

Composting in the School Garden

Farmers, gardeners, homeowners and schools all over Massachusetts are recycling food and yard wastes at the source, reducing the waste flow, protecting the environment and utilizing this valuable soil amendment. Adding a composting program to your school garden is also a way to teach first hand about soil science, decomposition and environmental sustainability. This guide provides an introduction to the science, how-to and options for school composting.

Decomposition is a natural biochemical process in which bacteria, fungi and other microscopic organisms **convert organic wastes into nutrients** that can be used by plants and animals.

Composting is a controlled process that manages **the natural recycling systems of decomposition**, creating optimal conditions for it to occur. The result is a dark, crumbly, nutrient-rich, soil-like substance called **humus**, or compost.

The Benefits of Composting

Compost is a valuable resource that can be used as a supplement to enrich the soil with nutrients, increase moisture retention, improve soil structure and provide a good environment for beneficial soil organisms.

Composting also helps protect the environment. The Environmental Protection Agency estimates that 25 percent of the solid wastes that Americans generate is food scraps and yard wastes that could be recycled through composting. These useful materials are too often sent to landfills and incinerators or go down the drain through the garbage disposal.

This trash clogs the **landfills** taking up limited space. Landfill wastes can cause water pollution and production of methane gas from anaerobic decomposition. **Incineration** reduces the volume of wastes, but produces flue gases that permeate the atmosphere and toxic ash that must be buried.

Use of the **garbage disposal** for food wastes places unnecessary burdens on the water supply, requiring about eight gallons of water to dilute a pound of wastes. Wastewater treatment plants then require more chemicals, produce more sludge, and consume more energy to process the increased volumes of water.

Composting also provides an opportunity to observe nature at work and demonstrate interconnections. Classroom discussion can center on soil science, waste reduction and management, decomposition, watershed protection, pollution prevention, bio-diversity, nutrition and more.

Organic Waste Decomposition

Many different soil organisms called **decomposers** digest the organic wastes. Most are microorganisms, too small to be seen by the human eye. Other macroorganisms are large enough to easily be seen. Each organism has a role in the web of the compost pile. **Energy flows from organism to organism** as one is eaten by the next. Heat builds up in the pile as a byproduct of the microbial work.

Naturally occurring bacteria start the process. They are the most numerous organisms and do the majority of the work. It is estimated that a tablespoon of soil contains billions of bacteria. **Fungi and protozoans** take over during the next stage of decomposition, when the organic material has been changed to a more digestible form.

Later in the cycle, earthworms, nematodes, millipedes, slugs, land snails, and springtails do their part, eating the level one organisms. In turn, other organisms will eat them, primarily centipedes, mites, beetles, pseudoscorpions, spiders and earwigs. Some organisms, like the earthworm, also consume organic residue.



How Does it Work

Successful composting occurs when the decomposers are provided with the optimum conditions to flourish. They need food, air, water, space and a habitable temperature.

Food: All organic material contains both carbon and nitrogen in varying amounts. The microorganisms need **carbon for energy and nitrogen to grow and reproduce**. They are most productive when the ratio of carbon to nitrogen is 30:1

“Brown” woody material is high in carbon. It is mixed or layered with damp, **“green” material**, such as vegetable scraps and grass clippings, which is **high in nitrogen**. A recipe of three parts “brown” material to one part “green” material (by volume), will result in an overall carbon to nitrogen ratio of 30:1.

Air: Compost micro-organisms are aerobic and need oxygen. The rate of decomposition is increased by addition of air to the pile.

Moisture: The micro-organisms in the compost pile thrive in damp but not soggy conditions. Fifty percent moisture is ideal. If material is not damp enough, the composting process will stop. If leaves rustle, they're too dry. If the material is too wet, the air spaces will fill with water resulting in anaerobic conditions and odor.



Volume and Temperature: Bacteria give off metabolic heat. As populations increase, more heat is produced and trapped in the center of the pile causing the temperature to rise. This creates a good environment for other heat-loving organisms to multiply. The most efficient decomposing bacteria thrive in temperatures between 100-160 degrees F. As temperatures reach 105-170 degrees F, thermophilic bacteria speed decomposition and heat up the compost even more, killing most weed seeds and plant pathogens. The pile should be large enough to maintain heat.

Compost is a great resource that will improve the fertility of the soil by holding nutrients until plants can use them. It also improves the structure of the soil by loosening and aerating it, while improving the water holding capacity.

Developing your Composting Program

The tested strategies below will help to plan the size and type of program.

* **First investigate the need and goals for your composting program.**

Will your compost be primarily for the school garden, for other classroom food scraps and/or other school meals such as lunch in the cafeteria?

How much waste is produced currently?

Do a waste audit to determine quantity of each type - trash, recyclables and compostables.

Where does it go now?

Could a waste reduction education program reduce some of these materials?

Can alternative compostable or recyclable food service items reduce some trash?

* **Meet** with the school administration, faculty, cafeteria staff, custodians and interested parents. Gain their support and build ownership. Form a planning committee and divide the tasks.

* **Identify interests and knowledge. Introduce the topics** of separation, recycling and composting and the educational benefit. **Survey students and teachers** to assess their knowledge, interest and cooperation. Plan a school wide education strategy. **Get students involved** in the planning and daily maintenance.



Autumn leaves are “brown” compost materials.



Food scraps are “green” compost materials.



Untreated grass clippings are “green” compost materials.

Make a plan. Design the waste separation and collection system. How will collection be best monitored to assure success? Define tasks and time requirements. Address container and sanitary concerns. What permits and approvals are required?

Determine how the compost, recyclables and trash will be handled. If composting on site, design compost bins that take into account your size needs. Introduce any accompanying educational opportunities that support curricula. Plan division of tasks, maintenance and use of finished compost.



Building the Compost Pile

Select a bin that is appropriate for your setting. There are many commercial containers available; others can be made from easy-to-find materials. Bin designs include 1, 2 and 3 bin systems made out of wood or bricks, and barrel turners. Some towns distribute compost bins funded by Massachusetts DEP. In an urban setting, choose a rodent-proof bin with a floor, tight fitting lid and no openings wider than ½ inch.

A minimum of **one cubic yard is recommended** (3' by 3' by 3'.) Piles wider or taller than 5 feet do not allow enough air to reach the microorganisms at the center. Piles smaller than one cubic yard will freeze in the winter, although the organisms will revive in the spring and composting will resume.

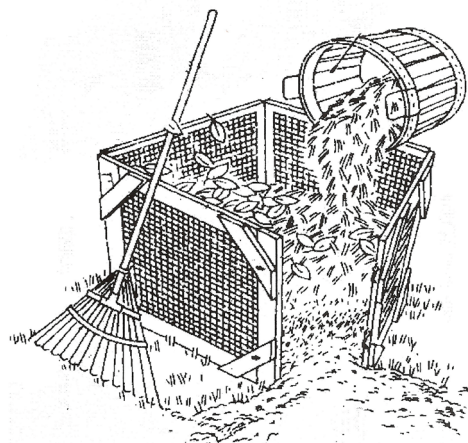
Choose a location for your bin. It should be easy to reach in summer and winter. A shady location is preferable. In the sun, it will tend to dry out quickly, requiring more water.

Prepare the bin by layering “green” and “brown” materials. Sprinkle a few shovelfuls of soil between the layers, approximately every 12”, to get the microorganism started. Moisten the pile, so the materials feel like a “wet sponge.”

“Green” materials are nitrogen rich. These wet materials include: fruit and vegetable scraps; coffee; tea bags; crushed egg shells; bread and grain; green grass clippings; fresh garden cuttings, annual weeds without seeds; animal manures (horse, cow, rabbit, chicken, goat and gerbil) and seaweed.

“Brown” materials are carbon rich. They include fall leaves; straw; hay; salt marsh hay; shredded paper; paper towels and plates; coffee filters; used potting soil; sawdust; chipped brush; wood chips; pine needles and thin layers of wood ash. Chop or shred materials to increase the surface area and speed the process. Gather these materials from the school yard or obtain from other local sources. Keep a pile of these next to your compost bin and use these materials to cover “green” materials.

Once the bin is set up, you can **begin to add fresh materials regularly.** Each time you add kitchen scraps and other “green” materials, cover them with three times as much “brown” material to maintain the ideal 30:1 carbon to nitrogen ratio. A compost mix too high in carbon will take longer to decompose. A compost mix too high in nitrogen can get sloppy and smelly. If in doubt, it is better to err on the carbon-rich side, which reduces the likelihood of odors.



Anything that was once alive is organic and will decompose. For public health and safety reasons, do not compost: meat; bones; fat; grease; oils; peanut butter; dairy products; foods cooked with butter or sauce; diseased plants, dog and cat manure. Other things that are not good for a small compost pile include weeds gone to seed, weeds that spread by roots and runners, sticks, banana skins, beech, birch and shiny leaves like magnolia and holly which are slow to decompose.

Turn or stir the material in the bin occasionally to introduce more air supply and speed up the process. Two piles will permit you to add fresh materials to one, while you turn and finish the compost in the other bin. Turning the pile with a pitchfork or inserting air tubes such as PVC pipes with air holes drilled into them into the center increases aeration. An odor like rotten eggs indicates anaerobic decomposition. A healthy compost pile does not smell!



With frequent turning compost can be ready in about 3 months. Composted plants and leaves from the fall could be ready for spring soil amendment. Once the compost stops heating up and the original ingredients have transformed into dark, rich, crumbly, sweet smelling humus, the compost is finished.

School compost often benefits from sifting before use, to take out anything that is not fully decomposed. Make a sifter using half inch hardware cloth (wire mesh) stapled onto a wooden frame that will fit over your wheelbarrow or cart. Shovel compost directly through the screen into your cart and transport to the garden.

There are many ways to **use finished compost in the school garden**: To use compost as a soil amendment, shovel compost about four inches deep onto vegetable beds and dig in before planting. You can blend your own seed starting mix by blending compost, peat moss, packaged soil and perlite, or a potting mix for older plants with equal parts compost and packaged soil. Make a compost tea to fertilize your plants. Soak a burlap sack full of compost in a bucket and seep several days until the “tea” is a light brown color, water your plants with this nutrient-rich solution. Mulch plants, shrubs and trees with an inch or more of compost. Top-dress lawns with a mixture of finely sifted compost and sand.

Avoid Attracting Pests to your Compost Pile: A well designed and maintained compost system will not attract unwanted insects and animals. Line the bottom and sides inside your bin with brown materials. Enforce burying green materials in the center of your pile with a cover of at least several inches of brown material. Make sure your bin has wire mesh or other rodent - proof design. Line your compost bin with bricks. Consider attaching mesh to the bottom of your bin to prevent burrowing. Have a secure lid. Some schools with high animal pressure, may need to have their compost bin off-site, inside a fortified area such as a courtyard, or to compost indoors, in worm bins.



If you don't have enough space to compost outside at your school, you can compost right in the classroom using a worm bin, with vermicomposting.

Vermicomposting

Vermicomposting is **composting with earthworms**. Earthworms speed up the composting process, aerate the organic material, and enhance the finished compost with nutrients and enzymes from their digestive tracts.

Red worms (*Eisenia foetida*) are best suited for worm composting. Also known as “red wigglers,” these are the worms typically used for fishing. They are smaller than common garden earthworms and red brown in color. Originally native to Europe, redworms have naturalized in the U.S., thriving in decomposing organic material such as leaf piles and compost heaps. They are surface feeders and eat many of the same foods as humans.

Redworms are **efficient processors of organic wastes**, eating and expelling an amount equal to their own weight every day. They are also a good indicator of fertile soil with a high organic content and a lack of toxic substances. Redworms adapt well to changes in temperature, although they prefer a range between 40 and 80 degrees Fahrenheit.

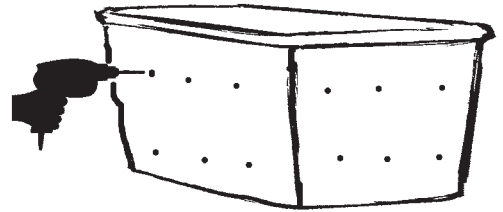


They are also **extremely prolific**. Fertilized eggs will develop in a cocoon in about three weeks. Two or more young may emerge. In three months the worms become sexually mature and will start breeding. You can purchase worms from a commercial vendor. Many are available on-line, and you may be able to find a local source in the phone book under "Fishing Bait" You can also collect redworms from decaying leaves, manure piles or compost piles. A pound of worms is enough to start most bins.

Building the Worm Bin

You can order a special worm bin from a supplier or make your own from wood. The **easiest and least expensive method is to convert a large plastic storage container**. Select an opaque container with a lid, as worms prefer darkness. A deep bin (15 inches or more) is preferable, allowing more room for layering and burying fresh material. The larger the container, the more material you will be able to compost.

Drill 1/8 inch holes in the sides and cover of the container, approximately three inches apart, starting four inches from the bottom. You may also choose to drill holes in the bottom. You will then need a tray to catch excess moisture. If you don't provide bottom drainage holes, add extra dry material if the bins starts to develop puddles.



Next **fill the bin with bedding**. This is organic material that provides enough air space for the worms to survive and breed. Bedding can also be used to cover food scraps. The worms eat the bedding along with kitchen scraps to make the compost. Many high carbon bedding materials may be used, such as chopped dry leaves, shredded paper, ground cardboard or peat moss mixed with vermiculite. Bedding can be a combination of materials. Fill the bin about 3/4 full.

Add water to the bedding material until the moisture content is 50 percent (as damp as a wrung out sponge). It is important to keep the bedding this damp or the worms will die. Mix a few handfuls of soil or finished compost with the bedding. Site the bin in a location where it will stay between 55-75 degrees F. At lower temperatures worms will stop reproducing; they will die at higher temperatures.

Add 1-2 pounds of redworms, based on the size of the container. There can be as many as 500-2000 worms in a pound depending on the size of the worms. Add only small amounts of food scraps until the worm population increases to handle more (3-4 months). The worms will begin to reproduce after just a few weeks. Also, the worms can't eat the food until it starts to decompose; be patient.

Worms will eat **any type of kitchen waste** including vegetables, fruits, tea bags, coffee grounds and crushed eggshells. Do not add meat or meat byproducts. **Bury the food scraps** enough that they are always covered by bedding. This prevents development of odors and fruit flies. Don't add more food scraps than the worms eat in several days. Chop the food scraps for faster decomposition.



Worms do not like to be disturbed. Bury fresh food just once a week. There is no need to turn the compost in the bin. Air holes in the sides and the tunneling action of the worms provide enough circulation.

Turning the garbage into castings as long as they have food, space proper temperatures and moisture. After about two-to-three months, the container will start getting full; much of the materials in it will look like soil. It's time to harvest. **Move the finished compost to one side of the bin** and add fresh bedding to the vacant side. Put new food wastes into the fresh bedding only. The worms will move from the finished compost in search of new food. After a few weeks, remove the lid under a bright light source. The worms will burrow away from it. Scoop out the finished compost a few layers at a time. Add fresh bedding. Worm compost is more thoroughly digested than most other composts making it desirable.

Fruit flies may be found in and around the bin. They are not harmful; but can be a nuisance. The larvae travel on the skins of fruits, especially bananas. Make a simple, non-toxic trap by placing a banana peel inside a clear plastic container. Make three or four holes all the way through the cover with a standard toothpick. Place the plastic container near the worm bin. Within 24 hours, 99% of the fruit flies will be trapped inside the container and can be released outdoors.

In the Cafeteria & On-Site Composting

Once you've determined that a cafeteria composting program is the goal, it is time to get started. Use the information collected during the waste audit to determine type and size of the program. It will also help determine the **number of collection containers** needed in the cafeteria, and compost bins required outside. Multiple bins are recommended, so new material is added to just one at a time.

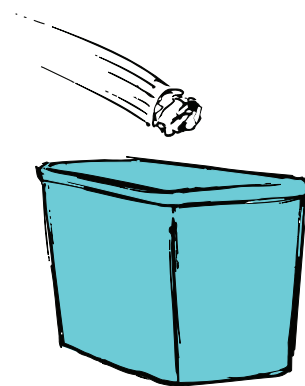
Work with the cafeteria and custodial staff to determine **type and location of each of the collection containers - trash, recycling and compost**. Make a plan for managing each collected material, including cleaning and storing containers.

Develop signage for individual bins and to demonstrate sorting of each type of material. Make a master list of any possible waste that may come into the cafeteria and the sorting category.

Recruit compost monitors and offer group training. Assign monitors to all lunches and post the monitor list in the cafeteria as a reminder.

Plan for managing collected materials following the lunch, including the disposal of trash, transferring recyclables and taking compostables to the bin.

Once compost is ready, **complete the cycle through gardening**. Harvest finished compost after three or more months and plant a garden. If your school is too large to implement on-site composting, try developing a plan for off-site composting.



Composting Activity Ideas

* It's estimated that an average American produces 1,600 pounds of trash a year. Ask student to think about **how much garbage they produce over the course of a day, week, year, lifetime**. Make a list of all the things that they threw out yesterday, this past week. How many of these were recyclable or compostable?

* **Monitor your wastes**. Keep a log of what is composted and when. Record the amount of wastes composted, the temperature of the pile, moisture content and other observations.



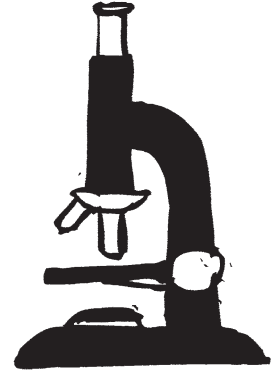
* Ask each student to **research one decomposer organism** in depth and make a five minute presentation.

* Investigate the **carbon: nitrogen ratio** in the pile. Ask students to calculate the materials that would result in an ideal ratio of 30:1 for your compost.

* A large percentage of the waste stream is made up of **"trashed" packaging materials**, from single-serving cans and bottles to the cardboard, plastic, and styrofoam that wrap merchandise. Ask students to design and present packaging for a product that will reduce these wastes for one item.



- * Explain how **worms improve the soil**. How are they a good solution to our organic waste problem? What impact do they have on the natural environment?
- * **Worms offer lessons in life cycles**. Find cocoons and young worm populations in the bin. Ask students to monitor a worm from cocoon to adulthood. What foods do they like to eat? Which are less popular? Study the anatomy to find the anterior and posterior end, circular and long muscles and setae. How do these help them move through the soil?
- * Make a **worm column** or worm observation chamber and trace the tunnels the worms make in the soil.
- * Discuss **anaerobic and aerobic decomposition**. Set up an experiment to watch food scraps deteriorate in and outside of a worm bin.
- * Collect **several samples from various stages of compost**. Feel, smell, and look at the “rotting” materials. Use a microscope to examine the materials. What do you see? What words would you use to describe these materials?
- * Can you identify any of the decomposer organisms?



Composting Resources

Organizations

Massachusetts Department of Environmental Protection
 Bureau of Waste Prevention
 One Winter St. 6th Floor Boston, MA 02108
 Ann McGovern (617) 292-5834
 ann.mcGovern@state.ma.us
<http://www.mass.gov/dep/recycle/reduce/composti.htm>

The Green Team: An Environmental Club for Massachusetts Schools
 Sponsored by Massachusetts DEP
<http://www.thegreenteam.org/>
 * Composting Lesson Plans & Materials

Massachusetts Department of Agricultural Resources www.mass.gov/agr/

Environmental Protection Agency <http://www.epa.gov/osw/conservation/rrr/composting/index.htm>

Compost Bin Designs:

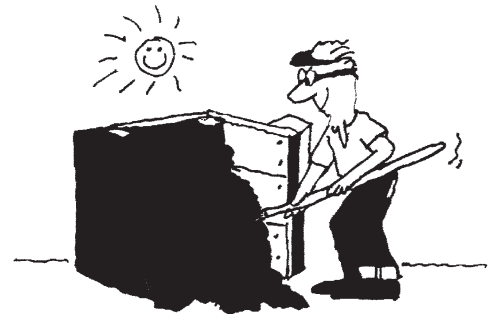
University of Wisconsin Cooperative Extension
<http://www4.uwm.edu/shwec/composter/how-to-build-a-compost-bin.cfm>
 Their “Master Composter” program provides blueprints for different kinds of composting bins.

Curriculum & Resources Websites

Association of Vermont Recyclers: Curriculum www.vtrecyclers.org/wastekit/compost.htm

Composting in NH Schools Manual www.schoolrecycling.net/composting.htm

Cornell University - Composting at School <http://compost.css.cornell.edu/schools.html>



National Institute of Environmental Health <http://kids.niehs.nih.gov/explore/reduce/worms.htm>

National Sustainable Agriculture Information Service <http://attra.ncat.org/soils.html>

School Ground Transformation www.schoolgrounds.ca/projects.html

Montpelier High School compost awareness video available on YouTube:
http://montpelier-vt.blogspot.com/2007_08_28_archive.html

Mansfield, CT School-wide Composting Program
http://www.ct.gov/dep/lib/dep/compost/compost_pdf/schmanual.pdf

Books

Let It Rot: The Gardener's Guide to Composting, by Kathleen Bond Borie, Storey Pub.

The Rodale Guide to Composting, by Deborah Martin, 1992, Rodale Press.

The Wonderful World of Wigglers, by Julia Hand, 1995. Foodworks, VT.

The Worm Book: Complete Guide to Gardening and Composting with Worms, by Loren Nancarrow.

Worms Eat My Garbage, by Mary Appelhof, 1997. Flower Press.

Information for this composting resource was taken from the resources above and from handouts from MAC workshops hosted by Greater Lowell Regional High School, Hubbardston Center School & South Hadley High School. A special thanks to Ann McGovern from Massachusetts Department of Environmental Protection.



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Please Visit the Massachusetts Agriculture in the Classroom Website
to tell us how you used this Composting Resource for the School Garden.

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