



Cornell Waste Management Institute

Department of Crop and Soil Sciences
Cornell University

Rice Hall • Ithaca, NY 14853
(607)255-1187

E-mail: cwmi@cornell.edu
<http://cwmi.css.cornell.edu>

COMPOST FACT SHEET #7: Compost Equipment

COMPOST FACT SHEET SERIES 2004/2005

*For these fact sheets and other
compost information:*
<http://cwmi.css.cornell.edu/Composting.html>

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Composting Liquids

Cornell Waste Management Institute Staff:

Ellen Z. Harrison, Director

Jean Bonhotal, Sr Extension Associate

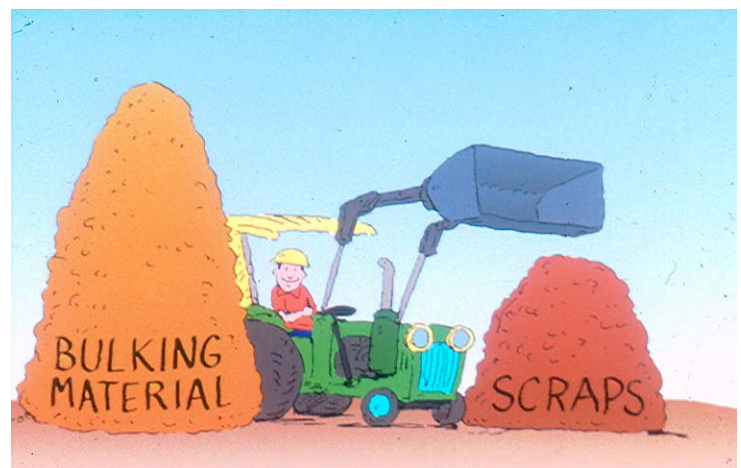
Mary Schwarz, Research Support Aide

Lauri Wellin, Program Aide

Play Before You Pay

Before purchasing composting equipment of any type, decide whether or not composting fits into your operation and schedule. Consider the feedstock that you plan to use and try a few different recipes. Experiment with equipment that is on site or close by, like a farm tractor, loader or even a pitchfork. The pile can be a round haystack approximately 5-6 feet tall or a windrow 5-6 feet high x 6-10 feet wide x greater than 4 feet long. After you create the mixture, check the moisture level. Take a handful of the mixture and squeeze. A few drops of liquid should come out. If the handful is too wet, add bulking material such as hay, woodchips, bedding material, etc. If it is too dry, add water. Monitor temperature in the pile with a compost thermometer. A thermometer is one of the best indicators that the process is progressing. If temperatures are not elevated, the carbon to nitrogen (C:N) ratio may need to be adjusted or the pile may need to be aerated. Temperature in a good working pile should range from 120-150°F.

Visit sites and talk to people that are using different composting methods and equipment. Rental is a good option while making decisions, especially when considering screening, bagging, or collection of organics like food scraps. Always consider renting equipment with an option to own. If the equipment is right for your operation, you will come out ahead economically. Used equipment is available from equipment dealers and on web sites.



In many composting operations, a turner may be needed weekly or monthly most of the year, whereas screens and size reduction equipment are generally used intermittently and need to be stored and maintained the rest of the year. For that short window, it may not be worth maintenance and storage. As with all equipment, regular maintenance is required, and because of the corrosiveness of decomposing organic material, systems have a finite life. Some companies use stainless steel components to extend the life of the equipment.



Straddle turner pulled by a tractor.

Space Considerations Affecting Equipment Choice

If you are located in an industrial zone, space will be expensive. In an agricultural area you will be competing with field crops and grazing. If space is tight, windrows can be built between 5 feet and 8 feet tall to save space, although turning equipment will influence pile height and width. Tall piles result in fewer piles to manage, use less space and require less time turning. However, too tall a pile results in compaction of the materials at the bottom. Larger piles provide insulation and are thus more forgiving in climates that experience cold temperatures. If the C:N ratio, moisture and particle size are in a good range, windrows will continue to work through cold weather and can be turned when conditions allow.

If space and time are not as critical, windrows can be built smaller and turned with a turner that manages smaller windrows. There are several compost management strategies that produce good compost with shorter piles. There are compost methods that depend

on use of smaller piles, e.g. 3 feet to 5 feet tall, to maximize the efficiency of the process, possibly providing better conditions for the microbes. In cold climates, however, organic materials should be stacked in piles, 5 feet to 8 feet tall for winter, even if actively composted in shorter windrows the rest of the year. Length of piles is determined by space available on the pad, but remember to allow space for equipment to turn around.

Size Reduction Equipment

Compost feedstock can come in various sizes and textures, and there are times when it is necessary or beneficial to use size reduction equipment. It can be useful in producing a more uniform nitrogen source when pieces vary greatly in size (e.g. clumpy manure, food scrap). Uniform size can improve and expedite the process. Carbon sources come in all sizes and shapes. It would be ineffective to compost a whole tree even though it has the potential to provide enough carbon. Trees, shrubs, hay bales, straw, leaves and other carbon sources may need to be processed so that the carbon is readily accessible. For additional information on carbon, see fact sheet #5 Compost Bulking Materials (<http://cwmi.css.cornell.edu/compostfs5.pdf>).

Forks – A forklift attachment for a loader or forks attached to a bucket can help to break material apart and make it more uniform. This can be effective if material is matted, such as wet leaves or manure/straw mixtures, and allows for increased airflow.

Grinding Buckets – Some loader buckets have grinding mechanisms in the bucket.



A mixer grinding cardboard and organics.

Material is scooped up with the bucket and ground as it drops out of the bottom of the bucket. The grinders are robust, but processing may be slow because of bucket size. They can be effective depending on the size of operation. Grinders not adequately sized could cause bottlenecks.

Wood Chippers – Wood chippers are useful for brush and small trees and provide a fairly uniform chip. Trees and brush fed into the machine and blades generally produce a 2-inch chip. If your site accepts a lot of brushy material, it may be worth renting or buying a chipper. It is hard to take whole brush and compost it. Depending on chip size and end use of the compost, the chips may need to be screened from the composted material.

Bale Choppers – Old hay bales dot the landscape and the hay is no longer useful for feeding or bedding animals, but can be used as a carbon source in composting. Bale choppers come in different sizes and can accommodate small, square to large, round bales. Since hay and straw tend to be long and stringy, it helps to break it out of the bale and chop the stems.

Tub Grinders – Tub grinders can accommodate stumps, trees and brush. These metal tubs have tearing and cutting blades that produce a combination of chips and longer, stringy pieces of wood. The varied particle size allows for good aeration in the piles, but will most likely require screening before use or sale.

If using one bucket for multiple operations, it is important to turn compost from oldest to youngest and not load finished compost with a pathogen-contaminated bucket. Finished compost can be contaminated with pathogens from materials that have not been fully composted.



Large multi-bin system.

Turning Equipment

Front End Loaders – Front end loaders come in all sizes. If purchasing a loader, make sure it will accommodate potential growth of the operation. If the loader will be used in a building or large, container-type system, make sure the bucket is sized correctly. A loader lifts the organic material and drops it back in place, or stacks it to form a new windrow. Some composters have attached forks to buckets so they can incorporate more air and fluff the material. Loaders are a good, all-purpose piece of equipment. They can move, mix, and load compost into trucks. Dedicated equipment designed specifically for turning is not as versatile. Loaders can turn material efficiently if the bucket is sized for the operation.

Mixers and Manure Spreaders – These can be used to mix materials and form windrows. With a flail spreader, it is necessary to move very slowly, allowing the material to pile into a rough windrow. The auger type unloads out of the back or a side-shoot. By moving the spreader slower than normal, it will form a windrow but will generally not make very tall piles.

Windrow Turners – Windrow turners are dedicated pieces of equipment that just turn compost windrows. The right turner will mix, reduce particle size, homogenize the organic material and may save time and space. Turners come in many sizes and the choice depends on the amount of use, climatic fluctuations (in cold climates a bigger turner may be needed to achieve adequate pile size), and a dedicated person available for composting. Most turner



Tow-behind PTO-powered turner.

manufacturers have different accessories, like water or inoculant tanks, rock guards, or attachments that manage compost covers. Windrow spacing needs to account for the size and type of the turner.

Push-type Self-powered Rotary Drum and Tow-behind PTO-powered Turners – These turners are pushed or pulled through windrows by a tractor. They are smaller than self-propelled turners. They have a rotating drum for mixing and aeration and use power from the tractor. They are designed to track on the right or left side of the windrow, and require enough space between the rows for the tractor. A tractor with a creeper gear or hydrostatic drive is required to operate these turners.



Tractor-pulled elevated face turner.

Auger-type Turners – Auger-type turners are like a plow with an auger in the bucket. These turners come in different sizes and break the pile up with each turn. Some move the whole windrow to the side. They are often used in under-house composting in poultry operations for fly control and mixing. They are made for many different size facilities.

Elevating Face Conveyors – These can vary in type from PTO driven to self-propelled. They lift the organics up the face and drop them off the back into the windrow. Each time the whole windrow is actually picked up and moved a few feet, which allows for good size reduction, aeration, and mixing.

Sharing equipment among businesses has merits and drawbacks. For small operations, it may not be worth owning equipment. Equipment might be jointly owned by several businesses, or services for turning and screening might be contracted. For this to work well, operations need to be in close proximity, cooperative, and have provisions in place for routine maintenance and storage.

Self-propelled Straddle Turners – These turners are generally for large facilities with five or more acres of windrows to turn. They can turn piles from 5 feet to 7 feet tall, and their larger size and horsepower allows them to turn windrows more quickly. A rotating drum shaft combined with hammers or flails reduces the size of the material and aerates and mixes the windrow. Drums on some turners can be moved vertically, which allows the operator to control the distance between the bottom of the turner and the pad surface. This is especially effective when turning dense feed stock, or incorporating additional bulking material that is laid as a base prior to pile construction.



Self-propelled straddle turner.

Other Systems

Rotating Drum Systems– Rotating drum systems are horizontal cylinders that mix and move the material through the system in a short period of time. Material is fed in at one end with aeration through mixing and/or forced air. The drum continuously turns at a slow speed, and immature compost is pushed out of the drum on a

continuous basis. At that point, the compost is stacked in windrows where the compost process continues. Retention time in the drum is measured in days, during which time the material heats up and is mixed, but months are needed to achieve a finished compost.

In-vessel Systems – In-vessel systems come in different shapes and sizes, from low technology containers to totally controlled systems inside buildings. They take the form of boxes with aeration, long cement bays, plastic tubes, tunnels and beds. Containment of organic material reduces weather issues and odor problems, and may provide better control of temperature, aeration and air emissions. Some in-vessel systems can be modified to meet particular facility requirements. Aeration can occur through passive aeration, by mechanically forcing air into the piles, and/or turning. Moisture is controlled through watering systems, adjusting turning frequency and perfecting recipes. For odor and emission control, a combination of negative air, airlocks, total containment and bio-filters are employed. In-vessel systems can expedite the active process, but if the system does not allow for curing, space needs to be available for that process.

Monitoring Equipment

Thermometers – Equipment for monitoring temperature is most useful when learning to produce compost or keeping a temperature log to meet regulations. Temperature probes come in different forms including 18 inches to 5 feet probes, thermocouples placed in piles and continuous read sensors, or data loggers that download to a computer and produce graphs. The temperature of a pile will give a good indication of how well the microbes are working. Heat produced through the composting process is an indicator of microbial activity. If the pile gets too hot, it can kill the microbes or spontaneously combust. Turning and/or watering can bring the temperature down. If too cool, it is an indication that the pile needs aeration or moisture. If the pile never heats, it may indicate that the mix of materials is not suitable for active composting. During the active stage, the temperature should range from 120-160°F. Once the active stage is completed, the pile will cool and can be left to cure. Sensors need to be able to reach the center of the pile and should have a range of 0-200°F.



Oxygen Meters – Microbes require oxygen in the active stage of composting. An oxygen meter can detect oxygen levels and indicate if there is a need to incorporate more air through turning, forced aeration or changing the mix to include more coarse bulking material. Oxygen levels should range from 5% to 16%. Oxygen sensors are used extensively with in-vessel units and can be used in other applications. Oxygen meters are especially useful to regulate forced aeration systems, and when developing the mixture for static pile composting.

Moisture Detection Equipment – Moisture detection equipment can be useful, especially with high moisture feedstock or in very dry climates. The simplest instrument is a gloved hand. The “squeeze test” will indicate relative moisture content. With a gloved hand, take a handful of the mixture and squeeze. If more than a few drops of water come out it is too wet. If it appears to be very dry, moisture will need to be incorporated. Moisture meters are also available from equipment dealers and laboratories can test for it. A moisture content of 50-60% is ideal.

Caution: Probes on monitoring equipment can easily be bent or broken. Store in a safe place. Remove from the pile before turning and insert and remove carefully. Many thermometers come with threaded PVC tubes. Data loggers may also need to be protected from heat and moisture.

Compost Facility Planning Model

Cornell’s Department of Biological and Environmental Engineering and Waste Management Institute have developed Co-Composter, an Excel spreadsheet model for the planning of composting systems for mixtures of dairy manure and other organic wastes. Co-Composter provides mass and volume balances, pad area estimations, and a cost analysis of alternate composting systems based on inputs entered by the user. The model is divided into seven worksheets: user input page, user output page, background, mass balance, areas and volumes, pad and building costs, turning and handling costs.

Co-Composter is able to model a variety of situations, and includes provisions for municipal solid wastes, bulking materials, animal bedding, yard wastes and manure separation. Six basic composting systems are available to choose from. Five of these are: windrows

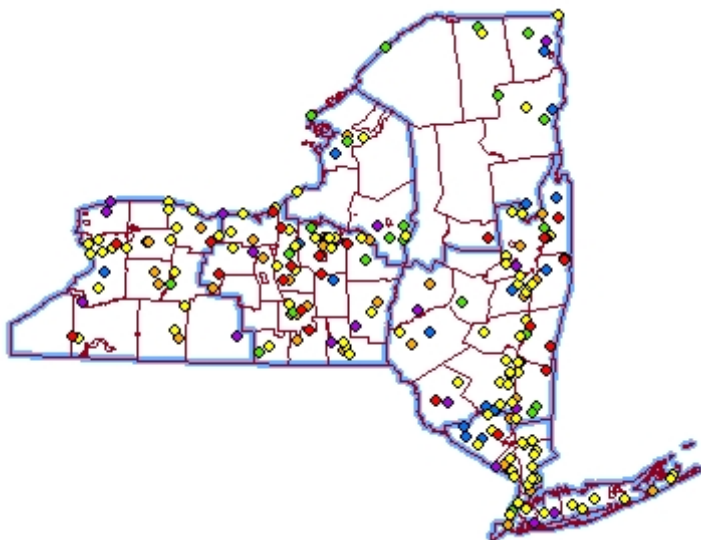
A list of compost equipment suppliers is available on the Cornell Manure Management Program web site: www.manuremanagement.cornell.edu/HTMLs/Equipment.htm

turned by a bucket loader, a small tractor-drawn PTO turner, a large tractor-drawn PTO turner, a tractor-drawn self-powered turner, or a self propelled turner.

The sixth system is static forced aeration. Co-Composter can be downloaded at: <http://compost.css.cornell.edu/CoCompost.html>

Maps of a database of New York State Compost Facilities can be accessed at: <http://compost.css.cornell.edu/maps/simple-search.asp> (see example below).

New York State Compost Facilities Search



Select a Map to view Facilities:

- All Compost Facilities
- Yardwaste Compost Facilities
- Manure Compost Facilities
- Foodscrap Compost Facilities
- Biosolids Compost Facilities
- Compost Research Farms
- Small Scale Compost Demonstration Sites

SOME ADDITIONAL COMPOSTING RESOURCES:

- **Farm-Based Composting: Manure & More (video)** - <http://www.nraes.org/publications/nraes150.html>
- **Natural Rendering: Composting Livestock Mortality & Butcher Waste:**
 Fact Sheet - <http://compost.css.cornell.edu/naturalrenderingFS.pdf>
 Video - <http://www.nraes.org/publications/nraes163.html>
- **Co-Composter** - <http://compost.css.cornell.edu/CoCompost.html>
- **Compost...because a rind is a terrible thing to waste (video)** - <http://compost.css.cornell.edu/FoodCompostpr.html>
- **On-Farm Composting Handbook** - <http://www.nraes.org/publications/nraes54.html>

For other composting resources see the CWMI web site at: <http://cwmi.css.cornell.edu/Composting.html>

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