apprentices at the UCSC Farm and Garden in 1990. Due to the use of copious amounts of compost, the potato beds yielded about one pound of potatoes per square foot, or about 1000 pounds total from these four beds, each 80 feet long.

Others actually do their composting in the soil, by burying kitchen wastes and other materials in trenches in the garden. Compost can also be used as a 'top dressing' on the soil during the growing season -- in this case it is added in around the bases of plants, where irrigation and soil animals will slowly incorporate it into the soil. On lawns, many people sprinkle/broadcast sifted compost as a top dressing in the spring -- I have been doing this on a 'problem area' of a lawn for several years, in an attempt to improve the soil there for better grass growth. It is also fine to top-dress houseplants occasionally with small handfuls of finished compost.

COMPOST AS MULCH: Compost can be left on the surface as a mulch around landscape and garden plants. This is essentially the same as a 'top dressing' application, described above, but mulches are typically meant to cover all of the soil around the plants that get mulched. Mulches protect the soil from erosion. They also save water by shielding soil from the drying effect of the wind and sun. As they decompose, mulches add nutrients to the soil, and if composed of small-enough particles, worms may slowly eat the mulch and incorporate it into the soil.

COMPOST AS TEA: Compost tea is made by combining equal parts of compost and water and letting it sit for a while. The liquid can help to provide a 'quick boost' to ailing houseplants or young seedlings and transplants (I recommend diluting it quite a bit for use on seedlings). Stu Campbell, in Let it Rot, says that the same compost can be used to make several batches of tea (2). When you're finished making compost tea, use the mucky dregs as a mulch in the garden or landscape.

How does compost improve the soil?

Compost does several things to benefit the soil that synthetic fertilizers cannot do. First, it adds organic matter, which improves the way water interacts with the soil. In sandy soils, compost acts as a sponge to help retain water in the soil that would otherwise drain down below the reach of plant roots (in this way, it protects plants against drought). In clay soils, compost helps to add porosity (tiny holes and passageways) to the soil, making it drain more quickly so that it doesn't stay waterlogged and doesn't dry out into a bricklike substance. Compost also inoculates the soil with vast numbers of beneficial microbes (bacteria, fungi, etc.) and the habitat that the microbes need to live. These microbes are able to extract nutrients from the mineral part of the soil and eventually pass the nutrients on to plants.

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The following items can be added to your compost pile:
GRASS/LAWN CLIPPINGS

Actually, it’s usually easier to leave grass clippings in the lawn, where they will decompose and benefit the soil directly. However, they can be composted, too. Be cautious to add grass clippings in very thin layers, or thoroughly mix them in with other compost ingredients, as they otherwise tend to become slimy and matted down, excluding air from the pile. Fresh grass clippings are high in nitrogen, making them a ‘green’ compost ingredient.

HAY

Farmers are often very happy to get rid of spoiled hay bales that have been out in the rain, and will give them away or sell them at a low price. Grass hay will probably contain a lot of seed, which can resprout in your garden. Alfalfa hay will compost very readily. The greener the hay, the more nitrogen it contains. Be sure that any hay you plan to compost is well-moistened prior to addition to the pile.

KITCHEN WASTES

Fruit and vegetable peels/rinds, tea bags, coffee grounds, eggshells, and similar materials are great stuff to compost. They tend to be high in nitrogen (this puts them in the ‘greens’ category), and are usually quite soft and moist. As such, kitchen wastes need to be mixed in with drier/bulkier materials to allow complete air penetration. Many people compost their kitchen wastes in enclosed worm bins or bury them 8” deep in the soil, to keep from attracting pests to an outdoor compost pile (check with your local government to see if it has regulations about this -- some forbid open piles containing food wastes because of the pest issue). Avoid composting meat scraps, fatty food wastes, milk products, and bones -- these materials are very attractive to pests.

LEAVES

If you live in an area where autumn leaves are still thrown away as garbage, cash in on the bounty each year by acquiring your neighbors’ leaves! Generally, leaves are an excellent compost ingredient. They can mat down and exclude air, though, so be sure that any clumps are thoroughly broken up, or that the leaves are only used in very thin layers. Ash and poplar/cottonwood leaves can raise soil pH if used in compost -- this may not be beneficial if your soil is already alkaline, as many soils are in the West (especially in semiarid and arid climates). Dead, dry leaves are in the ‘browns’ category, while living green leaves contain abundant nitrogen and are considered ‘greens’.

STRAW

Dry straw is a good material for helping to keep a compost pile aerated, because it tends to create lots of passageways for air to get into the pile. Be sure to wet the straw, as it is very slow to decompose otherwise. Straw is definitely a ‘brown’ and also requires mixture with ‘greens’ to break down quickly. Many stables use straw as a bedding material for horses -- straw that has undergone this treatment is mixed in with horse manure and breaks down more quickly.

WEEDS AND OTHER GARDEN WASTES

Many types of weeds and old garden plants can be composted. Avoid weeds that have begun to go to seed, as seeds may survive all but the hottest compost piles. Some types of weeds are ‘pernicious weeds’ and will
resprout in the compost pile -- avoid using these unless they are thoroughly dead. Green weeds are (you guessed it) a 'green', while dead brown weeds are a 'brown'.

WOOD CHIPS AND SAWDUST

Wood products belong in the 'browns' category, because they are fairly low in nitrogen. Some sawdusts, especially from broadleaved/deciduous trees, will break down quickly in an active compost pile. Others, especially from coniferous trees, will take longer to decay. Stir sawdust thoroughly into the pile or use very thin layers. Coarse wood chips will very slowly decay, and are probably better used as mulch unless you have lots of time to wait. Be sure not to compost chips or sawdust from any sort of chemically-treated wood -- you could be adding toxics like arsenic to your pile if you do.

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CHEMICALLY-TREATED WOOD PRODUCTS

Sawdust is often available from construction sites, friends, or your own building projects. If you are considering composting sawdust, be sure of the origin of the sawdust. Sawdust from chemically-treated wood products can be bad stuff to compost. For example, take pressure-treated wood (sometimes called CCA), which usually has a greenish tint to it (I have also seen it in other colors). It contains arsenic, a highly toxic element, as well as chromium and copper. There is evidence to suggest that arsenic is leached into the soil from these products when they are used to make compost bins or raised beds, so composting the sawdust would certainly be a mistake. You may wish to read the 'Letters' section of Organic Gardening, April 1994 and July/August 1992, for more information. Avoid other chemically-treated wood products and sawdust as well, such as wood treated with creosote or 'penta' preservative.

DISEASED PLANTS

Many plant disease organisms are killed by consistent hot composting, but it's difficult to make sure that every speck of the diseased material gets fully composted. It's best not to compost diseased plant material at all, to avoid reinfecting next year's garden.

HUMAN WASTES

Human feces can contain disease organisms that will make people very sick. Composting human feces safely requires that the compost pile reach high (thermophilic) temperatures over a period of time. It isn't necessarily that difficult to reach these temperatures in a home compost pile, but the potential health costs of improper composting are high. Composting of human feces should not be attempted, except by experienced 'hot pile' composters who are well informed of the temperatures and times required to kill pathogens, and who are willing to take 100% responsibility for the process and product. If you would like to learn more about composting humanure, I recommend The Humanure Handbook, listed in the resources section of the Rot Web.

MEAT, BONES, AND FATTY FOOD WASTES

These materials are very attractive to pests (in an urban setting, this could mean rats...). In addition, fatty food wastes can be very slow to break down, because the fat can exclude the air that composting microbes need to do their work.

PERNICIOUS WEEDS
Morning glory/bindweed, sheep sorrel, ivy, several kinds of grasses, and some other plants can resprout from their roots and/or stems in the compost pile. Just when you thought you had them all chopped up, you’d actually helped them to multiply! Don’t compost these weeds unless they are completely dead and dry (you may want to leave them in a sunny place for a couple of weeks before composting). Remember also that composting weeds that have gone to seed will create weeds in next year’s garden, unless a very hot pile temperature can be maintained to kill the seeds.

**PET WASTES**

Dog and cat feces may carry diseases that can infect humans. It is best NEVER to use them in compost piles. Some people do bury them 8" deep in the soil, but ONLY in areas where food crops are never grown.

There are a tremendous number of options for containing your compost. Some people choose to go binless, simply building a compost pile in a convenient spot on the ground. Others build bins from materials such as recycled pallets, or two-by-fours and plywood. And, of course, there are many commercial bins on the market.

The question arises, “Which system is best?” Each system has advantages and disadvantages that you should consider when making your choice. However, there aren’t many significant differences in actual composting performance between the various traditional bin systems (two exceptions might be worm bins and drum/turning units). More important to the success of your efforts is taking care to provide the proper environmental conditions for composting. Choosing a type of bin is much more a matter of asking questions such as, “How much kitchen and yard material do I have for composting?” and “What system best fits my preferences for neatness, attractiveness, and convenience?” If you’re agonizing over choosing a recycled-plastic, dome-shaped detrital digester model for $259 versus building your own setup from $199 of lumber and hardware, you may wish to slow down before laying out all that cash, and make sure that what you end up with will really meet your needs. There are some very attractive and well-engineered commercial bins out there, as well as plans for excellent do-it-yourself models. But why not find out about all the options? Many people, for instance, are very fond of low-cost, attractive units built out of wooden pallets that are free for the asking from local businesses.

One very strong recommendation that I do have is to AVOID THE USE OF TREATED LUMBER when building a bin system. ‘Pressure-treated wood’ (also known as CCA), which commonly has a green tint, contains arsenic, a highly toxic element (it also contains toxic levels of copper and chromium). There is evidence to suggest that arsenic will leach into your compost if you use CCA lumber in the bin. Unfortunately, many extension services and local governments actually recommend using this stuff for building compost bins. If you are contemplating using CCA wood, please take the time to read the information in the ‘Letters’ section of Organic Gardening Magazine, April 1994 and July/August 1992, before beginning.

**Possible Composting Systems:**

**One Bin Systems:**

A one bin system is the simplest way to make a compost pile, and is a great way to get started. If you plan to make a lot of compost, one bin may not be enough capacity, but adding another can be a simple matter. The basic idea of a one bin system is to make an enclosure for your bin that is at least three feet (or about one meter) across, although you may also choose to use no bin at all if you don’t need to keep everything tidy. Possible construction materials include free wooden pallets from local businesses, lumber, cinder blocks, or even steel posts and wire fencing. Once you’ve made your bin (or decided not to), you might build a pile all at once if you have the ingredients, but it’s more likely you’ll build the pile over time as you generate compostable materials.
If you build the pile over time, the stuff on the bottom will decompose first, since it will have been there the longest. When there is finished compost at the bottom of the bin, and you want to use it, simply remove the unfinished compost from on top, take out what you need, and throw the unfinished compost back on top. If your pile is not a high-temperature pile, you may want to let redworms (a kind of earthworm) help make the compost. They'll make the process go more quickly, and can create a very high quality finished product.

Two Bin and Three Bin Systems:

These systems consist of two or three adjacent bins, and may be made out of the same materials as a one bin system. The advantage of having more than one bin is that one can have a bin for the pile being built (as ingredients are accumulated over a period of time) and another one (or more) for a pile already built that is in a more advanced stage of decomposition. If you have the space for such a system, and are generating or gathering enough materials to keep the bins in use, this can be very convenient. When you start using a system like this, build your pile in one of the bins. When this bin becomes full, 'turn the pile' by transferring it to the adjacent bin (a garden fork or similar tool will help). This will aerate the pile and hasten decomposition. An alternative that I have found to be very successful is to let redworms do the turning 'in place' (this way I save myself labor and just leave the pile in its original bin). Whatever you choose to do, you can now begin to build a new pile in an empty bin while the first pile continues to decompose.

I find that a two bin system works well for me, but other people generate more compost or like to have a bin for storing finished compost, and therefore choose a three bin system. In a three bin system, you might start by building a pile in the leftmost bin. The original pile is turned into the middle bin when it's time to begin building another pile, aerating it to accelerate the composting process. Another pile is then built in the leftmost bin. When that pile is completed, the old pile (which is now in the middle) is turned a final time into the rightmost bin for finishing, and the just-built pile is turned into the middle bin, making the leftmost bin available for yet another pile. Finished compost will eventually be removed from the rightmost bin. Get the idea?

Rotating or Tumbling Systems:

The cost of these systems can be quite high, and they are somewhat small, but these factors are balanced out by the speed at which drum/tumbler systems can generate finished compost. Under ideal circumstances, compost may be finished in three weeks in a rotating drum composter! Fill the container partly full with a mix of greens and moistened browns, and then give the unit a turn every day or so to aerate the ingredients and remix them. It's important not to pack the container full, because the ingredients won't tumble and mix if packed in tightly.

While one batch is composting, you can accumulate the materials for the next batch. When the first compost is finished, you can dump in the materials you've saved to make more. It's possible to maintain relatively high temperatures in drum/tumbler systems even if they are small, both because the container acts as insulation and because the constant turning keeps the microbes aerated and active.

Sheet or Trench Composting:

This may be the ideal system for people that have garden space who don't want to fuss with bins and piles. Simply bury your kitchen wastes in a trench 8" deep dug in the garden, leave the buried materials to rot for a few months, and then plant above them. By the time you plant, the materials will have rotted into stuff in which plant roots will thrive. If you have copious amounts of materials to get rid of all at once, such as autumn leaves, you might want to spread them around the garden and rototill them into the soil (this is best done in the late autumn, or at least 2 months in advance of planting in the area).
Commercially Available Bin Systems:

Commercially available bins are typically somewhat expensive compared to do-it-yourself bins, but they do keep your compost neatly enclosed and can provide an ‘instant solution’ to the question of how to set up a composting system. In performance, many of the plastic bins may help to insulate the compost somewhat, allowing decomposition to occur later into the cold season. However, I don’t feel that there are major advantages in the actual composting performance of commercial bins -- they function more or less the same as a one bin system (described above). A few brands seem to claim that they are able to harvest some kind of special cosmic energy or the power of the pyramids in assisting decomposition. Nonsense. They certainly can function just fine as compost bins, but there is no magic involved.

Many of the companies selling plastic bins manufacture them from recycled plastic. If you plan to get a pre-built plastic bin, keep your eyes open for ones made from reclaimed plastic -- support recycling and businesses that sell recycled products!

Clean Air Gardening - http://cleanairgardening.com - Compost bins, manual reel mowers and other environmentally friendly lawn and garden tools. Free US ground shipping!

Worm Bin Composting:

Maintaining an enclosed bin specifically for ‘vermicomposting’ is an excellent way to take care of food wastes. In fact, such a system can even be kept indoors. With the exception of holes for drainage and ventilation, worm bins for indoor use are typically completely enclosed, with a lid of some sort to cover the top. Outdoors, worms can be turned loose in a pile in your compost bin, or contained in a worm bin built specifically for vermicomposting.

Some municipalities, fearful of rodent pests and the diseases they may carry, discourage or even prohibit the composting of food wastes in open piles, recommending enclosed worm bins instead. A sturdy outdoor worm bin is protected from pests, and produces compost quickly during the warm season (or year-round in mild climates).

One of the challenges of beginning a vermicompost system is finding a source of worms. A typical earthworm from the garden won’t do. Vermicomposting requires a species that is adapted to living in decomposing organic materials rather than in the soil. Two species are Eisenia fetida and Lumbricus rubellus. Also known as the redworm, manure worm, or red wiggler, Eisenia fetida is often available at bait shops (ask for red wigglers), but can be mail ordered less expensively from worm farms listed in the classified ads of Organic Gardening Magazine. Governments and organizations that promote vermicomposting may maintain ‘worm banks’ as a low-cost source of worms for the general public. Seattle Tilth, in cooperation with Puget Consumers Co-op, has a worm bank at a composting demonstration site in back of a PCC grocery store.

The general idea is to provide a cool, moist bedding (some kind of ‘brown’ compost ingredient such as shredded leaves or paperboard) for the worms to live in, and then bury kitchen wastes in the bedding. As bacteria and fungi begin to decompose the materials, the worms graze on the bacteria and fungi, and also break up the ingredients with their movement through the bedding. Eventually, the worms have ingested the ingredients and bedding, turning it all into worm castings (feces) that are an excellent finished compost.

Composting with worms is very easy to do, but there are a few basics of vermicomposting that are helpful to understand. I plan to provide a how-to guide some day. Meanwhile, you may wish to read the vermicomposting guide available on the World Wide Web from CITY FARMER, an organization in British Columbia.

Composting Info on the Internet/WWW:
COMPOSTING NEWSGROUP/LISTSERVE: This is an open discussion, via email, of composting topics. To receive all of the discussion postings, send email with no subject or signature to listproc@listproc.wsu.edu. The message of your email should read "subscribe compost your firstname yourlastname"

CITY FARMER: An excellent source of information on composting/gardening in urban situations. Includes a lengthy description of vermicomposting basics.

There is a large composting WWW site at Cornell University.

The Spokane (Washington) Regional Solid Waste System has a web site with information on home composting.

Books:

BACKYARD COMPOSTING

published by Harmonious Press, Ojai, California, 1992 (ISBN 0-9629768-0-6). This is the simplest, most easy to read how-to guide for composting. It is short and very easy to read, yet presents all the basics. 96 pp.

THE HUMANURE HANDBOOK

by J.C. Jenkins, Jenkins Publishing (P.O. Box 607, Grove City, PA 16127. $19.95 ppd., ISBN 0-9644258-4-X). The composting of human manure is controversial, or even outrageous, to many experienced composters. Joe Jenkins takes on the composting 'establishment' with this book, presenting a persuasive argument for why 'humanure' should be composted, as well as citing research to support the safety of his method. By carefully building a pile so that it reaches high enough (thermophilic) temperatures, and by monitoring the temperature of the pile over time, Jenkins argues that it is possible to safely compost human manure at home. Those with minimal experience in composting may find this book an interesting read, as it is very easy to understand. However, humanure composting should not be done unless one is an experienced 'hot pile' composter who makes an informed choice to take 100% responsibility for the process and its product. This is an important book in that it opens one's eyes to the loss of what should be considered a valuable natural resource. I found the book very interesting and helpful. Some may be offended by the terminology used. Nevertheless, I highly recommend this book! 198 pp.

LET IT ROT!

by Stu Campbell, Storey Communications, Inc., Pownal, Vermont, 1990 (ISBN 0-88266-635-5). This is a good general how-to guide for composting. It's very easy to read, but includes considerable detail for those who want to learn more about the composting process. 152 pp.

WORMS EAT MY GARBAGE

by Mary Appelhof, Flower Press, Kalamazoo, Michigan, 1982 (ISBN 0-942256-03-4). Mary Appelhof is an expert with more than twenty years experience using worms to compost kitchen fruit and vegetable trimmings. Her book is the best source of detailed information on the simple art of "vermicomposting" kitchen wastes. Interesting reading, with cartoons, drawings, and diagrams. 100pp.

WORMS EAT OUR GARBAGE

**Pamphlets:**

These booklets and pamphlets, or similar ones, may be available from cooperative extension offices in your state.


**HOME COMPOSTING,** Seattle Community Composting Education Program, Seattle, Washington.


**Periodical:**

**WORM DIGEST,** P.O. Box 544, Eugene, OR 97440, $12/year (4 issues). Worm Digest is a quarterly journal that covers the use of worms in composting and soil improvement. This is a great journal for anyone seriously interested in worm bins, and especially for those interested in teaching others or spreading the word about vermicomposting.

**Videos:**

**COMPOSTING FOR THE 90's - A REASON AND METHOD FOR EVERYONE**

from Earth to Earth Productions, P.O. Box 1272, Burbank, CA 91507-1272 (approximately 50 minutes long, ISBN 1-881647-02-1). This video covers everything from why to compost, and different ways to make and use compost, to how composting can save money on garbage bills. Very easy to understand, and complete, yet concise. Recommended for new composters who like how-to videos and for public libraries/organizations that want to provide user friendly how-to resources for their patrons.

**WORMANIA!**

from Flowerfield Enterprises, 10332 Shaver Road, Kalamazoo, MI 49002 (26 minutes, with a 48-page teaching guide, $38.40, ISBN 0-942256-07-7). Mary Appelhof has produced, partly with the help of a National Science Foundation grant, this video on the subject of worms and vermicomposting. In the video, Worm Woman visits a family, teaches them about worm biology, and helps them set up a worm bin for composting kitchen wastes. Several worm-related songs by Billy Brennan make up part of the video, which covers a lot of ground in a concise fashion, but is entertaining and engaging. Microvideo is used to illustrate worm anatomy. Worm movement, feeding/digestion, and reproduction are all covered, as well as the role worms play in improving soil drainage and organic matter content. A great video for libraries, school districts, master composter groups, and agriculture or biology classes. This is not primarily a how-to video for vermicomposting (use Mary Appelhof’s excellent book Worms Eat My Garbage for this purpose), but would be good for general outreach to promote the idea of vermicomposting, or as a supplement to how-to education.
North Carolina:

CHAPEL HILL: at the Community Center Park, sponsored by the Garden Club of Chapel Hill (no contact information available at time of listing).

CHARLOTTE: The Compost Garden is located at Compost Central, run by Mecklenburg County Solid Waste Management, on West Boulevard a mile past the Billy Graham Parkway, near Charlotte/Douglass International Airport. Hands-on how-to classes available in the spring and fall; cost is $5 and participants receive wire for making a bin as well as a guidebook. Listed 5/31/97.

DURHAM: Durham has a demo site at the Museum of Life and Science 433 W. Murray Ave. (phone 919-220-5429 for more information). Demonstration classes are sometimes available.

What is Compost Tea?

As the name implies, compost tea is made by steeping compost in water. It’s used as either a foliar spray or a soil drench, depending on where your plant has problems.

Bucket-Fermentation Method
“Passive” compost tea is prepared by immersing a burlap sack filled with compost into a bucket or tank, stirring occasionally. Usually the brew time is longer, from 7 to 10 days. This is the method that dates back hundreds of years in Europe, and is more akin to a compost watery extract than a “brewed” and aerated compost tea.

Bucket-Bubbler Method
The equipment setup and scale of production are similar to the bucket method, except that an aquarium-size pump and air bubbler are used in association with microbial food and catalyst sources added to the solution as an amendment. Since aeration is critical, as many as three sump pumps may be used in a bucket simultaneously. With homemade compost tea brewing, a compost “sock” is commonly used as a filter-strainer. Ideally, the mesh size will strain compost particulate matter but still allow beneficial microbes—including fungal hyphae and nematodes—to migrate into solution. Single-strand mesh materials such as nylon stockings, laundry bags, and paint bags are some of the materials being used; fungal hyphae tend to get caught in polywoven fabrics. If burlap is used, it should be “aged” burlap.

Trough Method
Large-scale production of compost teas employs homemade tanks and pumps. An 8- or 12-inch-diameter PVC pipe is cut in half, drilled full of holes, and lined with burlap. Compost is placed in this makeshift trough. The PVC trough is supported above the tank, several feet in the air. The tank is filled with water, and microbial food sources are added as an amendment. A sump pump sucks the solution from the bottom of the tank and distributes the solution to a trickle line running horizontally along the top of the PVC trough filled with compost. As the solution runs through the burlap bags containing the compost, a leachate is created which then drops several feet through the air back into the open tank below. A sump pump in the bottom of the tank collects this “tea” and distributes it back through the water line at the top of the trough, and so on. Through this process, which lasts about seven days, the compost tea is recirculated, bubbled, and aerated. The purpose of the microbial food source is to grow a large population of beneficial microorganisms.

Commercial Tea Brewers
Commercial equipment is available for the production of brewed compost teas (see a list of suppliers below).
Usually there is a compost sack or a compost leachate basket with drainage holes, either of which are used to hold a certain volume of compost. The compost-filled container is placed in a specially designed tank filled with chlorine-free water. Microbial food sources are added to the solution. A pump supplies oxygen to a specially-designed aeration device which bubbles and aerates the compost tea brewing in the tank.

**Summary**

Depending on your scale of production and the level of financial resources available to purchase commercial brewing equipment vs. making some kind of homemade brewer, there are several methods to choose from. Research at Soil Foodweb, Inc. in Corvallis, Oregon has shown that differences exist in the beneficial attributes of compost teas, with commercial tea brewers producing the greatest numbers and diversity of beneficial microorganisms.

*By Steve Diver*
*NCAT Agriculture Specialist*
*February 2002*

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**Composting with Red Wiggler Worms and Night Crawlers**

Earlier we’ve talked about the differences between compost bins and compost tumblers, and let you, our wonderful composting audience, decide for yourselves on what you thought would work better for your needs. Well, let’s put our differences aside and talk about worm composting, also known in the composting world as vermiculture or vermicomposting. There’s really not much to it, we use worms, right? Right, but not just any worms; red wiggler worms or night crawlers are the preferred types of worms to use. Why not earthworms, you ask? Well, I’ll explain that in a second, but let me first tell you why red wiggler worms and night crawlers are so beneficial to the composting process.

Red wiggler worms, also known as red worms and by their scientific name of Eisenia fetida, are recognized as the best kind of composting worm. Thriving in darkness and swearing off light, red worms are hardy workers and can eat half of their own weight. Additionally, they have hearty appetites and can live off of food scraps such as banana peels and chicken mash (a yummy mix of cornmeal and chicken meat, this is usually used only if you plan to raise your red worms as fish bait). Red worms also live well in damp places, and as fish bait, will wiggle around on the hook since they can survive in water for several days at a time.

Night crawlers which are popular amongst fishermen can also be used as composting worms. With the same performance level as red worms, they’re not really considered your number one composting worm. One reason may be that even though they thrive in cool, shady areas, they don’t seem to fare too well if there’s too much moisture; in fact, once they hit water they’ll pretty much just die. Unusually enough, fishermen seem to like using night crawlers as bait probably because they’re pretty big and fat.

Using earthworms such as the kind that show up when it starts raining is not recommended. Earthworms are great burrowers and excellent soil aerators, but they won’t digest the organic matter and leave behind worm castings, which is what you want. Your best bet is to stick with red wiggler worms. Though not necessary, mixing red wiggler worms with night crawlers is okay, but you’re fine with sticking to one or the other.

Vermicomposting can be a fun activity for families, classrooms, or even just solo. Just be sure to feed your worms and watch them as they do the work for you.

*How are worms beneficial?*
Volumes of material have been written on the subject; earthworms are the unheralded soldiers of the soil. Among the primary benefits of having earthworms in the soil are: they aerate it, break it up for easier access by plant roots, help the soil hold more water, clean up dead organic matter by eating it and turning it into the world’s best plant food, (whether natural or chemical), they contain 60% protein and are raised as a very high grade animal feed and much more. Then again, let us not forget, they make a lot of fishermen happy.

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**How much garbage can a worm eat?**

Generally speaking, 2 lbs. of earthworms will recycle 1 lb. of organic waste in 24 hours. In absolutely ideal conditions of comfort and ground up, moist food, the herd will recycle their own weight in wastes every 24 hours.

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**What do earthworms eat?**

Earthworms can be fed all forms of food waste, yard & garden waste, (plant and root material are OK but not too much dirt), paper and cardboard too wet to recycle otherwise, etc. Don’t worry about how nasty some waste matter may seem to be, the earthworms have strange tastes. In fact, they are at their highest level of activity, consuming and procreating with glee when recycling cow manure or sewage sludge.

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**What should not be fed to earthworms?**

Do not feed them: metals, foils, plastics, chemicals, oils, solvents, insecticides, soaps, paint, etc. Avoid all citrus products (oranges, lemons, limes, grapefruit), onions, garlic cloves, extremely hot and heavily spiced foods, and high acid foods. Also, avoid oleanders and other poisonous plants (if you are unsure about a species, ask a nurseryman). Be careful of plants that have been sprayed with insecticide.

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**How do you feed earthworms?**

The earthworms will need a little help from you in the preparation of some of the materials. Be sure the overall mix, (or any individual waste), is moist, about like a blueberry muffin or sponge cake.
Avoid soaking or flooding the food. Most food waste can be put directly onto the worm bed just as it comes from the table. Just scatter it around the top of the bed.

Before feeding them, the waste matter can be mixed together or not, whichever is easier for you. Chocolate cake, watermelon and Chinese mustard topped with bread, beef, herring, candy and banana peels make a scrumptious meal for the versatile little creatures. Coffee grounds too, they love the grounds.

Grinding (via a blender or food processor) or cutting things up to 1/4" size particles or smaller will speed recycling time by up to 50%. Don’t bother to bury the waste since they will come up for it, plus, it is easier for you to see when it is all recycled, and thus, feeding time again. Spread the material around, but not too evenly, leave the little recyclers room to "pull back" from the food when they feel like it. A loose coat of food up to 2" high is OK.

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**How do you harvest castings?**

With a two bin or single bin "through" system, it is quite easy, you simply take the container with the accumulated castings and pour them into a permanent storage container, directly onto your garden soil, or both. With any other bin, the worm/casting mix must go through a harvester to separate the worms from the castings. There are many types of harvesters from a simple framed piece of 3/16" mesh to motorized, drum type, large volume harvesters. For residential use, a hand held mesh frame should suffice.

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**What kind of bedding is needed for startup?**

Bedding material for startup and future re-starts can be: Canadian peat moss, soaked in water at least 24 hours, (US peat is too tough & stringy), yard clippings, dead leaves, wood shavings, newspaper (torn up and soaked in water), Garden clippings should have "aged" beyond the green stage. Any moistened organic material can be used for bedding. If you look around, there is usually plenty nearby, inside or outside of your house.

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**If I want to use manure for bedding, where can I get it?**

Many people live within a short driving distance from one type of livestock operation or another. Most rabbit, horse, cattle, ostrich, etc. farmers will make some sort of beneficial deal to get rid of their manure. Payment by you, if required, has to be substantially lower than bagged manure at the nursery. Many farmers will let you haul it off just to get rid of it.
Don’t use green manure for bedding, it has to be dried and composted. A few months in the outdoors usually is sufficient. This goes for any pet poop as well. However, small amounts of green poop can be placed on top of the worm bed if there is plenty of room around it for the earthworms to escape the heat of decomposition. The earthworms will nibble at the edges of the pile where the heat is low, thereby reducing the amount of material daily.

What conditions make for a good quality of life for earthworms?

Keep them at 55 to 70 deg. F., w/65 deg. being a good average temperature of the bedding. Mean humidity should be 55%, and keep the earthworms out of the rain. They will drown and/or scatter all over under rainy or very humid conditions. Finally, the pH of the bed should be as close to 6.5 as possible, with 7.0 and 6.0 being the upper & lower pH limits.

What happens if I order my starter, (or add-on) quantity of worms by mail and they arrive dead?

Write or phone your dealer right away. A reputable producer will replace the stock without question. If, however, the same customer, (out of dozens with no complaints), says that his worms arrive dead, time after time, most dealers will ask that the batch be returned for inspection.

Will the earthworm bin smell up the basement, garage, or storage shed?

Surprisingly, there is no odor from the worm beds in spite of the highly odoriferous feed they receive. A handful of earthworm compost held close to the nose smells like rich, loamy topsoil.

How do you clean that black stuff, (castings), off your hands?

Fresh earthworm castings have a unique clinging characteristic. However, any good hand cleaner, including soap and warm water, will take it off. Light use of a soft scrub brush will speed up the process.
How hard is worm farming?

Not at all hard, especially so a small, residential sized bin for recycling kitchen waste. An average of 5 to 10 minutes a day will do it. Obviously, the larger the worm farm the more work involved. Nevertheless, one person can successfully manage quite a large number of worms, up to at least 3,000,000. With larger farms your level of technology and equipment will make a big difference. If you are fully and state of the art equipped, one person can manage up to 10,000,000 worms, (approx. 6 1/2 tons). Whether or not you want to work that hard is another matter.

How fast do earthworms multiply?

Faster than rabbits. 10 lbs. of earthworms can become over two tons in two years. Naturally this presupposes good living conditions and no loss of earthworms due to ingesting toxic materials. The count of individual worms doesn't come into it except for fishermen. The rest of us are mainly interested in the work the earthworms do for us regarding agriculture and horticulture.