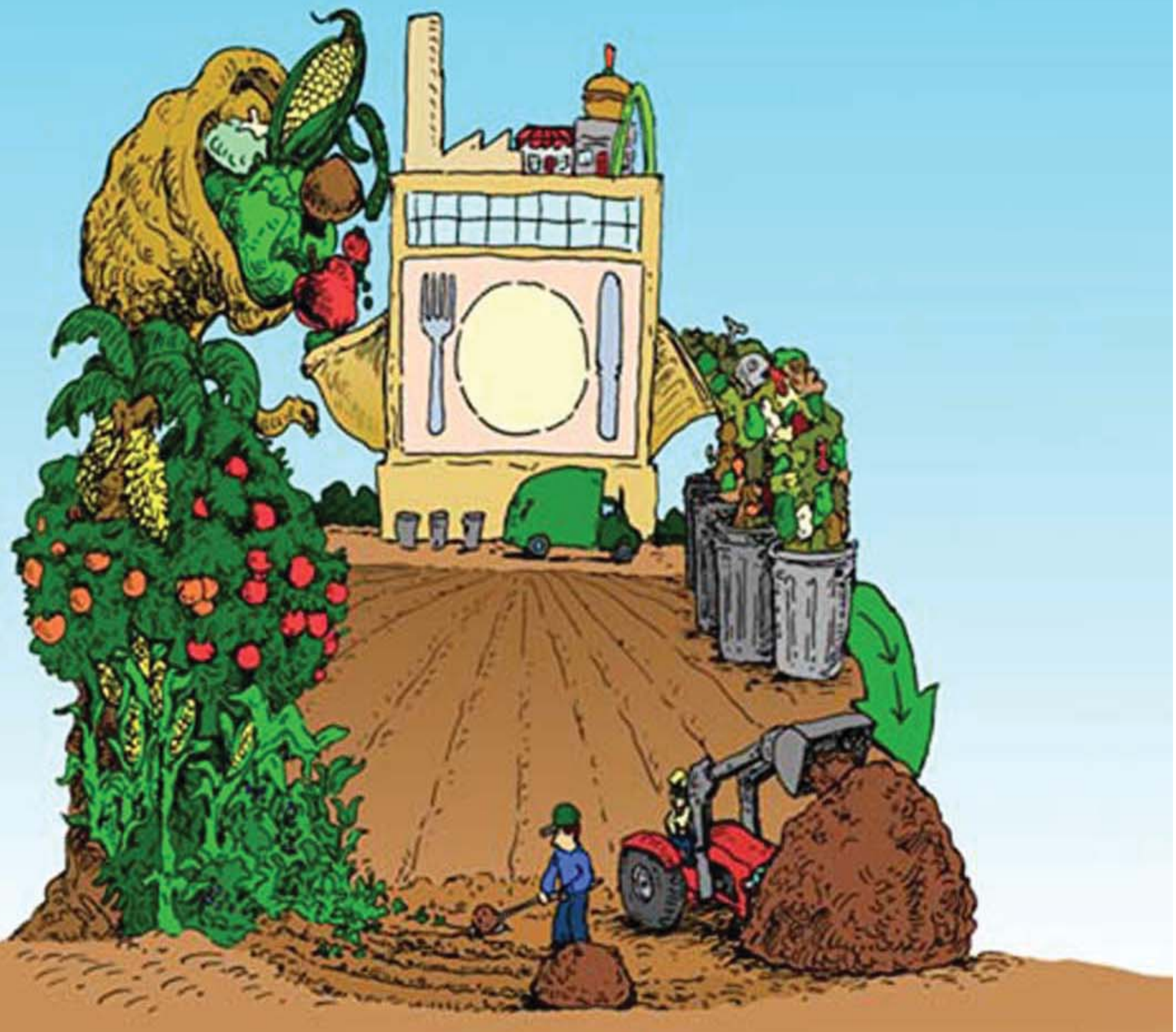
Compost... because a rind is a terrible thing to waste!



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The Cornell Waste Management Institute (CWMI), a program in the Department of Crop & Soil Sciences, was established in 1987. CWMI identifies and addresses the economical and environmental problems associated with waste management by focusing University resources and capabilities on this pressing issue. Through research, outreach, and teaching activities, CWMI staff and affiliated researchers and educators work to develop technical solutions to waste management problems and to address the broader issues of waste generation and composition, waste reduction, risk management, environmental equity, and public decision-making, as well as the technical issues of disposal through incineration, digestion, and landfilling.

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Copies of this manual can be accessed at: http://cwmi.css.cornell.edu/compostbecause.pdf. The manual and accompanying videos can be purchased from the Cornell University Press at: 800-666-2211 or http://cwmi.css.cornell.edu/cupressorders.htm.

October 1996

Table of Contents

Case Studies

Why Compost?

Why should someone in the business of preparing and serving food even be interested in composting? After all, the easiest thing to do is put everything out in the dumpster and let someone else haul it away to a landfill or incinerator. Increasingly, however, restaurants, grocery stores, cafeterias, and food processing plants are keeping food scraps and other organic materials out of the waste stream, choosing instead, to compost these materials either on or off-site. According to recent statistics published by the U.S. Environmental Protection Agency (EPA), the number of facilities composting food scraps is continually increasing, and composting is now recovering approximately 3.4 percent of the 14.1 million tons of food scraps generated across the country annually. The following provides brief insight into some reasons more and more facilities are opting to compost food scraps.

Economic Savings

Consider the cost of tipping and hauling fees. In instances where landfilling costs more than composting, there is a strong economic incentive for businesses to separate compostable materials, especially when these materials can be as much as 75 percent of a facility's total waste stream. In addition, for institutions composting on-site, the cost savings can be seen in several places—reduced hauling and tipping fees, availability of finished compost for use on facility grounds, reduced need to purchase other growing media, and/or a possible venture into the growing commercial market for compost.

Environmental Concerns

Increasing public concern over air pollution, water quality, and property values, along with more stringent environmental standards have slowed the growth of new landfills and burn facilities. Composting addresses the issue of decreasing solid waste disposal capacity, and also helps to replenish the earth's soil—another decreasing commodity.

Legislation

In New York State, The New York State Waste Management Act of 1988 established a 50 percent reduction/recycling goal by 1997. Source reduction, i.e., buying less of what will eventually become waste; excess packaging for example, (8-10 percent), is highlighted as the prime way to address the problem, followed by recycling and composting (40-42 percent), waste to energy incineration, and finally, disposal in landfills. Under this Act, institutional facilities are encouraged to undertake active waste management efforts to reach the state goal. Food scrap composting is one component of meeting this goal. New York State is not unique; most states have enacted similar waste-related legislation.

Composting Food Scraps

The volume of food scraps and other organic materials generated by institutional and commercial food service operations can be up to 75 percent of a facility's total waste stream. Grocery stores, restaurants, schools, and other businesses that serve or prepare food can spend a lot of money to dispose of this heavy, wet, hard-to-handle material, usually by sending it to landfills or incinerators. There is an alternative however, food scraps and other organic materials can successfully be diverted from the waste stream, composted, and used to make soils more productive.

Composting is equivalent to natural decomposition, where aerobic (oxygen requiring) microorganisms break down leaves, grass clippings, food, paper products, and other organic materials under controlled conditions into a soil amendment that can be used to enrich and revitalize the earth's soil. The degree of control and management required

To turn organic materials into compost depends on:

- the raw materials available for composting;
- land availability;
- technology used;
- time availability for composting;
- intended use of the final end product.

The factors that require management for optimum composting conditions are:

- oxygen
- water
- nutrients
- temperature
- pH.

In other words, the microorganisms that break down the raw materials need air to breathe, a moist environment, carbon and nitrogen for energy and protein synthesis, and temperatures and pH conditions that sustain microbial growth and activity. With the proper conditions, the microorganisms, primarily bacteria and fungi, colonize on the organic matter, metabolize it, and release energy in the form of heat as a byproduct. Ideally, this metabolic activity continues until the organic food supply is exhausted. As the food supply diminishes, microbial activity slows, the compost pile cools down and is ready for the next stage of the composting process─curring. The curing period continues the process but at a much slower pace requiring less control, until biological decomposition is complete.

It May Be Easier Than You Think!

While large scale composting is not a new idea, properlycomposting food scraps from the commercial and institutional sectors is an application that is still relatively rare. Food scrap compostingmay require implementing different management techniques. However, it may be easier than you think! In fact, with some methods, food scrap composting may take less equipment and less management than composting more traditional materials, such as yard trimmings or agricultural byproducts.

This manual and the accompanying videos have been produced to acquaint you with the basics of food scrap composting, provide an overview of the technologies being used, and present some case studies and success stories that may help to get you and your facility on the path to successful food scrap composting.

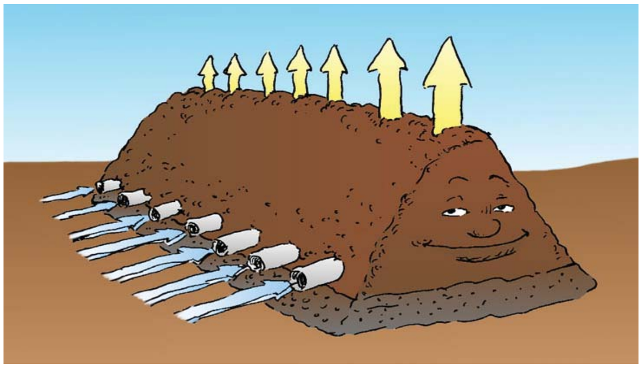
Composting Technologies

The most common technology for food scrap composting is the pile or elongated windrow system where food scraps are mixed with bulking materials (wood chips, sawdust, straw, or even finished compost) to absorb water and provide air space in the compost pile, and to provide the necessary carbon to nitrogen ratio. Optimum composting conditions require about a 30:1 carbon to nitrogen ratio. Food scraps typically have a 15:1 carbon to nitrogen ratio and must be mixed with other materials to increase the carbon content. The type of food scraps being composted will usually dictate the proportions—if a food is very wet, more bulking materials may be required. If very dry, additional moisture will be necessary. The compost mixture is then placed in piles on a well-drained, hard-packed gravel/soil area, asphalt or concrete pad, and allowed to decompose over time.

The following describes broad classes of technologies currently being used to compost food scraps. Each has advantages for different materials in various situations. The technologies range from low-intensity to high-intensity approaches. Space availability, the amount and type of food scraps generated, the ability and means of collec tion, and economic feasibility will all dictate the type of composting method used.

Low Intensity Methods

Unaerated static piles (passive composting) require the least amount of maintenance. This method consists of mixing food scraps with bulking materials, placing the mixture in piles and letting the piles decompose over time. Because the piles are not turned, the initial mixture of food scraps and bulking materials must be porous enough to allow air to penetrate and circulate. Static piles can be as long as space allows, but should generally be no higher than 6 feet or wider than 12 feet. If the time is taken in the beginning to get the mixture right, this method can complete the composting process with little assistance, although in some cases, it may be necessary to apply a thick layer of wood chips or other bulking material to control odor. This method takes longer than other methods, but is very effective.

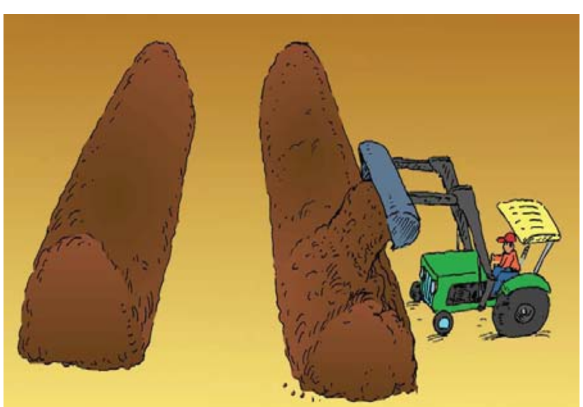


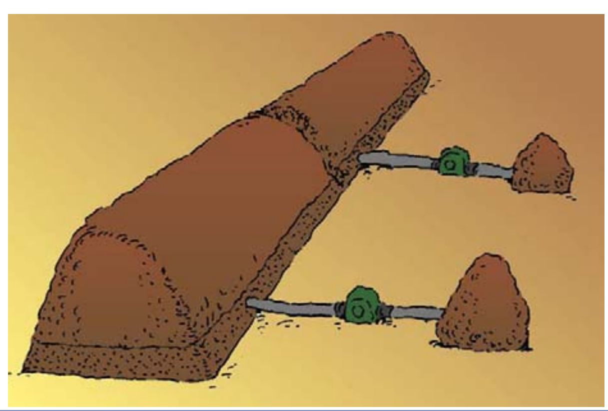
Passively aerated windrows are similar to static piles, but air is supplied to the composting materials through open-ended perforated pipes placed under each windrow. Cooler air is drawn into the pipes by a chimney effect as hot gases rise upward out of the windrow. This method requires placing the compost mixture on a porous foundation (sawdust, wood chips, straw, or finished compost) to absorb moisture and insulate the windrow. A covering layer of sawdust, wood chips, or finished compost is also needed to insulate the pile, and helps to absorb moisture, odor, and ammonia, and to discourage flies. Because there is no turning and remixing in this method, the materials must be thoroughly pre-mixed before being placed in the windrow. Windrows constructed in this method generally are 4-6 feet high, no wider than 10 feet, and can be any length.

Medium Intensity Methods

Turned windrows are elongated piles that are agitated or turned on a regular basis with a machine such as a front-end loader or specially designed equipment.

Regular turning and mixing of the materials help to further break down particles, creating more surface area for microbial colonization, faster decomposition, and a more homogeneous end product. Turning and mixing also increase the porosity of the pile and release trapped heat, water vapor, gases, and odors. Turned windrows can vary in size, depending on space availability and type of material being composted. The recommended size is 5-6 feet high, 10-12 feet wide, and as long as is appropriate for the site. This size pile has advantages in the winter. Turning and mixing a pile when the surface is frozen can introduce ice into the center of the pile and cause the composting process to slow or even stop completely. Sometimes it may be necessary to stop turning for awhile until temperatures moderate. With this size pile, the center will be insulated and composting can continue even when temperatures drop below freezing.





Low-tech in-vessel unit with

Aerated static piles are formed essentially the same as passively aerated windrows, but the network of pipes is attached to blowers that are used to force air through the pile. Piles can be bigger, generally 5-8 feet high and 10-16 feet wide. The width of the piles depends on the layout of the pipes; some piles are very wide with multiple pipes running through them. This method is more expensive than those previously mentioned because it requires additional equipment and relies on electricity to operate the blowers. However, this method can also speed up the composting process.

High Intensity Methods

In-vessel systems can take many different forms, from highly mechanical systems that can produce compost ready for curing in 20 days, to fairly simple containers that may use forced air or mixing within the container to expedite the process.

One in-vessel system utilizes bay enclosures with some mechanical means for mixing, moving, and aerating the compost—windrow turners, forced aeration, agitated beds, or paddle wheel turners are most often used. This system can consist of multiple bays, approximately 6-7 feet wide and 6 feet high, and can be as long as 180 feet. It may also be equipped with automatic controls for regulating aeration, moisture, odors, temperature, and turning.

In-vessel composting unit with biofilter.

Another type of in-vessel system is a transportable container that can process material on-site or be hauled off to another location to complete the composting process. These modular, airtight composting vessels usually include computerized aeration systems for moisture and temperature control, and built-in recordkeeping, mixing, loading, and screening equipment. But, some may be as simple as multiple bins with perforated piping for aeration.

Containerized composting systems are generally used when it is essential to move a lot of material through quickly, where odor may be a problem, i.e., in urban areas, or where space is limited.

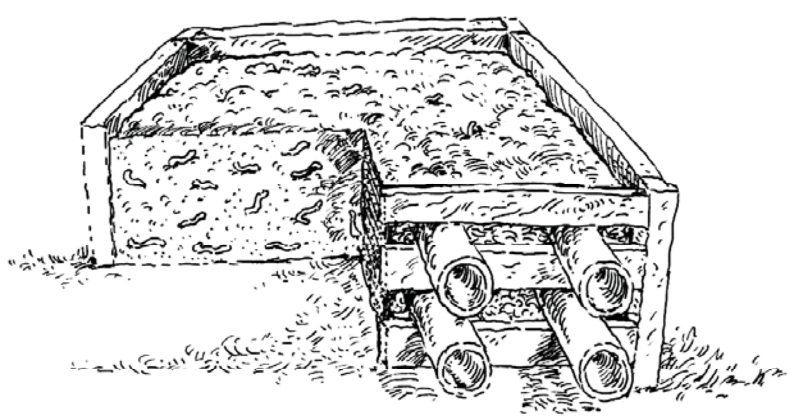
In-vessel systems can provide excellent process control for composting food scraps and other organic materials that are difficult to handle, and offer the advantage of protection from severe weather.

Vermicomposting utilizes worms to break down a variety of organic materials, including food scraps. Initially, bedding is prepared, using moist paper, wood chips or other bulking agents. Then the food scraps are mixed into the bedding. Worms added to the bedding work their way through the pile, digesting both the decomposing organic matter and the microorganisms that are also engaged in the decomposition process. As the worms digest the material, they excrete castings, a quality soil amendment rich in minerals and nutrients. There is no need to turn the piles, the worms provide natural aeration, although some degree of porosity is initially required. Once the worms have worked their way through a section, the castings can be screened out. Vermicomposting requires a high moisture content in the mix and mild temperatures to create a suitable habitat for the worms. Red worms, the most commonly used, cannot tolerate temperatures lower than 33°F (1°C) or higher than 96°F (36°C) and this type of system is not commonly found outdoors in areas where freezing temperatures occur. Additionally, unlike conventional composting, the organic material does not reach high temperatures. Depending upon the final use of the compost, additional heating and/or drying steps may be required. There are also pile size limitations to this method. Piles should be no higher than 2-3 feet, though widths and lengths are only limited by system design. Again, there are varying degrees of sophistication with this composting system—anywhere from single units designed for home use to large scale industrial systems utilizing multiple rows of insulated units equipped with shredders, screens, heating, cooling and ventilation, capable of processing up to a ton or more of organic materials per day.

In summary:

Composting technologies vary depending on:

- the amount of space available
- type and amount of food scraps gener¬ated
- the ability and means of collection
- economic feasibility, which can include initial capital investment, permit fees, labor, fuel, maintenance, repairs, upkeep, taxes, electrical, and distribution of end product.



Worm bin composting.

Decisions! Decisions!

METHOD	ADVANTAGES	DISADVANTAGES
Unaerated static piles	Least amount of maintenance No turning required Low cost	Longest composting time Care must be taken with initial mixture to ensure porosity and air circulation Must have available space to let piles sit for long periods of time
Passively aerated windrows	Faster composting time than above No turning required Piping network underneath pile speeds up process	Requires a porous foundation and a cover layer to absorb moisture and insulate the windrow Must have available space to let piles sit for long periods of time
Turned windrows	Regular turning and mixing speeds up process Effective in areas with freezing winter temperatures	Front-end loader or specially designed equipment necessary
Aerated static piles	Does not require turning Network of pipes and blowers speeds up process, allows better control over moisture and temperature Piles can be larger due to forced aeration	Higher overhead than other methods, i.e., electricity, blower and pipe network
In-vessel systems	High degree of process control Mechanical or automated control systems Fastest method of composting Transportable composting containers effective for urban areas Protection from severe weather	High cost of equipment, buildings, and overhead
Vermicomposting	No turning required Many different systems available, from single units to multiple rows	Initial mixture must include appropriate bedding and adequate moisture and oxygen to sustain worm habitat Moderate temperatures required for outdoor use Due to low temperatures, additional heating and/or drying steps may be required

Program Planning and Source Separation

Long-term success of food composting programs depends on careful planning and initial implementation. It is especially important that all levels of management are aware of and supportive of the program, as well as those who will actually be involved in the process—food scrap generators, collection personnel, and buildings and grounds people. Plan to start small and expand the program as you succeed. When planning your program, you will need to:

- Analyze your food waste stream, and determine where, what, and how much is being generated.
- Determine what products will/will not be included in the compostable material. Start with just a few items that are easy to collect, e.g., just the trimmings from the produce department, or just the food scraps from the food preparation area. You can always add more.
- Design a collection system that is specific to your facility's needs. Keep it simple and efficient; in the long-run, it should not require additional staff time.
- Develop a strategy to train employees and others who will participate in the program; consider staff turnover and make training part of new employee education.
- Provide positive feedback for employees, letting them know how many pounds have been diverted, money saved, and possibly, what the saved money will contribute to.
- Develop a trouble-shooting guide for handling potential problems associated with food scrap collection.
- Include representatives from all areas of operation, from employee generators to top management, on your team for effective communication and troubleshooting.

Analyzing Your Waste Stream

Designing a collection plan will include an analysis of your food waste stream—where scraps are generated, and in what amount. Appendix A contains a sample survey used to assess the amount of food scraps generated by a local college. The college is now composting food scraps generated from its three dining halls and a coffee shop. Another way of estimating the amount generated is to weigh all the scraps produced in each area during a typical operating week and project this amount over time. For example, if you have several stores or cafeterias, weigh one typical container of food scraps and multiply the amount by the number of containers collected.

Make sure employees know what you are doing, and that the containers contain food scraps only.

Any organic material can be composted, including "pre-consumer" food scraps, "post¬consumer" food scraps, and most paper products. Grocery store food scraps will be mostly pre-consumer. Pre-consumer food scraps include cuttings left from salad and vegetable preparation, as well as complete servings of food which have been prepared, left unserved, and cannot be reused. Post-consumer food scraps are food left on dishes after meals have been served, e.g., from cafeteria dinner plates. Following is a list of organic products that can be successfully diverted from the waste stream and composted:

Compostable Materials:

- Produce—trim from leafy vegetables, spoiled fruits, vegetables, salads
- Day old breads and pastries, excess batter, spoiled bakery products
- Wet or lightly waxed corrugated cardboard
- Dairy products—cheese, yogurt, ice cream, miscellaneous by-products
- Frozen foods
- Seafood
- Meat trimmings (Most facilities prohibit the inclusion of large bones or bulk quantities of grease, oils, and fats in the compost. Although these products are biodegradable, they are slow to decompose and may attract rodents or other animals. Local renderers are a better choice for handling significant quantities of this type of material.)
- Coffee grounds/filters
- Tea bags
- Egg shells/paper cartons
- Waxed paper
- Napkins/paper towels
- Paper plates and cups
- Paper trays
- Paper food wrappers
- Floral waste and trimmings/plants
- Leftovers that cannot be served again
- Bio-degradable service ware (e.g., potato starch plates).

Note: It may be easier to collect just food scraps at first; as staff gains experience, additional materials may be added.

Non-compostable Materials:

- Recyclables (unsoiled newspaper, clean, dry cardboard, metals and aluminum cans, glass bottles, plastics, etc.)
- Foil wrappers
- Styrofoam (plates, cups, etc.)
- Plastic utensils, (forks, spoons, knives, plates, cups, stir sticks, lids, etc.)
- Single serve containers (butter/jelly/jam/ketchup/mustard/cream, etc.)

- Fluorescent lights
- Batteries
- Plastic food wrap
- Plastic gloves.

Designing a Collection System

Collecting biodegradable (compostable) materials such as food scraps, and other organics separately from non-compostable materials at the site of generation is called source separation. In other words, organic materials that are acceptable for composting are kept separate from those materials that are either recycled, reused, incinerated, or landfilled. There are several advantages to separating compostable materials at the source—a higher recycling rate can be achieved, and a cleaner, more usable or marketable end product is produced.

The collection system is a critical component of any food scrap composting program. The procedures and materials used to source separate compostables at the site and transport the materials to the primary collection containers should be well thought out and specific to your facility's particular needs. The primary objectives of the collection system are to:

- maximize the capture rate of compostable materials
- eliminate nonorganic contaminants such as plastic wraps, rubber bands, glass, and metal
- minimize labor and space requirements.

Collection systems within different businesses will vary according to the specific needs of each business, space limitations, and general layout of work areas. In grocery stores and food service institutions, for example, collection containers can be placed at work stations in the produce, deli, bakery, and dairy departments. In cafeterias, containers can be placed near tray and silverware recovery stations if collecting plate scraps, and in the kitchen where preparation scraps are generated. In any case, containers should be conveniently located at points of generation and clearly labeled. Easy access to all collection containers, i.e., "food," "recyclables," and "trash," will help prevent contamination.

Collection Containers

Plastic garbage containers are well suited for holding food scraps, and can easily be placed in areas where scraps are generated. Container size will vary, depending on the amount and type of compostable materials generated and the amount of space available within the facility. One important consideration is how much employees or equipment can lift when containers need to be collected.

Some businesses will be able to utilize containers already on hand, while others will have to add additional containers. In a school cafeteria pilot

composting project, administrators felt that it would be easier for students to separate materials into different colored containers—green cans for food scraps, red cans for recyclables, and brown for trash. In this case, the purchase of additional containers was required. Whether color-coded or not, all collection containers should be well-labeled.

Depending on your particular business, daily cleaning of collection containers may be mandatory; but in all cases, frequent cleaning is recommended to eliminate odors. Some businesses prefer to use liners in collection containers. However, this does add to the expense of source separation, and also may add the extra step of removing liners from the organic materials at the compost site.

If you are not composting on-site, you will have to consider storage space availability between pickups. If there are several days between pickups, you may also need to consider refrigeration space. Refrigeration will prevent odors and slow the decomposition of material, especially during warmer weather. In addition, transportation and composting processing costs will affect the economic feasibility of the program. Costs will vary based on frequency of collection, distance to the processing facility, and tipping fees.

Team Building and Training

Once you have analyzed your food waste stream and determined what will and will not be source separated for composting, make sure everyone affected by the program has a means of getting involved with it. Proper motivation and training of all personnel handling compostable materials is essential to assure maximum source separation and production of quality compost. Successful programs are dependent upon committed personnel and team building. Everyone involved in the process—store or dining hall managers, food service employees, collection personnel, and buildings and grounds employees who may be implementing the composting operation, and/or working with the final product—will all play a part in the successful implementation of a composting program. Initial program planning for your facility should include representatives from each phase of the operation, and all employees should be included in training programs. Successful program managers report the following components have helped make their programs work:

- team-building facilitates employee commitment
- people who have been involved in the design process are more inclined to work together to solve problems

- periodic meetings and updates keep the commitment strong.

Contamination will be avoided if employees know exactly what goes where. Continuous employee education, getting employees to "buy into the system," and monitoring will help, as will color-coded bins and appropriate signage. In pilot projects, plastics have been found to be the primary contaminant, followed by aluminum foil. Easy to read signs on containers, "food and only food" for example, followed by "no plastic or aluminum" gets the point across.

Once employees have been trained, minimal extra time is required to separate materials because it becomes part of the normal daily work routine. However, an ongoing investment in employee training and workplace signage is critical to a program's long-term success. A suggestion box or periodic requests for employee input is also a good idea and may help to fine-tune the operation. Designating a team leader in each dining area who is actually on the food processing line is the best way to facilitate communication between food service workers, collection personnel, compost operators, management, and any others involved in the process.

Setting up collection systems and training employees in larger businesses will probably take more time than in smaller businesses.

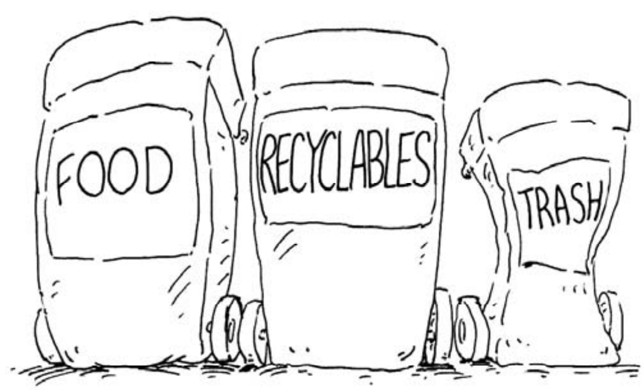
However in a larger business, it is still best to start small and expand with successful implementation of each phase of the program (i.e., in a setting where there are many food service areas, start with one cafeteria, then add others).

In summary:

To ensure long-term success of your food composting program:

- Analyze where and in what amount food scraps are generated in your facility in order to custom-design a source separation program.
- Determine what will be composted.
- Set up a simple collection system that employees can follow easily.
- Establish a team with partners in dining—generation and sorting, pickup and transportation, processing, administration, and end use—to ensure safety, control, and a quality system.
- Ensure employee commitment by encouraging feedback and ongoing education

Keep it simple at first, you can always expand the program later. (This may include collecting only preconsumer or easily separable food scraps at first.)



Off-Site Composting — Some Things to Consider

If composting on-site is not an option, you can make arrangements for getting your food scraps and other organic materials to a composting facility. Sometimes one of the biggest obstacles to composting off-site is reluctance or inability of collectors and haulers to maintain segregation of the source separated materials. Meeting with compost facility managers, haulers, and any others involved in the process to work out collection arrangements, acceptable containers, and appropriate collection vehicles can help to prevent contamination of the feedstock between generator and composter.

Some commercial generators of food scraps have found it easier and more economical to do the hauling themselves. One large grocery chain, for example, uses its own employees and a fleet of pick¬up trucks to collect food scraps from individual stores and deliver the scraps to a nearby compost facility. Another contracts with independent tractor trailer drivers who haul the materials to a company-owned composting site 150 miles away. In still another case, the manager of a small commercial food operation uses his own pick-up truck to periodically transport food scraps to the county-run compost facility.

In each of these cases, store managers met with all those who would be participating in the program—from employees generating the food scraps to composters with specific requirements/restrictions—to develop guidelines for content, containers, collection, transportation, and problem avoidance.

If you cannot find a compost facility in your area or if specialized hauling services are not readily available and you're not equipped to transport the materials, check with your local solid waste management facility. They may help you to identify and/or develop local resources. Many municipalities currently composting yard trimmings might welcome the addition of food scraps because of the relatively high moisture content, high nutrient value, and high organic content, all of which can improve composting when properly utilized. While the number of municipal composting facilities continues to increase and opportunities for composting expand, it may be necessary to meet with county and/or town officials to discuss the possibility of adding food scraps to an existing composting site, or even, to discuss the development of a composting facility if none currently exists. Again, your local recycling coordinator or solid waste manager can provide guidance.

Many municipalities currently composting yard trimmings might welcome the addition of food scraps because of the relatively high moisture content, high nutrient value, and high organic content, all of which can improve composting when properly utilized.

On-Site Composting — Setting Up Your Own Facility

Before establishing a compost site, it is recommended that you contact the regulatory agency responsible for municipal solid waste in your state to see what regula¬tions regarding food scrap composting might apply to your project. In New York State, the Department of Environmental Conservation (DEC) exempts on-site composting of food scraps generated at the same location from regulation under 6 NYCRR Part 360, "Solid Waste Management Facilities," Title 6, Subpart 360-1.7 (b) (4), of the Official Compilation of Codes, Rules and Regulations.

Area Requirements

The surface area required for composting depends on the volume and type of food scraps processed, the size and shape of pile, windrow or in-vessel technology used, and the time required to complete the process. Static piles and turned windrow methods require more land than the more intensive forced aeration and in-vessel system methods.

There should also be adequate space allowed for each phase of a particular operation. At a minimum, space will be needed for unloading incoming food scraps, mixing and blending materials, storing equipment, wood chips or other bulking agents, and for curing and storing the finished compost. Curing takes a minimum of one month and space requirements can range between 10 to 40 percent (assuming all bulking materials are screened out) of the incoming volume. Often, compost that is ready for curing, stor age, and marketing can be moved off the compost site.

In addition, regulated distances between the property line and the facility, and distances from residences or places of business other than the owner's must be met. These buffer zones help to minimize possible odor, noise, dust, and visual impacts.

Compost Pad

Outdoor compost sites can be located on moderate to well-drained, hard-packed soil with a gentle slope for good drainage. A slope of about two percent is desirable to prevent ponding of water. Steep slopes are not satisfactory because of problems with erosion, vehicular access, and equipment operation. Windrows should run parallel to the slope, rather than across, to allow runoff water to move between the piles rather than through them. The initial site preparation will usually require grading and may require surfacing with gravel or compacted sand to allow year-round use. Yearly maintenance may include regrading and regraveling where necessary. Concrete and asphalt pads can also be used, usually at sites where soils are highly permeable or where ground water levels rise too close to the surface. A paved site offers some advantages in terms of access, equipment operation, and ground water protection, but these advantages must also be weighed against added surfacing costs, as well as difficulties in managing run¬off. Most outdoor food scrap compost sites have paved surfaces, which are recommended due to the need for year-round access.

Ground Water and Surface Water Protection

New York State DEC regulations do not allow a compost facility to be sited in a flood plain or wetland, or where the seasonal high ground water is less than 24 inches from the ground surface, or where bedrock lies 24 inches below the ground surface, unless provisions have been made to protect water quality. High water tables may lead to flooding of the site which will make equipment access and operation more difficult. Flooding can also promote less desirable anaerobic (lack of oxygen) conditions in the compost process. A high water table also increases the likelihood of leachate contamination of ground water or nearby surface water. The shorter the distance leachate percolates through unsaturated soil, the less it undergoes natural biological and physical treatment.

Moderate to good soil percolation rates are desirable to avoid standing water, minimize leachate and rainwater runoff, and allow equipment to operate year-round. Surface water should be diverted away from the site using a diversion ditch, an interceptor berm, or an interceptor drain. Leachate can be harmful to surrounding surface waters because it can deplete oxygen and may contain unacceptably high levels of nitrogen or other pollutants. An initial bed of bulking materials underneath the compost pile, and a covering layer on top can help prevent excess runoff. Retention ponds can also be constructed to hold runoff from normal operations as well as excessive runoff resulting from storms. Sand filtration of outlet waters can also help.

County soil surveys that provide information on depth to groundwater, percolation rates, and soil types are usually available from your regional U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS).

Water Supply

Although rarely required when composting food scraps or other wet materials, some access to water is helpful at any facility. Sources include city services, wells, surface water pumps, or a water truck. An adequate water supply and delivery capacity is also an important fire safety consideration. Additionally, wetting facility grounds and windrows helps with the management of dust.

Intervale Compost Project - windrows on earthen pad.

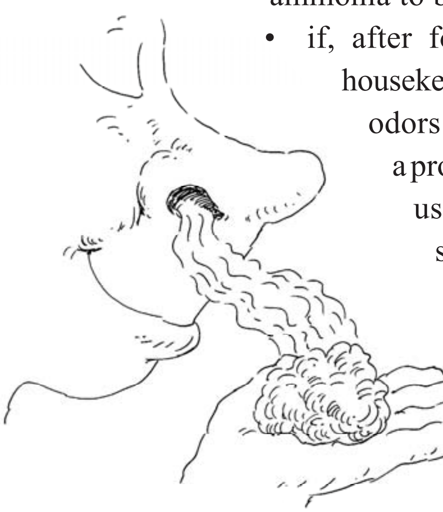
Security

A gate and fence can be used to control access and prevent illegal dumping. Fencing may be unnecessary if natural geographic barriers exist, and/or a berm consisting of earth and finished compost may serve in place of a fence at some points.

Odor Control

Odor control is critical to the success of a compost facility. One of the easiest ways to avoid odors is to establish good housekeeping practices. Keep a neat, clean site with special attention given to the following:

- daily cleaning of all equipment used at the site to prevent food scrap build-up
- immediate clean-up of any food spills that may occur in receiving, loading, or composting areas
- keeping routes to and from these areas as short and direct as possible
- eliminating excess water and maintaining good drainage around the compost area to avoid stagnant puddles
- avoid adding lime to piles—lime causes ammonia to be released
- if, after following good housekeeping practices, odors continue to be a problem, consider using a biofilter system (see below).



Biofilters

Biofilters absorb and break down odors. They can be as simple as a 6-inch cover layer of finished compost, shredded bark, and/or other materials over a static pile, but some biofilters (usually indoor or fully enclosed facilities) use a blower or ventilation system to collect odorous gases and transport them through a filtration medium. Typically, in an open system, the gases are distributed through the filter media via perforated pip¬ing systems surrounded by gravel. Closed systems usually utilize a perforated aeration plenum where the pressure inside the enclosure is greater than the outside pressure—forcing the gas through the filter. As the gases filter through the medium, odors are removed through biological, chemical, and physical processes. In a containerized modular system, a specially designed biofilter can be installed to capture exhaust air and recirculate the air back through the system.

Managing the Compost Site

Managing the compost site can be divided into three types of activities: monitoring the inflow and outflow of materials, keeping track of the key chemical/physical/biological parameters of the composting process, and operation and maintenance of the facility. Monitoring and accurate recordkeeping are important for several reasons—monitoring ensures proper compost management and helps avoid processing problems such as odor generation or excess moisture; records provide a means of comparing different conditions, and are important for controlling operating costs and improving efficiency. Good recordkeeping also provides invaluable background information in case of staff turnover.

Recordkeeping should include:

- quantities by weight or volume, types, and dates of materials received
- composition/proportions of compost mixtures
- ages and locations of piles, turning and watering schedules, precipitation, moisture levels, ambient/room temperatures, and outdoor temperatures
- curing time
- maturity testing
- equipment time, labor, fuel, maintenance, and other overhead
- distribution/use of composted materials, if applicable.

Incoming Materials

All incoming materials should be checked in by weight or volume, inspected for noncompostable materials, and all unwanted materials should be removed. Many off-site facilities automatically reject loads that include non-compostable materials.

Table 1. Sample Recordkeeing Form for Incoming Materials

Generator	Food Type Weight or Volume Percent of Total lbs or yd³	Pickup Dates				
		1-24-96				
Terrace Dining Hall	Total food	**3/4 yd³**				
	% vegetables	**10**				
	% fruit	**25**				
	% meat	**20**				
	% pasta	**15**				
	% bread	**15**				
	% other organics	**5**				
	% contaminants	**10**				

Source: Erin McDonnell, Cornell University. Developed for Ithaca College 1995.

One simple method of monitoring incoming material is to list each food service facility, type of food (and any contaminants), weight or volume collected and percent of total, and the pick-up dates. (See Table 1)

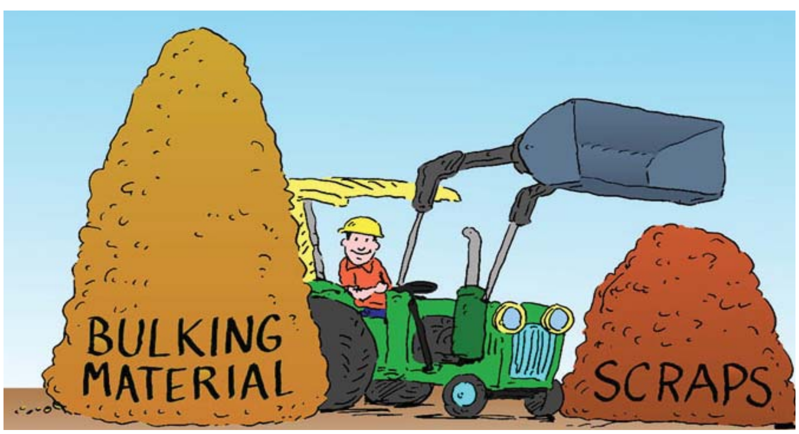
Ideally, effective site operations and odor control require that food scraps arriving at a composting facility be immediately processed and placed into compost piles. In reality, most facilities hold incoming material from time to time due to inclement weather, holidays and weekends, and/or lack of staff to process the material immediately. One effective method of holding food scraps until they can be processed, is to dump the scraps in a pile and place a cover layer of finished compost, wood chips, sawdust, or other bulking material over the pile. This will minimize odors and vector attraction.

Developing a Compost Mixture

The composting process will work most effectively if a well-balanced mix is achieved. Porosity (spaces through which air and moisture can pass) is the single most important property of an initial mix. Porosity is achieved by using large particle size materials such as wood chips. Porosity is also influenced by the moisture content. If the moisture content is excessive, pore spaces will be filled with water instead of air.

Drybulingmaterials serve to in crease the porosity of the mix and will absorb excess water if a mixture is too high in moisture. Most bulking materials will also increase the carbon content of the compost. Ideal composting conditions will have a 30:1 available carbon to nitrogen ratio. Food scraps by themselves typically have a 15:1 carbon to nitrogen ratio. A starting formula for mixing food scraps and bulking materials is two to three parts of bulking materials (by volume) to one part food scraps. The amount of moisture in the food scraps will ultimately determine the final ratios. Here again, accurate records are important for keeping track of different mixtures and subsequent compost results. It will take a few trial batches to see what ratios work with your particular feedstock and bulking materials.

Wood chips are the most common bulking material, but bark chips, sawdust, leaves, hay, cotton, shredded newsprint or dewatered paper pulp, nut hulls, and/or other resources that you may have available can all be used in a compost mixture. Remember, one group's problem material may be another group's solution. Mixtures will vary depending on what is available. Smaller particle size material, such as shavings from the woodshop that have not been chemically treated, can be mixed with larger particle size materials for good pore structure and better carbon and moisture control. Again, it will take a few trial batches to see what works.



Supplemental Equipment

Depending on the amount of compost your facility will be handling, and the amount of bulking materials required to provide the proper carbon to nitrogen ratio, you may want to buy or rent a tub grinder or chipper. Tub grinders use a rotating tub intake system to crush wood and brush. The rotation of the tub moves materials across a fixed floor, grinding the materials against a hammer mill. Tub grinders can usually be loaded with a bucket loader or a conveyor belt. As the loaded material is ground, it is forced through a screen or other restricted opening and conveyed into standing piles or a transport vehicle. Regular maintenance is required, including cleaning of screens and rotation and replacement of hammers.

Chippers slice particles with knives mounted on a cylinder or disc that rotates within a fixed housing. Chippers usually cost less than grinders, but the knives have to be replaced periodically.

Both tub grinders and chippers are available in different models with significantly different capabilities. Depending on the size of your facility, it may be more cost-effective to lease, rent or contract with a compost management firm on a per-hour basis, or even share the cost/use with other compost facilities in the area.

Process Monitoring

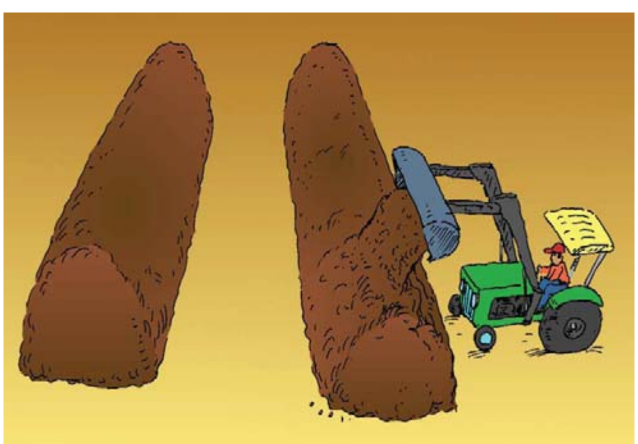
Overall, food scraps have a higher nitrogen, moisture, and readily available carbon (sugars, starches, and proteins) content than other types of compostable materials (such as yard trimmings). As a result, composting systems must be carefully monitored to prevent excess water, odors, and/or animal and insect attraction. Recordkeeping is important for daily planning, scheduling, and overall facility management, and should include the ages and locations of compost piles, contents, moisture and temperature data, turning, and watering schedules. (See Appendix C for an example of process recordkeeping.) While it is said that the most useful instruments for monitoring compost are experience, good hands, and a sensitive nose, experienced composters are sometimes hard to find. Oxygen monitors, moisture analyzers, and temperature gauges are all commercially available and are useful for a facility desiring data for purposes of quality assurance or process verification. In most facilities, however, temperature gauges are still the most common, and only, means of monitoring the process.

Oxygen

The maintenance of aerobic (adequate oxygen) conditions during the composting process is crucial for minimizing odor production and maximizing the decomposition process. Pile size and porosity are important in maintaining proper air flow into the pile. Oxygen levels of between 5 and 15 percent are usually recommended. For static piles, oxygen is provided by air circulation through pore spaces. For composting methods requiring turning, a front-end loader or a bucket loader on a tractor may be the single most important piece of equipment needed for smaller to moderate facilities using low-and medium-intensity approaches. Windrows or piles are turned by lifting the materials repeatedly and reforming the piles. In this method, piles must be spaced to allow equipment to move freely.

Commercial compost windrow turners are also available for windrow turning and aeration. The large models are self-propelled and straddle the windrow. Smaller units can be side mounted on front-end loaders or tractors that are driven between the windrows.

Some side-mounted units have their own engine for driving the aerating mechanism and only need to be pulled by the tractor or loader. Other side-mounted units must be attached to a tractor and run through the power take-off (PTO). Side-mounted units turn half the windrow at a time, which means two passes must be made to turn each windrow. Side-mounted units require more space between the windrows than straddle units.

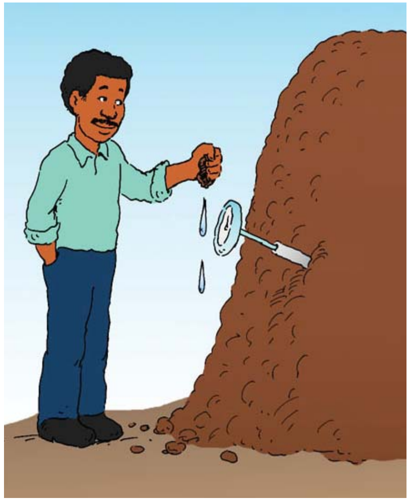


The advantages of windrow turners are that they thoroughly aerate and mix the material, turn more cubic yards per hour than front-end loaders, and usually produce a compost with superior texture. These are especially suitable for high-volume facilities; windrow turners can process between 700 and 3,000 cubic yards per hour. Disadvantages are that they usually require level surfaces to operate efficiently, some are difficult to move from site to site because of their size, they serve only one purpose, and can be costly.

Again, it may be more cost-effective to lease, rent, or share the cost/use with other compost facilities in the area. Oxygen sensing probes for active compost piles are available commercially for precise monitoring of oxygen levels. However, in most cases, keeping adequate moisture and temperature levels will also ensure adequate oxygen levels.

Water

A moisture content between 40 and 60 percent is ideal for composting materials. Too much water can limit the supply of oxygen to the mixture by filling the pores, leading to anaerobic conditions and odors. Too little water will cause decomposition to slow down and ultimately cease if water is not replenished. The "squeeze" test for moisture content is a good indicator—"only a drop or two of water should be expelled" from the mixture when tightly squeezed by hand.



Moisture content can also be determined by accurately weighing a representative sample of material before and after driving off moisture in an oven at 220^{0}F (104^{0}C) for 24 hours.

A = Weight of clean, dry dish (aluminum/ceramic/ glass)
B = Weight of wet compost, about 100 g
C = Weight of dry compost and pan after 24 hours in 220^{o}F (104^{o}C) oven

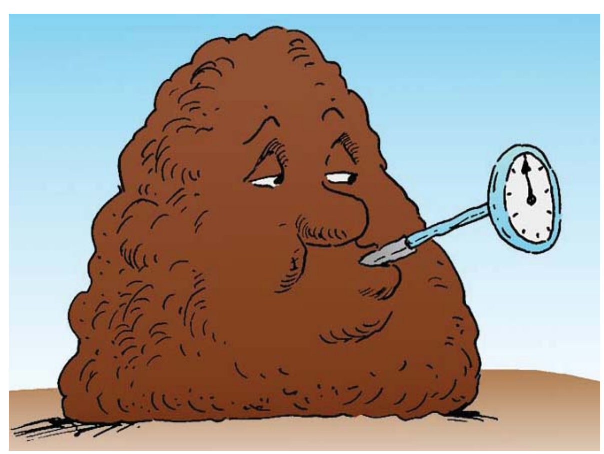
$$\text{Moisture content (percent)} = \frac{B-(C-A)}{B} \times 100$$

Generally, more water evaporates from a composting pile than is added naturally. Watering the compost as the piles are turned, or turning on rainy days can help get water into the mixture. Scooping out the top of the pile to create a concave shape will maximize water absorption. Conversely, if piles become too wet, excess water may have to be removed by turning and/or adding additional bulking materials to absorb moisture and increase porosity, and reforming the pile with a strong peak to shed water.

Temperature

Internal compost pile temperatures affect the rate of decomposition as well as the destruction of pathogenic bacteria, fungi, and some seeds. The most efficient temperature range for composting is between 104^{o}F and 140^{o}F (40^{o}C and 60^{o}C). Compost pile temperatures depend on how much of the heat produced by the microorganisms is lost through aeration or surface cooling. During periods of extremely cold weather, piles may need to be larger than usual to minimize surface cooling. When composting highly nitrogenous materials, smaller piles and frequent turnings are needed both to provide oxygen and to release excess heat. By turning the compost whenever temperatures get above 160 ^{o}F (71 ^{o}C), high quality compost will be produced in the shortest possible time. (While the most efficient temperature range for composting is between 104 ^{o}F and 140 ^{o}F [40 ^{o}C and 60 ^{o}C], the best turning temperature is 160 ^{o}F [71 ^{o}C]. Below that, there is a risk of drying out the compost.) As decomposition slows, temperatures will gradually drop after turning and finally remain within a few degrees of ambient air temperature.

Temperature monitoring is crucial for managing the compost process. Thermometers with a 3-4 foot probe are available from a number of sources and come in both dial-type and digital versions.



Pathogen (disease-causing organisms such as bacteria and fungi) control

Pathogens are naturally occurring organisms that can be found anywhere in our environment. Most people are immune to pathogens at typical levels. However, pathogens may be elevated in compost operations. While there are currently no temperature regulations for food scrap composting, the following NYSDEC regulations currently applicable for biosolids, are highly recommended to ensure adequate pathogen control and minimization in food waste composting:

- When using the turned windrow method, a minimum of 5 turnings is required during a period of 15 consecutive days when the temperature of the mixture is not less than 131°F (55°C) within 6-8 inches below the surface of the pile.
- If using an aerated static pile, the pile must be insulated (covered with a layer of bulking material or finished compost) and a temperature of not less than 131°F (55°C) must be maintained throughout the pile for at least 3 consecutive days, monitored 6-8 inches from an outlet of an aeration pipe.

Aspergillus fumigatus and other bioaerosols

There has been concern that Aspergillus fumigatus (AF), a naturally occurring mold that is found in dust all around us, indoors and out, may be elevated at compost sites where conditions can promote colonization.

While high temperatures destroy most bacteria and pathogens, the high temperatures also provide a favorable growing environment for AF. There is some potential danger for employees mixing or turning the compost materials if they have asthma or other respiratory illnesses. Protective dust masks approved by the Occupational Safety & Health Administration (OSHA) for all employees involved in this process will provide protection against AF, as well as dust and other irritants.

pH

Another factor that can be useful in diagnosing and correcting certain operating problems is the pH of the mixture. pH provides an indicator of the acidity or alkalinity of the composting material and is measured on a scale from 0 (very acidic) to 14 (very basic) with 7 being neutral. Decomposition occurs most efficiently between the pH range of 6 and 8, and the finished product is usually close to pH 7.

During the initial stages of decomposition, organic acids are formed that are normally consumed by aerobic microorganisms. As oxygen supplies in the pile decrease, these acids will not be converted as quickly and pH levels may drop below 6. Extra aeration usually solves this problem. Under low pH conditions, it is normally not advisable to add lime due to the overall effect on nitrogen (ammonia) loss. Overly high alkalinity (8.0-8.5) can cause the release of unpleasant smelling ammonia gas and also inhibit microbial activity. Adding materials high in carbon content will help bring the pH level down. Testing pH is very simple and can be done on-site with a soil pH testing kit, or a pH meter.

The pH of a compost will also be a factor in using and/or marketing the finished product. Excess acidity or alkalinity can damage or kill some plants. For example, acid-loving plants like azaleas or blueberries, can be harmed by the addition of compost with a high pH, especially if added in large amounts.

Curing

Compost mixtures require a "curing period" to finish the process and to develop the desired characteristics of a mature product. When the temperature of the windrow no longer increases after turning, the curing stage can begin. Curing continues the decomposition of the compost through an aerobic process, though at a much slower pace, and can, if desired, usually take place in a separate area. Curing piles do not require turning and remixing, although the piles should be small enough to allow air circulation (usually 6-8 feet high and 15-20 feet wide). Because turning is not required, the piles can be placed closer together than those actively composting.

It is important to locate the curing piles in well-drained areas with surface water channeled away from the piles. Slower decomposition does not generate enough heat to drive off excessive moisture, and anaerobic or sour conditions can develop, leading to odor and the development of compounds toxic to plants. Piles that contain too much moisture will need to be remixed and spread out to allow air circulation and evaporation.

They can be restacked again in a day or two where active composting may occur again for a short time. Curing is a critical and often neglected stage in the process during which the biological decomposition of the compost is completed. It is recommended that the curing process take a minimum of one month. Long curing periods provide a safety net helping to reduce the chances of using immature compost. The curing period may be considered complete when the temperature of the pile stays at or near the ambient level.

Screening

Screening the compost helps to separate materials of different shapes and sizes, to remove any unwanted objects or materials that are not fully composted, to recover bulking materials for reuse, and to improve the quality of the compost for sale or use. Screening is most efficiently accomplished when the moisture content is between 39 and 45 percent. Too much moisture leads to lumping and binding of the materials and can cause screens to become plugged; too little moisture can create dust. If the compost is too wet, operators recommend forced aeration or spreading the cured compost out to dry a few days before screening to minimize clumping and/or clogging of screens. If you have the proper equipment, (bucket or front-end loader) turning and dropping the compost on the ground to break up large clumps is also recommended.

Shredders and screening devices are useful for improving the quality of the finished compost by removing contaminants and reducing the particle size of the compost.

Shredders can process from 25-250 cubic yards per hour. Vibrating screens or trommels (rotating screens) can be used for compost. Trommels often have brushes for self-cleaning, and some screens recently introduced on the market are now featuring self-cleaning devices. (See Appendix D for sources of screening devices.)

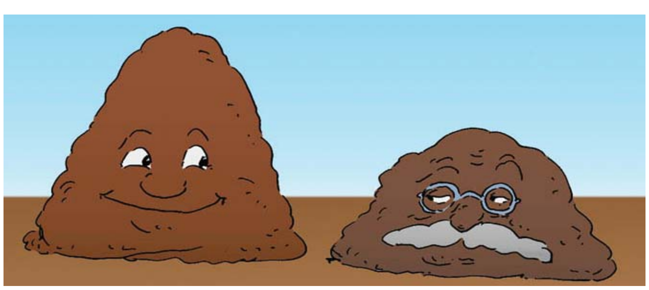
Maturity of Compost

Compost is considered mature when it can be stored and used without problems. Immature compost can become anaerobic, causing odors, and may contain acids or alcohols that can harm seedlings or sensitive plants. The end use of the compost will determine the degree of maturity required. Compost used for potting soils, for example, must be more mature than compost used for land reclamation.

Screening process at Pulaski.

The following are some simple indicators of compost maturity:

- The temperature within a static pile stays at or near ambient for several days when the moisture is near 50 percent and the oxygen concentration is greater than 5 percent at the center of the pile. Moisture can be tested by the “squeeze test,” and oxygen with an analyzing probe.
- A compost sample wetted and placed in a sealed plastic bag should emit a mild earthy odor when opened after a week of storage at temperatures between 68¬86^{0}F (20-30^{0}C).
- The temperature of the compost with 40¬50 percent moisture stays at room temperature after several days when placed in a well-insulated, sealed container.



In addition, some inexpensive test kits for measuring compost maturity on-site are being developed and tested. (See Appendix D.)

Compost Quality

Compost quality is measured by its chemical, biological, and physical properties. Heavy metal, organic chemical, and pathogen concentrations of the compost must be within the limits established by federal and state regulations. State nutrient labeling requirements must be met if the compost is to be sold for use in agricultural or horticultural applications. The physical characteristics—color, texture, structure, porosity, and particle size—of compost are important factors in product marketability.

Standardized testing of compost is increasingly being performed by certified laboratories across the country. Tests have been developed for measuring inorganic elements, nitrogen concentrations, organic matter density, heavy metal concentrations, microbial respiratory activity, phytotoxity levels, plant disease characteristics, and pathogen levels.

Check with your local solid waste manager for guidelines.

In summary:

Monitoring and recordkeeping ensure proper compost management and help avoid problems.

Composting is most rapid when conditions that encourage the growth of the microorganisms are established and maintained. The most important conditions are:

- adequate mixing of organic materials to provide the nutrients needed for microbial activity and growth
- a balanced supply of carbon and nitrogen (C:N ratio)
- oxygen levels that support aerobic decomposition
- enough moisture to permit biological activity without hindering aeration
- temperatures that encourage vigorous microbial activity
- a pH between 6-8 that encourages decomposition
- adequate time and space for curing the compost.

Keeping accurate records, establishing end product specifications, and instituting a sample analysis program will ensure a consistent product.

Troubleshooting Guide

Symptoms	Problems	Recommendations
Pile is soggy; smells sour	Pile too large, not enough air Pile not formed immediatelyy Pile too wet	Form piles no wider than 12', no higher than 6' Allow no more than 1-2 days between collection & pile formation Spread to dry Add more dry bulking materials Turn
Standing water/surface ponding	Inadequate slope Improper windrow/pile alignment Depression in high traffic areas	Establish 1-2 % slope with proper grading Improve drainage, add absorbent Run windrows/piles down slope, not across Fill and regrade
Inadequate composting rate	Material too dry Material too wet; pile too large leading to anaerobic conditions Pile too small, leading to excessive heat loss Uneven distribution of air, moisture, or nutrients	Add water initially, or as a corrective measure when turning Spread out to dry; remix, make pile smaller Make 5-6' high, colder regions may require greater heights Turn or shred pile, wetting if necessary
Center is dry & contains tough materials	Not enough water	Chip woody materials, moisten & turn
Ammonia odor	Too much nitrogen	Turn pile; add bulking material high in carbon, like woodchips or leaves If static pile, add high carbon biofilter
Pile too hot, stops heating, smells	Thermal destruction of microorganisms has occurred Pile too wet Pile too large	Turn pile 2 days in a row & monitor temperature Turn pile whenever temperature reaches 160^{0}F (71^{0}C) Reduce size

Troubleshooting Guide (cont'd.)

Symptoms	Problems	Recommendations
Low temperature	Pile too small Insufficient moisture Poor aeration Ambient temperature too low	Combine piles Add water while turning Turn pile Remix when ambient temperature rises, or mix with other pile
Pile has gotten very wet from rain or snow	Excessive moisture has smothered or drowned microorganisms	Turn pile every day until it starts to heat again (do not add more bulking materials)
Animal infestation	Food scraps exposed Lack of biofilter Materials spilled outside of pile	Process as soon as possible, add insulating cover Add biofilter Improve housekeeping, clean up spills Get a cat! Plant tall grasses to discourage nesting of birds
Mosquitoes/flies	Presence of stagnant water	Eliminate ponding Remix weekly to turn surface eggs and maggots into hot interior where they will be destroyed
Non-compost pile odors	Residuals left in receiving zone Organics spilled outside of pile Standing water, high in organic residue Build-up of food scraps on equipment	Practice good housekeeping, keep high traffic areas clean, remove residuals from equipment Clean up, reduce spills, cover with absorbent carbon sources Clean up spills, (see standing water/surface ponding) Routinely wash equipment and remove food residuals

Marketing Compost

Plans for the end use of your compost should be part of your initial program planning. Currently, most facilities are using on-site generated compost as a soil amendment for their own groundskeeping needs, and many municipal facilities simply give the finished compost to community residents or parks and recreation areas. However, there is a commercial market for compost and it may be one you want to explore if you will be producing large amounts.

To determine if marketing your compost is a viable option, you will need to find out what state regulations are in effect governing the sale of compost. If your end product will comply with state requirements, the next step is to assess your marketing and distribution options. Are there local markets for the compost? Are there existing distribution channels/outlets that can be utilized to your advantage?

If local markets are available, what products are currently being used? Compost is valuable as a soil conditioner and amendment. High quality compost can be substituted for black dirt, organic peat, and humus products sold in home and garden stores.

Compost quality is dependent on appearance, consistency, amount of impurities (e.g., stones, sticks, glass, plastics), chemical composition (nutrients, soluble salts, pesticide levels, metals), and stability of the finished product. These factors are generally dependent on the amount of impurities in the incoming materials and the level of process management. Standardized laboratory testing will help you to determine these factors and maintain consistency in the final product. Any new combination of materials should always be tested. Potential customers will want to know what they are getting, and you will want to be sure that your end product meets state and federal regulations.

Next, you will need to estimate how much compost your facility will generate. Your preliminary analysis of food scraps generated can help you estimate how much end product you will have. The volume of compost produced is generally about one-quarter to one-third the volume, and one-half the weight of the beginning mixture, however, this will depend on several factors—type of food scraps, bulking materials used, screening, etc. Production capacity will affect your target audience.

Look at user groups in terms of revenue and volume of business. Some may be able to utilize large amounts of compost, but only at a low price. While others may be willing to pay a premium for compost products, but require less volume.

Be creative in assessing local needs. An obvious use for compost is in landscaping applications. However, many landscape contractors, nurseries, and greenhouses mix their own materials, and may be reluctant to experiment with unestablished producers. They will be concerned about consistent quality of the product, and will most likely require a chemical analysis of the compost, especially for nitrogen, phosphorus, potassium, pH, and soluble salt content.

Don't limit your market assessment to the obvious. There are many others engaged in landscaping operations—road construction contractors, private and public agencies responsible for buildings and grounds upkeep, golf courses, and schools for instance—who may not have as stringent requirements.

In addition, there are commercial soil dealers who can put you in touch with potential customers. Area farmers can frequently use large quantities of compost.

Markets for compost that has not been highly managed may include sod farms, or agencies/municipalities involved with land reclamation.

You will also need to establish a price range and distribution system. Factors that influence price include the quality of the product, competition, and demand for and supply of your product. Compost can be sold to the general public on a "first-come, first-served" basis where the customer brings a container and loads the product; by selling the compost in bulk by the truckload; or by bagging. Bagging is a labor intensive operation that will require careful market analysis as well as continual marketing. There is also the additional cost of bagging equipment to be considered.

Finally, as with all phases of a compost program, employee education and team building will go a long way towards producing a quality end product.

In summary:

Estimate compost production and develop an end use plan for finished compost at the same time you are planning your compost operation.

If planning to market the compost:

- Contact state and local agencies to determine regulations affecting the sale of compost.
- Identify possible end users and determine what will be the most useful for their operation; establish a competitive price and work out a distribution system.
- Implement production, process monitoring, and storage procedures with end user requirements in mind.
- Continue employee education and team building efforts to ensure a quality end product.

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Case Study

Carrier Corporation

When recycling became mandatory in Onondaga County in 1991, composting was a natural spin off for a corporation with more than 4,500 employees, 18 buildings, three large cafeterias, a carpentry shop, and extensive landscaping requirements on its 206 acre campus. The Carrier Corporation is an internationally renown manufacturer of heating and air conditioning equipment, and is also the first corporation in Onondaga County to implement its own on-site composting facility.

"My colleague and I wanted to show our employees that we were serious about the whole concept of recycling at Carrier. We knew that management was promoting recycling, so we approached our manager, armed with facts and figures that demonstrated we could save money while at the same time enhance our recycling program. We sold him on the idea that composting cafeteria food scraps is just another phase of recycling," says Scafidi. Once corporate backing was obtained for the project, the first step was to train employees. Classes were held for the buildings and grounds employees who would be collecting and composting the materials, and for the food service workers who would be generating and saving the materials for collection. An informational pamphlet explaining Carrier's food composting program was also distributed to all other employees not directly involved in the project.

> *I think on-site composting has given us a better corporate image. Management is behind the project 100 percent, and the employees are excited about what we're doing. Right now all the finished compost is used on our campus, but our ultimate goal is to make enough to give to employees to take home.*
>
> *Angie Scafidi,*
> *Recycling Coordinator*

Separation and collection of the food scraps has been made as simple as possible. Preconsumer food scraps only are placed in special 90-gallon blue containers on wheels located near work stations in the food preparation areas of the cafeterias. All employees know that the blue containers are for food scraps only, and that the only stipulation is "no grease or meat products." The containers are picked up daily by members of the buildings and grounds crew, who use a front-end loader to transport the blue bins to the compost site. There, the food scraps are mixed with sawdust from the carpentry shop, wood chips from clean delivery pallets, and during the summer and fall months, grass clippings and leaves from the campus grounds. The front end loader is also used to incorporate the mixture into one of the existing compost piles. The bins are hosed out and returned to the collection site to start the cycle over again.

Medium-Intensity Methodology

Carrier has the space available to use the turned windrow composting system. The food scrap mixture is placed in piles on a graded pad. The shape of the pile varies with the weather--if there has been a lot of rain or snow, the pile is cone-shaped to slough off water; if it's been dry, the piles are indented on top to catch the water. Temperatures of the piles are monitored about once a week. If temperatures get over 140^{0}F (60^{0}C), the pile is turned with the front end loader. Ray Carney, compost manager, likes to take the temperature on all four sides of the pile. "Sometimes a pile gets hotter on one side than on the other. For example, if the wind is blowing, it might dry one side out faster than the other. By checking temperature levels in different places, I can tell if more moisture is needed, or if the piles need to be mixed up a little." Once a pile has stopped heating up, it is moved to a curing area, where it sits for about a month.

Employees feel good about the program and time requirements are minimal. Once an employee has been introduced to the system, it becomes routine—food scraps in the blue bin, non-recyclable materials in an adjacent (different color) bin. Collecting, mixing, and incorporating the food waste into the compost piles, cleaning up, and returning the bins to the collection site takes about an hour each day.

"I think on-site composting has given us a better corporate image," says Scafidi. "Management is behind the project 100 percent, and the employees are excited about what we're doing. Right now all the finished compost is used on our campus, but our ultimate goal is to make enough to give to employees to take home."

Savings

Scafidi estimates that approximately 5,478 cubic feet of food scraps are being diverted from the landfill through this effort, for a savings of $16,000 annually. In addition, 1,938 cubic feet of composted mulch was produced and used on corporate grounds. This is composted mulch that the company would otherwise have had to purchase. So the savings for Carrier is two-fold.

Source separation at Carrier Corporation

Case Study

Culinary Institute of America

The Culinary Institute of America is a private, not-for-profit educational institution for students interested in careers in the food service and hospitality industry. The facilities at the Hudson Valley campus in Hyde Park, NY include 36 professionally equipped kitchens and bakeshops, and four on-campus, student-staffed public restaurants. Students enrolled in the Institute prepare approximately 3,000 meals a day.

Since February of 1994, the Institute has been successfully source separating and recycling food waste; mostly, preconsumer food scraps from the public restaurant preparation areas. The food residuals are collected and sent to McEnroe Organic Farm in Millerton, NY (formerly Moody Hill Farms) where they are mixed with manure and yard trimmings and placed in open air windrows for composting. Once mature, some of the compost is sold to landscapers or private gardeners, but most is used on the farm gardens and the organically grown vegetables are then sold back to the Culinary Institute, where the cycle begins all over again.

> *Savings to the Culinary Institute is approximately $30,000 per year, not to mention the value of the farm fresh, organically-grown fruits and vegetables we also get out of the deal.*
>
> *Becky Oetjen*
> *Recycling Coordinator*

Source Separation/Off-Site Composting

"It's a very simple operation," says Becky Oetjen, recycling coordinator for the Institute. "Each food preparation station has three very small counter containers to separate waste, reusable scraps, and compostable scraps. The compostable scraps are dumped periodically into 32-44 gallon containers placed near the work stations. The larger containers are emptied, at least once a shift, into a 20-yard open box located in a common area outside the kitchens. The open box is pulled from the site twice a week and taken to the composting site. The only special equipment we have are color coded bins—gray for trash, yellow for mixed recyclables, and blue containers for 'food waste only'. All bins are on 4-wheel dollies. The food bins, especially, can get cumbersome for the students due to the weight of the food, so we are in the process of building a ramp to make dumping into the collection container easier." The farm accepts food only; paper products, cardboard, or other organics mixed with the food will cause the load to be rejected. However, any type of food is acceptable, including seafood shells and small amounts of meat. Initial experiments with collecting post-consumer scraps from the public dining rooms had to be discontinued because plate scrapings processed through a pulping system made it too difficult to successfully sort out paper products and/or other materials.

Due to the strict requirements of the farm composter, keeping the food waste stream free of contaminants is essential. This can present quite a challenge, especially when a new group of students comes in every three weeks! Guidelines for recycling and food waste composting have been established outlining what can be recycled, what goes where, what happens to the recycled products, and why it is important. This information is also included in the student handbook, printed on flyers that are posted in appropriate areas, and is part of a a course on sanitation that students are required to take upfront.

Still, it takes continuing education, constant monitoring, and diligent enforcement to keep contaminants out of the food waste stream, Oetjen says. (Although she finds that once the students understand the reason for recycling and begin following the guidelines, it all becomes pretty routine.) The following are some methods that have proven successful at the Institute for maintaining a contaminant-free food waste stream:

- Faculty responsible for supervising the students in the kitchens receive periodic feedback at faculty workshops held monthly on campus.
- Students are assigned to work groups in the kitchens and each group has a designated team leader. This helps facilitate communication if problems arise.
- Periodic unannounced sanitation inspections are routinely conducted. If contaminants are found, students are given an explanation of what is wrong, along with a copy of the guidelines, and an opportunity to ask questions if necessary. Subsequent instances of contamination lead to demerits.
- Buildings and groundspeople monitor the area, and report any problems to the supervisor.

The Insitute had several false starts to its recycling/composting program, and Oetjen believes it's because all the pieces weren't in place when the first programs were implemented. Her recommendations:

- Education is very important—let people know what you are trying to do, and how you are trying to do it.
- Develop guidelines—exactly what can be recycled, how, and where.
- Have all your ducks in a row before you start. Most people need to see something happening before they will commit to it. If something is not working right, people may begin to think "why bother?"

Savings

The commercial hauling and tipping fee for the Institute is currently $69/ton plus $160 per load. The composting hauling and tipping fee is $625, with each load weighing approximately 11.5 tons. The resultant savings to the Culinary Institute is approximately $30,000 per year, not to mention the value of the farm fresh fruits and vegetables they also get out of the deal! In 1995 alone, the Institute collected in excess of 1,000 tons of food waste for composting. This equates to over 50 percent of the total volume of waste being produced. In addition, Oetjen says, "our collection program has received national attention. Public image is important to any commercial establishment, and this type of proactive program definitely catches the public's attention!"

Case Study

Fletcher Allen Health Care

Fletcher Allen Health Care in Burlington, Vermont, is a 585 bed facility serving 4,000 meals a day from its in-house institutional kitchen. When recycling became mandatory in 1991, food scrap composting came about "as a matter of course," says Hollie Shaner, Waste Reduction Specialist for the facility.

Today, they are recycling 40 percent of all their waste, including 6-8 tons of preconsumer food scraps per month that is sent to the Intervale Compost Project (ICP). ICP, founded in 1988, is the first commercial-scale composting project in Vermont, set up specifically to divert organic materials from the landfill and redirect them to the composting facility. Tipping fees at Intervale are $40/ton, while commercial tipping/hauling fees in the Burlington area are $85/ton.

> *It's really important to build a feedback loop into the process to prevent contamination from recurring. We have a waste team that watches out for problem areas, and works with staff to find solutions to those problems.*
>
> *Hollie Shaner*
> *Waste Reduction Specialist*

Source Separation, Off-Site Composting

The food scraps, anywhere from 600-900 pounds per week day, is placed in 6, specially marked "food scraps" only, 64-gallon toters on wheels that are collected daily, along with other recyclables. The containers are picked up and transported to Intervale by a 19-21 foot facility box truck. Once empty, the containers are taken to an off-site facility recycling warehouse, where they are sanitized using a power washer, and returned to the kitchens.

Because Intervale will reject loads that are contaminated, it is essential that staff are aware of and committed to the program. Cleanliness in a health care facility is paramount—all food service employees receive training in sanitation and food handling. A natural addition to this orientation is a section on recycling and organic composting of food scraps, along with information on facility policies for source separation and collection of materials.

To strengthen and reinforce its recycling policies, an environmental services "waste team" was formed. "It's really important to build in a feedback loop to the generators," says Shaner. "The waste team watches out for any problem areas, and works with staff to find solutions—sometimes analyzing and reorganizing job responsibilities in order to perform recycling tasks more efficiently—sometimes handing a contaminant-filled 5 gallon bucket back to the employee(s) who generated the contaminated waste!"

The success of the program at Fletcher Allen has led to providing educational and training programs for more than 50 satellite health care facilities—doctors' offices, clinics—located in and around the Burlington area, and conducting feasibility studies for other Vermont health care facilities interested in implementing a similar comprehensive recycling program.

Savings

Shaner estimates the facility is saving between $5,000-9,000 annually by composting its food scraps.

Case Study

Hannaford Brothers Company, Supermarket Chain, Northeast, US

Hannaford Brothers Company began source separating food scraps for composting in 1989-90 after a waste characteristic study demonstrated that recycling/composting could help to reduce landfill tipping fees for many of their stores. Today, 50 Hannaford Brothers' supermarkets, located throughout Maine, New Hampshire, Vermont, and upstate New York, are routinely recycling and/or composting preconsumer food scraps from the produce, bakery and deli departments, along with dairy products that have been removed from the containers.

Never, never, never send food scraps to the landfill or incinerator!

Hannaford Brothers Company

The company's "golden rule" is "never, never, never send food scraps to the landfill or incinerator when recycling or composting is an alternative!" The food scraps are diverted in several ways. First, preconsumer usable food materials that have not sold are donated to local food kitchens. Secondly, produce trimmings and other suitable materials are used for pig feed at area swine farms. Any food that is not reused through these two methods is sent to a compost facility.

Store associates are trained by "area trainers" to source separate compostable food materials. Special signs are posted in each department reminding associates to source separate organic food products only. The separated food scraps are collected in 95-gallon totes that are transported to local facilities every other day.

In-store collection containers.

Off-Site Composting

Currently, the company has contracts with local haulers and four composting facilities in the Northeast. Three of the composting facilities are privately owned, but 25 stores in the Windham, Maine area are sending food scraps for composting to the Maine Correctional Facility located nearby. "To be economically feasible," says Ted Brown, Manager of Environmental Affairs at Hannaford Brothers' corporate office in Scarborough, Maine, "the stores need to be within 35-40 miles of the compost site. Any farther away, and we begin to lose money through hauling fees."

Hauling and tipping fees for landfill or incineration in the Northeast average about $72/ton; hauling and tipping fees to the composting sites are around $50-$60/ton. Most Hannaford stores are saving anywhere from $15-$30/ton right now, but transportation costs are seen as one of the deterrents for composting in many areas.

Savings

One Hannaford store generates about two tons of produce trim and other unsaleable food scraps weekly. By composting, the store saves about $15/ton or over $1,500 annually. Another store, generates just over a ton of compostable material weekly, saving $20/ton or over $1,000 annually. Prior to composting as an alternative, each store combined organic food waste with inorganic materials deposited in 30-40 yard compactors that were hauled and emptied once a week. The combining and storing of organics and inorganic materials often causes odor problems in compactors. This has been avoided through the source separation program.

Case Study

Ithaca College

Ithaca College began composting food scraps from its dining halls in January of 1993, as a part of its Resource and Environmental Management Program (REMP), a coalition of students and staff of Auxiliary Services at the Physical Plant, dedicated to promoting awareness of environmental concerns and resource management.

Source Separation/On-Site Composting

Preconsumer food waste from the dining room kitchens and some plate scrapings are collected in "food only" containers located at food preparation and dishwashing areas. Full containers are emptied into designated dump carts at the trash collection area at dining hall loading docks. These carts are emptied into a tipping dumpster on a fork-lift that is used for daily collection, Monday through Friday. On Saturdays, the food scraps are included with other materials to be taken to the landfill; Sunday's food scraps are held for Monday collection. Currently, the college is composting about 5 tons of food scraps per week, approximately 13-15 percent of the total waste stream.

> *Look around for suplus equipment that can be adapted to meet your needs. Our fans are just regular fans used to handle air in buildings, and the piping is ordinary corrugated drain pipe that's perforated.*
>
> *Mark Darling*
> *Compost Manager*

Medium-Intensity Methodology

The college uses aerated static piles to compost its food scraps. Modified building fans feed into perforated corrugated drain pipes and force air through the piles. The fans are connected to a computerized controller that activates the fans at timed intervals or by temperature. There is no specific recipe—food scraps are mixed with wood chips using an 8-yard modified cattle feed mixing wagon, until it reaches a consistency that holds together, but is not too wet (50-60 percent moisture). Using a skid-loader with a 5/8 yard bucket, the food and wood chip mixture is piled on an 8-12 inch base of wood chips spread over the perforated piping. Each pile contains 3 days' worth of food waste, approximately 3-5 tons of compost material. Temperatures of the piles are monitored both manually and electronically. After 5 weeks, the piles are screened to remove reusable wood chips, and the resulting "fines"—composted food scraps, are moved outside and cured in a windrow. The screened-out wood chips are remixed with new incoming food scraps as soon as possible; staff have found that this helps to raise temperatures in the new compost piles. The microbes and bacteria on the reused chips activate the piles quicker when they have not been exposed to snow and rain.

Part of the original proposal to fund the program included a savings projection based on producing compost in-house to reduce the need to purchase soil amendment materials. After extensive experimentation with compost to soil ratios in seed germinating and transplanting trials, IC is now field testing its compost. A mixture of 1/3 compost to 2/3 topsoil has been used on a test garden with dramatic and convincing results. Fin ished compost will now be incorporated into standard planting procedures following a sufficient curing time.

Some Recommendations:

- Only preconsumer food scraps, or post consumer scraps separated by food service employees are used. It was nearly impossible to ensure contaminant-free food scraps using voluntary separation in student cafeterias.
- Odor, due to leachate from frozen wood chips, caused problems during the winter. Screening out wood chips from composted materials and reusing them, cleaning up standing water, and keeping traffic down in the compost area have all helped. Freezing temperatures when mixing piles can result in moisture problems later on. The problem can usually be solved by piling piles higher and adding a cover layer of bulking materials for added insulation, and adding more bulking materials to the mixture to absorb moisture.
- We've eliminated pregrinding the food waste before mixing it with the wood chips in the mixer. We find the resulting product is the same, and we do not have to waste our wood chips cleaning out the grinder.
- We still purchase our wood chips, so screening them out and reusing them saves us money as well.
- We keep a daily log of temperatures in the piles; that helps us to know if we need to add more moisture, or force more air through.
- Look around for surplus equipment that can be adapted to meet your needs. Our controller that regulates air flow based on time or temperature is actually an old building air flow monitor that was no longer being used. The fans are just regular fans used to handle air in buildings, and the piping is ordinary corrugated drain pipe that's perforated. We've had to make some adaptations, but there's usually someone on campus who can help you accomplish what you want to do.
- Finally, let no compost out before its time! And then only for us as a soil amendment.

Investment/Savings

The initial investment in equipment—grinder, mixer, vibrating screen, precast concrete walls (to contain piles), fans and monitoring tools-was about $94,000. An existing steel building with a concrete pad, 30x90 feet that had been used to store buildings and grounds equipment and materials was converted to a composting facility. When the program began, tipping fees for landfilling were $105/ton. Since then they have dropped considerably—current rates are $60/ton. Still, during the 1994-95 school year, 130 tons of food waste were composted, for a

Food scrap collection bins, Ithaca College.

savings of almost $8,000 representing a 12-year payback period. This figure does not include the cost of electricity for monitoring and aerating the compost, approximately $2/day. The labor, about 10 hours/week, comes from the reassignment of one person from trash collection, formerly a two person job, to compost and recycling.

Case Study

Middlebury College, Middlebury, VT

In 1993, Middlebury College in Vermont launched a trial food waste source separation and collection program in its largest dining room after an analysis of the college's waste stream revealed that the heaviest component of the waste was food scraps. The trial project proved successful; the program was expanded and now includes all five dining halls and three snack bars.

Source Separation/Off-Site Composting

In the main dining halls, where only china and silverware are provided, most of the food scraps are generated in the food preparation and clean up areas. On average, approximately 3,300 meals are served daily during the school year. Collection is simple. Kitchen and dishroom staff are trained when they begin work. All food scraps, including meat and grease, are placed in "food only" containers near work stations in preparation areas. Scraps from the students' trays are scraped into "food only" containers by dishwashing staff. At the end of a shift, all the food scraps are collected and deposited into compactors (one 34-yard, and one 24-yard capacity). Four of the main dining halls are located next to the compactors. One smaller dining hall located some distance from the compactors usually serves breakfast and lunch only. Food scraps from this hall are deposited in toters that are collected daily (or every other day depending on the amount generated and/or staff availability) and emptied into one of the compactors.

> *Composting food scraps just makes more sense economically and environmentally than incinerating them.*
>
> *Jennifer Hodgen*
> *Environmental Coordinator*

In the campus snack bars, food, paper plates, napkins, cups, and bowls are collected in trash cans lined with trash bags, labeled "food and paper products only." The trash bags are pulled from the containers daily and trucked to the compactors by snack bar employees.

Dining services personnel keep track of compactor levels and when full, the contents are emptied into self-contained roll-offs and transported to Agri-Cycle, a composting facility in New York State, by a local hauler who has a contract with the College, (usually about once a month, but sometimes twice).

"We were able to develop support for our program by pointing out the economical and environmental benefits of composting," says Jennifer Hodgen, Environmental Coordinator at Middlebury College. "Economically, we would save money; environmentally it did not make sense to incinerate our food scraps when they could be composted and used again. Students, faculty, and staff are proud that Middlebury is composting these materials.

Some Recommendations

- Source separation is most successful when handled by personnel who support the program and are dedicated to the concept. Where we have found contamination, it's usually in trash bags taken from the snack bar areas where separation is not supervised. Contents of the bags are given a visual check before being dumped into a compactor. If there appears to be a lot of contamination, the bag ends up in the dumpster. "Unfortunately, a few plastic utensils and potato chip bags can contaminate an entire trash bag full of food scraps."

- Initially, only food scraps were collected, but paper products were added when some odor and maggots were detected during the summer months. The combination of food and paper products minimized the problem.

Savings

The college saves about $100/ton by composting food scraps instead of incinerating the materials. In 1995, 252.74 tons of food scraps, approximately 24 percent of the college's total waste stream, were diverted to the composting facility for a savings of more than $25,000.

Case Study

New Milford Farms, Inc.

New Milford Farms has a "recipe" for helping the environment—take some coffee grounds from a factory in New Jersey, add some food by-products from a food flavorings facility in Connecticut, mix in a batch of cocoa bean cleanings from a New York chocolate factory, and toss with lawn and yard trimmings brought in by local residents. At this Nestle owned and operated composting facility in New Milford, Connecticut, this formula also is the recipe for success. New Milford Farms now produces over 50,000 cubic yards of compost (enough to cover a football field 33 feet deep in compost) and keeps more than 50,000 tons of Nestle factory waste out of landfills annually—a "win-win" situation which produces a useful soil amendment and minimizes both the landfill burden and potential future liability for landfill cleanups.

> *In order to be successful, a composting facility needs to have adequate and secure sources of carbon and nitrogen rich materials available to provide an appropriate input mixture (C:N in the 25-30 range). Additionally, sufficient area for final curing is very important.*
>
> *Walter Carey, Ph.D.*
> *President*

Knowing that organic products should readily decompose if handled properly, Nestle set up a pilot facility in 1990 to test out the theory that organic food scraps can make a successful compost. Today, the facility processes approximately 54,000 tons of food by-products and clean yard trimmings per year, sells the finished compost to bulk buyers for use in potting soils and top soils, experiments with different compost/planting mixtures in an on-site greenhouse and, sponsors the "BIGGEST pumpkin" contest held annually in New Milford.

In-Vessel Composting

Set on the outskirts of New Milford, population 24,400, the composting facility is neat, clean, compact, and efficient. It's regulated by the Connecticut Department of Environmental Protection and has permits as both an in-vessel system and enclosed composting facility. The permits require that everything be enclosed or covered at all times.

All materials received, whether truckloads of food by-products for processing or clean yard trimmings from local residents, are checked in and weighed. The facility is open daily, except Sundays, to accept grass, leaves, and brush. Clean, untreated wood pallets are also accepted. Yard trimmings are put through a tub grinder, then screened by a magnet to remove any metal objects. The shredded yard trimmings are then stored in piles in an enclosed building adjacent to the main building.

Incoming food by-products are dumped by the truckload into one of two tipping gates at the foot of the main building. Using frontend loaders, operators transport alternate bucket loads of yard trimmings and food by-products (2:1) to two different types of piles—one type using an agitated bed system with walls and rails that support a compost turning machine; the other, consisting of elongated windrows approximately 300 feet long, 18 feet wide and 4-5 feet high. Both systems are turned daily to mix the piles and provide natural aeration. Perforated aeration pipes recessed in the paved floor and covered with stone and mesh, and a blower system provide additional aeration and/or temperature control. Blowers can be used to force air through the perforated piping when necessary. Another set of blowers is used to withdraw any odors that might accumulate. Air withdrawn from the building is piped into a soil biofilter where it percolates through stone and finished compost before being diffused into the outside atmosphere.

Compost managers monitor the piles daily, using temperature probes. A built in watering system provides moisture when needed. The operators base their decisions to turn a pile or add moisture on tests conducted in the on-site laboratory. These decisions are augmented based on "sight, smell, and feel" says Allan Ruhl, General Manager.

The composting process takes approximately 28 days. Operators add approximately 10 cubic yards of new material to each in-vessel bay daily, and remove an equivalent amount of composted material for curing. The compost is cured in static piles in an enclosed" finishing" building, and takes about 30-60 days to complete. After curing, the finished compost is put through a trommel screen. Screening helps to improve the quality of compost by removing any large clumps or foreign materials producing a more uniform consistency, and also allows for recovery of any bulking agents. Cured and screened compost samples are then sent to the Nestle Quality Control Laboratory in Ohio for analysis to determine product safety, integrity, and stability.

Currently, New Milford Farms sells the finished compost to bulk buyers for mixing with peat moss, perlite, or sand to sell as potting soils or top soils. But they are also experimenting with their own mixtures, and have just introduced a new bagging system into the operation. The plan is to establish New Milford Farms as a co-packer and sell bagged compost to a number of soil amendment distributors.

Staff are also exploring the possibility of incorporating food by-products from local supermarket chains. In Connecticut, each new waste product added to a compost facility operation must be preapproved by the state Department of Environmental Protection and a permit modification issued. In the meantime, New Milford Farms keeps on mixing up its unique recipe for compost, experimenting with the finished product, and looking for ways to expand its markets.

Savings

Through the use of New Milford farms, total savings for avoided landfill fees for affected factories is $1,000,000 annually.

Case Study

NYS Department of Correctional Services

The New York State Department of Correctional Services (DOCS) began composting food scraps from two corrections facilities in 1989 as pilot projects. The success of the pilots led to an expansion of the program; there are now 31 composting sites serving 48 correctional facilities across the state.

> *To reap maximum economic gains through cost avoidance, technical investment must be closely balanced with needs and long-term paback, especially in an institutional or commercial setting. Our motto has been "lowest effective technology."*
>
> *James Marion*
> *Resource Management Director*

Before setting up a composting operation at a facility, Jim Marion, Resource Management Director for the DOCS, spends several days on-site observing where food scraps are generated, where source separation should take place, where collection containers should be placed, who should be responsible for collection and removal of containers and, who should oversee each phase of the operation. Marion, who conducted the initial pilot projects as well as the expansion of the statewide program, and who serves as a consultant to others wishing to compost food scraps, knows from experience that careful planning is key to the success of a composting program. "When looking at a new composting operation, technology and scope of the facility should be driven by site-specific space, labor, feedstock, and quantities; not the prejudices of planners or consultants. To reap maximum economic gains through cost avoidance, technical investment must be closely balanced with needs and long-term payback, especially in the institional or commercial setting. Our motto has been 'lowest effective technology'."

Source Separation

Source separation is kept simple to eliminate as much contamination as possible. Thirty-two gallon unlined garbage cans are set up in kitchen preparation areas and dining halls. Preconsumer food scraps and plate scrapings only are collected for composting. An educator known as a "slop cop" oversees the collection containers in the dining areas to ensure that separation is done properly. Collection schedules vary: some facilities have walk-in coolers and can hold food scraps for a day or two before taking to the composting site; others transport the materials daily, or in some cases, after every meal. At most of the facilities, a dedicated team of inmates is responsible for transporting the food scraps to the composting site, and in several cases, inmates also operate the daily composting activities.

On-Site Composting

The on-site facilities fall under the New York State Department of Environmental NY-CRR 6, Part 360-1.7 (b) (4) regulation exemption for composting food scraps generated at the same location. (Under current DEC regulations, facilities that adjoin are considered a single site and may compost at a combined facility.)

Strict process control is adhered to at each facility. Upon arrival at the composting site, food scraps are immediately mixed with bulking materials and incorporated into working windrows.

An initial ratio of two parts bulking materials and wood chips to one part food scraps is recommended, but this may vary from 1:1 to 3:1 depending on the type of food scraps, and/or the amount of rain fall. Mixing methods also vary from site to site. Some sites utilize front-end loaders, others have mixers. Because food can be very wet and heavy, wood chips are the most important part of a bulking agent, Marion says, because they provide porosity, increase the air flow through the piles, reduce turning intervals, and alleviate ponding and leachate. But other materials generated on site are used as well—cotton from the more than 20,000 mattresses discarded each year, and low grade papers not used for animal bedding, for example.

Other process control requirements include:

- contaminant free ingredients that assure compliance with long-range regulation changes, and a quality end product that can be used in horticultural applications both within and outside of DOCS facilities
- daily temperature monitoring to satisfy DEC standards for pathogen control; and to determine if a pile needs more moisture or bulking agents, turning, or is ready for curing
- moisture levels that promote the most efficient composting (the simple squeeze test is the indicator)
- covering working windrows with finished compost or bulking materials to conserve moisture, control odors, and provide an insulation layer during cold winter months.

When composted material is ready for curing, it is usually screened to recover wood chips for reuse (2 inch wood chips have been found to survive up to 5 composting cycles before passing through a 3/8 inch screen, Marion says), and moved to a curing area where it stays for 60-90 days.

The initial composting facilities were located on existing concrete or compacted gravel pads, but DOCS is moving toward impervious compost pads (mostly reinforced concrete) with runoff control provisions for controlling leachate caused by heavy rain or snow conditions. Newer sites are centrally sloped to collect runoff in drains that empty into dead-end sub grade concrete septic tanks, sanitary sewer lines, or in smaller installations into grass infiltration zones. Three covered facilities have recently been built in areas where visual aesthetics, severe weather patterns, and high compost volume are indicated. Marion estimates each of the new covered facilities can handle up to 7 tons of organics a day at an initial cost of under $100,000 (utilizing inmate and civilian labor pools).

Early facilities used equipment that was available at the time, either on-site, shared, or rented, such as front-end loaders or farm tractors with bucket-loaders for mixing, and turning compost materials, and the unscreened compost was mostly used on-site for landscaping projects. While this is still practical for many sites, in areas where there are high quantities of compost and many outlets for marketing a high-quality soil amendment, more sophisticated equipment—skid-steer loaders, larger-capacity front-end loaders, and electric driven trommel screens—have been purchased. The cost of the equipment is offset by the higher capacities, improved compost quality, utilization of the finished compost state-wide for correctional facility landscaping needs, and an increasing market for high-quality compost.

Savings

Site generation of food scraps at the different facilities ranges from 150 pounds per day to 4 tons per day and the savings vary accordingly. A facility serving 1,100 inmates and generating .5 tpd is saving $23,440 a year; a 4 tpd facility serving 4,000 inmates is saving $156,000 a year. Statewide savings for the DOCS, as a direct result of composting food scraps, amounted to $1,248,000 in fiscal year 1995-96. In addition, inmates receive real world work experience. Upon release to parole and/or work release programs, many inmates have been placed with the private and public sectors in recycling programs.

Impervious compost pads with run-off control provisions for controlling leachate.

Case Study

Oswego County Division of Solid Waste

Oswego County's Division of Solid Waste food composting operations are excellent examples of successful low-cost, low-tech—"making use of what's available"—facilities.

At its Volney, NY, landfill and recycling center, the County takes in more than 300 tons of food scraps from local food processors each year. The discarded food, vegetables from a frozen food company, and pinto beans from a baked bean cannery plant, is food that does not meet standards, or that has fallen off assembly lines.

> *Be willing to experiment! Start small, work out problems, try different mixes, bulking materials, and pile sizes to see what works best for you.*
>
> *Auralie Ashley-Marx*
> *Program Coordinator*

The vegetables from the frozen food facility are collected on-site in 3-foot corrugated cardboard "totes" lined with plastic liners. Haulers with lined roll-off trucks transfer one to two loads a week to the compost site. The pinto beans are brought periodically to the compost site by the manager in the back of his own pick-up truck!

It is not always possible to process the vegetables immediately during the winter months in this heavy snow area, and incoming vegetables are sometimes simply dumped in piles and covered with 6 inches of bulking material, wood chips, or finished compost until conditions are right for processing.

The piled vegetables are left covered and untouched until an operator is available to mix the materials and form windrows. Using a front-end loader, the operator mixes the food scrap piles with waste paper pulp from local manufacturers, residential yard waste, florist shop cuttings, and wood chips supplied by the local electric company. If there's a shortage of wood chips, more paper pulp is added at a rate of 50-50 by volume. The resulting compost mixture, approximately two parts bulking material to one part food scraps, is placed in windrows on an asphalt pad.

There are currently 6 windrows on the 2 1/2 acre paved pad used for composting. Each windrow is approximately 12 feet wide, 8-10 feet high, and 50-80 feet long. Windrows are turned every two weeks in the spring, summer and fall, but are not turned during the winter months. In this case, the windrows are also covered with 6 inches of waste paper pulp or a 50-50 percent mixture of wood chips and paper pulp to help prevent odors and to control vectors and leachate generation. Decisions about turning and mixing are based on experience, and if one pile looks too dry and another too wet, Auralie Ashley-Marx, program coordinator with the Division of Solid Waste, has the operator mix them together to reach the right moisture balance.

The composting process is monitored using a temperature probe, and having compost samples analyzed at a local NYS certified laboratory. Two or three representative composite samples may be taken from each pile during the composting period. Sampling includes parameters such as pH, percent moisture, ammonia and other nitrogen, nutrients, and heavy metals.

Food waste is a regular ingredient in the mix at Oswego County's Composting Facility.

Static piles and unturned windrows are a trade-off between time and space—not all facilities will have the space to keep piles around for a year at a time.

It can take up to a year before Ashley-Marx feels comfortable with giving the compost to county residents on a "first come-first served" basis for use as a soil amendment. One problem she has encountered, is that customers raid the piles before the compost has matured. They've had to rope off areas and put up signs to prevent immature compost from leaving the site.

A Fish Story

As a result of the salmon run in several local rivers, approximately 350-450 tons of fish carcasses require management each year in Oswego County. Prior to 1991, all fish wastes were either landfilled, buried, or disposed of improperly. Last year, 88 percent, or 305 tons of fish waste were recycled through composting and distributed to county residents for use as a soil amendment on non-food chain crops.

Static Windrows

After conducting several small-scale trial piles, the static or unturned windrow was selected as the best composting method for handling large amounts of fish, and controlling odors and leachate generation. The static windrow has several advantages. It is inexpensive requiring only a front-end loader and a paved pad, and does not rely on turning the piles which can release significant odors.

First, a bed for the compost mixture is prepared and placed on the composting pad. The bed, approximately 16-20 inches deep and 6 feet wide, consists of fibrous paper pulp and wood chips processed from brush and tree waste collected from five regionally-located transfer stations in the county, mixed at a ratio of 1:1.

The fish are delivered by the truck loads in 55-gallon plastic drums. Each drum is manually emptied on top of the bed of bulking materials. The filleted salmon fish carcasses consisting of heads, guts, backbones, and skin, some as large as 48 inches in length are mixed into the bed using a front-end loader until a ratio of three parts bulking materials to one part fish scraps is reached. Mixing of the materials is accomplished by alternately lifting and dumping bucked loads of the materials.

When mixed to the point where all the fish are covered to the consistency of flour-battered chicken, the mixture is moved to another 16-18 inch bed of paper pulp and wood chips, approximately 12 feet wide. The 3:1 composting mixture is piled on the bed in a triangular shape to a height of about 7 feet, leaving approximately 12 inches of the bed uncovered on each side of the pile to allow for leachate capture. The windrow is then completely covered with 12 inches of 100 percent paper pulp. Each day the windrow is lengthened by adding that day's mixture next to the last section, until the finished length of the windrow reaches approximately 50 feet. A 30-inch temperature probe is used to take the interior temperatures on a daily basis for the first 30 days. Results show that after just two days, an interior temperature of 80^0F (27^0C) is reached. Temperatures taken later in the test period show an interior temperature range between 120^0-145^0F (49^0 -63^0C).

Each fall's batch of fish/paper pulp and wood chips takes one year to reach maturity and stability. The final product is cured, tested, and screened prior to being made available to county residents for use as a soil amendment on non-food chain crops, even though extensive analytical sampling has demonstrated that the finished compost meets the applicable Part 360 standards for Class I compost.

Recommendations

- Look for sources of free bulking materials—in our case, paper pulp from a local paper factory works as well as wood chips. Be willing to experiment with different mixtures.
- Educate people up-front if you are planning to source separate—if they know what's required and why, they will be more apt to keep contaminants out of the waste stream.
- In the beginning, vegetables from the frozen food plant were frequently contaminated, mostly with plastic, but also with butter and cream sauces that the company had agreed to keep out of the waste stream. Speaking to the management didn't solve the problem. It became necessary to examine every load brought to the site by the haulers. If contaminants were found, the hauler was required to manually pick the unwanted materials out of the delivery or take it away. The contamination problem quickly went away! Although all incoming loads are still monitored and visually screened.

Savings

The 305 tons of fish composted last year saved the county more than $16,000 and two percent of an acre of landfill volume at the landfill station.

The composting of the paper pulp and food scraps represents a savings of approximately $45,000 annually in avoided tipping fees for the local industries.

At a Glance

Institution/ Business	Size	Type of Waste	Type of Operation	Special Equipment	Diversion Rates	Annual Savings
Carrier Corporation	4,500 employees, 3 cafeterias	Preconsumer food scraps only; sawdust, wood chips, grass & yard clippings	Source Separation Turned windrows	Color-coded collection bins	5,478 cf/yr	$16,000 (includes both savings and cost avoidance, i.e., no need to purchase soil amendment)
Culinary Institute of America	3,000 meals/day	Preconsumer food scraps	Source Separation Off-site	Color-coded collection bins, 20-yard open box	1,200 tons/yr	$30,000
Fletcher Allen Health Care	4,000 meals/day 585 beds	Preconsumer food scraps only	Source Separation Off-site	Daily pick-up, 6 64-gal autocarts, own trucks, 9 member "waste" team; power washer	6-8 tons/mo	$5-9,000
Hannaford Brothers Supermarkets	50 supermarkets	Preconsumer food scraps	Source Separation Off-site	95-gal totes	Varies	Varies (See case study)
Middlebury College, VT	3,300 meals/day	Pre & post consumer food scraps, paper products	Source Separation Off-site	24 and 34-yd compactors	253 tons/yr	$25,000

Institution/ Business	Size	Type of Waste	Type of Operation	Special Equipment	Diversion Rates	Annual Savings
New Milford Farms (Nestlé-owned)	Several food manufacturing plants	Coffee grounds/cocoa beans/food seasonings/ yard trimmings/ wood chips	In-vessel, biofilter forced aeration	Windrow turners, grinder, screens	54,000 tons/yr	$1,000,000
NYS Dept. of Correctional Services	48 correctional facilities	Pre and post consumer food scraps	31 composting sites, methodologies vary	Varies (See case study)	Varies	Statewide (1995-96) $1,248,000
Town of Oswego	2 food manufacturing plants, paper mills Fish waste	Vegetables, beans/paper pulp/wood chips/yard clippings Fish waste/paper pulp/wood chips	Turned windrows Static windrows	Front-end loader, asphalt pad Paved pad	300 tons/yr 305 tons/yr	$45,000 $16,000
Washington State University	17,000 students, 3 dining areas	Pre and post consumer	18 windrows, paved site	2 pulpers, 200 lb. bins flatbed truck for pickup; windrow turner	1,000 lbs/day	$4-5,000/yr (75% of original tipping fee now used to finance composting operation)

Appendix A

Sample Dining Survey

Style of service (check most applicable):

______ Prepaid meals, single walk through
______ Prepaid meals, all you can eat
______ Cafeteria, 20% or less takeout
______ Cafeteria, 80% or more takeout
______ All items packed for takeout

Tableware and plate sorting: Fill in the blank with the estimated percentage (0-100%) of use:

We use ___________ % disposable plates and flatware.
We use ___________ % disposable trays.
Our employees sort ______ % of the customer's plate scraps.

Circle all meals served in a day:

Weekdays: breakfast, lunch, dinner, afternoon snacks, evening snacks Saturday: breakfast, lunch, dinner, afternoon snacks, evening snacks
Sunday: breakfast, lunch, dinner, afternoon snacks, evening snacks
(Or just write dining hours): weekdays: ______________________________
Saturday: ______________________________
Sunday: ______________________________

Occupancy:

Average number of customers served weekdays: ____________
Saturday: ____________
Sunday: ____________
Average number of customers served at breakfast: ____________
lunch: ____________
dinner: ____________

Hot foods prepared and cooked on site (circle)?

Some (____________%), All, None

Cold foods (salad, deli sandwich) prepared on site (circle)?

Some (____________%), All, None

Dining Survey - Continued

Using units compatible to your needs (e.g. lb., 30 gal trash can), estimate the following:

Units = ______________________________

Food discarded from:

Preparation areas: ____________

Customer discard/plate waste: ____________

Old or damaged stock: ____________

Unpurchased hot food lines: ____________

Unpurchased cold food lines: ____________

Other ____________ (describe source):

____

Breakdown into food types (approximate percentages):

Starches: ______%

Meats: ______%

Vegetables/Fruit: ______%

Cheese/Milk: ______%

Casseroles: ______%

Other (Describe): ______%

Materials Used/Percent Recycled:

Plastic (all types):_______________ % recycled: _______

Paper: ____________ % recycled: _______

Glass: ____________ % recycled: _______

Metal: ____________ % recycled: _______

Other: ____________

Describe: ____

Appendix B

Sample Recordkeeping Form for Incoming Materials

Generator	**Food Type Weight or Volume Percent of Total lbs or yd^3**	**Pickup Dates**										
Terrace Dining Hall	Total food											
	% vegetables											
	% fruit											
	% meat											
	% pasta											
	% bread											
	% other organics											
	% contaminants											
Tower Dining Hall	Total food											
	% vegetables											
	% fruit											
	% meat											
	% pasta											
	% bread											
	% other organics											
	% contaminants											

Source: Erin McDonnell, Cornell University. Developed for Ithaca College 1995.

Appendix C

Sample Recordkeeping Form for Managing Compost Loads

Materials Description in Pile #________	Temperature at Probe # (^oF)					
Date load 1:	**Date**	**Time**	**1**	**2**	**3**	**Comments**
Food (yd^3):						
Base Chips (yd^3):						
Mix chips (yd^3):						
Cover chips (yd^3):						
Biofilter (yd^3):						
% fruit:						
% vegetables:						
% meat:						
% starch:						
% other organics:						
% contaminants:						
Visual texture:						
Date load 2:						
Food (yd^3):						
Base Chips (yd^3):						
Mix chips (yd^3):						
Cover chips (yd^3):						
Biofilter (yd^3):						
% fruit:						
% vegetables:						Total Food (yd^3) out:
% meat:						
% starch:						Date screened:
% other organics:						Total chips out:
% contaminants:						Total fines out:
Visual texture:						Total reduction:

Source: Erin McDonnell, Cornell University. Developed for Ithaca College 1995.