ORGANICS RECOVERY PROGRAM DEVELOPMENT TOOL FOR COLLEGES AND UNIVERSITIES

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Introduction

The purpose of the *Organics Recovery Program Development Tool for Colleges and Universities* is to assist post-secondary institutions with organizing new or expanding existing organics recovery programming with a special focus on composting. This introductory guide is organized by common practical composting methods from existing resources that is supported with school-specific examples and best practices. In the first phase of the tool development, a profile for each participating school was created using an inventory of program characteristics (Institutional Partners, Funding Mechanisms, Operational Models, Student Involvement, Academic Programming, and Community Partnerships). Organics recovery program information for these EPA Region 4 (Southeast) schools can be found in the Compendium of Organics Recovery Programs at Colleges and Universities.[1]

Through the development of the Compendium, information gathered from each stakeholder provided a foundation for the examples chosen to be shared. Through this process, information was compiled through extensive online research and interviews with stakeholders of multiple perspectives; from staff, faculty, students, industry, public and nonprofit groups. The participating colleges and universities are post-secondary institutions that offer at least four-year degree programs with enrollment ranging from under 1,000 to above 20,000. Each school has an existing organics recovery program with a composting capacity ranging from small-scale demonstration or pilot composting efforts (bin-system) to large scale institutional efforts (windrow, aerated static pile, in-vessel), or off-site centralized composting.

It is important to mention that the focus of composting in this guide is one of many methods of organics recovery. In fact, the EPA Food Recovery Hierarchy[2] prioritizes food recovery methods from highest to lowest priority: Source reduction[3], feed hungry people[4], feed animals[5], industrial uses[6], composting[7], and landfill/incineration. Higher priority food recovery methods are briefly mentioned and groups such as the Food Recovery Network and dining service providers can provide methodologies to reduce pre- and post-consumer food waste.

Included in this Tool are the overarching considerations that should be taken into

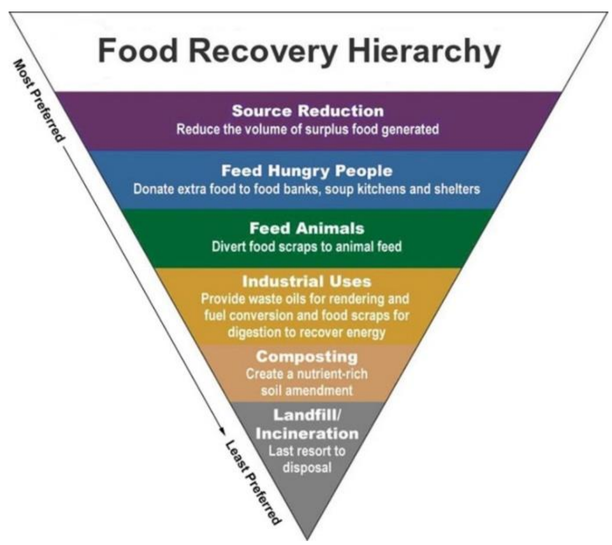


Figure 1. EPA Food Recovery Hierarchy prioritizes actions organizations can take to prevent and divert wasted food. Each tier focuses on different management strategies.

[1] http://louisville.edu/cepm/compendium
[2] https://www.epa.gov/sustainable-management-food/food-recovery-hierarchy
[3] https://www.epa.gov/sustainable-management-food/how-prevent-wasted-food-through-source-reduction
[4] https://www.epa.gov/sustainable-management-food/reduce-wasted-food-feeding-hungry-people
[5] https://www.epa.gov/sustainable-management-food/reduce-wasted-food-feeding-animals
[6] https://www.epa.gov/sustainable-management-food/industrial-uses-wasted-food
[7] https://www.epa.gov/sustainable-management-food/reducing-impact-wasted-food-feeding-soil-and-composting

account, such as the state/county/municipal regulatory framework under which a new on-site organics recovery program would fall. Throughout this document, it's suggested that schools take inventory and weigh certain elements that might sway a school between implementing on-site or off-site organics recovery. Given the various methods of organics recovery (from experimental do-it-yourself pilot projects to highly mechanized systems), the most common approaches were identified and researched; this included contacting each school's key representative(s) to learn more about financing mechanisms, rationale for decision-making, successes and failures, capacities and constraints for each technology, and techniques for participation.

Each section of this report is framed around the questions that institutions should ask themselves as they begin to compare different options for organics recovery. The Tool is organized to serve as a launching-pad for exploring methods that could suit the diversity of schools, regardless of size, student enrollment, and geographic location. With permission and input from institutional representatives, descriptions of existing programs and linked external resources are provided. It is understood that given the uniqueness of institutional management structures, funding availability, state/local regulations, on-site space availability or off-site centralized facilities, and a host of other factors, there cannot be a one-size-fits-all model for organics recovery decision-making. However, by revealing the key areas for weighing capacities and constraints, while learning about other existing programs, decision-makers can begin to gather the information that can lead to more informed decisions about which methods to adopt.

The organics recovery decision-making process at post-secondary institutions is influenced by a combination of factors. It can be driven by geographic location (city, town, suburb), land availability (on-site vs. off-site), financial considerations, staff/volunteer training and coordination, and the capacity to foster the internal and external support needed for a successful program.

Institutional partnerships and the identification of **funding mechanisms**, both of which determine the makeup of an **operational model** for organics recovery, are important elements of an organics recovery program. The operational model, whether on- or off-site, small- or large-scale, may function with **student involvement**, the incorporation into **academic programming**, and/or external **community partnerships**. By considering each of these factors and the unique characteristics of each school, colleges/universities can evaluate which method to adopt, who will be responsible for operations, how the program will be funded, and what type of added involvement is best from students, faculty, and the surrounding community.

INSTITUTIONAL PARTNERS

FUNDING MECHANISMS

OPERATIONAL MODEL

STUDENT INVOLVEMENT

ACADEMIC PROGRAMMING

COMMUNITY PARTNERSHIPS

Methods of Organics Recovery

Source Reduction

Source reduction is the action of decreasing food waste through methods such as continuous tracking of surplus and wasted food, reorganizing the way food is offered in dining facilities, and altering food handling procedures by kitchen staff. Regardless of the source reduction technique, the first step to making informed decisions is to keep track of the amount of food being ordered and then inventory pre- and post-consumer food waste. Conduct a baseline audit with the help of student volunteers and staff by tracking the amount, type, and reasons behind wasting food. Then, establish regular procedures for tracking food waste. For example, at Berea College, kitchen staff measure, monitor, and track waste by following a common procedure called LeanPath.[8] Through this system, food scraps are weighed multiple times per day then recorded on a wall-mounted table located directly above the scale. Once the food waste is weighed and recorded, it is transported to the campus garden for composting. In the kitchen, staff can ensure food handling procedures include proper storage techniques, and/or going trayless (if applicable). Another technique is to use excess fruits and vegetables to make salads, desserts, or soups. To discourage consumers from receiving excess serving sizes, dining facilities may offer individual portions at staffed food stations; rather than buffet style. By adopting the aforementioned source reduction techniques, schools can save money through food purchasing and/or labor, save in energy and transportation costs (production and/or shipping), while also preventing waste from ending up in landfills that contribute to the release of methane and overall pollution (Environmental Protection Agency [EPA], 2015a).

Feed Hungry People

If food waste is unable to be reduced through source reduction methods, schools may consider distributing excess food to hungry individuals. As of 2015, The U.S. Department of Agriculture (2015) estimates that 30-40 percent of food produced in the U.S. is at some point considered wasted. The majority of this percentage is food that can still be eaten. However, too often consumables end up in landfills rather than in the hands of those that could benefit from it. There are a variety of ways that schools can donate food. It can be given directly to individuals, neighborhood-based organizations, soup kitchens, food pantries, and/or food shelters. Some organizations will even pick-up excess food which can reduce the transportation costs a school would otherwise incur for delivery. Two groups/resources that can assist with food waste reduction and donation is the Food Recovery Network[9] and the Food Waste Reduction Alliance.[10] Aside from benefiting individuals, this recommendation from EPA (2015b) reduces food that enters landfills and saves the school money. Food donations also have the ability develop partnerships with the surrounding community. Prior to implementing such strategies, research and look into guidelines

[8] www.leanpath.com
[9] http://www.foodrecoverynetwork.org/
[10] http://www.foodwastealliance.org/

and regulations[11] to address safety concerns.

Feed Animals

A third option for handling food waste is using it as animal feed; this is especially suited for food waste that is inadequate for human consumption. Food wastes might be donated to a local zoo or animal shelters or to farms or other livestock research facilities that are managed by the school. However, precautions need to be considered for proper handling of the food waste to be used as animal feed. Before delivering food for animal feed, research state legal guidelines for the transference of food. Each state will differ regarding the amount of food allowed to be donated, types of feedstock allowed, and the frequency of donations (EPA, 2015c).

Industrial Uses

The fourth tier of the Food Recovery Hierarchy is reducing food waste through industrial methods (EPA, 2015d). This type of food reduction uses food waste to generate an alternative energy source. Types of food waste that could be recovered are fats, oil and grease that can be rendered and made into another product, such as biofuels. Another recovery method is anaerobic digestion, which can accept a wider range of organic waste. *See Anaerobic Digestion, page 22.*

Composting

Compost is formed by mixing different types of organic waste such as food residuals, yard waste, manure, animal bedding, and other builking agents in the right ratios to form piles (static pile, bin-systems), rows (windrows), or vessels (in-vessel, vermicompost, black soldier fly). With time and the correct nitrogen to carbon ratio, organic materials break down in three phases in the traditional composting process; mesothilic or moderate temperature phase (lasting a couple of days), thermophilic phases or high-temperature phase (lasting a few days to several months), and a cooling and maturation phase (lasting several months) (Trautmann & Olynciw, 1996). Vermicompost and Black Soldier Fly composting are similar to traditional composting, in that both convert organic waste into valueable end products for use as plant inoculent (castings, compost tea), soil amendment, or even animal feed (black soldier fly larvae).

[11] http://law.uark.edu/documents/2013/06/Legal-Guide-To-Food-Recovery.pdf

Permitting and Other Regulatory Issues

Regulations for organics recovery are established to protect the health and well-being of people and their environment and encourage the diversion of organic waste from entering landfills while also creating a useful product and service Ideally, regulatory standards minimize any strains that affect an institution's costs that are incurred (Governo, Gaskin, Faucette, & Borden, 2003). Depending on the State, institutions that produce food waste and generate compost solely on-site that is not for sale could be either exempt or fall under minimal permitting standards for demonstration composting. If organic waste or the finished compost leaves the generating facility at any point, there are certain operational standards to be aware of when applying for a composting permit. Whether demonstration or operational, if the compost is sold, it is important to note that each State has applicable laws/statutes and environmental regulations for waste, water, and air, as well as occupational safety, and product registration.

When determining where to locate a compost facility, find a site that is located away from surface water bodies and at a location that will mitigate the flow of surface water through the piles. By taking these parameters into account, the chance that runoff from the site will enter surface water will be reduced. Regarding water quality, some States may require that composting facilities minimize the production of leachate and runoff by designing storm water management features such as run-on prevention systems, which may include covered areas (roofs), diversion swales, ditches, or other features designed to divert storm water from areas of feedstock preparation, active composting, and curing. It is key to design and construct pads that are curbed or graded in a manner to prevent ponding, to control run-on and runoff, and to separately collect and convey all storm water and leachate to separate storage or holding systems.

To learn about composting permitting and regulatory considerations, visit and inquire with the relevant state departments[12] that manage composting programs or the State Chapter of the U.S. Composting Council.[13] Agencies that house these programs will vary and composting could be housed within the Solid Waste Division of a State Health Department or the State Department of Environment Quality. As the organics recovery industry continues to grow, regulatory agencies such as the South Carolina Department of Health and Environmental Control (SCDEC) are updating regulations in order to provide a clear path toward permitting food waste composting facilities while offering outreach and technical assistance (Chesley, 2015). For example, the North Carolina Department of Environmental Quality (NCDEQ) employs an Organics Recycling Specialist who focuses on recycling issues with the private and public sector and offers assistance to schools. At North Carolina State in Raleigh, NC, the NCDEQ has provided assistance when conducting a waste audit on campus for the purpose of transitioning their off-site composting program to on-site methods. Permitting applications may require a plan for processing compost, and during the planning of a facility, the State departments may conduct site visits to provide guidance and technical assistance to schools.

At the local level, municipalities may have an organics recovery program and offer technical assistance to educational institutions. For example Greenville County, SC's (home of Furman University) Solid Waste Division states on their website[14] that they "actively promote

[12] For information on state regulations and programs, visit the U.S. Composting Council's directory at: http://compostingcouncil.org/state-compost-regulations-map/

[13] http://compostingcouncil.org/statechapters/

[14] http://www.greenvillecounty.org/

composting" by providing resources for Greenville residents including composting instructions and a list of businesses in the area that offer composting as a method of organics recovery. Local government agencies that manage organics will differ and organics recovery information may be located on departmental websites such as waste management, public works, and planning. Local regulations for a new facility falls under land use, zoning, or conditional use permits, construction and occupancy, city/county code, stormwater, solid waste management, and hauling franchise agreements (Perszyk, 2015:2).

Aside from abiding by the proper regulatory agencies, connect with surrounding local and regional schools that have completed the permitting process for a composting facility. It will be useful to listen to lessons learned while determining the method and strategy for navigating the permitting process with as much ease as possible.

Institutional Partners

The successful planning and implementation of an organics recovery program depends on the demonstrated political will, partner commitments, and financial and volunteer support from internal and external groups. Some of the essential partnerships are among internal departments such as facilities management, the grounds department, dining service providers, waste reduction, recycling, sustainability staff and students. Other participating partners include administration, research staff/faculty, building managers, garden/farm/arboretum staff, residence halls, and other external stakeholder. Schools that are able to devote an ample amount of time for coordination may form special committees or councils that meet regularly to oversee organics recovery.

Below are a few questions to consider answering when establishing partnerships:

Georgia College and State University, Milledgeville, GA

Enrollment Size Category: 5,000 - 9,999

During Spring 2014, Georgia College and State University Environmental Science students, in coordination with the Campus Sustainability Director and Environmental Science and Biology Professors, initiated organics recovery planning. Here, students advocated for, planned, and assisted with the organization of an $180,000 in-vessel composting program. This project was selected by the Campus Green Initiative Committee of the Student Government Association to be funded by the Student Green Fee Grant Program. Students submitted a funding proposal that included a cost-analysis to determine the project feasibility and an implementation plan. Once constructed, the project will integrate student project leaders (two part-time workers) with Facilities Operations staff and Dining Services staff, to ensure that waste is handled and transported to the composting site five days a week. In addition, student workers proposed to produce educational materials and programs for other students and the community, along with a best-practices handbook to ensure continuity of the composting operations.

INSTITUTIONAL PARTNERS

Who should be included in organics recovery decision-making?

- ☐ Administration
- ☐ Dining Services
- ☐ External Stakeholders (Engineers, Technical Advisors, Planners, City/County Waste Management/Public Works, State Regulatory Agency, Neighborhood Partners, other local/regional Educational Institutions)
- ☐ Facilities Management (Grounds Department, Waste Reduction, Recycling)
- ☐ Faculty/Staff/Office Management
- ☐ Garden/Farm Manager
- ☐ Residence Life
- ☐ Student groups
- ☐ Sustainability Program

How should decision making and coordination occur?

- ☐ Existing Sustainability Committee/Council
- ☐ Special Composting Subcommittee/Taskforce

How are staff and volunteer responsibilities established?

Identify funding capacity and dedicated individuals to fulfill:

- ☐ Part-time/full-time paid staff assignments
- ☐ Paid/volunteer student work assignments
- ☐ Committed research faculty

Funding Mechanisms

Organics recovery programs can be financed through a combination of internal and external funding sources. Once the potential institutional partners are identified, it's advantageous to then connect with these partners and further explore available funding opportunities. Funding opportunities will vary depending on factors such as state, regional, local, and institutional programming. In addition the examples shared here and in the Compendium of Organics Recovery Programs for Colleges and Universities, connect with other institutions that have established organics recovery through groups such as the College and University Recycling Coalition (CURC).[15] Through this professional association, sustainability coordinators and recycling staff can gain experiential knowledge and learn about financing examples, then consider these lessons learned to best suit their own school's organics recovery program.

To learn about external grant funding opportunities, visit and inquire with the relevant state departments[16] that manage composting program information. Composting programs are housed within agencies such as the Solid Waste Division within a State Health Department or the State Department of Environment Quality. Often colleges and universities can apply for grants through State administered recycling programs. It is not uncommon for schools to team up on grant applications through public-private partnerships; which many grant programs promote. Additionally, local municipalities may offer grant funds through agencies such as local health departments and municipal waste management services. For example, at the Southern Illinois University at Carbondale, a small portion vermicomposting program was financed in part from grant funds received from the Jackson County Health Department, while the other portion was funded by a $150,000 grant from the Illinois Department of Commerce and Economic Opportunity. When grant opportunities are identified, students conducting coursework in programs such as Public Administration and Nonprofit Management can gain real-world experience in grant-writing while saving staff the time and money spent to develop and submit a grant application.

An internal source of funding for capital start-up costs of organics recovery projects has been demonstrated through "green fee" programs where dedicated student fees are allocated toward sustainability projects. For example, at Georgia College and State University in Milledgeville, GA, students applied for $183,000 to fund an in-vessel unit to compost the university's food waste.[17] At the University of Tennessee – Knoxville, funds have been received to purchase equipment to support their windrow composting operation. To learn more about existing "green fee" programs, the Association for the Advancement of Sustainability in Higher Education (AASHE) provides a summary listing[18] of student fees for sustainability programs.

[15] For information on CURC, visit: http://curc3r.org/
[16] For information on state regulations and programs, visit the U.S. Composting Council's directory at: http://compostingcouncil.org/state-compost-regulations-map/
[17] Information on GCSU's proposal with project budget: http://web1.gcsu.edu/green/docs/grfee/cgif_1409_wright_compost.pdf
[18] Information on student fee for sustainability programs: http://www.aashe.org/resources/mandatory-student-fees-renewable-energy-and-energy-efficiency

Other considerations for funding organics recovery programs can be from income received from services offered to the community, such as hauling services for small local businesses, the sale of finished compost, and offering educational opportunities. If a local business can be identified, a vehicle for transport, and the staffing is available, an option could be the diversion of organics by charging for hauling services, while receiving income to fund the staffing of a demonstration composting program. For the University of Louisville's bin-system composting program, the project manager has established an agreement with a local coffee chain to pick up coffee grounds once per week at a price of $500 per month. Also, schools can earn income by offering learning opportunities to community groups through workshops hosted by the school. As an example, Furman University offers a composting workshop series to community members at a price of $35 per person.[19] Although workshop fees may be small, this can result in a substantial amount of funding for small-scale demonstration composting programs. Other schools might finance their programs through the sale of finished compost, such as Clemson University who sells landscaping mulch, leaf mulch, and composted food waste to the community.[20]

A benefit of networking with nearby institutions of well-established organics recovery programs is to absorb their lessons learned while even having the chance opportunity to receive equipment donations as upgrades occur and older equipment is no longer needed. For schools considering off-site centralized composting arrangements, partnership with surrounding schools can create cost savings by negotiating multi-agency contracts with hauling services. For example, in the Charleston region of South Carolina,[21] the combined organics waste of multiple schools could guarantee a large amount of organic waste, thereby increasing their negotiating power to settle on a lower rate with a local hauling service.

Whether on- or off-site composting, the operational costs of a school's organics recovery program will depend on dedicated funding through existing institutional budgets for operations support staff. Food waste must first be collected at dining facilities, where kitchen staff is trained to sort and separate organics. By relying on back-of-house handling of food waste, the chances of contamination are reduced since diners are no longer responsible for handling their own waste. Other composting operational staffing is needed for the transport of collected food waste. These jobs can be filled by existing staff (dining services, facilities or farm management, and, in some cases student labor – paid or volunteer). Student staff could be hired as part of sustainability program funds, or other research funds associated with agriculture, environmental science, or engineering studies (just to name a few). Donated time and physical labor from faculty, staff and students include volunteer time from clubs, student groups, required coursework activities, and research associated with organics recovery. If a school utilizes off-site centralized composting, transporting food waste to off-site facilities would need to be contracted.

[19] For information on the Furman University Farm, visit: http://www.furman.edu/sites/LiveWell/EatWell/Pages/FurmanFarm.aspx

[20] For information on Clemson's compost for sale, visit: http://www.clemson.edu/facilities/recycling/composting/sale.html

[21] One example of a multi-agency contract is through the Medical University of South Carolina, the College of Charleston, The Citadel, and Trident Technical College. More information here: https://www.musc.edu/vpfa/eandf/sustainability/compost.htm

FUNDING MECHANISMS

What are the financing approaches to consider?

- ☐ Dedicating an internal operational budget (facilities, dining services, sustainability funds)
- ☐ Rely on donated time/equipment/work (students, faculty, staff)
- ☐ Apply for external funding opportunities (state or local grants, private foundations)

What type of labor will be used?

- ☐ Part-time/full-time paid staff assignments
- ☐ Paid/volunteer student work assignments
- ☐ Research faculty/staff

What costs should be considered?

- ☐ Preliminary studies (waste characterization study/audit, feasibility study, cost-benefit analysis, planning and design)
- ☐ Capital costs (site preparation, construction/installation of facility, tools and equipment)
- ☐ Operational costs (fuel for transportation of feedstock, labor, electricity, hauling contracts)

What savings should be considered?

- ☐ Savings from reduction in landfill fees
- ☐ Savings from reduction in compost purchase costs
- ☐ Changes in greenhouse gas emissions

Operational Models

The operational model for organics recovery will be unique to each school based on the combination of institutional participants, funding mechanisms, student involvement, academic programming, and community partnerships. Depending on the type of composting, the duration of the operational process for organics recovery will vary from a few days to several months. The size of the institution does not necessarily dictate the scale of the organic recovery program; some campuses employ several methods of composting that are both institutional (large-scale) and demonstration (small-scale) and/or combinations of both (Pompei Lacy, Sizemore, Heberle, & Norton, 2015).

This section provides an introduction to various scales of on- and off-site organics recovery methods that is interspersed with profiles of schools that have existing programs. When considering the appropriate operational model, it is useful to understand common program types, methods, and source inputs. Demonstration Composting (small-scale) is ordinarily coupled with demonstration gardens/farms and refers to composting that is visible to individuals while showcasing how to compost at home or other locations. Composting assistance may be generated through volunteers, interns, and at times, paid staff**.** Institutional Composting (large-scale) refers to composting efforts that the college/university manages from large-scale sources.

On-site Organics Recovery Methods

On-site organics recovery is conducted directly on the school's campus or a college/university-owned facility. While the "On-site Organics Recovery Methods" section describes the following listed methods, keep in mind that these same methods may also be conducted on off-site facilities through contract with waste management services or in partnership with community-based organizations.

Aerated Static Piles consists of placing large piles of compost (non-windrow) over pipes to allow air to circulate. This is a popular form of composting because the design structure is fairly simple, there is low operation labor, and lower capital costs than other forms of composting (EPA, 2015e).

Anaerobic Digestion is a process where microorganisms break down organic materials in the absence of oxygen, thereby producing biogas and soil amendments. Biogas can be used as a source of energy similar to natural gas (EPA, 2015d). One example includes the use of a biodigester.

Bin-System is a small- scale operation where organic waste is placed into containers or bins in order to retain the heat and moisture from compost. Commonly, bin-system composting is built from either wooden pallets, chicken wire, recycled lumber, and/or concrete blocks to make a four-sided container (EPA, 2015e).

Black Soldier Flies, Larvae Composting is similar to vermicompost (see below) but instead of worms, black soldier fly larvae are used. This type of composting has numerous benefits. For example, these flies eat a wide-range of food waste and black soldier fly larvae lowers disease threats in compost because they prevent unwanted insects from laying/hatching eggs in the compost (Bullock et al., 2013).

Compost Tea is derived by steeping finished compost to extract the liquid residue. Compost tea is a beneficial asset to enriching soil due to its high amounts of microorganisms (Pane et al., 2012).

In-Vessel composting is generally used to isolate organic waste into a container, such as a drum, silo, or even an enclosed building. In-vessel containers control the oxygen, temperature, and moisture level of the compost (Cooperband, 2002). These containers also have a tool that is used to turn the compost periodically (BioCycle, 2011).

Vermicompost uses red worms that are placed in the organic material to assist with the decay of the organic waste. The requirements for vermicomposting include worms, worm bedding, organic matter, and a bin to keep the worms enclosed (Dabbs, 2009).

Windrow Style is placing organic waste in long, narrow piles that allows waste to form compost. Windrows are the most common form of composting nationally due to their low operation.

Aerated Static Pile

Types	Passively Aerated Pile, Aerated Static Pile (ASP), Extended Aerated Static Pile (EASP), Static System, Positive (forced-draft) Active ASP, Negative (induced draft) Active ASP, Bi-directional Active ASP, Bin-system
Land/Space Requirements	Land requirements vary depending on the method used
Type of Feedstock	Food scraps, paper products, yard trimmings
Feedstock Restrictions	Animal byproducts, oil/grease
Feedstock Capacity	Less than 1 ton – 250 tons per day*
Retention Time	90 days (EASP)** – 6 months***
Notable Colleges/Universities	Appalachian State University (forced-draft), Clemson University (forced-draft), Georgia Southern University (Wire bin-system), Furman University (4 bin-system)
Technology Providers and DIY Designs	Proprietary technologies: Engineered Compost Systems, GORE Cover Technology, and Managed Organics Recycling, O2 Compost, Green Mountain Technologies.**** DIY Designs: Two-Bin Composting Unit, Designs for Composting Systems
Cost Considerations	Large Scale: Planning and Engineering ($25,000 – 50,000), Purchase of System Containerized ASP ($100,000 - $700,000) Small Scale: Planning and Engineering (<$25,000), Purchase of System ($10,000 - $25,000) Fuel for vehicles and equipment, labor, maintenance and storage facility for large equipment****
Roles and Responsibilities	Program/Recycling Coordinator, Student Coordinator (if student labor is used), Recycler/Hauler (to transport feedstock), Recycler (mix and add feedstock, transport finished compost), grounds/landscaping or farm staff (apply compost to grounds)
Essential Tools, Equipment, and/or Inputs	Front-end loader, skid-steer loader, farm tractor, or excavator. Screen (deck (flat), disc, grizzly, orbital, star and trommel screens), biogenic or synthetic covers, vertical mixer, shredder, grinder, trommel, compost baggerpH meter ($8 for basic to $225 for digital), soil thermometer ($7 for basic to $287 for digital)
Benefits	**Static Systems:** Lower capital and maintenance costs Less equipment and staffing No electric power needed **Aerated Static Piles:** Reduced space requirements Biofiltration can help control odors Shorter compost retention times****
Challenges	**Static Systems:** Large area required Feedstock restriction of putrescible materials Difficulty controlling odors Longer process times **Aerated Static Piles:** Higher capital costs Potential for faster moisture loss Feedstock should be mixed before adding to pile Higher operator skillsets needed Electric supply needed****
Common Terms	Active, passive, positive, negative, bidirectional, enclosed, containerized, covered, open, closed
Educational Resources	Static Pile Composting Video, The Specification of Static Pile Testing, Static Aerated Pile Composting-An Odour Free Option

*Green Mountain Technologies, **Siegrist, 2014, ***EPA, 2015e, ****Platt et al., 2014a

The aerated static pile (ASP) process is an example of a composting system where the substrate, such as food waste, is mixed with a bulking agent, such as wood chips, and formed into a large pile (Haug, 1993). ASP composting is increasing in the United States composting industry due to the potential for more consistent processing and, when covered, for potential improvements in odor management and storm water runoff quality (Coker & Gibson, 2013). The bulking agent creates the structural stability while maintaining air voids without the need for periodic agitation. Typically, no agitation or turning of the static bed occurs during the compost cycle, and the piles are formed on a batch basis (Haug, 1993). Detention time in the aerated pile is usually about 21 days, after which the pile is dismantled and curing occurs up to six months until the compost has matured. Static pile composting is usually limited to quantities less than 1,000 tons per year due to the large land area required (Platt, Goldstein, Coker, & Brown, 2014a: 13). For composting brushy and woody materials, piles are built and allowed to decompose for 2-3 years with little or no mixing or turning. As static systems, it is very important that the mixing ratios of the feedstocks be correct when the piles are formed and that the piles have adequate moisture, as fans in active systems induce evaporation easily (Platt et al., 2014a: 16).

Static pile systems can be passively or actively aerated. A passively aerated system is less expensive because schools do not incur the energy costs associated with powering fan systems to aerate the pile. However, it take less time to compost an actively aerated pile compared to a passively aerated system; thus requiring less space. Additionally, actively aerated systems can contain odor control systems to reduce potential nuisances.

Actively aerated composting systems (positive, negative, or bidirectional) use fans and blowers to move air through the compost pile to maintain aerobic conditions. In a positive aeration system, air is introduced through perforated pipes at the base of the pile then the air migrates upwards, carrying entrapped gases and moisture up and out of the pile. In some positively aerated systems, a layer of compost or a fabric cover is used to help manage odors and to retain heat and moisture in the pile. Negatively aerated systems pull "exhaust" air downward through the pile and into the aeration pipes. Due to the high temperature and moisture content of the air, it is usually cooled prior to entering an odor control system. Cooling the air condenses the moisture, so condensate management systems are needed. Odor control systems can contain biofilters or chemical scrubbers. Bidirectional systems are a combination of positive and negative aeration systems with more advanced ducting and controls to more efficiently control temperatures in the piles (Platt et al., 2014a: 15).

Aside from the passive vs. active pile types, another variation in ASP systems is that they can be in an open or closed area. Piles may be closed under pavilion-style or fabric-covered roofs, containerized systems enclosed by concrete bins, inside modified shipping containers, or covered with breathable fabric covers (Platt et al., 2014a: 16). Covered systems are considered batch systems because once covered, the pile remains undisturbed in place for the duration of active composting and/or curing. This type of system does not allow for moisture addition, but the covering conserves moisture evaporation in the composting process, so moisture addition is not usually needed. Covered ASPs can scale from a few thousand tons per year to over 200,000 tons per year (Platt et al., 2014a: 90).

There are various technologies available from companies that can accommodate different size capacities. Small-scale aerated compost bins are available and tend to be batch-oriented systems, capable of composting 3-20 cubic yards (CY) per batch (or per bin) and can include an active blower system or passive set-up. Systems can be filled and emptied manually or with a small skid steer loader or tractor. Small bin-systems can be reasonably priced, and are available for purchase and construction, or as do-it-yourself kits that can be constructed by leveraging local resources and paid/volunteer labor.

The type of materials for the operation of an ASP composting facility can range significantly depending on the amount of feedstock a school is processing. Static pile systems such as bin-systems can be as small as 4 CY per bin or large static pile systems that can handle up to 1,500 CY per day (Platt et al., 2014a: 16). Large static piles are normally built using front-end loaders, skid-steer loaders, farm tractors or excavators. With large volumes, additional automated equipment may be needed such as screeners or compost baggers. For smaller ASP systems such as the bin-system, inexpensive tools for manual labor such as a shovel, thermometer, and wheelbarrow can be used.

To determine where to site the ASP, find a site that is located away from surface water bodies and at a location that will mitigate the flow of surface water through the piles. By taking these siting parameters into account, it will reduce the chance that runoff from the site will enter surface water. This also reduces the chance that surface water will flow onto the compost piles (Harrison, Bonhotal, Schwarz, & Wellin, 2005). Moderate to well-drained, hard-packed soils with gentle slopes of about 2 percent are well suited to prevent ponding of water. Check with the USDA Natural Resources Conservation Service[22] for your area's soil information. Be sure the site is out of the floodplain or wetland. Check specific State rules to determine whether the siting of your facility would fall under specific regulations.

Regardless of State requirements, being mindful about the siting of a facility helps mitigate potential water quality issues and odor nuisances. A high water table may lead to flooding of the site which makes equipment access and operation more difficult. Flooding can also promote anaerobic conditions which may lead to malodors. Consider the distance of the site you're considering to neighboring areas since odor is likely the main reason that neighbors may complain about the operation. Determine the dominant wind direction, and if most air flow is directed toward populated areas, look for another site.

Some considerations when determining space requirements of the ASPs include area for the active piles, curing piles, storage of bulking materials, area for screening and bagging, and a space to store equipment. The area required depends on the volume and types of materials processed, the size and shape of piles, the type of technology used, and the time required to complete the process. Static piles and turned windrow methods require more land than forced aeration and in-vessel system methods (Harrison et al., 2005:3). For some rough estimation, determine the following: Weight and type of inputs (feedstock) to process on a weekly basis and/or the weight of outputs (finished compost) desired. Based on this amount and other aforementioned space considerations, the footprint and volume capacity of the facility can be determined. One of many helpful tools to determine space requirements is the Cornell Waste Management Institute's factsheet on compost pads.[23]

It is essential to have a committed staff member that has the knowledge and ability to organize the planning, construction, and facilitate the operation of the facility. First, this person should identify both internal and external stakeholders that may support and participate in the program. If small-scale composting is being considered, it is essential to equip all participating parties with the instructions and training on how to accomplish their assigned tasks throughout the composting process. If large-scale ASP is being considered, other partnership opportunities among internal and external departments are key to acquiring initial funding and ultimately to the success of the composting operation. Consider harnessing the knowledge and expertise of recycling/waste reduction, dining services, physical plant/grounds crews, cooperative extension, agriculture, or even external community groups to contribute to the process. Reach out to the appropriate State-level department[24] that can offer assistance with permitting and siting and, if applicable, identify potential grant funding opportunities. If deemed appropriate, convene a committee of department representatives and hold regular meetings to get the ball rolling

[22] http://www.nrcs.usda.gov/wps/portal/nrcs/soilsurvey/soils/survey/state/

[23] http://cwmi.css.cornell.edu/compostfs6.pdf

[24] For information on state regulations and programs, visit the U.S. Composting Council's directory at: http://compostingcouncil.org/state-compost-regulations-map/

while working through the questions that need to be answered.

Capital costs for ASP can be less than turned windrow systems, but only if the expense of a dedicated windrow turner is not incurred. Small-scale ASP systems are usually below \$10,000-\$25,000 each (Platt et al., 2014a:90). Actively aerated systems purchased from technology providers can have significant capital costs, which tend to be higher for tunnels, containers, and bags (Platt et al., 2014a). Operating costs can be less, as they are less labor-intensive, although electricity costs can be significant in larger facilities (Platt et al., 2014a: 16). Other operating costs include staff salaries and training and energy costs. Staff training encompasses how feedstock is transported and mixed, methods of monitoring and maintaining the piles, and harvesting, applying and/or distributing the finished compost. Energy costs (1/3 the energy) are associated with fuel for equipment and powering any fans or blowers (Siegrist, 2014).

Georgia Southern University, Statesboro, GA

Enrollment Size Category: 20,000 and above

A composting pilot was launched at Georgia Southern University (GSU) in summer and fall 2015. The project was organized by Brandon Blair, a Masters of Public Administration Graduate Assistant (GA) for the Center for Sustainability with the help of one undergraduate intern and many student volunteers. The group first concentrated on composting research and included a site visit to nearby University of Georgia to study their composting program. The student involvement element of the composting project has been critical to its success to date; the Center for Sustainability, facilities, and other departments do not have a dedicated staff position that focuses on composting.

Photo Courtesy of Georgia Southern University

The purpose of the pilot composting program at GSU was to inform and educate about the value of composting, and identify the best management techniques for a program expansion. The small-scale low-cost design (less than \$500 in materials) is composed of 4 ft. x 4 ft. wire mesh bins that are mobile, yet durable enough to handle a mixture of food waste from one dining hall and woodchips from the campus grounds. The GA's responsibilities range from supervising two undergraduate interns to training and monitoring Environmental Biology student volunteers who are required to complete a three-hour service learning requirement per semester. Volunteers complete tasks such as mixing feedstock, turning piles, monitoring temperature, and harvesting finished compost after a 3-4 month period. Through experimentation at the Campus Community Garden, ~~the~~ students even designed an innovative wheel-screen made of recycled bike rims, wire mesh, and castors on a small wooden frame. For oversight, the GA works alongside the Director of the Center for Sustainability to build partnerships with kitchen staff to collect pre-consumer food waste and facilities management to transport waste to the nearby composting site.

Through this low-budget yet time-intensive program, GSU has had the opportunity to educate and collaborate with students, faculty, and staff about the value of sustainability, while preparing facilities management to discuss the possibilities of ramping up the program to accept larger amounts of organics. As they approach one year of the piloted bin-system, GSU is exploring the expansion of their organics recovery program. By leveraging coursework of Public Budgeting students of the Masters of Public Administration program, a project team is conducting a location-specific cost-benefit analysis that compares methods, including on- vs. off-site composting. Once the analysis is completed, staff will continue discussing the feasibility of program expansion and potential funding mechanisms, such as the Sustainability Fee Grant program, which funds sustainability projects up to \$100,000.

Appalachian State University, Boone, NC

Enrollment size category: 10,000 – 19,000

Photo Courtesy of App State University

In 1999, composting at Appalachian State University (App State) began as a student-driven initiative using a small static demonstration pile that accepted pre-consumer food waste from one cafeteria, one coffee shop and occasional clippings from the Biology greenhouse. In the first year, 18 tons of food waste and coffee grounds were collected. With interest from Sustainable Resource Management students, the program was upgraded during a semester project by adding aeration to the pile. Aeration was resourcefully achieved through low technology and cost effective reuse of an old blower motor salvaged from the physical plant and some perforated pipe. By 2006, the school averaged 25 tons of food waste collected per year and continued to expand. By 2010 an average of 100 tons of food waste was collected per year.

In 2010, the University made the decision to invest in a facility upgrade, as the old system had reached its capacity to handle the increase loads of food waste and did not meet the requirements set by the North Carolina Department of Natural Resources (NC DENR). In 2011, the university completed a four-bin forced aeration facility in partnership with Advanced Composting Technologies, Inc. to expand their capacity from 100 to 275 tons. Since then, the University has expanded its operations to accept post-consumer waste from major events at the student union (2011), football stadium (2014), and the central dining facility (2015).

For the new forced aeration facility, App State is permitted through NC DENR to operate a Small, Type III Solid Waste Compost Facility. By abiding by the permit conditions, App State is ensuring that the facility is operated in such a manner that erosion and runoff from the site is controlled; leachate and runoff is managed so that ground or surface water quality isn't adversely affected. Additionally, a permit through the NC Division of Water Quality had to be obtained to manage any stormwater or wastewater runoff. The Compost Facility Permit also requires App State to conduct regular testing and reporting on temperatures, moisture levels, aeration intervals, and the amount of materials composted in tons. This annual report is submitted each year to the NC Division of Waste Management.

Partners that have participated in the planning, construction, and operation of the facility include New River Light and Power (the local utility provider), and departments within App State which include Physical Plant, Food Services, Design and Construction, Sustainability Office, Sustainable Development, Technology Department, and Biology. The facility has also broadened the scope of research opportunities for students and faculty which include hands-on learning opportunities. The finished compost is used on campus by App State's Landscape Services, in the university's greenhouse, and its University Farm.

Anaerobic Digestion

Types	Covered Lagoon, Complete Mix, Plug Flow, Fixed Film*
Land/Space Requirements	Land requirements depend on type of method
Type of Feedstock	Food waste, municipal wastewater solids, fats, oils, grease, livestock manure, dairy, paper, and/or leaf and limb
Feedstock Capacity	Fixed Film (2-3 days) Plug Flow Digester (15 or more days) Complete Mix Digester (15 or more days) Covered Lagoon (40-60 days)**
Notable Colleges/Universities	Ohio State University (OH)
Technology Providers	Quasar Energy Group
Cost Considerations	Costs for initial technical and economic feasibility assessment Capital costs Maintenance and repair costs.
Roles and Responsibilities	Consulting Firm/Developer/Partner, System Designer/Engineer, System Manager, System Operator (monitoring, repair, and maintenance) Student Coordinator (if student labor is used), Recycler/Hauler (to transport feedstock)
Essential Tools/Equipment/Inputs	Feedstocks, Solid/Liquid Separator, Digester Tank, Gas Cleaning Equipment, Generator Set (Michigan Farm Bureau)
Benefits	Outputs of energy production and nutrient dense fertilizer Odor control/reduction Reduced water contamination due to liquid effluent runoff Reduced pathogens due to controlled high temperature treatment of feedstock
Challenges	High capital costs and maintenance costs High skill sets needed for monitoring, maintenance, and repair Requires daily monitoring Permitting/Zoning requirements
Common Terms	Tank, vessel, bio-gas, methane, nitrogen, hydrogen sulfide, pre-treatment, digestion, gas upgrading, digester treatment
Educational Resources	U.S. EPA: A Manual for Developing Biogas Systems at Commercial Farms in the United States

*Illeleji, Martin, and Jones, 2008 ;** Anaerobic Digestion 101, 2016,

Anaerobic digestion is a type of composting method that breaks down feedstock in an oxygen free tank, vessel, or environment (What is Anaerobic Digestion, 2016; Anaerobic Digestion 101, 2016). This method produces a biogas that is used for energy for either generating electricity or heat. The biogas is primarily a mixture of methane (50 percent - 80 percent) and carbon dioxide (20 percent - 50 percent) but can also contain hydrogen, carbon monoxide, nitrogen, and/or hydrogen sulfide (Anaerobic Digestion Basics, 2013). Anaerobic digestion occurs in four stages: pre-treatment, digestion, gas upgrading, and digester treatment. There are also two types that vary by temperature and retention time: mesophilic and thermophilic. Mesophilic digestion requires lower heat (68 degrees Fahrenheit - 104 degrees Fahrenheit) and longer retention time (1-2 months) than thermophilic digesting temperature (122 degrees Fahrenheit -140 degrees Fahrenheit) of a two week retention time. (Biomas, 2011). This type of method allows for a wide range of feedstocks including food waste, municipal wastewater solids, fats, oils, grease, livestock manure, dairy, paper, and/or leaf and limb (Anaerobic Digestion 101, 2016). The overall process depends upon the nature of the content being composted, temperature, retention time, pH level, carbon to nitrogen (C:N) ratio, and mixing method used (Monnet, 2003; Anaerobic Digestion Basics, 2013). Aside from the recovery of biogas, the left over, more stable substrate can be recovered as a fertilizer or composted and reused for beding purposesl (Illeleji, Martin, & Jones, 2008).

As is with every composting method, anaerobic digestion has advantages and disadvantages. Anaerobic digestion can add extra value to the composting process by creating energy (What is Anaerobic Digestion, 2016; Anaerobic Digestion 101, 2016). It also has the ability to control odor by offering an enclosed storage space for waste (Compost: How to Make it and How Much to Use, 2016). If the goal is to profit from organic waste diversion, this method yields higher revenues compared to other methods (Tetra Tech EBAMetroVancouver, 2014). Among the other positive attributes are the ability to handle large quantities of feedstocks and requiring a lower C:N ratio than other methods. However, anaerobic digestion requires high capital and operational costs due to its complexity. This method requires costly specialized equipment and highly skilled labor (FOR Solutions, 2014; Compost: How to make it and How Much to Use, 2016). Anaerobic digestion can also raise safety concerns due to the gas being highly combustible. If a school were to utilize a similar method on-site, the digester would need to be located a safe distance from human activity if an accident were to occur (Anaerobic Digestion 101, 2016). However, shipping organics off-site to an anaerobic digester may be more ideal for a school wanting to use this type of method. An example of an off-site arrangement is between Purdue University and the City of West Lafayette (*See Off-Site Composting, page 40.*)

Ohio State University (OSU) in Columbus, OH has implemented anaerobic digestion on-site. In 2012, the Ohio Agricultural Research and Development Center received a $6.5 million grant from the U.S. Department of Agriculture and the U.S. Department of Energy to test and expand the university-developed anaerobic digestion technology (Espinoza, 2012). The 550,000 gallon digester can annually process 30,000 wet tons of biomass (Espinoza, 2013). Although the digester is located on the campus, it is actually managed by a private company and the energy is sold back to the OSU to power this satellite campus.

Black Soldier Fly Composting

Types	Black soldier fly larvae (BSFL) composting/bio-composting system
Land/Space Requirements	Temperature controlled environment needed with space requirements depending on number of units purchased/built. Household units can be ~2 cu. ft. with a maximum digestion capacity of 5 lbs. per day. Larger units can require space of ~4 cu. ft. with a maximum digestion capacity of 21 lbs. per day.
Type of Feedstock	Food waste (including meat and dairy products), manure
Feedstock Restrictions	Bones
Feedstock Capacity	On average 3 lbs. per square foot of feeding area per day
BSF Life Cycle	Egg: 4 days – 3 weeks Larvae: 2 weeks to 6 months (depending on living conditions) Pupae: 2 weeks Adult: 5-8 days
Outputs	15-20% bioconversion into "grubs" for further processing into animal/fish/reptile feed and/or biofuels, 5% bioconversion of waste into castings* BSF grubs can be dried and pressed to extract oil for biodiesel, and remaining meal can be used as a chicken feed, fish feed, and fertilizer.
Notable Colleges/Universities	Clemson University: Black Soldier Fly Digester, Clemson Sustainable Biofuels Texas A&M University: Forensic Laboratory for Investigative Entomological Sciences (FLIES) Facility, Publications
Technology Providers	ESR International, LLC, BSFL (Phoenix Worms, Northwest Redworms (WA)
Available Product and DIY Designs	The Biopod (plastic), a Pre-cast concrete or lightweight aggregate, The Protapod, 6 Gallon Bio-Composter, Vermiman's DIY BSF Bin, DIY BSF Bin, Build Your Own Black Soldier Fly Larvae Station
Cost Considerations	BSF larvae, any heating costs to maintain temperature controlled environment
Value of BSFL	$4-20/lb. of BSF Larvae $500/ton of BSF dry meal
Roles and Responsibilities	Program/Recycling Coordinator, Student Coordinator, (if student labor is used), Recycler/Hauler (to transport feedstock), Recycler (mix and add feedstock, maintain BSFs, aug larvae, castings, and liquid effluent), farm staff (to apply castings as inoculant)
Essential Tools/Equipment/Inputs	BSFL ($30 - $50 for ~1,000), feedstock, newspaper or other bedding, container and vehicle to transport feedstock
Benefits	The BSF has the ability to thrive in the presence of salts, alcohols, ammonia and a variety of food toxins and process swine, human, and poultry waste. Larvae are self-harvesting. Larvae are high in protein and fat content and can be used for feed. The BSF competes with filth-bearing flies and very effectively blocks their proliferation. BSFs do not have functional mouthparts; therefore they do not bite nor feed, and consequently, are not associated with transmission of diseases** High reproduction rate: Female lays 900 eggs and lives 5 to 8 days).
Challenges	Successful breeding and sustaining a consistent population of larvae. Maintaining temperature range for high productivity. Larvae are not approved by the FDA for use as livestock feed. ***
Common Terms	Black soldier fly (BSF), black soldier fly larvae (BSFL), pupae, adult, digester, bin, grubs, soldier grubs, insects, feed, feedstock, collection bins/jars, leachate, castings
Educational Resources	ESR International, LLC Black Soldier Fly Blog Black Soldier Fly Farming Website
Larvae Composting Farms (by State)	White Oak Pastures (GA), Enviroflight, LLC (OH)

*http://www.thebiopod.com/pages/biopod-plus.html, ,**Dilone, Habbab, Yanikara, et al., 2014,
***http://entomologytoday.org/2015/05/26/black-soldier-flies-as-recyclers-of-waste-and-possible-livestock-feed/

Similar to vermicomposting, black soldier fly larvae (BSFL) composting works by feeding organic wastes to larvae that eat and digest the feedstock resulting in castings and liquid effluent and mature grubs for harvesting. Depending on the temperature range and living conditions, BSFL consumes feedstock that is high in nitrogen (Savonen, 2005) at an average of 3 lbs. per square foot of feeding area per day. In thesummer , it takes about two weeks for newly hatched larvae to reach maturity, but during colder months, this period may extend to six months (Bio-Conversion of Putrescent Waste, 2008). What sets BSFL composting apart from vermicompost is that the larvae can digest a wider variety of feedstocks and reproduction occurs outside of the bin. The larvae spend the majority of their lifetime feeding and storing fat, protein, and calcium required to morph into pupae andadults (Dilone, Habbab, Yanikara, & Jesus, 2014:2). Once ready to pupate, the grubs will self-harvest by inching up a ramp and then dropping out of the bin. At this point, the grubs can be further processed for use as feed, or even extracted for conversion into biofuel. The castings and liquid effluent that result from BSFL can be used as fertilizer or added as feedstock for vermicomposting systems.

BSFL composting can and does occur alongside other composting methods. Similar to vermicomposting, pre-composted materials can be added to a BSFL compost bin to ensure consistency in the processing of feedstock. Also, due to the small-scale capacity of current bins on the market, schools may want to explore other large-scale traditional composting methods such as in-vessel, aerated static pile, or windrow style, while using BSFL composting to enhance organics recovery efforts and support other agricultural or horticultural activities.

Large-scale BSFL composting is possible though the technology to process large amounts of feedstock has not yet expanded in the U.S. According to research conducted at Clemson University, scale ups have many obstacles such as varying O2 and CO2 levels throughout the depth of digesters, temperature sensitivity, harvesting, and moisture accumulation. Currently, there are no large-scale university examples of BSFL composting beyond pilot and research projects nationwide.

When composting with BSFL, first designate a temperature controlled space where the larvae can be housed. Space requirements can be determined by first calculating the anticipated feedstock weight, then the size of the bin to accommodate this volume with additional surrounding space to maneuver around each bin. Whether pre-fabricated or self-made, the interior of each bin must include an evacuation ramp for larvae to self-harvest into a separate container. An added complexity to BSFL composting involves black fly breeding outside of the bin so that a consistent larvae supply is present to consume the feedstock. This requires a closed space that is near the larvae compost bin. Instructions for creating a breeding space vary, but some essential conditions include a light source, an artificial or real plant as a setting for the male and female flies to breed, and a small space for the female to lay her eggs. Female soldier flies typically lay eggs on the surface of exposed nitrogen-rich feedstock (Savonen, 2005). Depending on the set-up, egg laying can occur inside or outside of the BSFL compost bin.

To determine the space needed for composting, estimate the weight of inputs (feedstock) to process on a weekly basis. Based on this initial estimate, figure out how many BSFL composting units that's needed to process the anticipated feed load. An existing space to shelter BSFL while maintaining a consistent temperature year round is required. This space should have electrical hookups to power the lighting when it is time for breeding or any necessary heating units/pads. Pre-fabricated bins can range in size from roughly 2-4 cu. ft. each and can handle food scrap loads from 5-21 lbs. per day. Additionally, when calculating the space requirements, include measurements for extra space for maneuvering around the digesters.

The stakeholders that should be involved in organics recovery vary depending on the organizational structure of a school and continual demonstrated support from key departments. Since BSFL composting is often used to enhance other composting methods, recruit a staff/faculty member that participates in research on entomology or organics recovery methods. This person may have a research interest or knowledge of BSFL composting and thereby could be vested and committed to managing this program. Among key administrative decision-makers, learn where the support and commitment for the capital and operational funding of a BSFL composting program exists. Other roles and departments to consider involving are recycling/waste reduction, dining services, physical plant/grounds crew, cooperative extension, agricultural studies, or engineering programs. With the identification of a common interest and commitment to BSFL composting at the staff/faculty level, BSFL composting could then be incorporated into student projects and coursework for the purpose of creating learning opportunities.

To determine cost-estimates for the appropriate facility/equipment sizing, it is critical to estimate the volume that will be fed to the larvae during a specific period of time (Governo & Faucette, 2005). Other operating costs includes the training and payment of staff to (1) ensure feedstock is transported, mixed, and fed to the larvae; (2) monitor and maintain the facility; and (3) harvest and apply and/or distribute the mature grubs, castings, liquid effluent, and the cost for heating/ventilating the facility.

While determining costs are an important consideration, equally so is taking into account the savings and other positive impacts that results with BSFL composting at your school. Whether on- or off-site organics recovery, the savings from the diversion of organic waste that would otherwise enter the landfill demonstrates substantial progress in overarching waste reduction goals. To figure a rough estimate of financial savings based on your current landfill fees, rates, and amount of food waste diverted, calculate the average monthly weight of the food waste that is expected to be recovered, then project out one year's worth of savings. Additionally, by calculating the amount of grubs, castings, and liquid effluent that will be produced, an idea of the cost savings is calculated by comparing this to the purchase price for fertilizer that would otherwise be incurred. Unlike vermicompost, BSFL composting outputs are comprised more of weight of mature larvae and less of castings that can be applied as soil amendment. If there is more interest in demonstrating savings through a higher output of finished compost, rather than mature larvae, consider a more traditional larger-scale composting method.

While considering BSFL composting, think about both internal and external funding opportunities, including the leveraging of existing programs and volunteer labor. Based on the cost savings, learn where the capital start-up costs and continued operating costs can be drawn from. With the small-scale nature of BSFL composting, consider starting small. For initial research purposes, find a program on campus that could fund the incorporation of BSFL composting into coursework for experimental purposes. If after experimentation BSFL composting has proven to be a viable option for your school's organics recovery program, conduct a feasibility study for expansion. Identify other existing operating budgets could be leveraged to devote toward a portion of staff/faculty salary and the space/electricity to house BSFL. If the feasibility study projects BSFL composting to be an option, look into a funding-source for expansion. "Green Fee" grant program or other sustainability funds could go toward the investment of a larger scale facility. While identifying the funding for such a program is essential, it's vital that there is a commitment from the appropriate administrators that the composting facility is maintained and the end-products that are produced (grubs, liquid effluent, castings) are utilized to enhance agricultural efforts that already exist.

Clemson University, Clemson, SC

Enrollment size category: 20,000 and above

Since 2012, Black Soldier Fly Larvae (BSFL) research has been conducted at Clemson University through a two-four semesters long Creative Inquiry course. During this time, team-based investigations on BSFL digestion for use as biofuel are led by faculty mentors in partnership with the Clemson Biosystems Engineering Program, the Student Organic Farm, and Clemson's Facilities and Maintenance Department. Various types of waste material from campus dining halls and research facilities are placed into the system where the BSFL digest and convert the waste into resources like animal feed, compost, and oil for biodiesel fuel production.

BSFL experts from Clemson have been featured in BSFL composting workshops and have also partnered with local organizations such as the Carolina Farm Stewardship Association and local farms. BSFL digestion is a promising technology utilizing biomimicry to transform organic wastes into value added products. While the technology has proven effective at the pilot scale certain limitations exist in digester scale-up design inhibiting widespread commercial adoption of the technology.

Compost Tea

Types	Aerated and Nonaerated
Sub-types	Commercially purchased (special equipment) or homemade
Land/Space Requirements	This will depend upon the unit you buy or use. Compost tea units requires very little space.
Type of Feedstock	Pre-compost from another source
Mixing Ratios	Anywhere between 1:3 to 1:200 parts compost to water
Notable Colleges/Universities	Guilford College Furman University Kentucky State University
Technology Providers	Soil Soup, Garden Tea Co., Keep it Simple, Inc., Growing Solutions Inc,., Compost Werks!,
Available Products	Storch's Original Vortex Brewer, Geo Tea Compost Tea Brewer , Flo n Grow Brew Compost Tea Brewing System, TeaLab Compost Tea Brewer
Cost Considerations	Compost (if needed), Compost tea vessel (commercially purchased or homemade), pH meter, leaf shredder, soil thermometer
Roles and Responsibilities	Program Coordinator, Student Coordinator (if student labor is used), Recycler/Hauler (to transport feedstock), Recycler (mix and add feedstock, maintain worms, harvest castings), grounds/landscaping (apply castings to grounds)
Essential Tools, Equipment, and/or Inputs	Compost tea vessel, strainer, mixing/stirring tools, containers, pH meter ($8 for basic -$225 for digital), leaf shredder ($100 and up), soil thermometer
Supplemental Tools, Equipment, and/or Inputs	Time, water, strainer (example: burlap sack), mixing/stirring tools, containers to transport liquid to plant's location
Benefits	Control plant diseases Inhibit plant pathogens Adds essential nutrients to plants Adds extra value to composting
Challenges	Unreliable compost tea quality if compost quality is poor Potential for contamination Short shelf life
Common Terms	Castings, compost, liquid, steep, brew, ferment, fertilizer, nutrients, mixing, microorganisms
Educational Resources	Home Composting Made Easy , Compost Tea Production Practices, Microbial Properties, and Plant Disease Suppression , Compost Tea at The Morris Arboretum , UM-Ann Arbor Compost Feasibility Study-University of Michigan, Why Use Compost Tea?, Compost Tea: A Guide to Earth Friendly Soil Conditioning Through Using Compost Tea, LaHave Natural Farms

Compost tea is a liquid by-product derived from finished compost or castings resulting from composting methods such as windrow, aerated static pile, in-vessel, vermicomposting, and black soldier fly composting. The suggested industry standard formula for producing compost tea is 1:1000 part compost to water (Carpenter-Boggs, 2005:61). This formula is used as a guideline to produce compost tea to be used as a plant inoculant in greenhouse facilities. This byproduct is poured over plants to control plant diseases often in the early stages of growth. The liquid contains microorganisms and microbial metabolites that inhibit plant pathogens, trigger plant growth, and give added nutrients (Carpenter-Boggs, 2005; Arancon, Clive, Dick, & Dick, 2007). In order to make compost tea, finished compost is steeped and the liquid is allowed to "brew" or ferment; this brewing/fermentation is a defining characteristic of compost tea. The length of time required for brewing the compost tea depends on which composting method (aerated or nonaerated) is used. For aerated compost tea (most common), fermenting process takes approximately 1-2 days. For nonaerated, this process can take anywhere between 5 days to 3 weeks (Schurell, 2003; Grubinger, 2005; Arancon et al., 2007). Equipment used to brew compost tea can be purchase assembled from composting supply companies (Carpenter-Boggs, 2005) or as a do-it-yourself project using a plastic tub (vessel), compost, and water (Schurell, 2003; Arancon et al., 2007). Compost tea is not the liquid residual that leaks from a compost pile: this is leachate (Grubinger, 2005).

Even though compost tea has been beneficial for some, others question its potential. Studies on the advantages of compost tea are inconclusive because every compost is different, with a diverse range of feedstocks and variables. If the compost used to make the liquid by-product was poor, then the compost tea will most likely reflect the quality of the compost (Carpenter-Boggs, 2005). However, when brewed correctly, compost tea contains billions of beneficial organisms; one application does the work of many applications of regular compost. The result is savings of money and labor and efficiency of getting beneficial organisms into the soil and roots more quickly. Compost tea can also be applied directly to the leaves and flowers of plants. In order to enhance and maximize the benefits of compost tea, do the following:

- use quality compost
- add fermented nutrients
- giving the process adequate time
- control the temperature
- provide oxygen flow (if aerated) checking the pH level
- use proper equipment
- control the rates of application all enhances the product (Schurell, 2003)

As with other composting methods, learn best practices of compost tea by talking to current users and adopting/borrowing methods (Carpenter-Boggs, 2005).

Guilford and Furman College, two notable schools in the southeast region, create their compost tea from finished compost. Furman makes compost tea from compost made through in-vessel, vermicomposting, and bin-system methods. Once the product is complete, the tea is used on crops at the campus garden and farm. Guilford College also makes compost tea from compost made through in-vessel, vermicomposting, and windrow style methods. On Guilford's campus, compost tea is made by aerating a mix of compost and water with a GeoTea system in a 250-gallon container. The finished product is utilized as a fertilizer around the campus grounds and campus farm.

In-Vessel Composting

Types	Enclosed aerated static piles, agitated bed vessels, rotating drums
Sub-types	Continuous, batch, aerated, anaerobic
Land/Space Requirements	Container space requirements can depend upon the size of in-vessel unit
Type of Feedstock	Soil, "bedding" (shredded paper, cardboard, woodchips, etc.), water, food waste, plant waste, manure, animal mortality
Feedstock Capacity	Feedstocks amount will depend upon the capacity of the in-vessel unit
Notable Colleges/Universities	Guilford College Clemson University Furman University Warren Wilson College Davidson College
Technology Providers	X-ACT, Environmental Products and Technologies Corporations, ECS-Engineered Compost Systems, BDP Industries, Green Mountain Technologies, BIOMRF Technologies, Bactee Systems, Nath Sustainable Solutions, BW Organics.
Available Products	X-ACT System's Rotating Drum, EarthTub, The Rocket.
Cost Considerations	Vessel unit, carbon source, maintenance fees, labor fees, pH meter, water.
Roles/Responsibilities	Program Coordinator, Student Coordinator (if student labor is used), Recycler/Hauler (to transport feedstock), Recycler (turn and add feedstock, harvest castings), grounds/landscaping (apply castings to grounds)
Essential Tools/Equipment/Inputs	Vessel unit, carbon source, time, wood/concrete blocks/enclosed material (if making homemade in-vessel unit), labor.
Suuplemental Tools/Equipment/Inputs	Hand tools for manual turning (if unit does not turn), moisture detectors, miscellaneous materials (if making homemade in-vessel unit).
Benefits	Requires less space, less labor, relatively simplistic operations, faster composting times, control odors, control pests, control oxygen level, control temperature, control moisture level, ideal for numerous number of feedstocks, works well for both small and large scale schools, can be used with other types of methods, easiest way to get started, no short of options to consider
Challenges	Capital costs, maintenance costs, complex units may require skill to operate, food waste diversion is confined to in-vessel capacity, unit can break/cause problems
Common Terms	Auger, enclosed aerated static piles, agitated bed vessels, rotating drums, continuous, batch, aerated, aerobic, anaerobic, bin, tumbler, rolling drums, turner
Educational Resources	Guide to Selecting an In-Vessel Composting System, The Science Behind In-Vessel Composting

In-vessel composting is a common form of composting because it can be used where on-site space is limited. This method of composting requires less labor, has relatively simplistic operations, can reach desired temperatures faster, moves more compost, is a fast producing compost, and is able to control odors (Sherman, 1999; Gaskin, 2003; Platt, McSweeney, & Davis, 2014b). In-vessel composting is conducted in an enclosed system, which is generally intended to isolate the organic waste to control oxygen, temperature and moisture level (Cooperband, 2002; Platt et al., 2014b). The amount of waste, space/location, processing, carbon source, and time allotted for compost should be considered when making a decision upon what is best for your institution's needs (Bonhotal, Schwarz, & Feinland, 2011). In-vessel composting can be ideal for numerous types of feedstocks and from various sources from school facilities. Some other feedstock includes manure, yard waste, food waste (food scraps), cardboard, paper, and animal mortalities (Spencer, 2007:21).

There are three types of in-vessel composting: enclosed aerated static piles, agitated bed vessels, and rotating drums. Enclosed aerated static piles refers to compost that is covered in an airy fabric that mechanically controls aeration. This type is non-agitated. Agitated bed vessels are horizontal bays with a mixing device that continuously agitates the waste. A rotating drum works by placing compost materials in a tub/container that automatically turns or continuously agitates the compost. Among the three types of in-vessel composting, the rotating drum produces compost more quickly. Alongside these types, in-vessel can either be a continuous or batch system. Continuous systems have a continuous flow of waste, where batch systems do not have any new feedstocks added (King, et al., 2012; Platt et al., 2014b).

One possible barrier of using in-vessel composting is the associated capital costs from equipment and costs associated with maintenance (Platt et al., 2014a). The expected costs for in-vessel composting might range $40-$150 per wet ton of waste (Sherman, 1999:6). Depending upon the desired waste capacity, the size of the in-vessel will vary accordingly; the more technical and mechanized the in-vessel becomes, the higher the prices (Spencer, 2007). Smaller schools with limited space should expect to pay less than larger schools. For example, Clemson College uses in-vessel methods to compost their ~860 tons of food waste a year. The in-vessel model selected by Clemson College cost about $45,000. A consideration in factoring the cost of in-vessel composting is the technology associated with the in-vessel operation. The more complex the technology, the higher the cost for skilled and experienced labor. This may be a hurdle to schools that do not have access to this type of labor.

Determining the space needed for a school is best calculated by quantifying the anticipated volume of feedstock to be composted and/or estimate the volume of the desired finished product. Depending upon the type of in-vessel utilized, this composting method can be ideal for both small and large scale operations (Herbert et al., 2013). Depending upon which in-vessel unit is purchased, capacity will be limited. This may create a challenge for schools with large amounts of feedstock (Aslam, 2007). To calculate the amount of feedstock, obtain the weight log of food scraps from campus dining facilities and/or conduct a waste audit or waste characterization study to quantify the compostable feedstock that could be diverted through an organics recovery program. If an on-site composting program is being considered, check with physical plant, grounds department, or agricultural program representatives to discuss the potential contribution of yard trimmings, “leaf and limb,” or other high carbon feedstock. However, due to the high capital costs of in-vessel composting, this method is not suited for composting produced strictly from yard waste (Sherman, 1999). By learning what organics recovery already exists, identify opportunities to piggy-back on existing composting efforts.

Guilford College, Greensboro, NC

Enrollment Category: 1,000-4,999

Photo Courtesy of Guilford College

As a part of their recycling program, Guilford College began composting in 2009. On average, their composting operation saves around 34,000 lbs. of food waste a year. Guilford's composting process consists of a two-stream system where one stream is used for pre-consumer food and the other is for post-consumer food from their dining facilities (Meriwhether Godsey). Once the food is collected, it is shipped to a 3-acre production garden location. This negates the necessity for contracting their food waste outside of the school. In addition to collecting food waste from dining facilities, composting materials are collected in college dorms and offices around the campus.

The stream of compost intended for pre-consumer food waste is put into a digester where the food is composted within a 24-hour time frame. Food waste going into the second stream is collected when students, faculty, and staff put their food waste on a conveyer belt. Once on the conveyor belt, kitchen staff sorts food waste into a disposal system that pulps the waste. After it is has gone through the food pulper, the waste is then put into a 32-gallon tube and transported to an on-site location. Once at the on-site location, the food waste is put into two in-vessel containers (Earth tubs) where an auger mixes the waste. Guilford chose to use in-vessel as their method of composting to mitigate rodent issues. Sawdust, from an on-site saw mill operation is mixed within the in-vessel to achieve the correct carbon: nitrogen ratio. After the in-vessel process is complete, the composted material is transported to a location on-site to be placed in windrows that complete the composting process. The finished product is used as either soil amendment, compost tea, and/or landscaping onsite.

Guilford has experienced challenges to their operation. One is that their operation is labor intensive. In terms of amount, they are composting roughly 3,000 lbs. of food waste every 5-6 weeks. Timewise, their operation takes nearly two years for composting process to be complete. Other challenges reported include permitting issues, threat of contamination from food pulper digester, and incorporating sustainability and composting education into course curriculum.

Clemson University, Clemson, SC

Enrollment Category: 20,000 and above

Photo Courtesy of Clemson University

Clemson University employs various methods of composting which include, vermicomposting, windrow, black solider flies, and in-vessel. Roughly two tons a day is collected from the various campus locations such as dining services, leaf and limb, residence halls, and other buildings and taken to Cherry Crossing Research Center. The proximity of this Center to the campus (roughly one mile away) contributes to the efficiency of their operation. Trees, leafs, and limbs from around campus is used to achieve the correct carbon: nitrogen ratio. On average, Clemson has 50 students a year that help with this process through either volunteering (Eco-reps) or course work/research. Once, the food waste is composted, the finished product is either sold for $40/yard (screened) or $25/yard (unscreened) Income gained from sales go back into the recycling budget, ranging $4,000-$5,000 a year.

Financing for composting came from a Collegiate Recycling Grant, in the amount of $25,000, from the SC DHEC Office of Solid Waste Reduction and Recycling. This grant allowed Clemson to finance half of the expenses necessary for their organics recovery operation. The size of the unit purchased was constrained by their funding and budget The BW Organics In-Vessel Composter 9-Cubic yard unit has since been modified by upgrading the drive and adding a car tipper to it. For Clemson, purchasing an in-vessel from the beginning was the easiest way to start their composting program, but they were still faced with a large capital cost. They estimate their in-vessel composts around 1,000 pounds of food waste per day. This accounts for roughly one-fourth of all food waste being composted within the in-vessel unit. The in-vessel unit is used to start the composting process at the mesophilic stage, reaching temperatures of 90-120 degrees before it is transferred to an aerated static pile/windrow for final stages. Waste sits in the in-vessel unit for 3 days minimum and 7 days maximum before being transported.

Based on their experiences, Clemson recommends that in-vessel composting is more ideal for small schools with little space or schools with larger volumes of feedstock. For both types of schools, in-vessel is an easy way to start composting. For schools with larger volumes of feedstock, they suggest starting with in-vessel to mix the waste and then moving it to another type of composting operation such as, windrow or static aerated piles. Also, they recommend that newcomers to in-vessel should always have a Plan B just in case the unit malfunctions or goes down. Clemson has experienced some issues in the past with their motor malfunctioning. If the in-vessel malfunctions, then make sure you have another option or means to repair the unit. To newcomers it is also good to have a plan to market the material on campus or to the public so you have options/sources to use the finished product. Lastly, in-vessels units come in all shapes and sizes so make sure the unit is best suited for schools own needs.

Vermicomposting

Types	Container, Flow-Through, Windrow
Sub-types	Flow-through (continuous flow worm bins, flow through reactor, continuous flow digesters, continuous flow reactors, vermicomposting reactors, vermicomposting digesters. Windrow (row, wedge method, migrating windrow)
Land/Space Requirements	Container space requirements can range from 4' x 4' work area to 5' x 96'
Type of Feedstock	Soil, "bedding" (shredded paper, cardboard, woodchips, etc.), water, food waste, plant waste, manure
Feedstock Restrictions	No bones, meat, dairy products, and oils. Also, large amounts of acidic waste such as citrus, onions, and coffee grounds should be avoided.
Feedstock Capacity	Feedstock capacity depends on unit size and worm population as determined by the amount of estimated feedstock. Container unit capacity ranges from 1 lb. to 800 lbs. of food waste input per day.
Notable Colleges/Universities	University of North Carolina at Chapel Hill, NC Southern Illinois University – Carbondale, IL University of Illinois at Urbana-Champaign, IL Clemson University, SC: "Developing Vermicomposting at Clemson University" Middlebury College, VT: Vermicomposting Program
Technology Providers	Dirtmaker, Midwest Bio-Systems, Orbis Corporation, Uncle Jim's Worm Farm
Available Products	Worm Factory, Can-O-Worms
Cost Considerations	Worm Factory ($70 - $130), Can-O-Worms 0300 ($100 - $145), Worm Wigwam ($670 – 10-15 lbs. per day processing capacity), Pricing for larger Sustainable Agricultural Technologies units ($2,200 - $45,230)*
Roles and Responsbilities	Program/Recycling Coordinator, Student Coordinator (if student labor is used), Recycler/Hauler (to transport feedstock), Recycler (mix and add feedstock, maintain worms, harvest castings), grounds/landscaping (apply castings to grounds)
Essential Tools, Equipment and/or Inputs	Worms ($20-$38/lb.)*, pH meter ($8 for basic to $225 for digital), soil thermometer ($7 for basic to $287 for digital)
Supplemental Tools, Equipment and/or Inputs	Leaf shredder ($100 and up), commercial paper shredder ($150 and up), thermostated heating pad ($20 and up)
Benefits	Nutrient value is higher than compost Works well if coupled with existing agricultural and horticultural research activities Can be used as a method to enhance traditional composting systems
Challenges	Required temperature range of 59 – 77 degrees Fahrenheit Certain types of bins and windrow systems require manual sorting of castings from worms Applying raw feedstock can create higher moisture levels and an inconsistent final product Deterioration of bins and equipment overtime
Common Terms	Container, flow-through, windrow, eisenia fetida, red wigglers, pocket feeding, surface feeding, castings, bedding, vermiculture, substrate, digested, undigested, harvest
Educational Resources	NC State University Annual Vermiculture Conference NC State University Vermicomposting Workshops "The Worm Guide: A Vermicomposting Guide for Teachers" "Worm Away Your Cafeteria Food Scraps" Cornell Waste Management Institute "Making and Using Worm Compost" Check with your State's Cooperative Extension Service for vermicompost class offerings
Worm Farms (in Region 4 - Southeast)	Best Buy Worms (FL), Green Leaf Worm Farm (FL), Kazarie Worm Farm (FL), Our Vital Earth, Inc. (FL), GA Wigglers Worm Farm (GA), Bronwood Worm Farms (GA), Herron Farms (GA), Happy D Ranch (KY), Triple G Worm Farm (KY), Church Hill Worm Farm (MS), D&S Worm Farm (NC), Reorganics Worm Farm (NC), Blue Ridge Organics (NC), Carolina Worm Castings (SC), The Worm Ladies (SC), Wiggle Farm (SC), Silver Bait (TN)

*http://www.localharvest.org/red-wiggler-worms-C17476

Worm composting works by creating an environment for various organisms to break down organic matter (Dabbs, 2009:1). Vermicomposting refers to the process of managing earthworms to eat and digest feedstocks that result in “worm castings” which can be used as a soil amendment and plant fertilizer. While traditional compost reaches upwards of 160 degrees Fahrenheit during the thermophilic phase of processing, vermicompost is created as a mesophilic process, thriving in a temperature range of 59-77 degrees Fahrenheit (Dabbs, 2009:2). As a soil amendment, the high level of organic matter ensures a high water capacity and slow release of nutrients. These are better suited for plant uptake which, reduces potential nutrient loss compared to the use of commercial fertilizer (Governo & Faucette, 2005:48).

Vermicomposting is best set up close to where organic materials are generated or delivered. These composting sites include classrooms, offices, colleges, hospitals, and other institutions Vermicomposting systems can include windrows, batch systems ,worm bins of various sizes, wedge systems and flow-through/continuous flow digesters (Sitton, 2010:61). At educational institutions such as colleges and universities, vermicomposting can be coupled with other composting methods. Raw feedstock from the kitchen can be processed through a food pulper, or simply mixed and shredded prior to feeding to the worms. Though not necessary, the pre-composting of raw feedstock through traditional composting methods (static pile, windrow, in-vessel, etc.) can also aid the digestion process of the worms. With proper upkeep, the worm bin should not emit any odors or attract pests (Sherman, 2012: 2).

The primary vermicomposting material or piece of equipment is a place for the worms to call “home.” If windrow vermicomposting, locate the rows in an enclosed structure within a temperature controlled environment. Container and/or flow-through method need assembly and installed in an enclosed area. For lower-cost small-scale vermicomposting, a container could be constructed from scratch if a school has a group of capable workers/volunteers, a plan, and even found or donated materials made of plastic, untreated wood, or metal (Platt et al., 2014b). There are a variety of design possibilities, and simply googling “vermicomposting bin construction” unearths many examples. If a “tried and true” route is more your school’s style, a useful resource for bin-construction plans and how-to publications is through statewide extension service providers of land-grant institutions. While constructing a unit in-house is an option, composting bins of all shapes and sizes are available through commercial and retail outlets.

Within the bins, the worms need a “bed” in which to eat, sleep, defecate, and reproduce. In other words, the same essentials are needed for a population of thousands (maybe millions) of worms to efficiently and healthily digest the potentially hundreds of pounds of feedstock per day. Among different sized systems, a 1- to 2-inch layer of feed is spread along the top of the worms. Once this layer is consumed and the worms have migrated upward, the castings (excrement) are harvested from the bottom of the bin (Sitton, 2010). Given the nature of worms to migrate vertically upward as they eat, stackable bins are commercially available for smaller spaces. These, too, are often suitable from sources that contribute smaller amounts of feedstock such as residence halls or office buildings.

Once all the proper accommodations are built/installed and ready, the last of the materials to purchase are the worms. The most common worm variety is the “Red Wiggler” which can be purchased from worm growers (Sherman, 2012). Through an online search, worms are available for purchase in the range of $20-38/lb. If you are unsure about purchasing worms for composting online you can also check with local sources such as bait shops, garden suppliers, or worm farms in your area.

Vermicomposting works well alongside other composting methods especially as a smaller-scale accompanying method to other composting that is occurring on-site. For example, the University of Louisville maintains a population of red wiggler manure worms for creating vermicompost, which is harvested periodically to donate to community partners and for use at university gardens. Residing in a donated area inside the physical plant garage on-campus, the worms receive composted feedstock from nearby readapted in-vessel units. The worms live and work in modified blue plastic barrels that were donated to the project from a nearby distillery.

Efficiently processing large-quantities of feedstock requires space in a temperature controlled environment and worm bins capable of handling large amounts of feedstock. Large worm bins can be purchased online or at some garden centers. For example, the largest vermicomposting unit for sale through Sustainable Agricultural Technologies, Inc. is a 5’ x 96’ flow-through worm bin that can handle between 600-900 lbs. of feedstock per day and produce a range of 2,772-4,158 lbs. of output per week that could be stored and applied as soil amendment on campus grounds. Two notable large-scale school vermicomposting programs are located in Illinois; one at the University of Illinois at Urbana-Champaign and the other at Southern Illinois University – Carbondale.

To determine how much space is needed for vermicomposting, estimate the following: Weight of inputs (feedstock) to process on a weekly basis and/or the weight of outputs (vermicompost) desired. Based on these initial rough estimates and the dimensions of the vermicomposting unit that suits the composting program (giving space on all sides of the unit for movement), space capacity also needs to be designated to shelter worms while maintaining a consistent temperature year round. The potential space should have electrical hookups to power the components of the vermicomposting unit and any necessary heating units/pads.

The success of any composting program hinges on a committed and dedicated staff member that has the knowledge and ability to manage the facility. Important too is the support and commitment for continuous funding from the institution’s major decision-makers for a vermicomposting program. For small-scale composting, training and equipping on-campus, departments, offices, or residence halls with the tools and knowledge to vermicompost is vital to the program’s success. Larger scale vermicomposting is reliant on partnership opportunities among departments such as recycling/waste reduction, dining services, physical plant/grounds crews, cooperative extension, agriculture, or even external community groups to contribute to the vermicomposting process from start to finish. Having a committee formed of necessary school representatives that meets regularly with the composting manager ensures cooperation among facilities, departments, and management.

To determine cost-estimates for the appropriate facility/equipment sizing, it is critical to estimate the volume that will be fed to the worms during thetime period (Governo & Faucette, 2005:48). To estimate sizing, roughly one square foot of worm bin is needed for each pound of food waste produced per week (Sherman, 1997: 2). Other operating costs include the training and payment of staff to ensure feedstock is transported, mixed, and fed to the worms, to monitor and maintain the facility, then harvest and apply and/or distribute the worm castings and energy costs associated with heating/ventilating the facility.

Students at Macalester College, a small liberal arts school in Saint Paul, MN, studied the feasibility of a small scale vermicomposting system, estimated the costs and made recommendations for implementation (Brown, Flowers-Shanklin, and Merrill, 2010). These Senior Seminar Course students found that for a basic small worm bin system, the costs (in 2010 dollars) were estimated to range from $211-$321 for 4-5 units with ½ lb. of worms per 35-gallon retrofitted bin. Other costs included in this range were the price of wood to construct bin-stands.

While determining costs are an important consideration, equally so is taking into account the savings and other positive impacts that will result by vermicomposting at an institution. Whether an on- or off-site organics recovery, the savings from the diversion of organic waste that would otherwise enter the landfill demonstrates substantial progress in waste reduction goals and cost savings. To figure a rough estimate of financial savings based on current local landfill fees, rates and amount of food waste diverted, calculate the total feedstock diverted then project out one year's worth of savings.

Additionally, by calculating the amount of finished vermicompost that will be produced, cost savings can be calculated by comparing to the purchase price of compost that would otherwise be incurred. Worm compost can be used straight from the worm bin or stored for later use as a soil amendment, a slow-release fertilizer or in compost tea (Dabbs, 2009). Compost teas, in particular, have been used extensively by organic gardeners and farmers to promote plant growth by application to soils as drenches and to suppress plant diseases by soil or foliar sprays (Edwards, Arancon, Emerson, & Pulliam, 2007).

Nearly all colleges/universities find funding any new project or program is a challenge. Funding possibilities for composting programs might come from both internal and external opportunities, including the leveraging of existing programs and volunteer labor. By figuring the cost savings, factor this into overall budget that will be recouped from the initial capital start-up costs and continued operating costs. With a tight budget, consider starting small, then expand efforts as success and progress is experienced. If small-scale in nature, it might make sense to fund the initial purchase of materials then rely on student workers/volunteers to feed, then harvest, the vermicompost. If large-scale, state grant programs, other local incentives, or foundations could be sources for investment in organics recovery. A school's "Green Fee" or other sustainability funds could go toward the investment of a larger scale facility. Other existing operating budgets could be leveraged to devote toward a portion of staff/faculty salary and the space/electricity to house a vermicomposting facility.

Southern Illinois University – Carbondale, Carbondale, IL

Enrollment Size Category: 15,000 – 20,000

Another large-scale example of vermicomposting is at Southern Illinois University – Carbondale where a large-scale Vermicomposting Center was constructed in a 4,962 square foot pole barn. After 2 1/2 years of project planning, the Residence Hall Dining began diverting its pulped waste to the Vermicomposting Center. Ten tons of vermicompost was produced in that initial year (2004).

The vermicomposting project is financed with a $150,000 grant from the Illinois Department of Commerce and Economic Opportunity Bureau of Energy and Recycling's Recycling Expansion and Modernization Program, and other funding sources such as the local Health Department and the State Department of Agriculture. University partners for the project included the Office of the Provost, Plant and Service Operations, College of Agricultural Sciences and the College of Engineering's Department of Mining and Mineral Resources Engineering and Department of Civil and Environmental Engineering (Rosenbery, 2004).

While research is conducted on vermicompost applications, the recycling of food waste and energy efficiency are also important factors (Rosenbery, 2004). During the first three years of operation, the Vermicomposting Center used about 3 million red wiggler worms to dispose of more than 170,000 pounds of food waste per year from the University's three residence hall cafeterias. Not only does this composting method divert the waste from landfills, results include research opportunities for faculty and students and valuable fertilizer for the university grounds keeping (Crosby, 2007).

University of Illinois at Urbana – Champaign, Champaign, IL

Enrollment size category: 20,000 and above

Since its inception in 2009, the Sustainable Student Farm (SSF) at the University of Illinois at Urbana - Champaign (UIUC) has provided food for campus dining facilities using sustainable farming methods. The SSF needed a greenhouse to grow plants and a method of fertilizer production. In 2012, a pilot vermicomposting project was planned to close the loop between the SSF and one of the six dining facilities on campus. The project was launched with a team formed by Dining Services, the College of Agriculture, Consumer, and Environmental Services (ACES), Facilities and Services, the Urbana Landscape Recycling Center, the College of Business, and the Department of Crop Sciences. The initiative, referred to as the "Transplant and Vermi-Composting Multiuse Greenhouse Project," was financed from both internal and external funding sources: a $65,222 grant from the Student Sustainability Committee (SSC), $8,565 from the Office of Public Engagement, and $1,000 from a private source (Ngu, 2014). (SSC manages funds collected from student-approved fees for campus sustainability projects.) By 2013, the construction of a 30 ft. by 48 ft. automated controlled climate greenhouse was complete and ready to house a vermicompost program.

Photo Credit: Professor Bruce

The vermicompost program began inside the greenhouse with the purchase of 80 Ibs. of Red Wiggler Worms (80,000 worms) and the purchase and assembly of a 5 ft. by 16 ft. composting unit – a steel framed bin that is set up off the ground. The process involves placing a thin layer of raw pre-consumer food waste as a "green material", and then placing a layer of dried leaves on top as a "brown material". The SSF gets pre-consumer, plant based food waste from one dining hall two to three times (about 200-250 lbs.) per week. The SSF receives leaves from the landscaping services on campus.

In 2015, the SSF used the compost in a potting mix, which worked well in terms of fertility. However, because the process did not use a "hot" compost phase, the mix contained a lot of undesired melons, tomatoes and peppers. Sifting the compost is required in this application. The compost has also been used as fertilizer in the SSF's high tunnels and on its perennial crops.

In order to prevent seeds from sprouting, an alternative method could be pre-composting the food waste before feeding it to the worms. This would reduce a number of the issues with consistency and prevent the germination of leftover seeds. In relation to size and scale of operations, the high amount of manual labor makes vermicomposting more conducive to a smaller scale set-up that supplements farming programs, such as the program at UIUC.

Windrow Composting

Types	Static and Managed
Sub-types	Passively Aerated, Turned Windrow, Aerated Static Pile, Agitated Channel, Mass Bedding, Auger-type, Elevating face, Straddle type,
Land/Space Requirements	A windrow could be 7' x 14' (Pile height x base width) with 10' aisles See Turned Windrow Composting: Sizing Your Composting Pad for a recommended resource guide for sizing windrow operations.
Type of Feedstock	Soil, "bedding" (shredded paper, cardboard, woodchips, etc.), water, food waste, plant waste, manure, animal mortality.
Feedstock Capacity	See Turned Windrow Composting: Sizing Your Composting Pad for a recommended resource guide for amount of feedstock for a windrow composting operation.
Notable Colleges/Universities	Berea College University of Tennessee – Knoxville University of Georgia Clemson University
Technology Providers	Farmer Automatic of America Inc., Turn and Screen, Vermeer, SCARAB, TEREX, Brown Bear Corporation, Apollo Equipment, Unlimited Resources Corporation, EarthSaver Equipment, Bobcat
Available Products	Compost Cat, Mighty Mike SCARAB Models 6'-27', TWT500, Vermeer CT 612-1010TX, 200-500 Hyrdostatic Tractor, Bobcat Loader Attachments,
Cost Considerations	Labor, Turner, Meters, Carbon Source, Loader, Screener, Equipment to haul compost to windrow location.
Roles and Responsibilities	Program Coordinator, Student Coordinator (if student labor is used), Recycler/Hauler (to transport feedstock), Recycler (turn and add feedstock and harvest finished compost), grounds/landscaping (to apply compost to grounds)
Essential Tools, Equipment, and/or Inputs	Turner (or tractor), Loader, Screen, Compost Thermometer, pH meter, time, Water, Carbon Source.
Supplemental Tools, Equipment, and/or Inputs	Hand tools for manual turning, Wood chippers, Oxygen meters, Moisture detectors, PVC pipe (if wanting to make a homemade aerated system)
Benefits	Multiple feedstocks, Relatively low capital, operating costs, low technology requirements (depending upon your operation size)* No electricity needed, Well-suited to small feedstock quantities, Can provide thorough mixing of food waste residuals, Wide selection of windrow turning equipment available
Challenges	Require more land/space (compared to other methods), Labor intensive, Difficult to control odors, Wet and Cold weather exposure can create problems with the compost, Requires high operational control, Slow decomposition rate/long process times
Common Terms	Piles, Curing, Static, Managed, Unagitated, Passively Aerated, Blowers (Fans), Turner, Grinders, Loaders, Screens, Auger, Straddle,
Educational Resources	A Compost Turner Suited To You, Co-Composter (Cornell's Department of Biological and Environmental Engineering and Waste Management Institute), Turned Windrow Composting: Sizing Your Composting Pad. Easy Breezy Windrow Compost Aeration: EcoCity Farms Video, State of Composting in the US: What, Why, Where & How

*Platt et al., 2014b

Windrows are the most common form of composting nationally due to their low operation costs and ability to compost a wide range of materials (Vermeer Manufacturing Company, 2008; Yepsen, 2008; Platt et al., 2014a). This method is optimal for people and organizations, such as households, schools, farms, municipalities, and private entities (Pennsylvania State University [Penn State], 2016). Windrow Style composting implementation begins with placing organic waste in long, narrow piles, and then allowing it to complete the active and curing composting phases. Depending on the scale and size of the composting facility, piles will vary in width, height, and length, and can cover the entire length of a designated composting space. This method works best on a flat open area, requiring land that is close enough to the feedstock source to keep hauling costs efficient, while far enough away from populated area to mitigate odor disturbances.

There are two methods of windrow composting: static and managed (Platt et al., 2014a:12). Static refers to compost that is unturned or unagitated. If a school operates a static, passively aerated system, the windrows might be aerated through natural convection of air by installing perforated pipes, evenly spaced, across the width of each windrow. If the actively aerated method is chosen, powered fans or blowers are directed at the windrows while leaving the compost unturned throughout the composting process.

A managed windrow, on the other hand, has its compost turned or agitated on a regular basis. Depending on the size of the piles and frequency of turning, the amount of time it takes to complete the composting process varies. At Berea College's Farm in Berea, KY, compost cures for up to two years before being applied as a soil amendment, while the University of Alabama's compost cures for 6–8 months before use.

Determining the space needed for a college/university windrow system is best calculated by quantifying the anticipated volume of feedstock to be composted and/or estimating the volume of the desired finished product. Given the scalability of this method, it can be ideal for both small and large scale operations (Vermeer Manufacturing Company, 2008). To configure the amount of feedstock, obtain the weight log of food scraps from campus dining facilities; the dining service provider should have this information. Another way to determine feedstock is quantifying the compostable feedstock that could be diverted through an organics recovery program; this can be accomplished through a waste audit or waste characterization study.

If an on-site composting program is being considered, check with your institution's physical plant, grounds department, or agricultural program manager to discuss the potential contribution of yard trimmings, "leaf and limb," or other high carbon feedstock. By learning what organics recovery already exists, you are identifying opportunities to piggy-back on existing composting efforts.

Once the question of "how much feedstock?" is answered and site-options are identified, the appropriate size for the school's windrow facility can be determined. A recommended resource guide for sizing windrow operations is the Vermont Agency for Natural Resources Department of Environmental Conservation's publication, *Turned Windrow Composting: Sizing Your Composting Pad*. This worksheet template walks readers through detailed sizing calculations and other considerations to get a realistic gauge of what facility size a school would need to implement an on-site windrow composting program. Knowing the capacity needed is critical when estimating realistic capital and operating costs for the facility.

If managed properly, windrow composting can be ideal for numerous types of feedstocks and from various sources from school facilities. Other types of feedstock include manure, yard waste, food waste (food scraps), and even animal mortalities (Penn State, 2016). At a farm owned and operated by the University of Kentucky in Lexington, KY, composting operations take place with sourced inputs such as animal bedding, manure, agricultural residues, wood chips, and animal mortalities (beef, hogs, sheep, horses). At the University of Georgia in Athens, GA, food scraps (coffee grounds, fruit peels, etc.) are collected in smaller quantities through a voluntary Office Composting Program sourced from the break rooms of up to 35 offices on campus. Most often these raw feedstocks are hauled to composting sites located varying distances from campuses, ranging from a quarter mile (Berea) to five miles (University of Georgia).

University of Tennessee, Knoxville, Knoxville, TN

Enrollment Category: 20,000 and above

The University of Tennessee, Knoxville (UT) began composting informally in 2001. Over time, the Recycling Coordinator partnered with the grounds department and gathered University support for a more formalized composting operation. First, they began incrementally adding other feedstock, starting with coffee grounds (2005), then as the support for expansion was considered, a composting site was identified on-campus in a location away from populated areas. Once the site was established, a large scale windrow composting program began operation in 2010. Additional feedstock was added such as food scraps from dining halls, animal bedding, manure, and recently paper towels. An average of 10,000 lbs. of food waste and 14,000 lbs of manure and bedding is collected per week.

Photo Courtesy of The University of Tennessee, Knoxville

With the UT campus located a far distance from the nearest off-site commercial composting facility and with limited State composting program incentives and regulatory framework, on-site composting just made sense. Funding is primarily through operational budgets; other funding is from UT's Student Environmental Initiatives Fund "Green Fee", which has purchased specialized equipment, such as a Bobcat skid steer loader used to cover the food and move materials. The composting budget also pays student interns who help by collecting and hauling food waste from a total of 25 locations on campus. Other student participation occurs through volunteerism and coursework, such as the Organic Crop Production Program of the Institute of Agriculture.

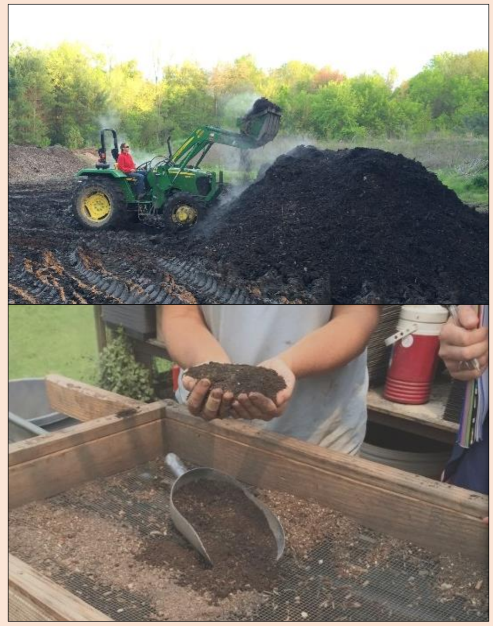
There are three general rules for implementing a campus composting operation. First, with windrow composting in open spaces, stormwater management and drainage planning is needed *before* constructing the composting facility. Second, manage the cost-benefit of the operations by calculating the cost savings of diverting organics from local landfills. Learn how this fits into a school's overall sustainability and waste reduction goals. And third, as UT has proven, when the right partnerships are fostered, a school can incrementally make its way toward reaching its composting diversion goals.

Berea College, Berea, KY

Enrollment Category: 1,000 - 4,999

Berea started their on-site turned windrow composting program in the late 1990s. Both, pre- and post-consumer food waste is collected from the dining facilities and taken to the campus garden where it cures. Transporting the food waste to the campus garden is relatively easy since the garden is only a quarter mile from Berea's dining halls. Once the compost cures, it is used as a soil amendment on-site at the campus garden. The garden's produce is harvested for use in its dining facilities.

Berea's garden manager has secured a cooperative agreement with a local tree service whereby wood chips, which serve as the carbon source for the compost, are dumped at the window site. These wood chips are mixed with food scraps to achieve the correct carbon:nitrogen ratios. After curing for about two years and four turns, the compost is ready to be used as a soil amendment on the campus farm.



Photos Courtesy of Berea College

Several factors contribute to Berea's successful composting efforts. One crucial piece to their success is through partnerships. Berea has built and maintained a strong relationship with Sodexo, their dining service provider. To reduce contamination, kitchen staff agreed to collect pre- and post-consumer food waste "behind the scenes." Once the food waste is collected back-of-house, buckets are dumped into a 35-gallon tub on average 6-8 times per day on an outdoor loading dock. In order to measure, monitor, and track food waste reduction, Berea and Sodexo follow a common procedure called LeanPath. Through this system, food scraps are weighed multiple times per day then recorded on a wall-mounted table located directly above the scale. Once the food waste is weighed and recorded, it is transported to the campus garden.

Student involvement is also crucial to the overall success of Berea's composting program. As a work-study college, all students must put in a total of 10 hours of work per week to build various skills. Students that are assigned composting duties complete tasks such as food waste hauling, mixing the carbonous wood chips with the nitrogenous food waste, removing contaminants, and sifting, packaging, and applying the finished compost product. While student labor remains crucial to the operation of the compost program, a major challenge program organizers face is student turnover. As students graduate every four years, training must occur on a revolving basis.

A key to the efficiency of Berea's composting operation is the close proximity of the campus garden to the on-campus dining facilities. The campus garden is located roughly a quarter mile away from the dining hall making transport of feedstock more time and cost effective by reducing transportation costs and the reliance on external commercial services. Berea also composts feedstock outside the scope of produce and coffee grounds, such as animal bones, noodles, and dairy products.

While in the past, they have attempted to compost eco-friendly biodegradable bags, Berea claims they no longer attempt to compost these due to delayed decomposition of synthetic materials. Through proper carbon:nitrogen ratios, maintenance of moisture levels, and other best practices, staff makes every effort to reduce odors that occur primarily when the piles are turned. While there is always a desire for more funding and support for the expansion of their composting efforts, they make it work with what they have.

Off-site Organics Recovery

By looking at the [EPA Food Recovery Hierarchy](https://www.epa.gov/sustainable-management-food/food-recovery-hierarchy),[25] one can see there are several ways that schools can implement off-site methods of organics recovery. Food that is still edible can be donated to feed hungry people or animals. Organic waste can be transported to anaerobic digesters or other industrial facilities to produce energy and can also be recovered at centralized composting facilities where finished compost can then be returned to campuses for use in landscaping. Regardless of the organics recovery method, each requires institutional partnerships among school staff to manage the handling and storage of waste prior to transport, and community partnerships with outside organizations to haul, transport, and recover the food residuals off-site.

Off-site centralized composting may be most feasible for schools that are located in densely populated urban areas with limited land and space availability. Additionally, if a school lacks the support of institutional partnerships and overall staff capacity for managing an on-site program, off-site composting may be the best option. Before starting an off-site composting program, identify a potential short-term storage area where organic waste can be held until pick-up for transport such as a loading dock located behind the kitchen at dining facilities. Contract with a hauler to transport waste to the off-site approved facility. If the amount of organic waste produced is too little to make contracting economically feasible, consider partnering with other schools to negotiate a multi-agency contract with haulers and receiving composting facilities. For example, the Medical University of South Carolina has partnered with the College of Charleston, The Citadel and Trident Technical College in a multi-agency contract with a hauler in an effort to divert cafeteria pre-consumer waste from the landfill to a centralized composting facility.[26]

Georgia Institute of Technology, Atlanta, GA

Enrollment Size Category: 20,000 and above

In 2009, the Georgia Institute of Technology's (Georgia Tech) Students Organizing for Sustainability (S.O.S.) and Dining Services sponsored a campus composting program (Georgia Institute of Technology, 2011). With its main campus located in an urbanized area, the University did not have the available land with adequate buffer zones to accommodate an on-site facility. For this reason, Georgia Tech decided to contract with a third party organization to haul and process food waste. The program began by accepting pre-consumer waste and eventually expanded to collect post-consumer waste, allowing diners to scrap their plates into designated bins. In 2014 alone, over 1,300,000 pounds of waste was composted (Georgia Institute of Technology, 2016). Once collected, food waste is hauled off-site by a private waste management company. When finished, compost is returned to Georgia Tech where it is used as a landscaping soil conditioner on campus (Nesmith, 2009). While off-site composting results in higher transportation costs, both parties claim that the environmental benefits keep the university in alignment with overarching sustainability goals to divert landfill waste.

Although organics are composted off-site, students still contribute toward Georgia Tech's composting efforts through interactive waste learning. Periodically throughout the school year, a "Weigh the Waste" event is held where all of the uneaten food from guest's plates are weighed. Once the findings are consolidated, the University reports to the campus community the total weight uneaten food. These events are tied to an awareness campaign that informs guests about food waste and its impact on the environment and the University community (Georgia Institute of Technology Dining, 2014).

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[25] https://www.epa.gov/sustainable-management-food/food-recovery-hierarchy

[26] https://www.musc.edu/vpfa/eandf/sustainability/compost.htm

Student Involvement

Students can play a variety of roles during the processes of planning, operations, monitoring, and evaluation of an organics recovery program. Through internships, assistantships, or work study positions that coincide with coursework and research interests, students often lay the foundation for program planning and implementation when staff otherwise does not have the time or resources. Under faculty and staff advisement, students have the structure to conduct waste characterization audits, program feasibility studies, and initial cost-benefit analyses. Other duties might include training kitchen staff on food waste sorting and separation, consumer education and awareness-building about proper disposal to reduce contamination. Operational participation includes food waste collection, weighing, and transport to composting facilities. Once food residuals are unloaded at the compost site, students may be tasked to sort out contaminants, mix feedstock with other bulking agents, add moisture and turn/mix compost, monitor and record temperatures, and harvest, package, or apply the finished compost to gardens or grounds. Once data is recorded on costs and savings over a period of time, the program can then be evaluated, which could be conducted through coursework in curricula that focuses on program evaluation. For more manual and monotonous tasks, volunteer hours of sustainability service-learning and course requirements can be fulfilled at campus gardens, food waste collection locations (dining facilities, offices, residence halls), or composting sites. Although programs may require just a few hours of volunteer labor, students can learn tasks quickly, and gain the experience, training, and awareness to apply in future waste reduction efforts.

STUDENT INVOLVEMENT

How will students participate in organics recovery?

- ☐ Program planning and design such as waste characterization study/audit, feasibility study, cost-benefit analysis, funding application
- ☐ Construction/installation of facility
- ☐ Training, education, and awareness building
- ☐ Operational tasks such as collecting and transporting food waste, compost aeration, sifting, packaging, and application.
- ☐ Research such as engineering, environmental biology, agriculture, sustainability studies
- ☐ Program evaluation

What type student labor will be used?

- ☐ Paid/unpaid internships
- ☐ Paid research assistantships
- ☐ Volunteer assignments through extracurricular clubs and service learning
- ☐ Research through practicums, theses, and other coursework

Academic Programming

Student and faculty participation in organics recovery efforts can take place through academic programming such as coursework, service-learning, and research. An advantage of conducting organics recovery at post-secondary institutions is having the existing institutional framework to create learning opportunities for students and faculty that can benefit the surrounding community (Pompei Lacy et al, 2015). Studies and publications can influence internal decision-making about which organics recovery efforts to adopt as well as influence the decisions of external partners. Topic areas can include conducting a waste characterization study, compost feasibility study, a cost-benefit analysis comparing organics recovery methods, and monitoring and evaluating an institution's program upon implementation. In addition to providing the basis for informed decision-making, study participants also develop an awareness of organics recovery and its environmental impacts on both a household and institutional level; this knowledge can be carried beyond the learning institution.

When inventorying existing academic programs to identify partnership opportunities, consider contacting department representatives of program areas such as Environmental Studies, Sustainability Studies, College of Agriculture, Public Administration, and Environmental Engineering (to name a few). If a land-grant institution,[27] contact the school's Department of Agriculture and/or nearby Cooperative Extension Services that can provide information on existing organics recovery education and research facilities. There may be project opportunities that could fulfill the needs for organics recovery program decision-making as well as course requirements. Noted below are a few examples of how schools have incorporated organics recovery into academic programming.

At the Woodford County Farm at the University of Kentucky, farm operators demonstrate and research animal mortality composting that is open for tours to agriculture students, business owners, and farmers from the surrounding region. Also, Extension Services typically provide brochures, fact sheets, and offer regional knowledge of the organics recovery industry.[28] As part of a Public Budgeting course at Georgia Southern University, students of the Masters of Public Administration program are tasked with conducting a cost-benefit analysis that compares methods, including on- vs. off-site composting.

Clemson University has both faculty research groups and approximately 50 students per year who participate in a service learning course called Creative Inquiry and others participating in composting through its student peer-to-peer learning education program[29] called Eco-reps.[30] The University of Louisville also incorporates organics recovery into coursework, as Business Ethics students study composting as a sustainable community model and contribute labor as part of the course's service learning requirements.[31] To evaluate organics recovery efforts, students in a Sustainability Metrics and Evaluation course at University of Illinois Urbana-Champaign conducted an evaluation of the school's vermicomposting program by using

[27] Directory of participating land-grant institutions of the Association of Public & Land Grant Universities located here: http://www.aplu.org/members/our-members/by-state-province/

[28] http://www2.ca.uky.edu/enri/compost.php

[29] http://www.aashe.org/resources/peer-peer-sustainability-outreach-campaigns

[30] http://www.clemson.edu/academics/programs/creative-inquiry/

[31] See "Student Involvement" at the following link for more information about academic programming at UofL: http://louisville.edu/sustainability/operations/composting.html

cost-benefit methodologies.[32] See technology-specific tables in the Operational Models section to learn other notable strategies that schools are taking to incorporate organics recovery within academic programming.

ACADEMIC PROGRAMMING

- ☐ Identify and connect with faculty from subject areas that are relevant organics recovery program decision-making and operational needs (Environmental Studies, Engineering, Agriculture, Biology, Sustainability, Business, or Public Administration).
- ☐ Identify existing service-learning and volunteer programs that students could direct time and effort toward organics recovery programming.
- ☐ Connect with land-grant institutions and Cooperative Extension Service representatives to learn about existing organics recovery efforts and studies that could provide information for program decision-making.

[32] http://icap.sustainability.illinois.edu/project-update/sustainable-student-farm-vermicomposting-project-i-compost-evaluation

Community Partnerships

Regardless of the organics recovery method, the participation of community partners can extend the reach of a program while leveraging the expertise and resources of outside organizations. Partnership opportunities will be unique for each school and its surrounding community. A school can build community partnerships to best suit their particular needs and program capacity. For example, if a school is in need of additional feedstock or specialized equipment, there may be local businesses or farms that can contribute toward the organics recovery program. Or perhaps a school has excess compost available and would like to offer it to households for free or for sale. If for sale, a school may have the income to finance a portion of the program. Whether offering excess compost to the community, or providing education through workshops, there are a variety of options for engaging external groups.

As previously stated, excess compost may be offered it to the community for a cost or for free. Individuals, households, community-based organizations, or businesses from regions that have limited access to centralized compost facilities may find this especially beneficial; the school could serve as a local source of compost that is otherwise not available. For example, the University of Alabama in Tuscaloosa, AL, advertises free compost to the community which includes farms and private enterprises within the area. By making finished compost available for a cost, schools may receive a small amount of financing, and even labor that could go toward the operation of its composting facility. Clemson University sells their compost for $25 a yard while also allowing community members the option of volunteering/assisting with the compost process in exchange for compost.

Schools may also receive supplemental feedstock that contributes to compost operations through agreements and contracts with external groups. For example, Berea College in Berea, KY, has an agreement with a local tree service that delivers wood chips for use as feedstock to mix with food waste obtained from campus dining facilities. Some programs pick up organic waste from external sources then deliver the waste to campus composting facilities. On a weekly basis, Sustainability Interns at the University of Louisville in Louisville, KY, pick up and haul coffee grounds, tea leaves, lemon rinds and other organic waste which is then mixed with wood chips that are collected on-campus by the grounds department. Other examples of schools accepting external food waste are at Clemson University in Clemson, SC, and Furman University in Greenville, SC. Both schools accept household food waste that is dropped off from on- and off-campus.

Aside from the donation and sale of finished compost, some schools have engaged the community through involvement in special events or learning opportunities specific to sustainability and/or organics recovery. The University of South Carolina annually hosts a week long sustainability event where community members are educated on various organics recovery methods and best practices. Furman University offers summer workshops and adult learning events that are open to the public. Both North Carolina State and The University of Kentucky craft educational resources and offer training courses that are offered online and amongst the community. When developing their program at the University of Florida in Gainesville, FL, program developers reached out to a local grocery chain to learn about their composting strategy as a starting point for the school's program.

Community engagement through peer-learning with other academic institutions and outside establishments/organizations is beneficial for a school to improve its organics recovery programming. Establishments/organizations can include local private waste management facilities, local businesses, and local municipalities. Connecting with professional associations and programs that share information on organics recovery can also be beneficial; these might include EPA's Food Recovery Challenge,[33] the national Food Recovery Network, the Food Waste Recovery Alliance,[34] AASHE's Sustainability, Tracking, Assessment, and Rating System (STARS)[35] standards, and the U.S. Composting Council.[36] Connecting with other colleges and universities with similar characteristics (enrollment size, population density, rural/suburban/urban setting) can also provide an opportunity to learn what others are doing so as not to "reinvent the wheel."

COMMUNITY PARTNERSHIPS

- ☐ Professional associations (CURC, Food Recovery Network, EPA's Food Recovery Challenge, Food Waste Recovery Alliance, AASHE, U.S. Composting Council (and State Chapters)
- ☐ Local/regional post-secondary and K-12 institutions
- ☐ Local/regional waste management facilities
- ☐ Local businesses
- ☐ Local municipality
- ☐ Community-based organizations such as gardening clubs, food banks, etc.

[33] https://www.epa.gov/sustainable-management-food/food-recovery-challenge-frc
[34] http://www.foodwastealliance.org/
[35] https://stars.aashe.org/
[36] http://compostingcouncil.org/

Conclusion

College campuses have many opportunities for recovering organic materials. Incorporating organics recovery systems (whether on- or off-site) into campus operations is a vital part of reducing campus waste and greenhouse gas emissions. Ways to consider reducing a school's waste stream might include food recovery through source reduction, providing food for the hungry, feeding livestock, finding industrial uses, and composting. These methods of organics recovery provide alternatives to incineration or landfilling organics.

As colleges and universities strive to reach waste reduction and recycling goals through participation in programs such as the annual Recyclemania Tournament,[37] the EPA's Food Recovery Challenge,[38] the national Food Recovery Network, AASHE's Sustainability, Tracking, Assessment, and Rating System (STARS)[39] standards, organics recovery in the form of composting has emerged as one of the preferred methods for waste reduction and diversion. There are different types of existing organic waste reduction and recovery programs, with each campus using its unique characteristics to garner support from idea to implementation, often beginning with overarching policies such as sustainability and waste reduction plans.

Aside from accomplishing waste reduction goals in the quantifiable sense, campus communities have a responsibility to embrace the shift that is occurring from both an individual and institutional standpoint toward reducing the amount of waste entering landfills. The examples shared in the Compendium and this guide demonstrates how movement across campus communities can shift waste management programs toward the expansion of organics recovery. Being post-secondary institutions, this simultaneously results in learning and research opportunities. The response to this demand often begins with demonstration or pilot composting that accompanies a community garden or greenhouse on a small scale. Once the practical experience is gained and the benefits of composting are proven, and through proper planning and design, programs may naturally expand into a larger institutionalized system that influences a larger-scale behavioral shift among students, faculty, staff, and even the surrounding community.

The hyperlinks and profiles included in this Tool are meant to showcase current organics recovery efforts and encourage peer-to-peer learning opportunities among college/university organics recovery program representatives. Future iterations may include information from additional colleges/universities that are interested in sharing their composting efforts.

While this guide places a heavy emphasis on composting, future iterations could include an expansion on other organics recovery methods and further guidance on how to conduct feasibility studies, waste characterization studies, benefit-cost analyses, and the creation of detailed process charts and other visuals. As with the Compendium, the Organics Recovery Program Development Tool should also not be seen as a static document, but rather one that can evolve as more methods and programs are included.

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37 http://recyclemaniacs.org/

38 https://www.epa.gov/sustainable-management-food/food-recovery-challenge-frc

39 https://stars.aashe.org/

Appendix A. Organics Recovery Program Considerations

INSTITUTIONAL PARTNERS

-Who should be included in organics recovery decision-making?

- ☐ Administration
- ☐ Dining Services
- ☐ External Stakeholders (Engineers, Technical Advisors, Planners, City/County Waste Management/Public Works, State Regulatory Agency, Neighborhood Partners, other local/regional Educational Institutions)
- ☐ Facilities Management (Grounds Department, Waste Reduction, Recycling)
- ☐ Faculty/Staff/Office Management
- ☐ Garden/Farm Manager
- ☐ Residence Life
- ☐ Student groups
- ☐ Sustainability Program

-How should decision making and coordination occur?

- ☐ Existing Sustainability Committee/Council
- ☐ Special Composting Subcommittee/Taskforce

-How are staff and volunteer responsibilities established?

Identify funding capacity and dedicated individuals to fulfill:

- ☐ Part-time/full-time paid staff assignments
- ☐ Paid/volunteer student work assignments
- ☐ Committed research faculty

OPERATIONAL MODEL

-What type of organics recovery method?

- ☐ Source reduction
- ☐ Feed hungry people
- ☐ Feed animals
- ☐ Industrial uses
- ☐ Composting

-What is the operational budget?

-What are the land/space requirements?

-What type of organics does this method accept?

-How much organic waste can this method accept?

-Which schools that are conducting this method?

-What technology providers are offering products and service?

-What are the roles and responsibilities for this method?

-What additional tools/equipment/inputs will be needed for this method?

FUNDING MECHANISMS

-What are the financing approaches to consider?

- ☐ Dedicating an internal operational budget (facilities, dining services, sustainability funds)
- ☐ Rely on donated time/equipment/work (students, faculty, staff)
- ☐ Apply for external funding opportunities (state or local grants, private foundations)

-What type of labor will be used?

- ☐ Part-time/full-time paid staff assignments
- ☐ Paid/volunteer student work assignments
- ☐ Research faculty/staff

-What costs should be considered?

- ☐ Preliminary studies (waste characterization study/audit, feasibility study, cost-benefit analysis, planning and design)
- ☐ Capital costs (site preparation, construction/installation of facility, tools and equipment)
- ☐ Operational costs (fuel for transportation of feedstock, labor, electricity, hauling contracts)

-What savings should be considered?

- ☐ Savings from reduction in landfill fees
- ☐ Savings from reduction in compost purchase costs
- ☐ Changes in greenhouse gas emissions

STUDENT INVOLVEMENT

-How will students participate in organics recovery?

- ☐ Program planning and design such as waste characterization study/audit, feasibility study, cost-benefit analysis, funding application
- ☐ Construction/installation of facility
- ☐ Training, education, and awareness building
- ☐ Operational tasks such as collecting and transporting food waste, compost aeration, sifting, packaging, and application
- ☐ Research such as engineering, environmental biology, agriculture, sustainability studies
- ☐ Program evaluation

-What type of student labor will be used?

- ☐ Paid/unpaid internships
- ☐ Paid research assistantships
- ☐ Volunteer assignments through extracurricular clubs and service learning
- ☐ Research through practicums, theses, and other coursework

ACADEMIC PROGRAMMING

- ☐ Identify and connect with faculty from subject areas that are relevant organics recovery program decision-making and operational needs (Environmental Studies, Engineering, Agriculture, Biology, Sustainability, Business, or Public Administration)
- ☐ Identify existing service-learning and volunteer programs that students could direct time and effort toward organics recovery programming
- ☐ Connect with land-grant institutions and Cooperative Extension Service representatives to learn about existing organics recovery efforts and studies that could provide information for program decision-making

COMMUNITY PARTNERSHIPS

- ☐ Professional associations (CURC, Food Recovery Network, EPA's Food Recovery Challenge, Food Waste Recovery Alliance, AASHE, U.S. Composting Council (and State Chapters))
- ☐ Local/regional post-secondary and K-12 institutions
- ☐ Local/regional waste management facilities
- ☐ Local businesses
- ☐ Local municipality
- ☐ Community-based organizations such as gardening clubs, food banks, etc.

Appendix A. Composting Terms

GLOSSARY OF COMPOSTING TERMS [40]

Aerated Static Pile - composting system that uses a series of perforated pipes as an air distribution system running under the compost pile and connected to a blower. The pile is not turned.

Aeration - bringing about the contact of the compost with air through turning, or ventilating to allow microbial aerobic metabolism.

Aerobic - occurring in the presence of oxygen. For successful composting, sufficient oxygen should be provided to keep the system aerobic. This ensures that the composting proceeds rapidly and with minimal odor.

Ambient Temperature - temperature outside the compost pile.

Anaerobic - occurring in the absence of oxygen. Anaerobic composting proceeds slowly and is odiferous.

Biodegradability - the potential of an organic substance to be broken down into simpler compounds or molecules through the action of microorganisms.

Bulking Agent - material, such as wood chips, added to compost primarily to help create good pore structure for air flow. Often provides part of carbon source as well.

Bulk Density - the mass of a unit volume of soil, generally expressed in gm/cm3. The volume includes both solids and pores. Thus soils that are light and porous will have low bulk densities, while heavy or compact soils will have high bulk densities.

Cation Exchange Capacity - a measure of the negative charge on soils (primarily on clays and organic matter). It is expressed as the quantity of cations (positive ions) that can be adsorbed by the soil and is expressed in centimoles of charge/kg of soil (6x1023 charged particles are contained in one mole of charge).

Cellulose - a polysaccharide composing cell walls.

Contaminant - unwanted material. Physical contaminants of compost include glass, plastic, and stones, and chemical contaminants include trace heavy metals and toxic compounds.

Curing - the last stage of composting that occurs after much of the readily metabolized material has been decomposed. Provides for additional stabilization and reduction of pathogens and allows further decomposition of cellulose and lignin.

Decomposition - the breakdown of organic matter through microbial action.

Heavy Metals, Trace Metals - trace elements whose concentrations are regulated because of the potential for toxicity to humans, animals, or plants. Examples include chromium, copper, nickel, cadmium, lead, mercury, and zinc.

[40] Source: Cornell Waste Management Institute. 1996. "Glossary of Composting Terms." Retrieved March 1, 2016 (http://compost.css.cornell.edu/glossary.html).

Humus - a complex aggregate made during the decomposition of plant and animal residues; mainly derivatives of lignin, proteins, and cellulose combined with inorganic soil parts.

Inorganic - substances in which carbon-to-carbon bonds are absent. Mineral matter.

Leachate - liquid that drains from the mix of fresh organic matter.

Lignin - a hard substance embedded in the cellulose of plant cell walls that provides support.

Mature Compost - the stabilized and sanitized product of composting;it has undergone decomposition and is in the process of stabilization. it is characterized as containing readily available forms of plant nutrients; it is low in phytotoxic acids.

Metabolism - exchange of matter and energy between an organism and its environment and the transformation of this matter and energy within the organism.

Moisture Content - weight of water in material divided by weight of solids in material.

Organic - all compounds whose molecules contain carbon with a few exceptions such as carbon dioxide.

Pathogen - an organism including viruses, bacteria, fungi and protozoa capable of producing an infection or disease in a susceptible host.

Permeability - A measure of the rate at which water can percolate through soil.

Phenol - a caustic, poisonous acidic compound present in coal tar and wood tar; a hydroxyl derivative of aromatic hydrocarbons.

Phytotoxin - an element or compound that injures plants.

Source Separation - the practice of separating waste generated within each household or commercial operation into separate fractions such as newspapers, glass etc., and placing them in separate containers for recycling, composting, and disposal.

Stability - the degree to which the composted material can be stored or used without giving rise to nuisances, or can be applied to the soil without causing problems due to incomplete degradation of readily biodegradable materials.

Thermophilic - relating to organisms growing at high temperatures (40¡C-60¡C). A stage in composting.

Toxins - substances that cause a reduction of viability or functionality in living things.

Windrow System - composting mixture is placed in elongated piles called windrows. These windrows are aerated naturally through the chimney effect, or by mechanically turning the piles with a machine or by forced aeration.

Yard Trimmings - grass clippings, leaves, and weeds and shrub and tree prunings six inches or less in diameter from a residence or business.

LOCATION AND SCALE

Demonstration Composting (small-scale) is ordinarily coupled with demonstration gardens/farms and refers to composting that is visible to individuals while showcasing how to compost at home or other locations. Composting assistance is generated through volunteers, interns, and at times paid staff.

Institutional Composting (large-scale) refers to composting efforts that the college/university manages from large-scale sources. Examples of this include waste recovery from campus dining services, grounds department, and waste management facilities.

Off-site organics recovery is when compostable materials are transported off-campus to a secondary location not managed by the school.

On-site organics recovery is conducted directly on the school's campus or a college/university-owned facility.

METHODS

Aerated Static Piles consists of placing large piles of compost (non-windrow) over pipes so the air has the ability to circulate. This is a popular form of composting because the design structure is fairly simple, there is low operation labor, and lower capital costs then other forms of composting (U.S. Environmental Protection Agency [EPA], 2002).

Anaerobic Digestion is a process where microorganisms break down organic materials in the absence of oxygen, thereby producing biogas and soil amendments. Biogas can be used as a source of energy similar to natural gas (EPA, 2015d). An example includes the use of a biodigester.

Bin-System is a small- scale operation where organic waste is placed into containers or bins in order to retain the heat and moisture from compost. Commonly, bin-system composting is built from either wooden pallets, chicken wire, recycled lumber, and/or concrete blocks to make a four-sided container (EPA, 2015e).

Black Soldier Flies, Larvae Composting is similar to vermicompost (see below) but instead of worms, black soldier fly larvae are used. This type of composting has numerous benefits. For example, these flies eat a wide-range of food waste and black soldier fly larvae lowers disease threats in compost because they prevent unwanted insects from laying/hatching eggs in the compost (Bullock et al., 2013).

Compost Tea is derived by steeping finished compost to extract the liquid residue. Compost tea is a beneficial asset to enriching soil due to its high amounts of microorganisms (Pane et al. 2012).

In-Vessel composting is generally used to isolate organic waste into a container, such as a drum, silo, or even an enclosed building. In-vessel containers control the oxygen, temperature, and moisture level of the compost (Cooperband, 2002).

Vermicompost uses red worms that are placed in the organic material to assist with the decay of the organic waste. The requirements for vermicomposting include worms, worm bedding, organic matter, and a bin to keep the worms enclosed (Dabbs, 2009).

Windrow Style is placing organic waste in long, narrow piles that allows waste to form compost. Windrows are the most common form of composting nationally due to their low operation

COMPOST SOURCE INPUTS

Campus Gardens/Agricultural Farm are sources for campus produce and livestock and both produces and uses organics waste. These are managed and operated by students, faculty, and staff, can be curriculum or agricultural degree driven, attached to a campus program (sustainability, green initiative, healthy foods), or organized by a campus-based volunteer organization. These gardens and farms range in scale from small operations that produce small yields to large-scale operations where the production is much higher.

Dining Services prepare and serve food to campus students, faculty, and staff. Food services may be operated through contract services or managed and operated by the college/university.

Leaf and Limb are carbon sources for compost that is collected by grounds and landscaping staff or provided by outside local businesses. Leaf and limb collection is normally in the form of wood chips, leaves, limbs, or sawdust.

Off-Campus refers to composting sources that did not fall into other compost source categories. One example would be organic refuse from local surrounding businesses such as coffee shops or solid waste collection organizations. Also included in this category are off-campus arboretums, livestock/animal mortalities, animal bedding, and manure.

Office food waste is collected from campus building offices. This is brings more administrative staff into the programs and can increase compost inputs.

Residence Hall/Dormitory food waste is collected and transferred to another location as compost inputs.

Special Events are campus-wide events used to target and recruit students, faculty, staff and/or community members into organics waste procedures and recycling education. These consist of campus-wide recycling at events with high attendance (such as athletic games), programs established at residential halls to promote composting, or creating special opportunities for individuals to donate time and efforts to campus composting programs.

INSTITUTIONAL PARTICIPANTS

Administration is the high-level college/university departmental support of an organics recovery program. This includes maintenance of the program grounds and facilities, financial services, and/or other assistance to the overall program.

Committee/Council oversees and assists in the operations of the composting program. Committee/council members act as stakeholders of the program and often consist of a group of individuals that oversee the functioning, funding, operations, and other aspects of the composting program. These committees/councils are located within offices of sustainability, special composting councils, internal staff and faculty-run councils, and student-run councils.

Dining Services prepare and serve food to campus students, faculty, and staff and can either be the sole participant in operating composting procedures or a secondary participant that helps the college/university with their organics recovery. They can be internal to the organization or contracted out. The primary food service companies discussed in the profiles are Aramark and Sodexo. Other food services referenced are Bama Dining and Carolina Dining Services.

External Stakeholders are entities from outside of the college/university system that contributes to the organics recovery operations. Examples include community support (residents), organizations, businesses and/or waste management facilities.

Facilities Management are staff dedicated to the operation and maintenance of organics recovery programming. Departments and positions include grounds and landscaping, waste reduction and recycling, or farm/garden managers. Compost-related duties include leaf and limb collection, transportation of food waste/carbon source, monitoring and turning of compost. In some cases, finished composting is used by grounds and landscaping crews in their maintenance of campus grounds.

Faculty/Staff/Office lend assistance to colleges/universities organics recovery efforts. As institutional participants, these individuals have the opportunity to work directly with composting efforts, conduct research, volunteer, or even help to establish the creation of the program.

Internal Producing Partners refers to any operation that produces food within the college/university that are not part of food services; most often these are campus gardens or farms. Internal producing participants help with organics waste recovery through storing or using the final compost to produce future products.

Residence Halls refers to college/university buildings containing living quarters for student residents who contribute to food waste collection.

Students enrolled at the college/university whether they live on or off-campus may participate through volunteer work hours, student internships, course work, or outreach and awareness building. Students can also be the sole participants in the operation by designing and operating the entire organics recovery program.

Sustainability Programs are multi-faceted programs that incorporate sustainable practices in all aspects of college/university programs, policies, and operations. A sustainability program can either be the sole participant in operating composting procedures or a secondary participant that assists with campus organics recovery.

FUNDING MECHANISMS

Internal Operational Budget is allocated from existing institutional operational budgets. This funding can come from the college/university's overall budget, departments, student fees, or facility services such as dining services.

Donated Time/Equipment/Work examples include volunteer time from clubs, student groups, required coursework activities, and donated supplies and equipment.

Incoming Funding/Resources: Refers to funding and resources that are external to the college/university and not a part of their overall internal operational budget Examples in the profiles include external private waste management facilities that pick up organic waste and external organizations that bring their waste to be added to the institutions' compost. This procedure is paid for by the external organization and is then added to the overall budgeting for the composting program.

No Additional Funding indicates that the organics recovery operation is financed solely through volunteer efforts of the campus community.

STUDENT INVOLVEMENT

Course Work is an effective method to engage students in their school's organic recovery program. Course activities might include researching different methods of composting procedures or evaluating their institution's composting program. Some colleges/universities offer students the ability to incorporate organics recovery programming into an independent study course or act as a tour guide/docent at the institution's composting site(s) for course work credit.

Internships are often used to offer student employment and/or work-study opportunities. These internship responsibilities and duties are often associated with the operations and maintenance of a composting project or program while also working on the campus garden/farm.

Student Volunteer Programs are common for providing labor required for maintaining campus gardens, composting sites, and recovering individual organic waste in residential halls. Students gain experience and training through these programs.

ACADEMIC PROGRAMMING

Research/Course Curriculum is the incorporation of composting research and course requirements into an academic programming structure. This includes course syllabi, research projects, independent studies, tours of campus farms, or faculty-based research.

Service Learning is when students, faculty, and staff teach and learn by working directly with and providing service to composting programs to gain first-hand experience in various aspects of organics recovery.

Resource/Publications about organics recovery are often produced by institutions as a result of academic programming. Colleges and universities have produced resource guides, reports, and scholarly articles on topics such as tracking program development and success, best practices, and analysis of specific techniques.

COMMUNITY PARTNERSHIPS

Compost for Donation makes compost available to the surrounding community (i.e. individual households, community-based organizations, or businesses) at no cost.

Compost for Purchase makes compost available to the surrounding community (i.e. individual households, community-based organizations, or businesses) for a cost.

Community Education is an external engagement where the surrounding community is directly involved in special events or learning opportunities specific to organics recovery.

Learning Community in which institutions systematically interact with other academic institutions, and outside establishments/ organizations to exchange information that leads to strengthening organics recovery programming. Establishments/organizations include private waste management facilities, local businesses, and municipalities.

Appendix B: Sustainability Tracking Assessment and Rating System (STARS) Considerations

The Sustainability Tracking, Assessment & Rating System (STARS) is a self-reporting framework of the Association for the Advancement of Sustainability in Higher Education (AASHE) for colleges and universities to measure their sustainability performance. Pertaining to composting, schools should pay attention to the incentives within this framework for implementing organics recovery; in particular OP-T2-7: Pre-Consumer Food Waste Composting, OP-T2-8: Post-Consumer Food Waste Composting, and OP-T2-9: Food Donation, OP-T2-23: Landscape Waste Composting. In determining Greenhouse Gas Emissions, credit can be counted for the carbon offsets resulting from carbon storage resulting from on-site composting (Association for the Advancement of Sustainability in Higher Education [AASHE], 2016). Credits for sustainable dining are also recognized if a school participates in pre- and post-consumer composting, and in competitions or programs, such as the U.S. EPA Food Recovery Challenge, and/or uses a food waste prevention system (e.g. LeanPath) to track and improve food management (AASHE, 2016). Other participation in food waste reduction includes the offering of discounts or other incentives to customers who use reusable containers instead of disposable or compostable containers, or provides resusable and/or third party certified compostable containers and service ware for "to go" meals in conjunction with the on-site composting program (AASHE, 2016). Credits are also offered for landscape management practices that include waste minimization through composting and/or mulching on-site waste (AASHE, 2016). Composting is included in the calculation for waste minimization by including the short tons of materials composted per year.

Appendix C. Resource Links

College and University Links

Website: Gator Dining Services Sustainability Information
Website: Institute of Food and Agriculture Sciences
Website: Recycling and Solid Waste Management
Website: Student Compost Cooperative
Website: University Athletic Association Sustainability
Website: UA Compost
Website: Agnes Scott College Compost
Website: Office of Sustainability Eco House
Publication: Georgia College Campus Sustainability Plan
(includes composting goals 1 and 2 of Waste Management)
Website: Georgia College Student Green Fee
Website: Georgia College Sustainability Council
Website: Green Fee Grant Application for Composting
Article: Faculty/Staff Newspaper article on composting
Website: Georgia Tech Sustainability Initiatives
Article: University Newspaper article on campus garden
Publication: Thorne, Kacie L. Miss, "Composting: Sustainable Efforts on a University Scale" (2014)
University Honors Program Theses. Paper 39.
Website: Garden of the Coastal Plain
Food Waste Composting: Institutional and Industrial Applications.
Website: Sustainable UGA Recycling and Compost
Website: UGA Biorefining and Carbon Cycling Program
Website: UGArden. Learning and Demonstration Farm.
Video: Berea College Composting Program
Website: Ecovillage
Website: Food Waste Composting
Website: Office of Sustainability
Publication: ID-166: On-Farm Composting of Animal Mortalities
Publication: ID-167: On-Farm Disposal of Animal Mortalities
Website: UK College of Agriculture Composting Info
Website: UofL Sustainability - Composting
Article: WKU Composting Food Waste from Fresh Food Co.
Facebook Page: Project Grow (demonstration garden)
Website: Baker Arboretum
Website: Composting at Ole Miss
Website: Green Student Intern Program
Website: The Maynard W. Quimby Medicinal Plant Garden
Website: The UM Green Fund
Website: Campus Composting
Website: Physical Plant Compost and Sustainable Practices

Video: Food Waste Management at Guilford College
Website: Guilford Sustainability
Website: Biological and Agricultural Engineering Composting
Website: NC State Vermicomposting
Website: Pizza Box Composting Project website
Website: CCCG Compost Donations
Website: Carolina Green Events
Website: Compost Program Overview
Website: ResHall Composting Pilot Program
Website: Waste Reduction and Recycling Reporting
Website: Composting Facility
Website: Creative Inquiry Course
Website: Soldier Fly Digester
Video: Composting at the Furman Farm
Video: Furman Organic Farm Information
Website: Furman Farm
Facebook Page: Carolina Community Farm and Garden
Website: Food Week Sustainability Events
Website: Green Quad
Website: Office of Sustainability
Website: Campus Composting
Website: Student Green Fee Program
Website: Undergraduate Organic Production Concentration
Website: Undergraduate Plant Science Courses

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