Cornell Waste Management Institute

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Composting at Home - The Green and Brown Alternative

Sustainability and going green are all the rage. For many, recycling glass, plastic, aluminum, metal cans, cardboard, newspapers and other paper products has become automatic, but what about the rest of our waste? Organics such as food scraps, food preparation residuals, food soiled paper products, leaves, grass clippings, brush and tree trimmings comprise over 60% of our waste stream and are completely recyclable. That's where composting steps in; organic waste can be recycled through composting and the resulting product can be used to improve soil quality and help plants grow. Collecting these organic residuals for diversion to a municipal composting program or for composting at home conserves energy and natural resources, reduces air and water pollution, and saves landfill space. This fact sheet describes how to separate and collect organic residuals, discusses manufactured and homemade containers designed for composting and gives information on how to make composting work.

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Separation and Collection in the Kitchen

There are several kitchen collection containers on the market, but you can also use a recycled container or pail with or without a lid. Containers should allow air to flow through your scraps so that they will not smell before incorporation into the compost bin. Placing your food scraps in layers with crumpled newspaper can also help with odor by absorbing some of the moisture in the food. Some manufactured kitchen collection containers include a charcoal filter or have holes in the bucket to help with potential odors. Some require the use of liners (paper or compostable bags) to hold the scraps inside the bucket. As with fresh fruit sitting on your counter, collection containers may attract fruit flies in warm weather.

Kitchen container with compostable bag.

Kitchen container with locking lid and aeration holes.

Recycled kitchen container.

Example signage for home separation.

Any food preparation or post plate material, spoiled food, napkins, and degradable serviceware can be composted. Milk and meat products are not generally added to home compost piles, but can be composted by municipalities collecting organics because they compost greater volumes of residuals and reach proper temperatures. Signage can help while learning what to put into the containers and where many people use a shared kitchen.

In a municipal program, the municipality may provide containers for use in your kitchen that would be emptied into a larger container for curbside pickup. Some containers may be targeted to collect both yard waste and food scraps. This is a good way to collect as you can layer carbon and nitrogen right in the container. Whenever you layer wet with dry material there will be little odor, and the municipality may be able to reduce collection frequency. If this is the scenario, stockpile some carbon material for winter food collection as food will smell if not layered with carbon (see sidebar "Stockpile Browns" page 5).

Separation and Collection of Yard Waste

Yard waste includes leaves, evergreen needles, sticks, brush, grass clippings and garden cleanout. If at all possible, compost your yard waste in your back yard or a multi-family (communal) compost unit. With multi-family units, directions and good signage lead to success. Keeping and composting residuals at home is the most sustainable option and provides a great soil amendment. If that is not possible, check with your municipality to see if they pick-up or if you need to deliver yard waste to their site. Large branches, logs and stumps are collected curbside in some communities. In others, you need to convey these materials to a transfer station for management. Depending on your municipality, containment may be required in plastic, paper or reusable containers. Some municipalities require leaf and yard waste to be left loose at the curbside.

Collection containers for yard waste include:

- **Plastic bags:** These are made of petroleum products and provide good containment but may cause contamination at the compost facility. It is difficult to debag leaves effectively without a lot of labor and it can be nasty work.
- **Compostable plastic bags:** These bags are designed to be incorporated into compost windrows with the yard waste and no debagging should be necessary. These bags tend to be more expensive than the petroleum-based bags but may save in labor.

Compostable plastic bags.

- **Paper bags:** Paper leaf bags can be a good choice since they have a base that allows them to stand up while loading, and can be incorporated into the compost along with the leaves which avoids the debagging process. However, they can be more expensive to purchase.

Paper leaf bags.

Reusable curbside collection containers.

◆ **Reusable containers:** These are generally made of durable plastic or metal with a large capacity and are intended to be used for mixed organics. Feedstock should always be layered in these containers, otherwise you will have a smelly mess and the container will need frequent cleaning.

◆ **No containment:** Just rake them to the curb! Some municipalities may want leaf and yard waste to be left at curbside with no containment at all. This generally has to do with the type of collection equipment they use.

Loose leaves curbside .

Balancing Greens and Browns

Composting comes in all shapes and sizes, can take intensive management or can be as simple as you want it to be. Sometimes, composting gets a bad rap…"It smells, attracts critters, looks messy". If that describes your compost or composting experience, read on:

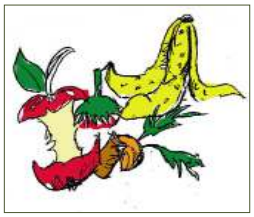
The process of composting is not just separating and placing all of your food scraps in a heap. The old adage "compost happens" is certainly true, but you can help it happen smoothly by remembering who is actually doing the work in your compost pile. Millions of micro- and macro-organisms are the work force. To process organics into compost, the workers need food, air and moisture. For the organisms to be productive, the system has to be in balance. This is not hard; it just takes some forethought and good management techniques. To compost effectively, you need the right feedstock in the right proportions and space in which to compost. Then, by following a few general procedures, you can easily recycle your food scraps and yard trimmings into a valuable soil amendment.

Feedstock

Compost feedstocks are the organic material you put in your compost pile. The best way to describe these feedstocks is by color: ***greens*** and ***browns***.

Greens = Nitrogen Wet Materials	Browns = Carbon Dry Materials
Food scraps • Grass clippings • Fresh manure • Garden clean out	Brown leaves • Straw • Soiled paper • Saw dust • Woodchips

Greens, the nitrogen source, are colorful and wet. They provide nutrients and moisture for the compost workforce.



Greens: Food scraps and grass clippings.

Browns, the carbon source, provide energy, and are also used for absorbing excess moisture and giving structural strength to your pile. They help keep the pile porous, facilitate air-flow and prevent compaction.


Browns: Leaves and wood chips.

Space and Compost Volume

A minimum volume of 1 cubic yard (3'x3'x3') is required for a pile to become sufficiently self-insulating to retain heat. Heat will help reduce pathogens and allow the process to occur more quickly. In hot-dry seasons and cold-wet winters larger piles up to 7'x7'x7' will hold the heat longer, regulate moisture and work more effectively. Larger piles will provide the optimal conditions for thermophilic composting, which promotes rapid decomposition and kills weed seeds and disease-causing organisms. However, composting will still occur in smaller piles, it will just take longer to produce a finished product.

Location of the pile can have an effect on the composting process. It should be located in a level, well-drained area. In cool climates, putting it in a sunny spot can help trap solar heat, while shade in warmer climates may keep it from drying out.

The Three Phases of Thermophilic Composting

Thermophilic composting can be divided into three phases, based on the temperature of the pile:

(1) mesophilic, or moderate-temperature phase (50-104°F or 10-40°C), which typically lasts for a couple of days;

(2) thermophilic, or high-temperature phase (104-150°F or 40-65°C), which can last from a few days to several months depending on the size of the system and the composition of the ingredients; and

(3) several-month mesophilic curing or maturation phase. Monitoring temperatures can assess the process and help determine whether or not to change the feedstocks, turn the pile, add moisture, or put it aside for curing.

Bins, or some sort of containment can be beneficial. They can be either 3 or 4 sided with a removable front to facilitate turning. One can build containers of scrap wood, pallets, fencing, cinderblock or cement. Metal, wood and molded plastic containers can be purchased for use as well. The bottom dimensions should be at least 3' x 3', and the sides as tall as is comfortable. Woodchips or pallets can be placed on the ground as a base to help air flow into the bin and through the organic materials. Another way to facilitate or encourage air-flow in the bottom is to crisscross sticks and stalks to a height of 6-8" before adding nitrogen to the bin. Covering the top of the pile with carbon keeps out flies and other pests and serves as a filter for odor.

Putting it all Together – Layering

Layering and choosing the right organic material creates the right environment for compost to "happen". Start with a layer of coarse "browns" in contact with the soil. Make a well or depression in this layer and put the "greens" into the well. Keep the food scraps away from the outside edges of the pile (only brown material should be visible). Cover your "greens" with a generous layer of "browns" so that no food is showing. This will keep insect and animal pests out of the pile and filter any odor. Keep adding layers of greens and browns (like making lasagna). Keep layering the feedstock until the mass reaches a height of 3 to

Cross-section of layered browns and greens.

Stockpile Browns

Probably the hardest part about home composting is getting enough "brown" material to be able to continue composting your food scraps year-round. Here are some ideas:

1. Rake leaves in the fall, but instead of bagging them and putting them out at the curb, put them in a loose pile up off the ground (on pallets, or wire mesh or inside a shed) and keep them under cover.

2. Trim brush, then cut it or chip it and keep that in a dry place.

3. Collect excess wood shavings/sawdust from a local woodworker or sawmill. However, be careful not to use any from treated or painted wood.

4. Check with your local highway department or electric company and find out where they are cutting and chipping limbs. You may be able to pick up their wood chips, and sometimes they will even drop them off.

5. Purchase or barter straw from a local farmer; they may also have used animal bedding that works well.

6. Paper and cardboard can be part of the mix; it is generally best to shred or tear before adding.

Manufactured on-ground compost units.

7 feet. As you are building the pile, management choices can be made. If you have time and space and can wait for a usable product (9 to 15 months after building the pile), let it work passively. Passive composting requires less labor but more time. If processing space is limited and you want a product more quickly, turning will help to speed the process. The pile can be turned with a pitch fork or shovel, which helps to break up material and better homogenize the mass.

Homemade on-ground compost units.

Choosing a Compost Unit

So, you've decided to compost! You know all about balancing greens and browns and what residuals you can and cannot compost. Containing compost in a bin helps to keep things neater. You can build your own, or you can purchase one. Using multiple containers or piles is a good management strategy. Fill one bin, then while it is processing and curing, start filling the second. An internet search for "compost bins" brings up 810,000+ results and one for "compost bin plans" will net 155,000+. If you'd like some help sorting the results out, read on.

Types of Composters:

- **On-ground Compost Units:** These units sit directly on the ground so that worms and other decomposers can come up from the soil to assist in the composting process. Whether homemade or purchased, these types of composters can be used as holding bins or can be

aerated through turning or mixing. To use an on-ground compost unit, continuously add food scraps and cover with carbon. If desired, stir the mixture with a fork or a tool specifically made for aerating compost, and cover with browns as needed. Open bins or bins with a relatively large lid are desirable for easy loading and turning. Some manufactured bins have a door at the bottom to remove finished compost. After 6 months to a year, remove the bin and harvest the finished compost at the bottom, then begin again with the mixture left at the top of the composter.

Manufactured rotating drum compost units.

- **Rotating Drum Compost Units:** These units are off the ground on stands or bases. They are turned either with a handle or by pushing the drum. Most drums are batch compost units in which you add feedstocks as they are generated, but with each green addition, the process is interrupted, lengthening the composting time. For best results, the drum should be full to create a batch; compost activity occurs while you are filling but conditions are not optimal until it is full. To improve processing, 2 drums can be used consecutively, or a holding bin and drum can complement each other. Some are designed with side-by-side drums for this purpose. Once the drum is full, turn it as directed to mix the feedstocks until you have a finished product.

Homemade rotating drum compost units.

Manufactured continuous feed compost units.

- **Continuous Feed Compost Units:** These composters are designed to be fed daily. Feedstocks go in one end and compost comes out the other. These include rotating drum and bin composters that are designed specially to push waste through the system, and also include indoor, electric composters.

Indoor worm box.

Manufactured worm compost unit.

◆ **Worm Compost Units:** Worm composting utilizes worms to help process organic material and produce castings. Worm composting is often done in 24" deep beds or trays. Bins are fed from the top and worms move up to the food to process it. Because the worms are sensitive to temperature, they should be protected from high heat and freezing temperatures. The ideal temperature for composting with worms is between 59-77ºF (15-21ºC). If it gets too hot worms will migrate to cooler areas. This method can be ideal for apartment dwellers and those with little outdoor space.

Companies that Offer Bulk Bin Sales - updated May 2016

The following companies offer programs for municipalities and non-profits interested in having bin sales or distributing bins to residents.

•Covered Bridge Organic, Inc., Jefferson, OH: http://www.cboinc.com/programs.htm

•Earth Machine: http://www.earthmachine.com/municipal/index.php

•Nature's Footprint, Inc. The Municipal Wormcycler Composter for municipal governments and non-profit organizations: http://naturesfootprintinc.com/products/wormcycler/

Plans for Compost Systems - updated May 2016

There are many websites where you can get plans for making your own compost unit. Your local County Cooperative Extension Service or local Solid Waste Management Department may have free plans or bins for sale. Look them up on the web or give them a call. The following websites have free plans:

Cornell Waste Management Institute has "Designs for Composting Systems" http://hdl.handle.net/1813/11729 and "Six easy steps to setting up a worm bin" http://compost.css.cornell.edu/worms/steps.html.

Cornell Cooperative Extension of Tompkins County has information on home composting as well as some bin designs: http://ccetompkins.org/gardening/composting/compost-resources.

New York City's Department of Sanitation has a website that gives information on low cost bins and how to build a bin and where to buy worms: http://www1.nyc.gov/assets/dsny/zerowaste/nonprofitsagencies/food-yard.shtml.

Free plans from "Do-It-Yourself" are available at: http://www.free-diy-plans.com/plans-compost-bin.html.

Decisions, Decisions…. Make sure the compost unit meets all of your needs.

1. What type of organic material do you want to compost?

It is recommended that home composters limit their food scrap composting to fruits, vegetables, plant matter and paper products, as most home composting piles do not get hot enough to destroy pathogenic organisms found in meats, fats, oils and cat and dog manures. In addition to pathogens, these items can be odiferous and may attract unwanted pests. Combining yard waste with food waste is the most effective combination.

2. How much organic material (brown and green combined) do you have to compost?

Determine how much you have for composting by estimating the amount of food scrap you generate. Example: how many gallon buckets do you fill each week? Remember, you will need 1 part wet (food scraps): 2-3 parts dry, (carbon) depending upon moisture. Estimate the amount of yard waste you want to compost. When you have determined how much you have to compost, find a container to match the

volumes. For small amounts of organics, it may be more effective to use worm composting, bins in contact with soil or direct incorporation. For larger amounts you may want 1-3 bins or a multi bin unit, and compost in batches. Batches allow for use of compost at different times of year or in different seasons.

3. Do you have enough carbon and a place to store it?

Carbon is essential for composting. It is the energy source for the microorganisms that process feedstock and helps to absorb moisture. In most, cases, you will need at least 1 part brown material for every part of green (food scraps, grass clippings). Collect carbon in a holding bin or bags for use when carbon is less available (see Stockpile Browns on page 5).

4. Where are you going to put the bin?

If you have plenty of outdoor space, you can use any bin, but if space is limited, find one with a smaller footprint. Bins should be placed in a convenient location in sunny or shaded areas. In cities, they can be located in trash collection areas as long as they are well labeled. If you are using a bin with a lid, you will need a level area for siting, otherwise the corners of the bin are likely to be stressed and the lid will be difficult to keep in place. Lids can blow off and may need to be weighted down. Place the bin near where finished product will be used.

5. What is the compost bin made of and how will it look in its space?

Some manufactured compost bins are made with 15% (or less) recycled materials while others are made from 100% recycled materials. Some are high density polyethylene, some are polypropylene and others are made from galvanized steel or wood. Most are black, green or brown. If building a compost bin, think about what materials you will use. Compost bins can be made from recycled pallets, old snow fence, used welded wire, old cinder blocks, recycled plastic barrels and many other reusable materials.

6. How fast can organic materials be turned into compost?

Time in all systems depends on mixes, moisture and airflow. With well-balanced mixes, turned or unturned, compost can be produced within 6 months. Creating a good habitat for microorganisms helps the process work better. By balancing your browns and greens and checking your moisture content (see squeeze test pictures below) you can create a mixture that allows air to flow evenly through the pile. This “passive” air flow can produce the same results as turning. Keeping that stockpile of coarse carbon on hand will help achieve this. With less optimum conditions, it will take from 6 months to a year or more to produce finished compost. With rotating drum composters, continuous composters and worm composters, finished compost can be created in a relatively short time of 6 months or less.

Optimum moisture content for compost is 40-60%, damp enough so that a handful feels moist to the touch, but dry enough that a hard squeeze produces no more than a drop or two of liquid.

Troubleshooting Compost Problems

Symptom	Problem	Solution
Pile is wet and smells like a mixture of rancid butter, vinegar and rotten eggs	Not enough air Or too much nitrogen Or too wet	Turn pile Mix in straw, sawdust or wood chips Turn pile and add straw, sawdust, or wood ship; provide drainage
Pile does not heat up	Pile is too small Or pile is too dry	Make pile larger or provide insulation Add water while turning
Pile is damp and sweet smelling but will not heat up	Not enough nitrogen	Mix in grass clippings, food scraps or other sources of nitrogen
Pile is attracting animals	Meat or dairy products have been added Or food scraps are not well covered	Keep meat and dairy products out of the pile; enclose pile in 1/4” hardware cloth Cover food with brown materials such as, wood chips or finished compost

Resources:

- It’s Gotten Rotten (video) - http://hdl.handle.net/1813/11656
- Composting at Home: the Green and Brown Alternative - http://hdl.handle.net/1813/29111
- Composting at Home (slide show) - http://hdl.handle.net/1813/44789
- Composting: Wastes to Resources - http://hdl.handle.net/1813/11729
- Composting to Reduce the Waste Stream - http://hdl.handle.net/1813/44736
- Cornell Cooperative Extension (county offices) - http://cce.cornell.edu/localoffices
- Vermicompost: A Living Soil Amendment - http://cwmi.css.cornell.edu/vermicompost.htm.

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On-Ground Compost Units (cost ranges $30-$270) The following table provides only a few of the many manufactured compost units available and may be helpful when choosing a compost unit. Cornell Waste Management Institute does make any endorsements of these products.

Name	Material & Recycled content	Length (in)	Width (in)	Height (in)	Weight (lb)	Capacity	Other Information
Biostack	Polyethylene 60%	28	28	34		12 ft^3	Stackable bin will make more batches at a time. Unstack to start new batch while waiting for first to finish composting.
Compost Wizard Standing Bin	Polyethylene	25	29	37		12 ft^3	Door on bottom for unloading
Earth Machine	HDPE 50% min	33	33	33	15	10.5 ft^3	Base plate can be purchased; door on bottom for unloading.
Eco Composter	Canadian Spruce	26.25	26.25	30	34.5	90 gal	Slatted box. No doors, but sides unbolt.
FeelGood Composter	Plastic resin 100%	30	30		19	90 gal	All 4 sides have sliding panels.
Garden Gourmet	Black plastic 100%	24	24	36	29	11 ft^3	One sliding bottom door. Additional panels can be added to increase capacity.
Garden Wise Compost Bin	Polypropylene 100%	28.5	28.5	33		12 ft^3	4 sliding panels for unloading.
GeoBin	Plastic mesh	36	36	36	8	14 bu	Adjustable "fencing" to hold feedstocks.
Juwel Compost Bin: AeroQuick Small AeroQuick Medium AeroQuick Large AeroQuick 235	Polypropylene up to 40%	 28.4 31.5 37 42	 28.4 31.5 37 42	 31.5 42 43 43	 22 30 49	 77 gal 110 gal 187 gal 235 gal	2 side doors for removal of compost. Base plates included with larger models.
Soilsaver	Polyethylene 75%	28	28	32	30	11.4 ft^3	2 sliding sides for unloading and turning if desired.
WIBO Composter	Polycarbonate 100%	30	30	34	19	110 gal	All 4 sides have sliding panels.

Pictures?

Rotating Drum Compost Units (cost ranges $70-$500) The following table provides only a few of the many manufactured compost units available and may be helpful when choosing a compost unit. Cornell Waste Management Institute does make any endorsement of these products.

Name	Material & Recycled content	Length (in)	Width (in)	Height (in)	Weight (lb)	Capacity	Other Information
Black and Blue	Plastic - 99%					7 ft^3	Wheeled base for turning and twist lid.
Compost Wizard, Jr. Compost Wizard Hybrid	Resin - 100%	25	29	37	27	7 ft^3	2 models; the Hybrid base is a 47 gal rain barrel so compost tea is combined with rain water.
ComposTumbler BackPorch Compact Original ComposTumbler2	 HDPE Galvanized metal Galvanized metal Galvanized metal	 31 42 50 50	 26 33 40 40	 37 43 68 68		 5 ft^3 12 ft^3 22 ft^3 22 ft^3	
Envirocycle	Plastic 50%	25.5	20	25.5		7 ft^3	
Joracomposter JK125 JK270	 Galvanized steel Galvanized steel	 36 44	 27 28	 33 52	 64 84	 33 gal 70 gal	
Mantis ComposT-Twin		65	41	66		25 ft^3	2-12.5 ft^3 compartments for continuous composting.
Suncast Tumbling Composter	Resin composter galvanized steel frame	41	31.5	42.5		6.5 ft^3	
Tumbleweed Compost Maker	UV protected polypropylene	34	26	46	22	60 gal	Vertical tumbler on stand.

Continuous Compost Units (cost ranges $140-$450) The following table provides only a few of the many manufactured compost units available and may be helpful when choosing a compost unit. Cornell Waste Management Institute does make any endorsements of these products.

Name	Material & Recycled content	Length (in)	Width (in)	Height (in)	Weight (lb)	Capacity	Other Information
Aerobin Aerobin 400 Aerobin 600		29	29	47		113 gal 160 gal	Includes base with leachate collection tank; door for compost removal. Uses a lung or aeration core inside the sealed bin to add oxygen and moisture.
Earthmaker	UV stabilized polypropylene – 15%	30	30	47	27	120 gal	Door for unloading. Material moves vertically through the composter.
NatureMill The Classic Plux XE Pro XE	Housing: recycled polypropylene. Internal components: stainless steel.	12	20	20	17	80 – 120 lb/month	Drawer to remove compost. Indoor use; requires electricity. Accepts all food including meat, milk and oils.
Sun-Mar Sun-Mar 200 Sun-Mar 400		33.5 42	24 28	31 36	38 60	50 gal 100 gal	Continuous flow composting using a double drum design. Compost is removed by opening the output port, rotating the drum and allowing compost to fall from the inner drum into a container.

Worm Compost Units (cost ranges $45-$120) The following table provides only a few of the many manufactured compost units available and may be helpful when choosing a compost unit. Cornell Waste Management Institute does make any endorsements of these products.

Name	Material & Recycled content	Length (in)	Width (in)	Height (in)	Weight (lb)	Capacity	Other Information
Tumbleweed	UV treated high impact polypropylene	23	15	10	10		1,000 worms required to start off the farm.
Vermihut Vermihut – 2T Vermihut – 3T Vermihut – 4T Vermihut – 5T	HDPE 100%	 16 16 16 16	 16 16 16 16	 19 20 21 22	 10.4 11.7 13 14	 2 lb/day 3 lb/day 4 lb/day 5 lb/day	Has 2-5 trays depending on model; each can hold up to 2 lbs of worms. Worms migrate upward to food source leaving the bottom tray full of compost.
Worm Factory 3-tray system 4-tray system 5-tray system Worm Factory 360	Recycled HDPE	 16 16 16 18	 16 16 16 18	 21 24.5 28 28	 11 12 13 13	4-5 lbs food/wk per tray	Has 3-5 trays depending on model. Worms migrate upward. 360 model comes with bedding, accessory kit, DVD and illustrated guide.