STATE OF COMPOSTING IN THE US

What, Why, Where & How

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About the Institute for Local Self-Reliance

www.ilsr.org

The Institute for Local Self-Reliance (ILSR) is a national non-profit research and technical assistance organization that since 1974, has championed local self-reliance, a strategy that underscores the need for humanly scaled institutions and economies and the widest possible distribution of ownership. ILSR's Waste to Wealth program focuses on converting waste from liabilities to valuable assets. It is unique in promoting zero waste planning specifically aimed at maximizing the economic development potential for local communities. During the last three decades, ILSR has documented model composting initiatives, the job creation benefits of composting, and the link between expanding composting and climate protection. More recently it has researched states with model compost facility permitting regulations and other model policies to promote composting, and has led a peer-to-peer technical assistance program for farmers interested in composting in the Mid-Atlantic region. It currently chairs a metropolitan DC Organics Task Force as well as the US Composting Council's Legislative & Environmental Affairs Committee.

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Executive Summary

Compost is the dark, crumbly, earthy-smelling material produced by the natural decomposition of organic materials. It is a valuable soil conditioner. Compost adds needed organic matter to soil, sequesters carbon in soil, improves plant growth, conserves water, reduces reliance on chemical pesticides and fertilizers, and helps prevent nutrient runoff and soil erosion. But it also reduces the volume of and recycles materials that might otherwise be disposed in landfills or trash incinerators such as leaves, grass clippings, brush, garden trimmings, wood, manure, and food scraps. Furthermore, unlike recycling, composting is inherently local and part of the natural ecosystem. Recovered organics cannot be shipped abroad to be made into compost; this happens locally with myriad benefits to the local economy and environment. It is a place-based industry, which cannot be outsourced abroad. Thus, advancing composting and compost use in the US is a key sustainability strategy to create jobs, protect watersheds, reduce climate impacts, improve soil vitality, and build resilient local economies.

With all these benefits, why aren't we composting more? How can we generate and use more compost to sequester carbon in soil and improve soil structure and fertility? Where can the compost come from? What kinds of systems are the most effective? What types should be promoted? What are the threats to expanding composting? What are its limitations? What infrastructure and policies are needed to advance composting? How do we do implement these?

The State of Composting in the US: What, Why, Where & How seeks to address these questions. It explains what composting is and why it is important; summarizes model programs, technologies and systems; and provides a national and state-by-state snapshot of activities, infrastructure needed, and policy opportunities. It concludes with recommendations on how to grow composting in the US.

Section 1: What Is Composting and Compost

Composting is the controlled aerobic, or oxygen-requiring, decomposition of organic materials by microorganisms, under controlled conditions. It reduces the volume and mass of the raw materials while transforming them into a valuable soil conditioner – compost. Composting is a proven approach to recycling a wide variety of organic materials from household kitchen scraps and yard trimmings to crop residues, biosolids, animal manures, and soiled paper. Composting, at any scale, is a biological manufacturing process. The resulting compost product is valued for its organic matter content and is utilized to enhance the chemical, physical, and biological properties of soil. Compost is not typically considered a fertilizer, although it can reduce the amount of fertilizer needed.

Composting can take place at many levels – backyard, block, neighborhood, schoolyard, community, on-farm, and regional – and in urban, suburban, and rural areas. There are many methods and scales and ownership can be private or public or a combination of the two. Large-scale centralized facilities can serve wide geographic areas and divert significant quantities of organic materials from disposal facilities. Composting locally at the neighborhood or community-scale level yields many other benefits: improved local soils, more local jobs, greener spaces, enhanced food security and fewer food deserts, less truck traffic hauling garbage, increased composting know-how and skills within the local workforce and reinforced in the next generation. When composting is small-scale and locally based, community participation and education can flourish.

Composting Systems

There are many types of composting systems, large and small, and everything in between. Regardless of size, managed composting systems have adequate microorganisms to digest organic materials, adequate oxygen, adequate moisture, adequate food for microorganisms (that is, a balanced carbon to nitrogen ratio), diversely sized particles that provide pore space for oxygen to travel, and an adequate volume of material to best allow the microbial population to grow and thrive (usually a cubic yard or more). Food scraps represent materials high in nitrogen; thus, any food scrap composting program must find adequate supplies of carbon-rich materials such as wood chips, straw, leaves, and brush. In addition, compost needs time and space to stabilize and mature after an initial phase, typically characterized by high temperatures, and frequent monitoring and management.

Composting is a relatively simple process that can be performed outdoors in most climates. Because of a desire to operate the process more efficiently, control odors, and minimize the effects of weather, some facilities operate under structures, in fully enclosed buildings, or in entirely mechanized facilities (and combinations thereto). There are many composting configurations in use today. All fall into one or more of these classifications: open vs. contained, passive vs. active, static vs. managed, and onsite vs. centralized. Several basic composting systems are available:

Static Systems: Static pile systems are passively aerated, relying on the "chimney effect" where the internal air heated by microbial decomposition rises and is replaced with cool air.

Turned Windrow Systems: Windrow composting involves forming material in long, narrow, low piles known as windrows that are about twice as wide as they are high. Windrow composting is the most common composting system used in the US today due to its suitability to a wide variety of materials and capacities and low capital and operating costs.

Passively Aerated Windrow Systems: Similar to static systems but where aeration is enhanced by using perforated pipes to allow air into the pile.

Actively Aerated Systems: These systems use fans and blowers to move air through the compost pile to maintain aerobic conditions in the piles. These are generally static systems with little or no turning during the 30-45 days of active composting. Appendix A explains the various aerated static pile (ASP) systems available and spotlights examples of operating facilities around the country.

Bioreactors: A bioreactor is an enclosed, rigid structure or vessel used to contain the material and is usually equipped with process control systems that monitor the operating performance of the composting process such as temperature and oxygen or carbon dioxide. Bioreactors can be classified by their configuration (horizontal, vertical with channels, with cells, with containers, with tunnels and with rotating drums), by operational mode (continuous or batch), and by movement of material within the reactor (static or dynamic). Appendix B provides more detail and examples of the wide range of bioreactor configurations available.

Vermicomposting: Vermicomposting – or worm composting – involves special species of worms decomposing organic materials into a rich humus. *Eisenia fetida*, commonly called red wigglers, is the most popular type of worm for vermicomposting. Vermicomposting systems are more suited to smaller-scale applications like backyard/individual, on-site, and on-farm than to the larger-scale applications. There are numerous sources of worm bins for small-scale applications. Larger-scale units are available from some technology providers.

Costs

Composting system costs vary and establishing a facility can be expensive (although as we note pales in comparison to building new landfills or trash burners). Fixed assets associated with composting facilities are land, site improvements, and the processing technology. Site improvements at larger-scale facilities can include security gating, grading, constructing roadways and materials handling impermeable surfaces, weigh scales and offices buildings, and storm water management facilities. Site improvements can be on the order of $250,000/acre.

Smaller-scale, community-level composting facilities can be done for significantly less, in that many of them operate on municipally-donated or leased land or can be sited in repurposed commercial or industrial buildings, have limited site improvement needs and can use more affordable, small-scale processing technologies. One recent study estimated a capital cost of about $220,000 for a network of four community-level composting facilities and one centralized curing/product management/equipment maintenance facility.

Costs for processing technologies vary widely and are considered proprietary information by most technology providers. Small-scale aerated static pile systems are usually below $10,000-$25,000 each; horizontal bioreactors and containerized ASPs can vary between $100,000 and $700,000 each; and larger-scale in-vessel systems and dry fermentation AD systems cost multiple millions of dollars. Technology providers generally sell the physical equipment, help oversee installation, provide operations and maintenance manuals, provide start-up training assistance, and, often, ongoing phone/internet support for a period of time along with a warranty.

Operating costs in organics recycling are similar to those in any bulk commodities industry: fuel for vehicles and equipment, labor costs, and vehicle/equipment maintenance.

A growing concern among many composters is the increasing cost of carbonaceous amendments needed to provide carbon and structural porosity for proper composting. In less than ten years, due in large part to demand created by the growth of the biomass industry, the price of wood chips has risen from near-nothing to over $20 per ton. As the normal weight-to-weight ratio between wood chips and compostable solid waste is 1:1, this adds potentially crippling costs to a composting operation.

Despite the success of many composting enterprises, raising financing from traditional lending and equity institutions can be challenging. Banks and other financial institutions are not familiar with these operations. As noted in Section 3, state grants and loan programs for composting have decreased over the last 10 to 15 years (see Table 3-7); these financing programs helped composters procure necessary equipment to get facilities started.

Material Feedstocks Available for Composting

There is enormous potential to increase composting and the production of compost in the US. At the same time, the need for compost is great, especially to restore soil structure, vitality and fertility.

From the municipal waste stream alone (material discarded by households, businesses, and institutions), approximately 35 millions tons of food scraps, 14 millions of yard trimmings, 13 millions tons of soiled paper, and 13 millions tons of wood waste are landfilled or burned each year. Assuming only half of this wood waste and the paper is suitable for composting, 62 millions tons of municipal organics now disposed in the US could instead be captured for composting, producing an estimated 21 million tons of additional compost.

Livestock manure and municipal biosolids are also suitable compost feedstocks. Dairy cows generate about 146 millions tons of manure each year. Beef cattle produce an estimated 280 million tons, swine 287 million tons, and poultry livestock 230 million wet tons. On a dry ton basis, this equates to 136 million tons of manure each year. Municipal biosolids are the residual semi solid material from wastewater treatment. Each person produces about 30-50 dry pounds of biosolids per year. With a US population of 316 million in 2013, this translates to 5 to 8 million dry tons of biosolids per year. Manures and biosolids are high in nitrogen, and thus require mixing with high carbon feedstocks such as leaves, wood waste, or agricultural crop residues (e.g., corn stalks, corn silage, or wheat straw) in order to properly compost.

Millions of tons of agricultural crop residues are potentially available for composting, but it should be noted that excessive harvesting of agricultural residuals could have long-term impacts on soil quality, especially if the land from which they are harvested is not replenished with the compost or other organic matter. No-till farming is increasingly recognized for its ability to retain organic matter and cycle nutrients in the soil. It is a method of farming in which crop residues are left on the field and there is minimal soil disturbance. One potential avenue for using some agricultural residues high in carbon such as wheat straw, rice straw, barley straw and stalks from sorghum, would be to first use the material as animal bedding. The advantages of this approach include providing two uses for the material and the likely proximity of animal operations to fields used to produce animal feed.

Challenges and Impacts

Composting has many benefits but it is also not without its drawbacks and challenges. These include odors, pathogens, contaminants, and concerns about nutrient run-off. Composting inherently involves dealing with putrescible materials, which means odors need to be actively managed to avoid becoming a nuisance. Pathogens also need to be reduced, which is why time, temperature, and mixing are important. High-quality compost has to be free of harmful and physical contaminants. Physical contaminants – most notably plastics – are increasingly a problem, particularly for facilities accepting post-consumer food scraps. Persistent herbicides are another challenge, as they can find their way into composting facilities and even in very minute concentrations cause crop damage when the compost is used. However, failure to control and manage odors is the single biggest cause of adverse publicity, regulatory pressures and facility closures in the organics recycling industry. Appendix D discusses managing odors at compost sites.

Markets and Applications for Compost

There are many markets and applications for compost, both existing and emerging: agricultural and horticultural, landscape and nursery, vegetable and flower gardens, sod production and roadside projects, wetlands creation, soil remediation and land reclamation, sports fields and golf courses, and sediment and erosion control. Moreover, markets for quality compost are growing thanks to the expansion of sustainable practices associated with green infrastructure such as stormwater management, green roofs, rain gardens, and other forms of low-impact development (LID). Another emerging market is use of compost to sequester carbon.

Highest and Best Use

Composting is an age-old and important technique for cycling organic materials into soil, but it is not considered the highest and best use for all organic materials. Avoiding the generation of waste in the first place – source reduction – and rescuing food to feed people, for instance, are considered higher priorities than composting for food scraps. The US EPA has developed a hierarchy that represents EPA's perceived best management activities for food scraps. Reducing wasted food and feeding the hungry are considered the most beneficial, followed by industrial uses and composting. Landfill and incineration are identified as the least attractive.

ILSR endorses a more nuanced hierarchy of highest and best use, one that takes into account scale, ownership, and the level of community engagement. In general, we believe locally based systems should be prioritized over centralized systems. Locally based composting is important to support local food production and keep our backyards and streetscapes rich in organic matter. (Training programs are needed to ensure small-scale decentralized sites are well operated.)

The concept of highest and best use can apply to the finished compost in addition to how the raw organics materials are managed. Compost used for daily landfill cover, for instance, is a high-volume but low-value end market. In order to recycle organic materials into high-value compost, composters have to produce high-quality compost suitable for the desired end market. Buyers may be concerned with weed seed content, soluble salts, pathogens, pH, nutrient value, and level of organic matter. Compost quality requirements can differ significantly depending on the end use. The US Composting Council has a compost testing, labeling and information disclosure program – the Seal of Testing Assurance program – that provides reliable information on the quality of compost. The program supports production of consistently high-quality compost for high-value end uses.

Section 2: Why Compost?

Unsustainable patterns of wasting drive climate change, resource depletion, habitat destruction, and a range of other environmental crises. At the same time we throw away valuable organic materials, our soils suffer from topsoil loss and erosion, which in turn leads to severe watershed problems and threatens our ability to sustain life on earth. Shifting toward a decentralized recycling infrastructure addresses these environmental threats and forms the basis for strong local economies that operate in harmony with nature. Advancing composting and compost use is a key sustainability strategy to create jobs, protect watersheds, reduce climate impacts, improve soil vitality, and build resilient local economies.

Compost to Improve Soil & Protect Watersheds

One-third of the world's arable land has been lost to soil erosion and continues to be lost at an alarming rate. In the US, 99 million acres (28% of all cropland) are eroding above soil tolerance rates, meaning the long-term productivity of the soil cannot be maintained and new soil is not adequately replacing lost soil. Erosion reduces the ability of soil to store water and support plant growth. Much of the soil that is washed away ends up in rivers, streams and lakes, contaminating waterways with fertilizers and pesticides. Amending soil with compost has the following benefits:

- Improved soil quality and structure
- Erosion and sedimentation control
- Improved water retention
- Reduced chemical needs
- Cutting non-point source pollution

Compost to Protect the Climate

When landfilled, biodegradable organic materials are a liability as they break down and produce methane, a greenhouse gas 72 times more potent than carbon dioxide in its global warming strength (over a 20 year time horizon). Compost protects the climate in two main ways: it sequesters carbon in soil and it reduces methane emissions from landfills by cutting the amount of biodegradable materials disposed. There is a significant and growing body of evidence that demonstrates the effectiveness of compost to store carbon in soil for a wide range of soil types and land uses.

Compost to Reduce Waste

The potential to expand composting is enormous. The US disposes of 164 millions tons of garbage per year. Almost half the materials Americans discard – food scraps, yard trimmings, and soiled paper – is compostable. Food scraps alone represent one-fifth. While 58% of yard trimmings are recovered for composting, the recovery level for food scraps remains low at only 4.8%. Many communities (such as San Francisco) have proven the ability of convenient composting programs to achieve high diversion levels.

Compost to Create Jobs

Jobs are sustained in each phase of the organics recovery cycle. In addition to the direct jobs at composting facilities, the use of compost supports new green enterprises and additional jobs. Most of the end markets for compost tend to be regional, if not local. Each recycling step a community takes locally means more jobs, more business expenditures on supplies and services, and more money circulating in the local economy through spending and tax payments.

- On a per-ton basis, composting sustains four times the number of jobs as landfill or incinerator disposal.
- In addition to manufacturing compost, using compost in "green infrastructure" and for stormwater and sediment control creates even more jobs. Green infrastructure represents low-impact development such as rain gardens, green roofs, bioswales, vegetated retaining walls, and compost blankets on steep highway embankments to control soil erosion.
- An entire new industry of contractors who use compost and compost-based products for green infrastructure has emerged, presenting an opportunity to establish a new made-in-America industrial sector.
- Utilizing 10,000 tons of finished compost annually in green infrastructure can sustain one new business. For every 10,000 tons of compost used annually by these businesses, 18 full-time equivalent jobs can be sustained.
- For every 1 million tons of organic material composted, followed by local use of the resulting compost in green infrastructure, almost 1,400 new full-time equivalent jobs could potentially be supported. These 1,400 jobs could pay wages from $23 million to $57 million each year.
- Composting and compost use represent place-based industries that cannot be outsourced abroad.

Compost to Build Community

When composting is small scale and locally based, it has the potential to build and engage the community. Locally based composting circulates dollars in the community, promotes social inclusion and empowerment, greens neighborhoods, builds healthy soils, supports local food production and food security, embeds a culture of composting know-how in the community, sustains local jobs, and strengthens the skills of the local workforce.

Composting done in conjunction with community and school gardens provides a full soil-to-soil loop that few students would experience otherwise. Young composters grow into old composters, and students are instrumental in spreading compost awareness and experience throughout the entire community. Investment in training and education of today's youth will have a long-term payback for composting efforts in the future.

Section 3: Where Is Composting Happening – National Snapshot and Models to Replicate

Municipal and county government, and private food scrap generators increasingly recognize the importance of diverting yard trimmings and food scraps from disposal to reach recycling goals and manage solid waste handling costs. Yard trimmings composting programs are fairly well developed in the US. Of the 4,914 composting operations identified in the US for this study, about 71% compost only yard trimmings (based on 44 states reporting.) Food scrap recovery is slowly growing. More than 180 communities have now instituted residential food scrap collection programs, up from only a handful a decade ago. Countless supermarkets, schools, restaurants, and other businesses and institutions are also source separating their food scraps for composting. But the current infrastructure remains inadequate.

State organics recycling officials contacted as part of this project were asked to tally the number of composting facilities in their state by volume of material processed. For the states that provided total tonnage diverted and the number of facilities, the average diverted per facility per year was 5,155 tons. This is far too small. To achieve higher levels of composting in the US, more processing capacity will be needed.

Model Policies

At the state level, policies have been enacted to encourage or require diversion of source separated organics. Over 20 states enacted bans on disposal of yard trimmings in landfills many years ago. More recently, a handful of states have established food waste disposal bans. Connecticut's and Massachusetts' laws cover commercial food waste streams. Vermont's law covers both residential and commercial, phased in over the years 2014 to 2020. Commercial generators are required to comply first; residential organics diversion is required by 2020.

But disposal bans are certainly not the only mechanism for driving composting. Of the top five states in terms of diversion of organics to composting, only Iowa has a ban on disposal of yard trimmings in landfills. While California does not have a disposal ban on organics, it passed a waste diversion law in 1999 — AB939 — that required jurisdictions to divert 50% of the waste stream by 2000 or be subject to fines. The waste diversion goal has been effective at establishing local organics diversion programs — for both yard trimmings and food scraps.

Of the 39 states that responded to the question on programs in place to support composting, only 14 reported having a grant program, and even fewer, 7, have a loan program. This lack of funding via grants and loans to establish or expand composting infrastructure is discouraging in light of the critical need for more organics processing capacity in the US. In addition, many states have cut the number of full-time employees dedicated to composting, i.e., state organics recycling specialists often are given other programs to manage that are unrelated to composting and organics management. The Ohio Environmental Protection Agency and the California Department of Resources Recycling and Recovery (CalRecycle) stand out as two exceptions to this trend. Massachusetts, which is getting ready to enforce its commercial organics disposal ban in fall 2014, has contracted much of its technical assistance for composting to a nonprofit organization, so has not added staff at the agency level.

One reason for the lack of more facilities accepting food scraps is an inadequate regulatory structure to facilitate the development of new operations. In ILSR's August 2012 survey of Maryland composters, regulations and permitting were the most frequently cited challenges to facilities' financial viability and their opportunities for expansion. This is beginning to change. States are starting to modify their regulations to facilitate composting of source separated organics. Massachusetts, Ohio, Oregon and Washington are examples of several states that recently revised composting rules to create distinct categories for source separated organics including food waste. The permitting and site approval process in this tier is designed to be more streamlined and less costly.

Demand for compost will help drive the supply and development of new infrastructure. Compost purchasing incentives and specifications are needed. At the state level, a number of Departments of Transportation (DOT) have specifications for compost-based products for erosion and sediment control and storm water management. In almost all cases, the specifications require that the compost be certified under the US Composting Council's Seal of Testing Assurance (STA).

At the local level, municipalities — as part of their compliance with the federal Clean Water Act storm water rules — are utilizing green infrastructure tools such as green roofs and bioretention swales to manage storm water. In July 2013, Washington, DC's Department of Environment finalized new storm water regulations that rely in part on storm water retention. In its best management practices (BMP) guide for achieving water retention, compost is an element of several of the BMP groups, including green roof growing media, bioretention media, and compost-amended trees.

In Washington State, the Washington State Department of Ecology (DOE) *Stormwater Management Manual for Western Washington* includes a BMP for "Post Construction Soil Quality and Depth," which requires preserving site topsoil and vegetation where possible, reducing soil compaction, and amending disturbed soils with compost to restore healthy soil functions. The BMP calls for planting beds to have a topsoil layer with a minimum organic matter of 10% dry weight, which equates to 30-40% compost by volume. Turf areas should have 5% minimum organic matter (15-25% compost amendment by volume). King County, Washington, is one jurisdiction that has adopted this guideline as policy in its County code.

A small number of cities are requiring new lawns to incorporate compost as a water-saving measure (Leander, Texas, and Greeley and Denver, Colorado). Montgomery County, Maryland's RainScapes Program incentivizes the use of compost in raingardens and new landscapes. These innovative programs and policies could easily be adopted across the country.

Model Programs

Examples of successful composting facilities are plentiful. And feedstocks composted range from the typical municipal solid waste and wastewater organics (leaves, brush, grass clippings, food scraps, soiled and nonrecyclable paper, biosolids) to the "exotic" (road kill, whales, pizza dough). In short, source separation of organics, provides tangible rewards for changing behavior. Households and businesses can witness their trash shrinking by downsizing to smaller carts or less frequent set-out in the case of households, and downsizing from compactors to small dumpsters that are serviced less frequently in the case of businesses and institutions. When households become involved in composting, either at home or in the community, they reap the further reward of the finished compost.

ILSR has been documenting model composting programs for more almost 30 years and the archives of *BioCycle* are filled with how-to information on establishing and managing source separation and composting programs for residential, commercial and institutional organics. In addition, a number of toolkits are in the public domain.

In general, the most successful programs have the following elements:

- Convenience for participants (such as bins provided, frequent collection)
- Education and outreach (participants need to understand the benefits, what materials are accepted and how to sort properly)
- Targeting a wide range of materials (year-round yard trimmings, all types of food scraps, food-soiled paper)
- Elimination of sources of contaminants (such as banning polystyrene foodservice ware and requiring reusable, recyclable, or compostable ware)
- Pay-as-you-throw trash fees (which provide an economic incentive to reduce and recycle as much as possible and participate in recycling and composting programs)

Section 4: How to Advance Composting

There are many strategies to advance composting in the US. Solid scientific research is needed to demonstrate composting's benefits. The US Composting Council's Research and Education Foundation, for instance, is actively seeking support to compile and improve data related to storm water discharge from composting facilities, propose standards and specifications for compost use in green roof media, and demonstrate water savings with compost use across different soil/climate/crop scenarios. An accurate estimate of the number of composting and digestion facilities in the US and evaluation of both the direct and indirect economic benefit from the existence of these organics recycling facilities is needed to support economic development efforts to expand the industry. Further research to document the actual impacts (social, environmental, economic) of small-scale community composting facilities is also warranted.

New rules and policies are very effective means for growing composting. There are numerous local and state policies that could be implemented to accelerate composting and compost production. Also needed is financial modeling to provide valid data for investors and other interested parties. Training is critical to the success of composting, regardless of the size. The development of professional compost science, engineering and usage programs at state land-grant colleges in the US could be funded to both raise the professionalism of the industry and to create a cadre of graduates that can help run and expand composting facilities.

A diverse and local composting infrastructure is needed. Composting can take place effectively in a wide range of scale and sizes: small backyard bins, community gardens, onsite systems at schools and hospitals, rural and urban farm-based operations, and large low-tech and high-tech regional facilities. Communities embracing a decentralized and diverse organics recovery infrastructure – one that first prioritizes food rescue, backyard composting, onsite institutional systems, community composting, and urban and rural on-farm composting before the development of centralized regional facilities – will be more resilient and will better reap the economic and environmental benefits that organics recovery has to offer. ILSR's October 2013 survey of community composters identified a number of needs including training and staffing, technical assistance and grants, policies and standards, access to land, and help with public education and marketing. (Appendix F summarizes the survey results.)

Conclusion

America is at a crossroads. Our recycling rate has stagnated at around 40% for more than a decade. With compostable material making up one-third to one-half of municipal solid waste, there is an enormous opportunity to achieve higher recycling levels with comprehensive composting. In addition to yard debris and food scraps, soiled paper such as pizza boxes and paper towels can be composted. Switching to compostable foodservice ware and packaging would further help divert materials from disposal facilities. Increasing composting and compost use would benefit the US in other important ways too.

At the same time many states struggle to increase their recycling levels, local watersheds continue to suffer from excessive nitrogen and phosphorus levels due to nutrient-laden runoff pollution. Excess fertilizers from farms and suburban lawns, sewage from septic systems, and sediment from construction projects wash off the land and into our waterways every time it rains. When added to soil, compost can help manage these erosion, sedimentation, and stormwater runoff problems, while providing other benefits such as carbon sequestration. Healthy soils are essential for protecting local watersheds. Naturally occurring (undisturbed) soil and vegetation provide important stormwater functions: water infiltration; nutrient, sediment, and pollutant adsorption; sediment and pollutant biofiltration; water interflow storage and transmission; and pollutant decomposition. These functions are largely lost when development strips away native soil and vegetation and replaces them with minimal topsoil and sod. Organic matter is vital to soil quality and amending soil with compost is the best way to increase the organic matter in soil, which improves soil's ability to retain water as well as sequester carbon.

Expanding the use of compost for stormwater and erosion control and in green infrastructure such as green roofs and rain gardens will create a new business sector throughout the US. For every 10,000 tons of compost used per year, about 18 jobs are sustained. This is in addition to the jobs that could be created by expanding the manufacturing of compost at composting sites.

There are countless farmers who could potentially start composting if they were trained and could navigate zoning and other regulations. Expansion of backyard composting would reduce municipal government costs to collect and handle material and retain valuable organic matter in our neighborhood soils. The creation of a comprehensive food recovery strategy would ensure that edible organics are diverted to those who need them most.

However, despite best intentions, composting and compost use will ultimately be limited if disposal fees remain cheap, new trash incinerators are built (under the false guise of providing renewable energy), persistent herbicides remain on the market, and policies are not passed to support the development of adequate infrastructure.

Incinerators need waste to make good on bond obligations. While incinerators are presented as green, renewable, economical solutions to waste problems, in reality, these facilities drain financial resources, pollute, undermine waste reduction and economic development efforts, and compete with the introduction of comprehensive food scrap composting systems.

Composting operations, on a per-ton and a per-dollar-capital-investment basis, sustain more jobs than landfills or incinerators. For every 10,000 tons per year flowing to an incinerator, one job is sustained. A 2013 ILSR study, *Pay Dirt*, focused on Maryland, indicates that landfills sustain two jobs per 10,000 tons per year landfilled. In contrast, composting operations sustain four jobs for every 10,000 tons per year they handle.

Hundreds of new jobs could be created if organic material was diverted from landfills and incinerators to composting facilities. The potential job creation would increase if a diverse composting infrastructure was developed, that included many small- and medium-sized operations. The study found that if every 1 million tons of organic materials now disposed were instead composted at a mix of small, medium, and large facilities and the resulting compost used in green infrastructure, almost 1,400 new full-time equivalent jobs could potentially be supported, paying wages ranging from $23 million to $57 million. In contrast, when disposed in landfills and incinerators, this tonnage only supports 120 to 220 jobs.

ILSR recommends a comprehensive composting strategy: one that promotes home composting and small-scale farm and community sites as a priority, followed by onsite institutional systems and then development of commercial capacity for remaining organics.

It is time to adopt a national soils strategy that institutionalizes the role of healthy soils — achieved by adding organic matter such as compost — as a tool to manage the harsh effects of climate change as well as sequester carbon. The US has millions of acres of marginalized land starving for organic matter. Just applying 1/2 inch of compost per year to the 99 million acres of cropland eroding above soil tolerance levels would require about 3 billion tons of compost. There is not enough compost to meet this need. No organic scrap should be wasted. □

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Introduction

Compost is the dark, crumbly, earthy-smelling material produced by the natural decomposition of organic materials. It is a valuable soil conditioner. Compost adds needed organic matter to soil, sequesters carbon in soil, improves plant growth, conserves water, reduces reliance on chemical pesticides and fertilizers, and helps prevent nutrient runoff and soil erosion. But it also reduces the volume of and recycles materials that might otherwise be disposed in landfills or trash incinerators such as leaves, grass clippings, brush, garden trimmings, wood, manure, and food scraps. Furthermore, unlike recycling, composting is inherently local and part of the natural ecosystem. Recovered organics cannot be shipped abroad to be made into compost; this happens locally with myriad benefits to the local economy and environment. Thus, advancing composting and compost use is a key sustainability strategy to create jobs, protect local watersheds, reduce climate impacts, improve soil vitality, and build resilient local economies.

With all these benefits, why aren't we composting more? How can we generate and use more compost to sequester carbon in soil and improve soil structure? Where can the compost come from? What kinds of systems are the most effective? What types should be promoted? What are the threats to expanding composting? What are its limitations? What infrastructure and policies are needed to advance composting? How do we implement these?

The State of Composting in the US: What, Why, Where & How seeks to address these questions. It explains what composting is and why it is important; summarizes model programs, technologies and systems; and provides a national and state-by-state snapshot of activities, infrastructure needed, and policy opportunities. It concludes with recommendations on how to grow composting in the US. □

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Section

1

What Is Composting and Compost?

Composting and Compost Defined

Composting is the controlled aerobic, or oxygen-requiring, decomposition of organic materials by microorganisms, under controlled conditions. During composting, the microorganisms consume oxygen. Composting, at any scale, is a biological manufacturing process, where the inputs to the process are material feedstocks, air and water, and the outputs are compost, heat, water vapor and carbon dioxide (biogenic). Composting reduces the volume and mass of the raw materials while transforming them into a valuable soil conditioner – compost.[1] Compost is valued for its organic matter content and is utilized to enhance the chemical, physical, and biological properties of soil. It is not typically considered a fertilizer, although it can reduce the amount of fertilizer needed.[2]

Regardless of size, managed composting systems need to have adequate microorganisms to digest organic materials, adequate oxygen, adequate moisture, adequate food for microorganisms (that is, a balanced carbon to nitrogen ratio), diversely sized food particles that provide pore space for oxygen to travel, and an adequate volume of material to best allow the microbial population to grow and thrive (usually a cubic yard or more). Food scraps, for instance, represent materials high in nitrogen; thus, any food scraps composting program must find adequate supplies of carbon-rich materials such as wood chips, straw, leaves, and brush. These latter materials often serve as bulking agents to lessen bulk density and provide adequate pore space. In addition, compost needs time and space to stabilize and mature after an initial phase, typically characterized by high temperatures, and frequent monitoring and management.

Figure 1-1: Handful of compost

Photo credit: Institute for Local Self-Reliance

Composting is a proven approach to recycling a wide variety of organic materials from household kitchen scraps and yard trimmings to crop residues and animal manures. This report's snapshot survey counted a total of 4,914 composting operations in the US; 71% of those only compost yard trimmings. See Sec. 2, Table 2-3. Composting is a self-heating process that destroys pathogens and weed seeds and produces a material similar to soil humus. Heat is produced by biological activity of decomposition and temperatures rise

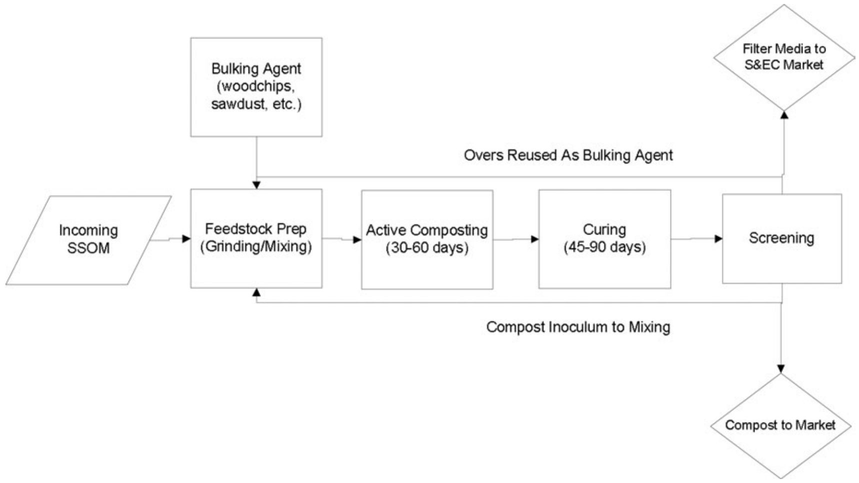

Figure 1-2: Composting Process Flow Diagram

Credit: Coker Composting & Consulting

to thermophilic levels (115° F. – 160° F.). This heating kills pathogenic microbes like fecal coliform and *Salmonella sp.* Well-stabilized (and mature) compost can be stored indefinitely and has a wide variety of product markets in residential and commercial landscaping, sediment and erosion control, agriculture, non-point source water quality management systems, disturbed lands remediation, and commercial horticultural applications.

Basic Composting Process

Composting is a relatively simple process that can be performed outdoors in most climates. Because of a desire to operate the process more efficiently, control odors, and minimize the effects of weather, some facilities are constructed under structures, in fully enclosed buildings, or in entirely mechanized facilities (and combinations thereto). Figure 1-2 illustrates a hypothetical process flow diagram for a composting system. Incoming source-separated organic materials (SSOM) would be processed by grinding/shredding/mixing to achieve a consistent particle size, and to combine the SSOM with fresh bulking agent, oversized bulking agent from the screening process, and finished compost (used as a microbial inoculum).

After a 30-60 day period (faster in some enclosed and in-vessel systems), the compost is moved to a curing area, where it ages to improve marketability. Curing will take 60-90 days, depending on weather conditions (less if done indoors). Following curing, the compost is screened to a 3/8-inch or half-inch particle size and is ready for use, distribution, or sale. A composting system comprises all the processing steps noted above.

In addition to being a biological manufacturing process, it is also a batch-type volumetric materials handling process. Compost recipes[3] are developed on a mass, or weight, basis to ensure that the mix conforms to desired process design criteria, but the feedstocks are commingled on a volumetric basis (i.e. so many cubic yards [CY] of feedstock A mixed with so many cubic yards of feedstock B). In backyard and small on-site systems, these volumes are measured with pitchforks and shovels. In on-farm systems, tractors with loading buckets are used. Skid-steer loaders are often used in on-site and small commercial systems and large rubber-tired loaders are used in most commercial and municipal operations. Mixing is done either manually or with a mechanical mixing device (usually some form of counter-rotating augers).

The volumes of compost mixed at any one time correspond to both the quantities of feedstocks that must be handled and the available charging capacity of the system being used. In a backyard bin, that might be an open space of 3-4 inches at the top of the compost bin due to settlement of previously emplaced feedstocks to handle several days' worth of a household's food scraps. In an on-site system, that may be the 6-10 CY capacity of a recently emptied in-vessel system, which might take a couple of days to completely fill. In a large-scale facility, it may require mixing 500-1,000 CY per day.

These commingled feedstocks then enter the active phase of composting, dominated by bacterial decomposition of the most putrescible feedstocks in the mix, which are those with higher nitrogen contents. This active phase of composting can take from 21 days in an enclosed system with forced aeration and high degradation potential (for example, sewage sludge), to 8-10 months, in the case of an outdoors operation with high carbon content (for example, fallen leaves). During this active composting period, there may be turning, or agitation, of the mix but it essentially stays in the same processing area until active composting is finished, which is usually defined as reaching a certain level of biological stability (when all waste decomposition is complete). At this point, the fresh compost is moved out of the active composting area to free up space for freshly mixed feedstocks. The volumes of compost being handled vary with scale; in very large facilities, it means moving 1,000 to 1,500 CY of fresh compost.

The next step in the manufacturing process is a finishing step known as curing, or maturation. This step is needed to allow degradation of some of the products of decomposition (such as volatile acids) and to allow decay of more resistant portions of the woody material in the mix. Fungi dominate this phase more than by bacteria. The curing phase can last from 30 to 120 days, varying primarily due to weather, as this step is usually accomplished outside. The curing piles are turned periodically to homogenize the material, but the curing compost stays in one area until the curing is complete. On sites with ample room, both composting and curing may take place in the same area. Curing is deemed finished when the composting process is complete and this is often measured with seedling germination tests. Once finished, the cured compost is moved to product handling in order to free up space for fresh compost to be cured. The volumes of materials being handled in curing are around 60%-70% of the volumes handled in active composting, but because the holding times are longer, the processing areas tend to be bigger.

Product handling is largely a physical manipulation of the cured compost to make it ready for market. This step in the manufacturing process often involves screening, where mostly woody particles larger than 3/8-inch to a half-inch are screened out of the compost. Compost usually goes to market in bulk dump truck and tractor-trailer quantities, or, in some cases, it goes into a bagging system or into a soil blending system.

Figure 1-3: Screened compost ready for sale

Photo credit: Institute for Local Self-Reliance

Applications for Composting Systems

The managed decomposition of plant and animal residues into compost for use in agriculture, in gardening, and in landscaping has been practiced for centuries. Organizing and optimizing composting into biological manufacturing facilities using composting systems has primarily taken place over the past 40 years. Originally, composting was done on-farm, or in the backyard, using minimally-managed static piles, with larger operations opting for a turned windrow composting approach, with the main focus on agricultural residuals and animal manures.

Two Federal laws were passed that provided the impetus for the evolution of composting systems: the Marine Protection, Research and Sanctuaries Act of 1972 (MPRSA), which banned the ocean disposal of sewage sludge and industrial wastes by December 31, 1991; and the Resource Conservation and Recovery Act of 1976 (RCRA), which began the phase-out of unlined solid waste landfills and the start of the recycling industry and culture in the US today. MPRSA led to the development of aerated static pile composting at the USDA Beltsville (MD) Agriculture Research Center for the land-based management of sewage sludges by composting. The RCRA-driven reduction in the number of solid waste landfills, coupled with an increase in landfilling costs due to new regulatory requirements, led to a reevaluation of the rationale for landfill disposal of biodegradable solid wastes, which, in turn, led to the imposition of bans on the landfilling of yard trimmings (brush, grass clippings and leaves) and the creation of a yard trimmings composting infrastructure.

Now, some 40 years later, there are composting systems in use at homes, farms, industrial and institutional sites, municipal facilities and commercial merchant facilities using a wide variety of technologies. This section presents examples of systems tied to various scales (sizes) of facilities. Pages 11 to 18 present composting systems organized by the type of composting approach used.

Backyard/Individual Systems

At the simplest scale are the many types of backyard composting systems in use in various residential backyard settings. Most serve a single-family dwelling unit, handling the kitchen scraps, soiled paper, and landscaping debris from one home. In some cases, multiple homeowners collaborate in providing feedstocks, managing the system, and utilizing the compost produced by one owner's backyard system.[4] Many of these backyard systems are homemade units, crafted from pallets, hardware cloth, or fencing; others are purchased from various retailers and hardware stores. The increase in backyard composting systems is driven in part by a growing realization of the environmental value of recycling food scraps, however, growth is tempered by a lack of long-term commitment by some who find the labor-intensive nature of backyard composting unappealing.

Community/Neighborhood

This is a relatively new innovation in composting, driven by the growth of the "locavore" food movement and the rise in community gardens in urban areas. This is a larger-scale embodiment of the cooperative neighbor approach noted above, and can usually handle 300-500 cubic yards (CY) of feedstocks annually. These types of operations take in gar-

Figure 1-4: The Dirt Factory in Philadelphia uses an Earth Tub compost system to produce compost year-round from neighborhood organic materials. The Dirt Factory is also a community education center, featuring residential scale composting facilities, where community members can learn more about composting at home, and gardening using compost.

Photo Credit: The Dirt Factory

den residuals from community gardens, food scraps from garden members (and others), and similar materials. Composting is done in multiple backyard-style systems, or in small-scale in-vessel systems (there is a shortage of suitably-sized technology options in the US for this scale of composting). The business model for this scale of composting system is still evolving and most of the existing community composting operations are operated by non-profit organizations, are minimally funded, and are staffed by volunteers.[5] Many of these operations do not charge food scraps producers for waste management, nor charge for compost produced. Composting locally at the neighborhood or community-scale level yields many benefits: improved local soils, more local jobs, greener spaces, enhanced food security and fewer food deserts, less truck traffic hauling garbage, increased composting know-how and skills within the local workforce and reinforced in the next generation. An example of this type of composting system is The Dirt Factory in the University City area of Philadelphia, which takes in leaves from City street cleanings, allows food scraps drop-offs on-site twice per week and uses a containerized composting system known as "Earth Tub" (Green Mountain Technologies) as its composting system.[6] For detailed information on community-based composting, see *Growing Local Fertility: A Guide to Community Composting* (2014), which ILSR produced in collaboration with the Highfields Center for Composting.

On-Farm

There are a large number of on-farm composting systems, primarily in the agricultural sectors of animal husbandry and certified organic agricultural practices. Some of those farms in animal agriculture have turned to composting due to limitations on their abilities to land-apply all the manure from the animals, such as Otter River Farm in Winchendon, Massachusetts, which composts the manure from 200 dairy cows on-site with short paper fiber from a nearby cardboard recycling mill.[7] Organic agriculture enterprises that practice composting often do so to reduce the need to bring in outside inputs that may not be compatible with organic farming and to add another income stream and efficiency to their operations. For example, the McEvoy Ranch, an 80-acre organic olive ranch in Petaluma, California, composts olive oil mill wastes, livestock manure, and landscape and orchard debris, handling about 800 CY of feedstocks annually.[8] Due to the large amounts of available acreage and relative isolation of most production farms, open-air turned windrow composting is the preferred composting method, although some horse farms have begun to use forced-aeration static pile bins for composting manure and bedding. Urban farm composting is growing too. Urban farms are located on urban land and sell or donate the food they produce. They need enriched soil. ECO City Farms in Edmonston, Maryland, is an example of a community-based urban farm that uses several composting methods (aerated static systems and vermicomposting) to produce soil for its hoop houses.

Figure 1-5: Produce growing in compost-based soil at ECO City Farms, an urban farm in Edmonston, MD

Photo credit: Institute for Local Self-Reliance

On-Site

In some cases, there are enough feedstocks generated by a single entity to justify the costs of an on-site composting operation. For example, an industrial manufacturing facility might have a biodegradable waste byproduct of manufacturing or enough food scraps from an on-site employee cafeteria to justify the expense. Another example of on-site systems often seen in the US are associated with State correctional facilities, where they attempt to balance executive orders for improved environmental sustainability with the necessary security realities of limiting interactions with outside parties. For example, the Washington State Department of Corrections has composting activities at nine of its twelve facilities handling food scraps and yard trimmings. Composting systems in use at their facilities include individual aerated static pile, a rotary drum bioreactor(DTE Environmental's "EnviroDrum"), and a horizontal bioreactor (Wright Environmental Systems).[9] These types of on-site systems can handle 500 to 3,000 CY of feedstocks annually.

Figure 1-6: Windrow turner aerating compost piles at the City of College Park, MD's municipal yard trimmings compost site

Photo credit: Institute for Local Self-Reliance

Municipal

City and county governments, along with regional waste authorities, have historically used composting systems to handle wastes they are obligated to properly manage, such as sewage sludges and yard trimmings, and are now exploring systems for handling food scraps diverted as part of expanded recycling programs. Due to the wet, heavy, and odorous nature of sewage sludges, most municipal sludge composting systems use some form of forced aeration static pile composting (although windrow composting is practiced in arid southwestern US areas). Yard trimmings are usually composted in open-air turned windrows, although some municipal facilities with nearby neighbors are turning to fabric-covered forced aeration composting for improved process control and reduced odor potential. Food scraps are being managed, in many cases, by incorporating them into existing yard trimmings facilities, by co-digesting them in anaerobic digesters located at wastewater treatment plants, and by directing them to processing by third-party commercial merchant composters. Municipal composting systems vary in size from 2,000-3,000 CY to more than 100,000 CY of feedstock annually. For example, the Wasatch Integrated Waste Management District in Layton, Utah, composts about 50,000 CY of yard trimmings from the Salt Lake City area each year. They had been composting in open-air turned windrows, but due to recent residential development nearby, are in the process of switching over to a fabric-covered forced-aeration system.[10]

Commercial

Like municipal facilities, private-sector commercial merchant composters have varying capacities. Commercial composters provide waste processing services to generators of biodegradable wastes, often under contracted terms and conditions, but also under spot market terms. They provide composting services to industries, municipalities, and commercial enterprises, but less often to residential accounts. These are usually centralized facilities that draw feedstocks from a 50-mile to 100-mile radius from the facility (varying due to road networks and travel times). In many cases, commercial composting companies have vehicle fleets for collecting feedstocks

Figure 1-7: The Wilmington Organics Recycling Center operated by Peninsula Compost in Wilmington, DE, sources material from New York City and Washington, DC.

Photo credit: (left) Peninsula Compost, (right) Institute for Local Self-Reliance from generators and for delivering composts, and compost-amended soil blends, to market. In the past ten years, a new commercial industry sector has developed to take compostable materials and anaerobically digest them to capture biogas for energy recovery before composting the digested solids. An example of a small-scale commercial composter is Black Bear Composting in Crimora, Virginia, which handles about 7,000 CY of feedstocks annually.[11] Black Bear collects food scraps from numerous restaurants, groceries and schools in its service area, providing the collection containers and hauling, as well as composting. At the other end of the commercial size scale is the Wilmington Organics Recycling Center (WORC) in Wilmington, Delaware, which takes in over 350,000 CY of feedstocks annually, drawing material from as far away as New York City.[12] WORC does not have its own trucking fleet, relying instead on waste haulers for feedstocks and common carriers for product distribution.

Industrial

In some cases, a single industrial facility may elect to build its own captive composting system for process wastes from its manufacturing processes and/or food scraps from an on-site employee cafeteria. Driving forces behind development of these captive facilities include a desire to increase environmental sustainability practices or reduce costs associated with the landfilling or land application of waste products. An example of an industrial facility is the Novozymes North America enzyme manufacturing facility in Franklinton, North Carolina. Its on-site composting facility handles the process sludge from its enzyme production facility. The facility is sized for 125,000 CY per year and accepts the enzyme process residuals from its manufacturing facility, and augments that with carbonaceous materials like clean wood wastes, and yard trimmings. They also take in gypsum wallboard from construction debris, and food residuals from both the on-site cafeteria and spoiled produce from a nearby food bank.[13]

Materials Composted and Sources

Many materials are biodegradable and can and are being composted: leaves, grass clippings, brush/branches, soiled paper, food scraps, crop residues, manures, food processing byproducts, biosolids (end result of sewage sludge treatment), and animal carcasses.

There is no single agency tracking all the potential feedstocks and the amounts now recovered through composting. The US Environmental Protection Agency (EPA) tracks the amount of municipal – residential, commercial, and institutional – food scraps and yard trimmings generated and recovered. Its municipal waste characterization studies include paper products and wood waste but do not assess the amounts and portions that are potentially compostable. The US Department of Agriculture maintains some statistics on animal manure generation and management. Little data is available on food manufacturers' residuals.

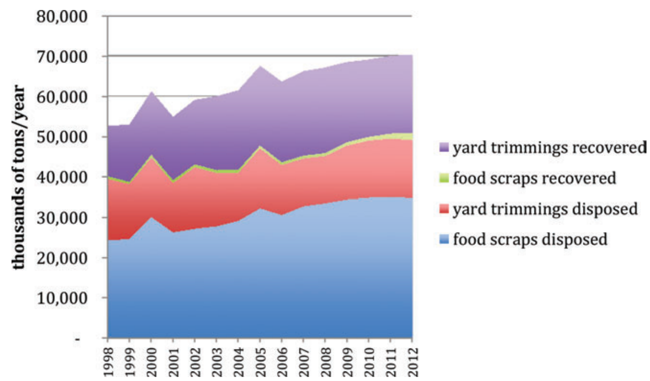

Figure 1-8: Yard Trimmings and Food Scraps Disposed and Recovered in the US, 1998-2012

Source: US EPA, MSW Characterization Reports, 2012, 2011, 2010, 2008, 2007, 2006, 2005, 2003, 2000, and 1998.

Municipal Yard Trimmings, Food Scraps, Paper, and Wood

Figure 1-8 shows the amount of municipal food scraps and yard trimmings generated and recovered over the last 15 years according to US EPA data. In 2012, 58% of yard trimmings were composted, with 14.4 millions tons landfilled and incinerated. Food scrap recovery remained low at 4.8%; 34.7 millions tons were disposed.[14] Many composting sites accept paper such as cardboard, paper plates and cups, kraft bags, and soiled paper towels. Soiled paper and paperboard could account for another 13 millions tons per year.[15]

In addition to woody material in yard trimmings/debris, there are other sources of urban wood that are typically landfilled. Construction debris often contains significant amounts of wood. A study conducted for the Washington Department of Ecology tested the feasibility of using wood from construction debris and land clearing debris as a compost feedstock.[16] Wood waste was co-composted with municipal biosolids. The finished product was used as potting media for marigolds and peppers. Wood waste and biosolids composts performed as well as the peat-perlite standard mix for both plants.

The US EPA estimates that 13.4 million tons of municipal wood waste were disposed in 2012. Assuming only half of this wood waste and the paper is suitable for composting, 62 millions tons of municipal organics now disposed in the US could instead be captured for composting, producing an estimated 21 million tons of additional compost.

Animal Manures

Wasted agricultural materials such as crop residues and animal manures are a huge potential feedstock for composting. Manures are produced in large quantities and have the potentially highest nutrient value of any agricultural residue. Use of animal manures as a soil conditioner and fertilizer is an age-old practice. However, ready availability of synthetic fertilizers and costs associated with transport and land application of manures have made beneficial use less common. Another issue with land application of manures to meet the nutrient demands of different crops relates to the increasingly regionalized animal rearing operations. Historically, smaller animal rearing operations had a sufficient land base to easily apply the animal manure at agronomic rates. With more centralized facilities, increasing transport distances are required to access a sufficient land base to allow for nutrient-based manure applications.[17]

Table 1-1 shows the total amount of wet and dry tons of manure generated by the main categories of livestock raised in the US. The national distribution of this production varies. For example, chicken broiler production is concentrated in the southeastern and south-central states.[18] Hog production is concentrated in the Midwest and in eastern North Carolina. The western and northern mid-western states are home to most of the dairy cow operations.

Agronomic Crops

There is a range of other agricultural residues that are suitable for composting. These include residues from large-scale agronomic crops as well as residuals from specialty crops, truck farms and food processing facilities. Agronomic crops are crops grown on significant acreage that are used to provide staple grains for people and livestock. Examples include corn, wheat, and soybeans.

Corn is grown on 80 million acres of farmland with production concentrated in the heartland region.[19] As a basis for comparison, tree fruits (citrus, stone fruits and nuts) were grown on 4 million acres in 2012. Corn stover — the leaves and stalks of the plant — is a high carbon residual left after corn is harvested and processed. In most cases stover is left on the soil surface after grain harvest. Its value for maintaining soil organic matter concentrations is increasingly recognized and alternatives for maintaining soil carbon if stover is removed from the soil are being considered.[20] Suggested alternatives include composts and animal manures.

Wheat, grown on 30 million acres, leaves a high carbon straw (stalk and leaves) after harvest that could be a compost feedstock. Soybeans were planted on 77 million acres in 2012 with over 3 billion bushels harvested. Other high carbon residuals from agronomic crops include rice straw, barley straw and stalks from sorghum. Rice was planted on 2.7 million acres in 2012-3, with an average yield of 3.75 tons per acre.[21] Typically, the residual portion of these crops accounts for about 50% of the total yield.[22]

All of these materials are high in carbon. One potential mechanism to use the straw for composting would be to first use the material as animal bedding.[23] If it is used as bedding, it will become soiled with animal feces and urine and so have sufficient nitrogen to compost. The advantages of this approach include providing two uses for the material and the likely proximity of animal operations to fields used to produce animal feed.

Other Crops

There are a wide range of non-agronomic crops that also generate residuals during harvesting and processing. In some cases, production of these crops is also highly localized. For example, California is the largest producer of almonds worldwide with total in-state acreage of 870,000. The types of crops and consequently the types of residuals that are potentially available for composting will vary regionally.

Washington State Department of Ecology's 2005 survey of available organic residuals may be the most comprehensive survey of its type. The project aimed at geographically identifying, categorizing, and mapping potential organic material waste streams in Washington by county. The sources included field residues, animal manures, forestry residues, food packing/processing waste, and municipal wastes in each of

Table 1-1: Livestock manure generation in US

Animal	Wet Tons per Animal/Year	Dry Tons per Animal/Year	Animal Number [year]	Total US Wet Tons Produced (million)	Total US Dry Tons Produced
Dairy Cow					
500 lb cow	7.8	1			
1,000 lb cow	16.2	2.06	9 [2011]	146.2	18.6
Beef Cattle					
500 lb animal	5.5	0.64			
1,000 lb animal	11	1.27	25.8 [2012]	282.5	32.8
Swine					
Growing	0.8	0.07			
Finish	2.4	0.22	120	286.9	26.4
Poultry					
Layer	0	0.01	292 [2012]	11.2	2.8
Broiler	0	0.01	8,600 [2009]	219.7	55.4

Note: The amount of manure each animal produces varies based on the growth stage of the animal.

Source: Sally Brown, University of Washington, 2014. Based on published data by USDA Economic Research Service available at http://www.ers.usda.gov/topics/animal-products; Purdue Food Animal Education Network Pork Facts at http://www.ansc.purdue.edu/faen/Pork%20Facts.html; and American Egg Board, Egg Industry Facts Sheet, http://www.aeb.org/egg-industry/industry-facts/egg-industry-facts-sheet. *Livestock Waste Facilities Handbook*, third Edition Table 2-1. Pg 2.1 http://www.animalrangeextension.montana.edu/ExtnAgents/Articles/NatResourc/cnmp/other/manure_tabl1.html.

Paudel, K.P., and C.S. McIntosh. 2005. Country report: Broiler industry and broiler litter-related problems in the southeastern United States. *Waste Manage* 25: 1083-1088.

Table 1-2: Select organic material resources in Washington State

	Thousand of Dry Tons
Field Residues	
Wheat straw	1,614
Grass seed straw	1,35
Barley straw	319
Corn stover	73.5
Other Field Residues	
Mint slugs	97
Hops residue	5.4
Forest Residues	
Logging residue	1,901
Forest thinning	506
Mill residue	5,278
Land clearing debris	419
Food Processing	
Cull onions	2.3
Cull potatoes	91
Cull apples	41
Cull fruit	9
Asparagus Butts	0.67
Apple pomace	28
Grape pomace	19
Berry pomace	2
Fruit Pomace	12
Cheese whey	44
Potato solids	19
Asparagus trimmings	0.12
Animal Manures	
Dairy	457
Cattle	242
Horse	407
Swine	13.6
Poultry	785
Animal Wastes	
Poultry meat waste	5.5
Beef meat waste	35.8
Pork meat waste	0.28
Animal mortality	5.9
Fish waste	8
Shellfish waste	3.7

Source: Washington Department of Ecology. 2005. Biomass inventory and bioenergy assessment: An evaluation of organic material resources for bioenergy production in Washington State. Publication No. 05-07-047 http://www.pacificbiomass.org

the state's 39 counties. Washington state has a wide range of agricultural products that fall into broad categories: agronomic, animal, fish, high value, and forest based products. Table 1-2 shows the total dry tons of select residuals generated. The study showed that Washington State has an annual production of over 16.9 million tons of under-utilized dry biomass and that the biomass is generated from a diverse range of sources. While that study focused on assessing biomass available for combustion and anaerobic digestion, other states could replicate the methodology to assess biomass residuals available for composting.

Natural Selection Farms in Yakima County, Washington, exemplifies the ability of agricultural commodities to be composted. The farm's composting operation processes a significant portion of agricultural feedstocks including: hops residue, cull apples, other cull fruit, apple pomace, grape pomace, other fruit pomace, cheese whey, beef meat waste, and fish and shellfish waste.

Figure 1-9: Aerial view of the windrow composting operation at Natural Selection Farms in Sunnyside, WA

Municipal Biosolids

The most familiar urban residuals that are used to produce compost are yard trimmings and food scraps. However, other materials produced in urban areas are suitable compost feedstocks. Municipal biosolids are the residual semi solid material from wastewater treatment.[24] Each person produces about 30-50 dry pounds of biosolids per year. With a US population of 316 million in 2013, this translates to 5 to 8 million dry tons per year. End use of biosolids or disposal of biosolids is the responsibility of the wastewater treatment agency, typically an arm of the local municipal government. Currently about 50-60% of the total biosolids produced are beneficially used with the remainder landfilled or incinerated. Beneficial end uses of biosolids include land application to agronomic crops, use for rangeland and mine land restora-

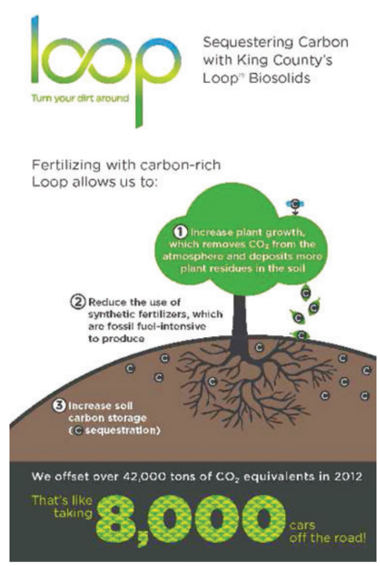

Figure 1-10: Graphic from King County, Washington, Wastewater Treatment Division web site on benefits of utilizing biosolids as a soil amendment

Source: http://www.loopforyoursoil.com

tion, as well as use on home gardens, turf grass, landscaping and other food crops. Biosolids can be composted, typically with a high carbon feedstock.

As biosolids are produced by municipal agencies and the influent to wastewater plants includes human waste, biosolids end use is regulated both on a national level and by individual states. The national regulations covering biosolids use were developed based on scientific research and are risk based for metals and organics. The regulations for pathogens are process based. In order to be beneficially used, biosolids must meet standards for metal concentrations. Metals in modern day biosolids are typically about an order of magnitude lower than the risk based limits. Organics contaminants such as pesticides and toxic organics were considered in the initial rule making and deemed too low in biosolids to merit regulation. Pathogen concentrations must be significantly reduced for biosolids to be land applied. There are two levels of pathogen reduction for land-applied biosolids. 'Class B' biosolids have been treated to significantly reduce pathogens with fecal coliform used as a measure of pathogen kill. 'Class A' biosolids are treated to kill all pathogens and may be used without any restrictions. Composting is a way to meet pathogen reduction requirements for production of 'Class A' biosolids.

For example, King County, Washington, produces about 25,000 dry tons of biosolids annually from a population base of 1.5 million people. The vast majority of the biosolids are treated to achieve 'Class B' pathogen reduction standards and are used to fertilize dryland wheat and commercial forestry plantations. A small portion of the biosolids are composted to meet 'Class A' pathogen reduction requirements and are sold to local gardeners or landscapers. King County is unique in that it has branded its biosolids product, "Loop," and actively touts its benefits.[25] Most municipalities do not brand their biosolids and have typically tried to remain out of the public eye. In addition to explaining that Loop is loaded with nutrients and organic matter and enriches the soil, the County explains how Loop sequesters carbon (See Figure 1-10).

Composting System Features

There are many types of composting systems, large and small, and everything in between. Literally dozens of composting configurations are in use today. Systems can be characterized by different key features, which heavily influence system selection. These features correlate to the questions: How are materials moved? How is aeration managed? Are the materials covered or contained?

All composting systems fall into one or more of these classifications: Open vs. contained, passive vs. active aeration, static vs. managed, and onsite vs. centralized. Each is described below.

Open vs. Contained

Most composting facilities in the US are outdoor open-air facilities, although there is a distinct trend towards enclosures of various sorts (such as pole barn/pavilion roofs, hoop buildings, and pre-engineered metal buildings). Contained systems also include the various configurations of in-vessel systems.

Passive vs. Active Aeration

Passively-aerated piles or windrows rely on natural convection of air, coupled with the "chimney effect" of heated air ris-

Figure 1-11: Open composting system

Photo credit: Coker Composting & Consulting

Figure 1-13: Passive composting system

Photo credit: Robert Rynk

Figure 1-12: Contained composting system

Photo credit: Coker Composting & Consulting

Figure 1-14: Active composting system

Photo credit: Coker Composting & Consulting

Figure 1-15: Static composting system
Photo credit: Sandra Oldfield

Figure 1-16: Managed composting system
Photo credit: Coker Composting & Consulting

Figure 1-17: On-site composting system
Photo credit: O2 Compost

Figure 1-18: Centralized composting system
Photo credit: McGill Environmental Systems

ing and being replaced at the bottom by cooler air, whereas active aeration relies on fans or blowers to manage the air flowing through the pile. Passive aeration piles tend to be smaller-sized systems. Active aeration can either push or pull air through the pile.

Static vs. Managed

Static, in this context, means unturned or unagitated. Managed means some active interaction with the compost piles or windrows while active composting is taking place. Static pile composting is most often associated with active forced aeration, but is often used with nonputrescible organics like forestry industry residuals. All turned windrow operations are considered managed facilities.

On-site vs. Centralized

Some composting systems are established as an on-site operation serving one (or only a few) sources of feedstocks; others are set up as centralized commercial facilities taking in feedstocks from numerous sources in a 50-100 mile radius. While the number of centralized facilities has grown significantly over the past 20 years, that growth trend is slowing while the rate of growth in on-site facilities is increasing.

Types of Composting Systems

The many available composting systems and how they work are described below, along with their suitability for certain material feedstocks. We provide examples of operating sites for each type of system. Appendices A and B provide more detail. The examples featured capture the wide range of sizes and systems possible for a diverse array of materials. Table 1-3 summarizes the pros and cons of different composting systems.

Deciding what composting system is appropriate is primarily a function of economics (mostly capital costs) but influencing considerations include feedstocks, land, environmental considerations, location, scale, potential growth, mission and goals (both business and institutional), existing resources, regulations and time.

The degradation potential of various feedstocks is a factor. Degradation potential can be viewed as odor-producing potential. Some feedstocks, like yard trimmings, are only highly degradable at certain times of year, while others, like sewage sludges, always have a high degradation potential. Feedstocks with low degradation potential favor low-technology, open systems, while high degradation feedstocks favor enclosed or in-vessel systems.

Minimizing the potential for off-site odor impacts is also an important consideration. For smaller area sites within 500-1,000 feet of a sensitive receptor (such as a home, school, park, shopping center, or church), systems should have higher degrees of process and environmental control, which favors contained systems. Large rural sites distant from neighbors can use low-technology open systems. Some communities siting composting facilities at other public facilities will opt for a higher level of process and environmental control to mitigate additional impacts on residents.

Time can be a factor in system selection. If there is no need to get product to market quickly, that favors less capital expense, less equipment, less management and more space. If a composting enterprise needs to get product to the market quickly, then more capital expense, equipment and management, and sometimes less space, is usually called for.

The availability of resources (such as equipment, pavement, buildings, people) often influences system selection. Farmers wishing to expand into composting already have resources they can put to use, as do businesses in related industries that get into composting (such as plant nurseries and conventional materials recyclers) and municipal governments with existing public works infrastructure (such as landfills and wastewater treatment plants). The economic advantages of sharing land, equipment and labor can be substantial.

Passively-Aerated Systems

Static Systems

Static pile composting is usually limited to quantities less than 1,000 tons per year due to the large land area required. It is not a suitable system for materials that are putrescible, such

Table 1-3: Advantages and disadvantages of different composting systems

Advantages	Disadvantages
Static Systems • Low capital and operating costs • Less equipment and staffing requirements • No electric power needed	• Large area required • Not suitable for putrescible materials • No means of controlling odors • Slow decomposition rate / long process times
Turned Windrow Systems • Can handle putrescible feedstocks • Relatively low capital and operating costs • Relatively low technology requirements • No electric power needed • Extensive industry experience	• Large area required • More labor intensive • No means of controlling odors • Exposure to weather can be problematic
Passively Aerated Windrow Systems • Low capital and operating costs • Well-suited to small feedstock quantities • No electric power needed	• No means of controlling odors • Construction more complicated • Slow decomposition rate / long process times
Aerated Static Piles • Reduced space requirements • Negative aeration with biofiltration can help control odors • Smaller surface area reduces weather impacts • Significantly shorter composting times	• Slightly higher capital costs • Moisture loss is accelerated • Proper feedstock preparation and mixing needed • More operator skill needed • Three-phase electric supply usually needed
Bioreactor Systems • Low to moderate space requirements • High degree of odor control • Highly automated, so reduced labor costs • Small sizes allow for modular expansion • Can be located indoors or outdoors	• Often need to purchase carbon amendments • Shorter composting period, finishing needed • Not suitable for large-scale operations • Capital costs can be high
Tunnel Bioreactor Systems • High degree of odor control • Corrosive process exhaust air is routed outside of building, extending building life	• Cast-in-place concrete increases capital costs • Less opportunity for automation • May be designated as a "confined space" and thus need health and safety protocols
Agitated-Channel Bioreactor Systems • Usually enclosed in buildings, so high degree of odor control • Less space required than for windrow composting • Mechanical turning systems elevated so easier to maintain	• Medium-to-high capital costs • Limited flexibility in handling peaks in incoming materials • Lower indoor air quality from positive aeration • Building and facility footprint are long and narrow; may not fit all sites
Rotary Drum Bioreactor Systems • Body of drum can be located outdoors, typically only ends need to be covered • Effective mixing and agitation of feedstocks and amendments	• Higher mechanical complexity due to drive system and loading/unloading systems • Drums and drive systems need periodic realignment • Air injection systems prone to clogging • Short composting time; finishing needed

Figure 1-19: Static pile composting bins

Photo credit: USDA Natural Resources Conservation Service

as grass clippings, food scraps, animal manures or biosolids.

Static pile systems are passively aerated, relying on the "chimney effect" where the internal air heated by microbial decomposition rises and is replaced by cool air (like a fireplace). This requires a certain amount of structural porosity so that air can move through the pile efficiently and effectively. For composting brushy and woody materials, piles are built and allowed to decompose for 2-3 years with little or no mixing or turning. These types of static piles are usually limited to 15 feet high to minimize the potential for spontaneous combustion. With animal mortalities, the carcasses are layered between alternating layers of high-carbon materials (such as sawdust, hay, and straw) and left undisturbed for 6-9 months. Mortality piles are rarely more than 6-8 feet high.[26] (Figure 1-19 shows static pile composting bins.) Static piles are normally built using front-end loaders, skid-steer loaders, farm tractors or excavators. As these are generic systems, they are not available for purchase.

Turned Windrow Systems

Windrow composting is the most common composting system used in the US today due to its suitability to a wide variety of materials and capacities and low capital and operating costs. These are generally open systems suitable for use in on-farm, municipal, commercial, and industrial applications. In some cases, windrow composting is done beneath agricultural-type hoop or pavilion structures (usually due to storm water quality and process control considerations). These systems are suitable for a wide range of capacities, from 3,000 to 150,000 tons per year.

Windrow composting involves forming feedstocks into long, narrow, low piles known as windrows (Figures 1-20 and 1-21) that are about twice as wide as they are high. The length can be as long as the available space. They are built using front-end loaders, skid-steer loaders and excavators. Space requirements for a windrow composting pad vary depending on method of turning, as windrows can be turned with a loader, or with a drum turning machine. These turners are either a pull-behind type towed with a loader or a tractor, or a self-propelled straddle-type machine. Turning with a loader or pull-behind turner requires 15-20 feet of space between each windrow, where straddle-turned windrows can be as close as 2 feet apart.

The windrows are regularly turned to reestablish porosity, and to break up and blend the material. While turning windrows reintroduces oxygen, windrows rely on passive aeration, so structural porosity is important. Each turning releases trapped gases from the windrows, and as they are usually outdoors, there is no opportunity for active odor control other than timing the turnings so as not to affect neighbors. Odor management is greatly facilitated by passive measures such as proper process design and materials handling protocols.

Windrow composting is commonly used to process yard trimmings (grass, leaves, brush), and woody materials. Food scraps, industrial residuals (i.e. food processing or paper wastes), manures, and biosolids are also composted in windrows, but these facilities are usually located in arid, warmer regions to minimize impacts from weather, or use fabric windrow covers to deter vectors (such as birds, dogs, raccoons, and rodents) drawn to the more putrescible feedstocks.

Like static pile composting, there are no electrical or utility requirements. Infrastructure generally includes an outdoor working pad, access roads, and accompanying storm water management facilities. The capital cost depends, in large part, on the material used to make the composting pad and

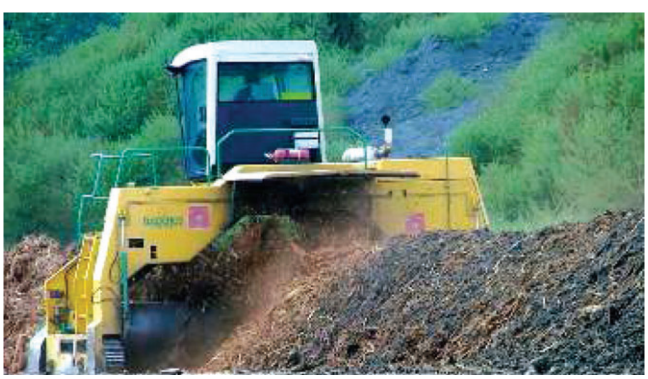

Figure 1-20: Windrow turned with straddle turner

Photo credit: Coker Composting & Consulting

Figure 1-21: Tractor pulled windrow turner on a farm

Photo credit: Institute for Local Self-Reliance

Spotlight

An example of a successful windrow composting facility is Royal Oak Farm in Evington, Virginia (www.royaloakfarmllc.com). This facility is located 3 hours west of Richmond and comprises a 20-acre composting facility in the middle of a 117-acre farm. It currently takes in about 50,000 tons per year of food scraps, yard trimmings, and residuals from animal feed manufacturing and cellulose acetate manufacturing. The farm started composting in 1999 while raising hogs and upgraded the facility to meet state regulations for composting industrial residuals in 2007. Royal Oak Farm has 54 windrows in process at any given time and each windrow is 8-feet high, 16-feet wide, and 425-feet long. The capital cost to upgrade the facility was $2.4 million (2007 dollars); capital investment in turning equipment, loaders and transport trailers was another $6 million. Operating costs are approximately $22 per ton of incoming feedstocks.

the selected turning equipment. Composting of yard trimmings is often done on unimproved sites, whereas state regulations usually require some sort of hardened pad for composting more putrescible materials. Pad materials include concrete, asphalt, compacted gravel, and soil-cement, with costs similar to automobile parking lots made of these materials. As this is a generic composting system, there are no providers of this technology. Operating costs vary depending on type and age of equipment, but can run $15 to $20 per ton of feedstocks processed.

Passively Aerated Windrow Systems (PAWS)

This is similar to the static pile system discussed above, but where aeration is enhanced by using perforated plastic pipes to allow air to get inside the pile (Figure 1-22). The mixture of feedstocks to be composted is built into a windrow, but the windrow is constructed over a network of 4-inch perforated plastic pipes that are left open to the atmosphere to allow air in. The pipes are placed perpendicular to the long axis of the windrow and spaced 12 inches to 18 inches apart and covered with a layer of wood chips or unscreened compost.

Figure 1-22: Passively aerated windrow system

Photo credit: Oregon Department of Environmental Quality

Like static pile composting, PAWS composting takes a long time, on the order of one to two years. It is considered capable of handling up to 10,000 tons per year.[27] Piles are built using front-end loaders, skid-steer loaders and excavators. Capital costs are similar to those for turned windrow composting; operational costs can be lower as expensive turning equipment is not needed, but there would be an ongoing cost to replace plastic pipe damaged during pile teardown procedures.

Actively Aerated Systems

Actively aerated composting systems use fans and blowers to move air through a compost pile to maintain aerobic conditions in the piles. There are generally three types of aeration systems, positive (or forced-draft), negative (or induced-draft) and bi-directional. Figure 1-23 illustrates these concepts. In a positive aeration system, air is introduced through perforated pipes at the base of the pile and allowed to migrate up through the pile, 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

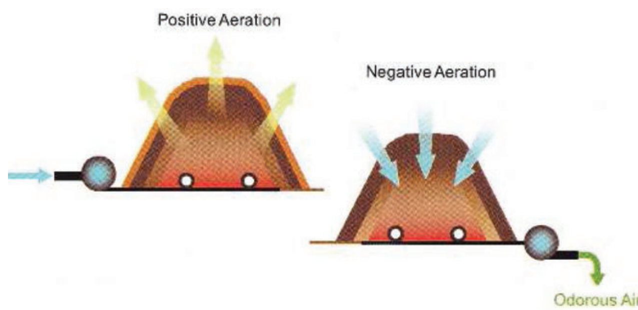

Figure 1-23: Positive vs. Negative Aeration

Illustration credit: Environment Canada

manage odors and to retain heat and moisture in the pile. Negatively aerated systems pull air downward through the pile and into the aeration pipes. This “exhaust” air has high temperature and moisture content, so 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 are usually either biofilters or chemical scrubbers. Bidirectional systems have more advanced ducting and controls and switch between positive and negative to better control temperatures in the piles.

Actively aerated systems can deliver air on a continuous or on an intermittent basis. Continuous aeration allows lower air delivery rates but risks excessive cooling of the pile. Intermittent aeration is more common and is controlled either by timed on/off timers or by a system that measures temperatures in the piles and turns the fans on and off, like a thermostat. The size of the fans/blowers used depends on the type and porosity of the mixed feedstocks, the size of the ASPs, and the airflow characteristics of the air distribution system.

These are generally static systems with little or no turning during the 30-45 days of active composting, although some hybrid systems are on the market with a combination of turning and active aeration. 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 the fans induce evaporation easily.

These systems can be open or closed systems and they are applicable to community, on-farm, on-site, municipal, commercial and industrial applications. While ASP composting is a generic approach to composting, it is the basis for several different proprietary technologies available from various companies. They are also applicable to a wide variety of capacities, varying from small aerated compost bins that hold 4 cubic yards (CY) each to large systems capable of handling 1,500 CY per day. Piles are built using front-end loaders, skid-steer loaders and excavators.

Capital costs can be less than with turned windrow systems, but only if the expense of a dedicated windrow turner is not incurred. Actively aerated systems purchased from technology providers can have significant capital costs. Operating costs can be less, as they are less labor-intensive, although electricity costs can be significant in larger facilities.

Composting systems using active aeration come in a wide variety of technology options, including simple aerated static piles (ASP) similar in concept to the piles illustrated above in Figure 1-23 (either out in the open or covered with a pavilion-style or fabric-covered roof), to containerized systems enclosed by concrete bins, inside modified shipping containers, or covered with breathable fabric covers. Appendix A provides more detail on the range of aerated static pile systems available.

Bioreactors

A bioreactor is an enclosed, rigid structure or vessel (reactor) used to contain the material undergoing biological processing. Bioreactors are usually equipped with process control systems that monitor the operating performance of the composting process, usually temperature and oxygen or carbon dioxide content. Bioreactors are available in a wide range of configurations. They can be classified by their configuration (horizontal, vertical,[28] with channels, with cells, with containers, with tunnels and with rotating drums), by operational mode (continuous or batch), and by movement of material within the reactor (static or dynamic).

Here is a brief breakdown of these configurations; additional information is in Appendix B.

Horizontal Bioreactors

Often dynamic systems, in that forced aeration is supplemented by internal turning or agitation (horizontal static bioreactors were described above under containerized ASP systems). They tend to be operated in continuous mode, rather than the batch mode of the static bioreactors, such as enclosed aerated static pile systems. They tend to have smaller capacities and are modular, so are suitable for community, on-site, and on-farm applications.

Tunnel Bioreactors

Another form of actively aerated composting systems, more suited to larger-scale applications like municipal, commercial and industrial sectors, with capacities up to 100,000 tons per year. These systems consist of long narrow cast-in-place concrete walls and floors. The positive aeration system is in the floor. They are designed to be filled and emptied with large rubber-tired front-end loaders. The airtight door systems that close each tunnel after filling.

Agitated-channel Bioreactors

Similar to turned windrow systems, except the windrows are contained within two long parallel concrete walls that are 6- to 8-feet high and spaced 9- to 18-feet apart. The mixed feedstocks are loaded into one end of the channel and are moved down its length by a turning machine (similar in function to a windrow turner) that moves forward on the rails. With each turning, the machine moves the compost a set distance toward the end of the bed. Most commercial systems include a set of aeration pipes or an aeration plenum recessed in the floor of the bed and covered with a screen and/or gravel.

Rotary Drum Bioreactors

Uses a horizontal rotary drum to mix, aerate and move the material through the system. The drum is mounted on large bearings and turned through a bull gear. Air is supplied through the discharge end and is incorporated into the material as it tumbles. The composting process starts quickly; the primary advantage of rotary drum composting is it usually achieves the requisite pathogen kill time-temperature relationship (>55° C for three days), and it can reduce potential odor problems due to rapid decomposition of highly degradable organics.

Vermicomposting

Vermicomposting is the process of making vermicompost, the product of composting with worms. Vermicomposting uses certain species of earthworms to make a heterogeneous

Figure 1-24: Worm Wigwam

Photo credit: Sustainable Agricultural Technologies

Figure 1-25: A handful of worms at Red Hook Community Farm, Brooklyn, NY

Photo credit: Red Hook Community Farm

mixture of decomposing food scraps, bedding materials and excreta (known as vermicast, or worm castings). Vermicompost is widely viewed as an excellent, nutrient-rich organic fertilizer and soil conditioner. Vermicomposting systems are more suited to smaller-scale applications like backyard/individual, on-site, and on-farm than to the larger-scale applications. There are numerous sources of worm bins for small-scale applications. Larger-scale units are available from technology providers like Sustainable Agricultural Technologies, Inc., (http://www.wormwigwam.com/) which makes and sells The Worm Wigwam (Figure 1-24).

For vermicomposting at small scales, a large variety of bins are commercially available, or a variety of adapted containers may be used. They may be made of old plastic containers, wood, or metal containers. The design of a small bin usually

Spotlight

ECO City Farms in Edmonston, Maryland, is an educational, non-profit organization designed to serve as a prototype for sustainable local urban farming. The one-acre farm, erected in 2010, composts an estimated 700 pounds of incoming food scraps per week from area residents, using several different methods including: in-vessel, passively aerated static piles, and vermicomposting via sixteen custom-built wooden worm bins. See Figure 1-26. Resulting compost is used as a soil amendment to grow produce in the farm's hoop houses.

Figure 1-26: Custom-built vermicomposting bins at ECO City Farms, Edmonston, MD

Photo credit: ECO City Farms

Spotlight

The Compost Club, Healdsburg (Sonoma County), California, consults with schools, other institutions, and private venues to set up vermicomposting systems that handle food scraps and animal manures. It makes worm bins that are two feet tall with corrugated plastic culvert pipe sides and plywood tops and bottoms. A layer of landscape fabric is topped with 3-4 four inches of angled 1.5-inch driveway rock to provide sufficient drainage. Holes also are drilled in the bottom, and the bins are raised to prevent rotting. Since it began in 2003, nearly a dozen schools and businesses have initiated a site-wide vermicompost system through the Club's assistance.

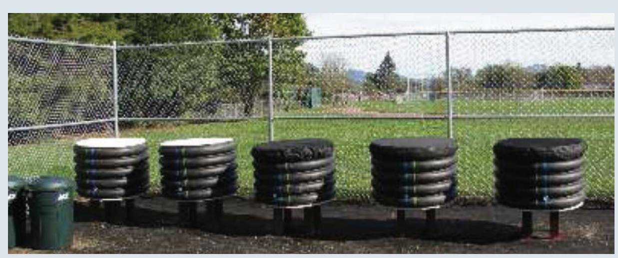

Figure 1-27: (left) Bins at a dairy farm, (middle) bins at North County Detention Facility, (right) bin system at Wright Charter School

Photo credit: Compost Club, Sonoma County, CA

Spotlight

Larger-scale vermicomposting systems are rare in the US, due primarily to the availability of lower-cost means of handling food scraps. Worm Power, in Avon, NY (www.wormpower.net) is an exception. In 2009, RT Solutions, LLC, designed and built a large-scale vermicomposting operation at a 1,600-head dairy farm adjacent to a 1,700-head farm. Manure from both farms is mixed with silage and composted for 14 days. The fresh compost is loaded into the vermicomposting bays at Worm Power. Total vermicompost output is 1,250 tons per year.[30]

depends on where an individual wishes to store the bin and how they wish to feed the worms. Some materials are less desirable than others in worm bin construction. Metal containers often conduct heat too readily, are prone to rusting, and may release heavy metals into the vermicompost. Some cedars – such as yellow cedar – and redwood contain resinous oils that may harm worms, although western red cedar has excellent longevity in composting conditions. Hemlock is another inexpensive and fairly rot-resistant wood species that may be used to build worm bins.[29] Worm bins need holes or mesh for aeration.

Composting worms are detritivorous (eaters of trash). Red wigglers, *eisenia fetidae*, are an example. They are epigeic (surface dwellers). Together with symbiotic associated microbes, red wigglers are ideal for decomposing food waste. Common earthworms such as *Lumbricus terrestris* are anecic (deep burrowing) species and hence unsuitable for use in a closed system.

Anaerobic Digestion Systems

Like composting, anaerobic digestion (AD) is a biological treatment process. But it is an anaerobic (caused by the absence of oxygen) process versus composting, which is aerobic (caused by the presence of oxygen). In AD systems, the lack of oxygen results in organic materials decomposition and stabilization by a different group of microorganisms that produce a usable energy source in the form of biogas. The products of anaerobic digestion are methane, carbon dioxide, trace gases and stabilized solids. Biogas production is approximately 4,200 cubic feet per ton of incoming feedstock. The biogas has an average methane content of 55-65%. Pretreatment is needed to remove impurities before it can be used for energy production.[31] A typical process flow diagram for anaerobic digestion is shown in Figure 1-28.

AD systems can be configured to handle liquid or solid materials. Liquid material digesters can be either low-solids (less than 10% total solids) or high-solids (25%-50% total solids). Solid material digesters are known as dry fermentation reactors and normally handle feedstocks with more than 50-70% total solids. The majority of AD systems operating in the US today are low-solids liquid systems, which are used at wastewater treatment plants for sewage sludges and on farms handling liquid animal manures. High-solids liquid digesters are used in Europe and Asia to handle food scraps and similar feedstocks that can be moved by high-solids piston pumps; none are operational in the US at present. Dry fermentation reactors are an emerging AD technology in the US. The first dry fermentation system came on-line in Wisconsin in 2011. (See Appendix C for a description of this project.) Since then, several others have begun operating, including a 90,000 tons/year facility in San Jose and a 5,000 tons/year small-scale project on the Monterey (CA) peninsula.[32]

All AD systems produce biogas, digestate (i.e. the residuals from digestion, which can be either liquid or solid), and effluent (the wastewater from dewatering liquid digestates, or the percolate used in dry AD systems). The flammable nature of biogas requires all processing to be completed in gas-tight systems, which allow for the capture and management of most process odors. The digestion process also reduces the volatile fatty acids produced in decomposition that are a common source of odors. The degree of biogas contaminant removal needed depends on the market for the biogas, with electrical production via a low-BTU generator requiring the least cleanup and injection into existing natural gas distribution pipelines requiring the most cleanup.

A Word about the Compatibility of Composting with Anaerobic Digestion Systems

One benefit of composting is that it is compatible with anaerobic digestion, another microbiological process that breaks down organics materials in the absence of oxygen to produce a biogas, with properties similar to natural gas. (Composting is an aerobic process.) The digestate – or solids – remaining after anaerobic digestion can be composted. Indeed, a number of North American cities are now operating or pursuing hybrid composting and anaerobic digestion systems, including Toronto, San Jose, and San Francisco. These hybrid systems are widely implemented in Europe. Anaerobic digestion systems are enclosed or "in-vessel," which typically means that their capital costs are higher than most composting systems. As a result, digestion systems may not always make sense for every community but some sort of composting almost always will.

The output from the digester is called digestate. Digestate retains most of the nutrients present in the feedstocks being digested; liquid digestates are often land-applied to cropland to capitalize on that nutrient value. Liquid digestates can also be mechanically dewatered to reuse the solids as animal bedding, as a land-applied soil amendment or as feedstock to an aerobic composting facility. Solid digestates are usually composted prior to beneficial reuse. Consequently, solid material AD is often an energy-extraction step prior to composting.

Effluent from digestate dewatering is either land-applied on cropland or discharged to a sewer, depending on the distance to, and availability of, suitable farmland. Percolate from

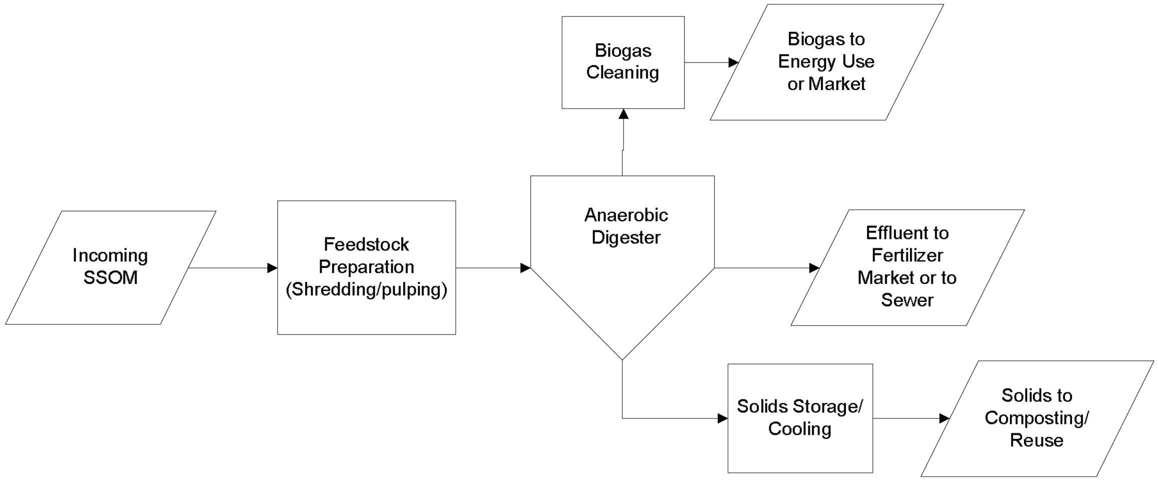

Figure 1-28: Anaerobic digestion process flow diagram

Illustration credit: Coker Composting & Consulting

solid waste digestion (similar to leachate) is recycled internally to keep the dry fermentation process anaerobic.

More details on various anaerobic digestion processes and technologies can be found in Appendix C of this report.

Composting System Costs

Establishing an organics recycling facility using composting, vermicomposting and/or digestion can be a very expensive undertaking. A number of factors influence a facility's cost structure, many of which are summarized below. In recent years, total "all-in" up-front and capital costs have varied from $650,000 for a 3,000 ton/year food scraps windrow composting facility on a 45-acre mini-farm to over $26 million for a 160,000 ton/year fabric-covered ASP system in an industrial area of an eastern city.

Up-Front Costs

Entrepreneurs planning new commercial merchant facilities need to budget $25,000 - $75,000 for up-front planning, engineering, and business plan development costs. On-farm, on-site, and municipal facilities can get by with somewhat lesser amounts, but proper prior planning is usually a prudent investment. All planning efforts for organics recycling facilities should address the following questions:

- Feedstock capture plan – what tipping fee materials are out there and how are they going to be captured?
- Feedstock collections plan – how are feedstocks going to get from the generation source to the composting facility?
- Product market capacity – how much of what types of products (compost, soil blends) will the market absorb (within a 50- to 100-mile radius for the soil amendments)?
- Preliminary manufacturing plan – how much space will the volumetric biological manufacturing of these products require?
- Technology and equipment evaluation – what composting technology is most appropriate for the planned feedstocks? What specialized equipment needs to be obtained?
- Siting evaluation – where are suitable candidate sites for a planned facility, given needed setbacks from community and environmental features? If a site is available, does it meet the restrictions of state regulations and/or best management practices?
- Approvals needed – organics recycling facilities almost always need local government approvals for zoning, solid waste management planning, public health related issues (air and water quality), and construction-phase activities (building permits, sediment/erosion control, etc.), and state-level permits for solid waste management, storm water management and (in some places) air emissions. What approvals are going to be needed and how long will they take to obtain?
- Cost estimates – what are the capital cost estimates for site acquisition and development, technology, and equipment? What are the operating cost estimates for purchased feedstocks, fuel, labor, electricity, equipment maintenance, and product marketing and sales?
- Pro formas – what are the expected income and expenses for this enterprise over a three-year period?

The results of these evaluations can be summarized in a business plan for investors, in a loan request for a bank, or in a budget request for municipalities.

Capital Costs

Fixed Assets

The fixed assets associated with an organics recycling facility are land, site improvements to that land, and desired/needed processing technology. Given that land requirements can be extensive (on the order of total processing plus buffer area of 50+ acres for a facility handling above 75,000 tons/yr), the cost of land can be high, with even ru-

Table 1-4: In-Vessel Composting Options, Sizes, and Costs

Type and Source	Model No.	Unit Size (ft)	Maximum Capacity[1,2]	Costs ($)	Notes
Containerized ASP					
Micro-Bins (O2 Compost)		4 x 4 x 4	1 cy total capacity FS & BM	1,000	Batch system. Multiple units may be needed. Separate curing needed
Horizontal Bioreactors					
Big Hanna (Susteco AB)	T60	4 x 8	150-250 kg FS/week	38,000	Continuous aeration with auger. 6-8 weeks retention time. Needs additional curing
	T75	4 x 10	225-325 kg FS/week	42,000	
	T120	5 x 13	300-500 kg FS/week	48,000	
	T240	5 x 17	400-1200 kg FS/week	76,000	
Earth Tub (Green Mountain Tech)		7.5′ diam	40-150 lbs FS & BM/day	10,000	Continuous flow system. 3-4 weeks of active composting. Additional curing needed.
Earth Bin (Green Mountain Tech)		5 x 24	0.25-2 tons FS & BM/day	88,000	Continuous flow system. 14 day retention time. Additional composting/curing needed.
Hot Rot	1206	4 x 20	600-800 lbs FS & BM/day	125,000	
	1509	5 x 29	1,000-3,000lbs FS & BM/day	240,000-320,000	
	1811	6 x 36	4,000-5,000 lbs FS & BM/day	290,000-360,000	
Rocket Composter (NATH)	A500	2 x 8	80 gal FS/week	18,500-89,000	
	A700	3 x 10	180 gal FS/week		
	A900	3 x 13	460 gal FS/week		
	A1200	5 x 23	925 gal FS/week		
Rotary Drum					
BW Organics	105	5 x 7	1 cy FS/day	16,390+	Continuous flow system. 3-6 day retention time. Additional composting/curing needed.
	205	5 x 12	2 cy FS/day	25,696+	
	305	5 x 18	3 cy FS/day	36,362+	
	405	5 x 24	4 cy FS/day	43,362+	
Eco Value Technology	C825	5 x 18	825 lbs FS/week	30,000	Continuous flow system. 1-2 wk retention time. Additional composting/curing needed. Customized sizes available.
EnviroDrum (DTE Environmental)	408	4 x 8	0.9 cy FS & BM/day	45,000-65,000	Continuous flow system. 3 day retention time. Additional composting/curing needed.
	514	5 x 14	2.5 cy FS & BM/day	85,000-130,000	
	616	6 x 16	4.2 cy FS & BM/day	100,000-150,000	
	632	6 x 32	8.4 cy FS & BM/day	140,000-200,000	
	840	8 x 40	18.6 cy FS & BM/day	220,000-300,000	
XACT BioReactor	5′ diam	5 x 10	1 cy FS & BM/day	18,000-75,000	Continuous flow system. 5 day retention time. Additional composting/curing needed.
		5 x 15	1.5 cy FS & BM/day		
		5 x 20	2 cy FS & BM/day		
	6′ diam	6 x 10	1.5 cy FS & BM/day		
		6 x 15	2.2 cy FS & BM/day		
		6 x 20	2.9 cy FS & BM/day		

[1]FS = food scraps, BM= bulking material, cy= cubic yards. [2]Capacity reported by manufacturer. Some reported by weight (lbs or kg), others by volume (cy). Some report capacity for food scraps only, others include bulking materials. Some report amount that can be added per day or week, others report total capacity of unit. Source: Jean Bonhotal, Mary Schwarz, and Gary Feinland, In-Vessel Composting Options for Medium-Scale Food Waste Generators, *BioCycle*, March 2011, p. 49.

ral land now selling for more than $10,000/acre. Site improvements at larger-scale facilities can include security gating, grading, constructing roadways and materials handling hardened pad areas, weigh scales and office buildings, and storm water management facilities. Site improvements can be on the order of $250,000/acre.

Smaller-scale, community-level composting facilities can be done for significantly less, in that many of them operate on municipally-donated or leased land or can be sited in repurposed commercial or industrial buildings, have limited site improvement needs and can use more affordable, small-scale processing technologies. One recent study estimated a capital cost of about $220,000 for a network of four community-level composting facilities and one centralized curing/product management/equipment maintenance facility.[33]

Costs for processing technologies vary widely and are considered proprietary information by most technology providers. Small-scale aerated static pile systems are usually below $10,000-$25,000 each; horizontal bioreactors and containerized ASPs can vary between $100,000 and $700,000 each; and larger-scale in-vessel systems and dry fermentation AD systems cost multiple millions of dollars. Technology providers generally sell the physical equipment, help oversee installation, provide operations and maintenance manuals, provide start-up training assistance, and, often, ongoing phone/internet support for a period of time along with a warranty.

Table 1-4 presents published cost data on composting technology options for medium-scale food scraps generators.

Mobile Assets

Much of the materials handling equipment used in organics recycling facilities is the same equipment used in other bulk commodity industries, like sand and gravel. Specialized equipment includes straddle and pull-behind windrow turners for turned windrow composting operations, and the particular equipment associated with particular technologies.

Table 1-5 lists the approximate range of costs of new types of equipment often found in composting facilities.

Table 1-5: Materials handling equipment costs

Equipment (new)	
Grinders	$100,000 - $500,000+
Slow-speed shredders	$400,000 - $800,000
Mixers	$40,000 - $200,000
Loaders	$85,000 - $400,000
Turners	$30,000 - $900,000+
Moisture addition	$5,000 - $90,000
Screens	$45,000 - $350,000+
Baggers	$30,000 - $500,000+

Many small-scale and start-up facilities buy mobile assets in the used equipment market, where prices run about 25% - 50% of new equipment prices. This used equipment has much higher and more unpredictable maintenance costs.

Funding/Financing Sources

Developing a composting facility can require $25,000 - $100,000+ expended before the start of construction, depending on the nature and extent of regulatory approvals needed, design work, etc. Land acquisition is usually done under options contracts, with the contract contingent on receipt of all permits and approvals. Many of the technology providers require either full payment in advance or significant deposits at the time of technology order, with full payment required before shipment.

Many entrepreneurial composting start-ups use personal, family and angel investor funds for the initial pre-construction costs. Land acquisition is usually bank-financed, as are the site improvement costs. Some technology providers will help in finding asset financing sources for their technologies. Mobile assets can be purchased outright, or are often leased from third-party leasing companies, sometimes with 5-year leases and balloon payment of principal at the lease term end. There is not a lot of venture capital money in the composting industry in the US. This is primarily due to the difficulty of having any patent-protected intellectual property, the lack of any "cutting-edge" technological advantage, and the challenges of developing an easily replicated national-scale model.[34]

Municipal composting facilities are often associated with solid waste or wastewater "enterprise funds," where user fees are used to finance specific operations separate from the government's general fund. These enterprise funds usually have the legal authority to borrow money and issue revenue bonds. Those composting facilities funded from a jurisdiction's general fund get capital from bond financing like other capital improvement projects.

Smaller-scale community composting ventures often rely heavily on donations (of both time and money) and on access to leasable municipal sites. The Lower East Side Ecology Center operates on land leased from the New York City Department of Parks, and gets some funding from the City's Department of Sanitation.[35] Hill City Garden and Compost in Chattanooga, Tennessee, used revenues from produce sales from their garden to save up part of the capital to buy a GMT Earth Tub for producing compost.[36]

Operating Costs

Operating costs in organics recycling are similar to those in any bulk commodities industry: fuel for vehicles and equipment, labor costs, and vehicle/equipment maintenance. Facilities using forced aeration composting also have electricity costs. Maintenance costs are very unpredictable and can have significant impacts on short-term financial performance. Effective odor management systems can also be costly.

A growing concern among many composters is the increasing cost of carbonaceous amendments needed to provide bioavailable carbon and structural porosity for proper process management in composting. In less than ten years, due in large part to demand created by the growth of the biomass industry, the price of wood chips has risen from near-nothing to over $20 per ton. As the normal weight-to-weight ratio between wood chips and compostable solid waste is 1:1, this adds potentially crippling costs to a composting operation. Several composters have started ancillary contract grinding operations to gain access to wood chips. One composter reports bidding grinding work for free provided he can keep all the wood chips.[37]

Challenges and Impacts

Composting has many benefits but it is also not without its drawbacks and challenges. These include odors, pathogens, contaminants, and concerns about nutrient run-off. Composting inherently involves dealing with putrescible materials, which means odors need to be actively managed to avoid becoming a nuisance. Pathogens also need to be reduced, which is why time, temperature, and mixing are important. High-quality compost has to be free of harmful and physical contaminants. Physical contaminants – most notably plastics – are increasingly a problem, particularly for facilities accepting post-consumer food scraps and yard trimmings in plastic trash bags. A commercial organics program serving the Portland, Oregon metropolitan area, for instance, has been overwhelmed by non-food compostable items as well as prohibited material. As a result the regional government, Metro, has decided to focus only on food scraps in order to ensure the program's longevity.[38] A 2011 study found that the plastic-coated paper products currently being collected by many composting programs produce both macro- and micro-fragments of non-biodegradable plastic that contaminate the finished compost. Once these plastics are dispersed into the environment, they have not been shown to biodegrade and are suspected of causing detrimental effects to organisms in a variety of ecosystems.[39]

Persistent herbicides are another challenge, as they can find their way into composting facilities and even in very minute concentrations cause crop damage when the compost is used. Composters face liability claims, product testing, and financial losses. In Vermont in 2012, the Green Mountain Compost facility (owned by the Chittenden Solid Waste District, CSWD) received 510 confirmed complaints of herbicide damage to a variety of garden plants and ended up paying 449 claims. Settling those complaints and retrieving unsold product from its resellers, cost CSWD an estimated $270,000. CSWD incurred another $372,000 for testing and legal assistance to address the issue. The loss in value added sales of products that could not be made or sold due to the presence of persistent herbicides added another estimated $150,000. CSWD's costs totaled approximately $792,000. The culprit? Mainly aminopyralid, although the other primary persistent herbicides of concern – clopyralid, picloram, and aminocyclopyrachlor – were also found in compost, and regulators were unable to identify all sources of contamination.

Herbicide-contaminated compost is not a new problem. The first incidents of herbicide contamination in compost were reported in 2000 in Spokane, Washington, where compost produced from yard trimmings contaminated with clopyralid damaged vegetable and garden crops. The City of Spokane suffered an estimated $4 million in damages and the facility was forced to close.[40] The City had joined a class-action lawsuit with other composting operations against Dow, but only received $23,000 in compensation. With every new incident of crop damage due to herbicide-contaminated compost, consumer confidence in the use of compost will decline. Despite the known severity of this issue for more than a decade, chemical companies continue to produce herbicides that persist in compost and soils, and the US Environmental Protection Agency (EPA) continues to approve the registration and re-registration of these products while taking no meaningful action to resolve the problem. Recent incidents of persistent herbicides in compost and soils have underscored the urgent need for action. Nurseries, landscapers, crop farmers, and gardeners all represent industries threatened when soil is contaminated. Aminocyclopyrachlor-contaminated soil kills trees. Soils with trace amounts of aminopyralid stunt crops and hamper seed germination. As a result of the potential threat to the composting industry, the US Composting Council is calling on chemical manufacturers to withdraw herbicides known to persist in soil and compost with phytotoxic plant effects and to take responsibility for the damage these persistent herbicides cause, and on the US EPA to take immediate and decisive action to prevent further environmental and financial damage.[41]

Another issue for both operating composting facilities as well as for using compost is nutrient run-off. Nitrogen and phosphorous find their way into aquatic ecosystems with devastating impacts. Operators of composting facilities need to ensure that the raw feedstocks being processed do not leach nitrogen and phosphorous into surface or groundwater. In addition, those using compost need to be cognizant of land application rates. Compost applied at too high of a rate can increase soil phosphorous to levels that exceed the soil's phosphorous-binding capacity, resulting in increased phosphorous run-off. Although compost itself contains some nitrogen and phosphorous, it can mitigate nutrient problems by preventing soil erosion and runoff in the first place, and by converting nitrogen into a more stable and less mobile form and phosphorous into a less soluble form.

Generally speaking, product quality and nutrient challenges can be addressed internally by the composting facility operators. Persistent herbicides in incoming feedstocks are difficult to control, however steps can be taken internally to evaluate both feedstocks and finished compost for persistent herbicide contamination. Odors, however, have been the downfall of many composting facilities over the years — primarily because once they are detected by facility neighbors, the fate of the facility is often controlled by external factors. Failure to control and manage odors is the single biggest cause of adverse publicity, regulatory pressures and facility closures in the organics recycling industry.

The Importance of Odor Management

Aerobic composting and anaerobic digestion facilities have one thing in common; they manage the process of decomposition, which is an odorous process. Decomposition is a process that begins immediately after the death of a living plant or animal, whether that's an orange plucked from a fruit tree, an animal rendered to feed people, or a shrub branch pruned by an avid gardener. Decomposition is a biological and chemical process whereby complex biochemical compounds are broken down into their constituent building blocks. At each stage of the decomposition process, there are a variety of different organic compounds, each with its own volatility characteristic. Think of a compound's volatility characteristic as its potential to generate odor.

The major odor-causing compounds in composting are sulfur-, nitrogen-, and carbon-based. Table 1-6 lists some compounds that cause odors, and the nature of those odors.

Factors that can influence odor generation include: feedstock composition, the metabolic activity rates of the decomposers doing the work, the availability of the nutrients in the feedstocks to the microbes, how well mixed the feedstocks are, and several physical factors, such as moisture content, particle size, oxygen content and diffusion, and temperature.

Table 1-6: Odor causing compounds at compost sites

Compound	Nature of Odor
Sulfur Compounds	
Hydrogen sulfide	Rotten egg
Methyl mercaptan	Pungent, rotten cabbage, garlic
Carbon disulfide	Rotten pumpkins
Dimethyl disulfide	Putrid, sulfurous
Nitrogen compounds	
Ammonia	Pungent, sharp, eye-watering
Methylamine	Putrid, Rotten fish
Cadaverine	Putrid, decaying animal tissue
Indole/Skatole	Fecal
Carbon compounds	
Acetic acid	Vinegar, pungent
Butyric acid	Rancid butter, garbage
Iso-valeric acid	Rancid cheeses, sweaty
Acetaldehyde	Green, sweet, fruity
Formaldehyde	Acid, medicinal
Limonene	Sharp, lemony
α-Pinene	Sharp, turpentine

Composting is never odor-free. Even under optimum conditions for aerobic decomposition of organic matter, odors are going to form. However, failure to develop those optimum conditions is guaranteed to make odors worse, particularly those odorants that people find annoying or unpleasant. The more odors that are formed due to poor composting conditions, the more quantities of that odorant escape into the atmosphere, and it becomes much harder to disperse those quantities below the recognition thresholds.

Optimizing the conditions of a good compost pile or windrow is vital to managing odors. The first step in controlling the microbial activity is a mix that adheres to good best management practices: the right nutrient balance between carbon and nitrogen (at least 25 parts of carbon for each part of nitrogen), adequate moisture (around 50-55%) and enough structural porosity to ensure a free air space of at least 40% to keep oxygen levels above a 8 to 10% minimum. Particle sizes to provide adequate structural porosity should be in the 2- to 3-inch range. Following best management practices in site layout and design and in compost pile recipe development and construction will not eliminate odors, but will greatly reduce the potential for odor episodes that will cause problems.

Appendix D has a comprehensive explanation of the causes of odor generation and how to optimize composting conditions to minimize their generation.

Markets and Applications for Compost

There are many markets and applications for compost, both existing and emerging: agricultural and horticultural, landscape and nursery, vegetable and flower gardens, sod production and roadside projects, wetlands creation, soil remediation and land reclamation, sports fields and golf courses, and sediment and erosion control. Whether one is producing or using compost, jobs are sustained at every stage of the organics recovery cycle. Moreover, markets for quality compost are growing thanks to the expansion of sustainable practices associated with green infrastructure such as stormwater management, green roofs, rain gardens, and other forms of low-impact development (LID). Growth in demand for compost can also be attributed to a strong green building movement helped along by the US Green Building Council and its LEED certification, as well as the Sustainable Sites Initiative's voluntary national guidelines and performance benchmarks for sustainable land design, construction and management (www.sustainablesites.org).

The following summarizes the major markets for compost, highlighting the diversity and abundance of compost applications, and underscoring the great potential to produce and use this product throughout the US.

Agricultural

In agriculture, compost can be used for a number of different reasons: amending soil to improve infiltration rates, water holding capacity, and soil tilth; fertilizing the soil to supplement nitrogen, phosphorous, and potassium. Applying mature, finished compost never "burns" like fertilizers do[42] and can offset the need for and cost of chemical, oil-based fertilizers that pollute the environment. Billie Gibson, an organic farmer in Delaware reduced her chemical use by amending soil with compost, which cut her input costs in half, while producing a noticeable improvement in the quality of her vegetables.[43] Similarly, a major fruit and vegetable grower in California cut pesticide use by 80% through an organic matter management system. Organic matter is vital to soil quality and amending soil with compost is the best way to increase the organic matter in soil.[44] Additionally, growers in the San Joaquin valley recorded a savings of $35 per acre on defoliation costs by using compost. Compost can also help farmers to increase pasture quality, a pivotal strategy in the intensively or overly grazed lands in today's agricultural systems.[45]

While on-farm composting is an age-old process, the agricultural industry is still largely an untapped market for compost use. Agriculture is beginning to see more use of compost, predominantly in California and on the west coast; but compared to the huge potential for market growth, commercial farmers "have not even scratched the surface yet" with regard to their compost use, says Al Rattie, Director of Market Development for the US Composting Council. "If agriculture ever realizes the significance of compost from its value as a source of organic matter for its water holding capacity and its ability to reduce chemical fertilization, there won't be enough composting in the United States to begin to start satisfying that need."[46]

Construction

Whether traditional construction or state of the art LEED certified building projects, compost can be used in and ben-

Figure 1-29: Eric Paris of Tamarlane Farms (VT), is a certified organic dairy farm that uses compost to fertilize its pastures and croplands. Driven by the need for an organic soil amendment, Tamarlane created a composting facility to process its on-farm materials as well as food scraps from the greater community.

Photo Credit: Highfields Center for Composting

efit nearly any land development project. General contractors and companies implementing more conventional projects can realize significant benefits by using compost that can equate to cost savings and easier compliance with permitting and inspections, such as in establishing a stringent erosion and sedimentation control (ESC) plan to meet local codes. Conventional development practice strips away topsoil during grading, compacts the whole site from heavy equipment during construction, and replaces only 1-2 inches of soil over the compacted subsoil before landscaping, thus reducing infiltration and increasing stormwater runoff volume and rate leaving a site. Conversely, amending soils with compost (recommended 30-40% compost by volume in planting beds and 15-25% in turf areas) allows for healthier soil that increases infiltration and binds erodible sediment.[47] Compost can also be used to grow vegetated cover on soil stockpiles during construction. Companies using products and developing site plans that incorporate compost are making projects more sustainable and reducing environmental hazards that would otherwise often result in project delays or disapproval from local citizens and regulators.

Low-Impact Development/Green Infrastructure

"Low Impact Development (LID) is a comprehensive land planning and engineering design approach with a goal of maintaining and enhancing the pre-development hydrologic regime of urban and developing watersheds."[48] LID systems typically replace impervious surfaces with more pervious ones or direct the flow of water runoff from an impervious surface to a more pervious holding area that will let water slowly infiltrate the ground, mimicking the natural environment. Compost can play an integral part in LID projects which include green roofs, bioretention cells or rain gardens, filter strips, infiltration trenches, and open grid pavement systems.[49] Three of the main goals of these systems are reducing the flow rate, volume, and contaminant level of stormwater runoff. Amending soil with compost helps fulfill these goals. Compost filters runoff waters to mitigate urban pollution, reducing an astounding 60 to 95% of contaminants.[50] Compost also acts like a sponge to retain as much as 20 times its weight in water.[51] This minimizes water lost as runoff and evaporation and benefits the construction, landscaping, and home gardening industries by cutting summer irrigation needs by up to 50%.[52]

There is a growing market for using compost and compost-based products to manage runoff and erosion through green infrastructure. Leading the industry is Filtrexx International LLC, which occupies 98% of this market and is giving rise to new businesses, projects and job positions all over the country.[53] The company has dozens of patents for numerous products such as compost blankets, compost filter socks, and other mesh-containment systems which can be used in applications including sediment control, inlet protection, dam checking, concrete wash-outs, slope protection, temporary seeding during construction, bank stabilization and more. These products have the ability to filter and remove up to 99% of bacteria, 73% heavy metals, 92% of nutrients, and 99% of hydrocarbons from stormwater (much of that capability to remove pollutants is due to use of compost in the filter media). More than 100 Filtrexx certified installers now use approximately 2 million cubic yards of recovered organics annually. This means that approximately

Figure 1-30: (Top) Sediment trap, (middle) Slope protection and erosion control blanket made from compost, (bottom) vegetated walls

Photo Credit: Filtrexx

10,000 tons of compost can sustain one new business in the field of compost-based green infrastructure design and installation.[54] This statistic alone demonstrates the vast potential for market growth in the compost production and usage industry.

Homeowner and Community Gardens (Vegetable, Fruit, and Plant Production)

Compost has the ability to "boost the soil health and growing power of community gardens across the country;" the more quickly organics are collected for composting instead of wasted, the more quickly communities can rehabilitate food deserts and supplement impoverished communities with nutritious local food. Initiatives like the US Composting Council's (USCC) "Million Tomato Compost Campaign," are generating awareness and momentum for compost use in gardening, and have the potential to link compost to nationwide food health and security campaigns. This USCC campaign is an effort to "boost the health and growing power of community gardens across the country."[55] As of summer 2013, more than 140 community gardens received compost donations in an effort to grow one million tomatoes and a larger effort by the USCC to educate potential compost users and consumers on the merit of this "value-added" soil amendment product.

Figure 1-31: Growing Power in Milwaukee is one of the premier urban farming and community-based composting enterprises in the country, combining non-profit status with a land trust.

Photo Credit: Growing Power

While community gardening has long been woven into the fabric of American society as witnessed for example during the era of "victory gardens," the modern day swell toward eating healthy, locally-grown fruits and vegetables coupled with increased composting infrastructure make gardens and urban farms a pivotal market for compost use. According to Rhonda Sherman, vermiculture specialist at NC State University, "more than ever there is interest and development of community gardening… and if you are gardening, you're going to need compost." Food system revolution pioneers like Growing Power's Will Allen echo this sentiment acknowledging that good food requires good soil, which requires good compost. What's more, promotion of the USCC's Seal of Testing Assurance (STA) program over the past decade has greatly benefited the marketability of a solid product for compost producers and helped consumers distinguish between quality versus inferior compost or other organic products.

The more the compost industry connects with existing and national efforts toward sustainable food systems (such as Michelle Obama's healthy food initiative via her "Let's Move" campaign and White House Garden work), the greater the potential market for compost use in community gardens. This will also help fulfill the Million Tomato campaign's goal of "bringing together compost manufacturers, chefs, community gardens and food pantries to help build healthy soil that produces sustainably grown, local food for the nation's communities." To date, compost manufacturers in the campaign have provided 39,000 cubic feet of compost[56] to community gardens; but with an estimated 18,000 community gardens throughout the US, this is just a taste of what is possible through similar initiatives.

Silviculture

"Silviculture is the art and science of controlling the establishment, growth, composition, health, and quality of forests and woodlands to meet the multitude of purposes and values of landowners and society on a sustainable basis."[57] Compost's many benefits when applied to soil make it advantageous to the vitality of trees and overall silviculture systems. Research indicates that compost enhances productivity, size, survival rate, and growth potential in forest tree crops. A project of the University of Florida's School of Forest Resources and Conservation also found higher nutrient content (leaf and twig nitrogen concentrations) in compost-amended trees (versus control samples that were not amended), with more foliage and dense fine roots surrounding clumps of organic matter. These results suggest "potential for rapid future growth" and indicate how a product rich in nutrients and organic matter like compost can be a critical element in the silviculture industry.[58] As such, reforestation and tree planting campaigns in the US such as "Mayors 10,000 Trees Campaign" in Tucson or New York City's "Million Trees NYC" could benefit from greater compost production and provide a great opportunity to spur compost use. There are approximately 2.5 million trees planted annually in the US and world-renowned international movements such as the United Nations Environment Programme (UNEP's) "Billion Trees Campaign" or Wangari Maathai's successful trend-setting million trees campaign in Kenya demonstrate a potentially fruitful market for compost in silviculture.[59]

Sod/Turf Production

Research demonstrates that incorporating compost into sod fields can improve turf quality, produce a lighter material, and enhance growth efficiency. While applying compost to existing sod fields has demonstrated superb results, "when considering the economics of sod production, the use of compost as the growing media for sod probably provides the greatest promise."[60] There is an existing compost-based patented sod growing system that produces sod in ten weeks, and as little as seven weeks for tall fescue.

Landscaping

According to the USCC's Al Rattie, landscapers are probably the single largest market segment using compost in the US. There are approximately 35,000 to 38,000 landscape contractors in the US and an additional 3,500 lawn care professionals that all could be using compost. While the number of these companies decreased during the economic recession, the landscaping industry is rebounding and can expect greater compost use as well – "the landscaping industry that was in decline is definitely on the way back and we believe compost is going to make that happen and make it happen quicker" says Rattie. Landscapers are realizing the need to diversify their services, providing irrigation, tree care, and a number of services that require or are enhanced with compost. What's more, the industry is adapting to a shift toward environmental site design, greenscaping or zeroscaping (aka xeriscaping) that calls for more sustainable design, installation, and maintenance practices and will undoubtedly necessitate higher volumes of compost. Compost's exquisite ability to retain water is sure to drive market demand as water shortages are becoming increasingly more common in various region of the country today – some municipalities are even requiring home lawns and new landscapes to utilize compost amended soil. What's more, using compost in the landscaping industry as a component of backfill mixes has been a popular practice, with benefits including early improved root growth, plant establishment and survivability, and poor soil enhancement.[61]

Nursery, Horticulture

Compost has several main applications in the nursery. It can be used as a growing media component (i.e. horticultural substrate) for the production of various containerized crops. Composted bark products are considered an industry staple, while biosolids compost has been one of the most researched and commonly used types of compost commercially. Positive results with compost use include an increased number of flowers per plant and improved drainage when using a coarser compost.[62] Compost also plays a critical role as a soil amendment in fields to facilitate nursery production of larger shrubs and trees. Because field production is often a lengthy process, nurserymen benefit by using compost that produces higher quality plants and trees in a shorter amount of time. Applying compost (and its organic matter content) before planting or directly after plants reach maturity and are harvested minimizes the need for nurseries to plant cover crops, thus, making for a more efficient operation and avoiding taking fields out of production.[63] Expanding composting in the US will also allow for increased use of compost in raised and grounded planting beds where nurseries produce various shrubs, perennials, and ornamental grasses.[64]

Athletic Fields and Golf Courses

Using compost on sports and athletic fields has various benefits such as "extended color retention in the fall and quick spring green-up."[65] Compost can also act as a light mulch on new seedlings to help retain moisture and provide seed to soil contact.[66] Currently compost is being used on various types of athletic fields and customers range from colleges and universities to national football league teams. Some compost manufacturers are turning food discards into a valuable soil amendment for sports fields. McGill Environmental Systems, for instance, processes over 300,000 tons of biosolids, yard trimmings, and food discards annually and provides compost for sports fields in the Mid-Atlantic region. The Washington Redskins and the University of North Carolina-Charlotte used McGill's compost to amend soil before sodding their fields. McGill's service area throughout Virginia and the DC region is a prime market for sourcing feedstocks and selling high value compost. Serving NFL teams like the Redskins is an indication that high quality compost can be considered an effective and valued soil amendment in the most demanding markets. This past August, compost-amended soils on the Redskins practice facility field withstood torrential rains while surrounding areas became a "soggy mess." The performance of compost-amended fields has led to a positive relationship and opportunities for expanded compost use between McGill and the landscaping company that manages the Redskins practice facility – a positive sign for the market for compost use on athletic fields.

Golf courses are another target in the realm of sports with the potential for high volume compost use. With their substantial and often over-applied chemical use (e.g. fertilizers and pesticides), golf courses significantly contribute to land and adjacent waterway contamination. However, this chemical use can be offset or entirely replaced by using compost. For example, Meadows of Sixmile Creek Golf Course in Wanaukee, Wisconsin replaced 100% of its synthetic fertilization and 95% of its chemical herbicide use within three years of first applying compost to its fairways and tee boxes.[67] Reported results at Meadows of Sixmile and another nearby golf course also using compost include sustainably

 

Figure 1-32: (left) A coal power plant and coal mined lands in Centralia, WA. A portion of the mined lands were restored with a mixture of municipal biosolids and topsoil in the 1980s. (right) The plant cover on the restored sites.

Photo Credit: Sally Brown

supplying nutrients at a lower cost than fertilizers, a reduction in thatch, and increase in water-holding capacity. Purple Cow Organics, the compost supplier, sees its golf course customers as "living laboratories," in which the company delivers biology to the soil using compost, and is seeing healthier turf. With results like these, Purple Cow says interest is beginning to build in a potentially sizable market. States that embrace policies that could promote compost-amended soils, such as Wisconsin's ban on phosphorous fertilizers, can help this market grow.[68]

Land Reclamation and Carbon Sequestration

Compost has the ability to improve marginal land and sequester carbon. Research has shown that land application of composts and other organic residuals (manures, pulp and paper sludge, and municipal biosolids) results in increased soil carbon storage. This increase is the result of two factors: the direct addition of carbon to soil with the amendment and through the resulting increases in net primary productivity that seasonally add more carbon to the soil in the form of plant biomass.[69,70,71,72,73,74,75,76,77] This increase in soil carbon following the use of organic amendments has been shown for a wide range of soil types and land uses. The rate of carbon stored per dry ton of amendment will vary based on the loading rate of amendment, the local climate, and the extent of soil disturbance. Rates ranging from 0.1 to over 1 ton of CO_2 per ton of amendment applied have been reported.[78]

Mined Lands

Lands disturbed through mining operations can broadly be categorized by the time that they were mined. In 1977, the Surface Mining Control and Reclamation Act was passed (SMRCA, Public Law 95-87). This act requires that topsoil be set aside and preserved for later use in reclamation and also imposes much more rigorous standards for a site to be considered as restored. While 3.2 million hectares of land have been permitted for mining following passage of that act, an unknown quantity of land was disturbed by mining prior to passage. Organic amendments are appropriate for all types of mine sites as a way to restore soils and reestablish a plant cover.[79] Amendments have increased soil carbon in land disturbed by hard rock mining, coal mining, sand and gravel pit mining, and borrow pit mining (where topsoil has been removed from a site to use elsewhere). There are many types of mining operations with associated levels of soil disturbance.

Hard Rock Mining

Hard rock mining refers to operations that extract metal ores or minerals. Examples of hard rock mines include mining for zinc, copper, gold and silver. Mining operations can be open pit or underground. The majority of metal ore deposits in the US have already been extracted. Historic mining sites are common in areas like Arizona, Montana, and Colorado. There are very few operating hard rock mines in the US. In addition to the absence of soil on these sites, restoration can be complicated by the presence of metal contamination in the surface material. Many of the historic sites are listed on the US EPA Superfund list. Previous work has shown the ability of organic based amendments including composts and biosolids to restore a vegetative cover and increase soil carbon concentrations on these sites.[80,81]

Coal Mining

Coal mining operations are much more common than hard rock mining in the US. Remnants from both historic and ongoing operations require restoration. Use of organic amendments is a common and well studied practice for these sites.[82,83] States with extensive coal deposits recommend use of organic amendments for restoration and also prescribe appropriate application rates for amendment (Virginia Department of Mines, Mineral and Energy). Even in cases where topsoil has been stockpiled, including amendments with the topsoil in a restoration mix has been shown to result in higher rates of carbon storage in comparison to the use of topsoil alone.[84]

Other Types of Mining Operations

Other types of mining operations include sand and gravel pits as well as borrow pits. Borrow pits are cases where topsoil

Figure 1-33: Different composts were tested for restoring this borrow pit in Vashon Island, WA

Photo Credit: Sally Brown

has been removed from a site to use elsewhere. In comparison to hard rock and coal mining operations, these sites are typically small in size. They are also much more common. In many cases these types of mines are close to populated areas. Use of composts is much more common than less stabilized materials because of the proximity to people. A borrow pit on Vashon Island, Washington, where different composts were used in a trial to determine the best amendments to restore the site is shown in Figure 1-33. The site is bordered by a nature trail.

Other Land Uses (Non-Mining)

It is important to note that in addition to mined land, the carbon stocks in almost all of our agricultural soils and urban soils have been depleted over time. Conventional tillage of agricultural soils has allowed high oxygen flow into the soil, broken soil aggregates and resulted in mineralization of high percentages of soil carbon stocks. Disturbances in urban areas from road and home construction have also resulted in loss of soil carbon. Neglect of soils in urban areas has also resulted in lower productivity and as a result, lower quantities of carbon from plant material being added to the soils. For agricultural soils, the potential to remove crop residues is a concern because a significant portion of these residues are incorporated into soil organic matter. Removal will result in decreased soil carbon concentrations over time.

Studies have shown that use of organic amendments in agricultural and urban soils will result in carbon sequestration at rates that are similar to those observed in mined lands.[85,86] For example, one study observed that manure or compost addition increased soil organic carbon in the 0-25 cm soil profile by 25% and 41% respectively in comparison to the conventionally managed soil.[87] Another study noted approximately an order of magnitude increase in soil carbon sequestration when biosolids were added to soils managed under no till.[88] In urban areas, use of residuals on roadside soils and in stormwater bioretention systems will result in both increased soil carbon storage and hydrologic benefits. Use of residuals in urban agriculture and landscaping will improve soil physical properties, may reduce the bioavailability of contaminants in these soils, and will also result in increased soil carbon storage.[89,90]

As more and more landfill space becomes occupied or exhausted, the need for composting will be greater. Composting can become not only a more sustainable but also a cheaper way to handle organics than landfills as tipping fees rise. Agriculture perhaps presents the greatest opportunity to use compost to replenish soils and improve their fertility as farming practices continue to degrade land over time.[91] Farmers that manufacture compost will not only diversify their marketable products to add potential income but replace or offset the need for and cost of chemical-based fertilizers by using compost. They also will have a beneficial resource that reduces harmful agricultural runoff from contaminating their watershed. As noted elsewhere in this section, many other uses for compost, including landscape, nursery, public agency and homeowner applications, continue to see increased demand.[92]

A Word about Highest and Best Use

Composting is an age-old and important technique for cycling organic materials into soil, but it is not considered the highest and best use for all organic materials. Avoiding the generation of waste in the first place – source reduction – and rescuing food to feed people, for instance, are considered higher priorities than composting for food scraps. The US EPA has developed an inverted pyramid hierarchy focusing on food waste recovery. The hierarchy represents EPA's perceived best management activities for food scraps, starting with the most beneficial at the top and moving down to the least attractive:

Source Reduction: Reduce the amount of food waste being generated;

Feed Hungry People: Donate excess food to food banks, soup kitchens and shelters;

Feed Animals: Provide food scraps to farmers;

Industrial Uses: Provide fats for rendering or fuel and food discards for animal feed production;

Composting: Compost food scraps into a nutrient rich soil amendment; and

Landfill/Incineration: Send food scraps to landfill or incineration if there are no other beneficial options. See Figure 1-34.

Where anaerobic digestion fits in has been somewhat controversial. EPA's and Oregon's statutory hierarchies, for instance, differ in their placement of energy recovery from food waste. EPA places energy recovery above composting; Oregon places it below. The Oregon Department of Environmental Quality's limited review of the literature comparing aerobic composting to anaerobic digestion was inconclusive.[93]

ILSR endorses a more nuanced hierarchy of highest and best use, one that takes into account scale, ownership, and the level of community engagement. Like composting, anaerobic digestion can be small scale, large scale, and everything in between. Small-scale anaerobic digesters are in use in rural China, India, Nepal, Africa, and Latin America for treatment of animal manures and sometimes food scraps.[94] In general, we

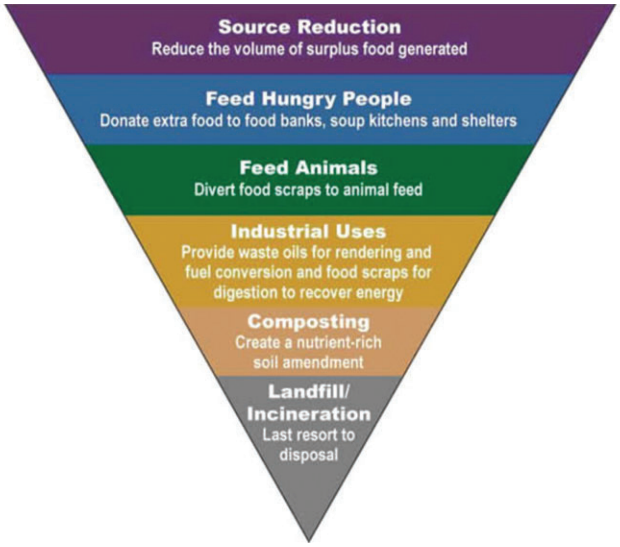

Figure 1-34: US EPA's Food Recovery Hierarchy

Credit: US EPA

believe locally based systems should be prioritized over centralized systems.

Where composting has become institutionalized, the systems implemented tend to be centralized, relying on large-scale collection to out-of-town large-scale regional facilities. These cities have had tremendous success composting and as a result are diverting significant portions of their waste stream from disposal. San Francisco now reports that 80% of its municipal solid waste is recycled and composted. Clearly, communities cannot maximize composting and overall diversion levels without providing all waste generators the opportunity to set out their organic discards for collection for composting. But to build more resilient communities and reduce the government and business cost of handling organic material, particularly transportation costs, backyard and onsite composting need to also be encouraged along with community composting at closer-in smaller-scale facilities such as at community gardens, and urban and rural farms. (Training programs are needed to ensure small-scale decentralized sites are well operated.)

Figure 1-35: This food was delivered to a compost site. The lettuce was not even wilted.

Photo Credit: Institute for Local Self-Reliance

Expanded Food Discard Hierarchy and Strategies for Source Reduction

The City of Glendale, California's Zero Waste Plan features an expanded list of options for managing food discards in addition to centralized organics recovery programs. Activities located higher up on the list are preferable as they recover organic materials at a higher use value and/or at a lower cost than those at the bottom. The Plan also includes a compilation of source reduction strategies for the food service industry.

Hierarchy of Options for Food Scraps

- Source reduction
- Donation to food banks
- Food to animal feed and direct land application
- Subsidized distribution of compost units and intensive training for residents
- Shared, small-scale, decentralized composting systems for residences and businesses
- Use of discarded organics for production of liquid fertilizers and other value-added products
- Centralized composting of food residuals through drop-off or curbside collection programs

Source: Richard Anthony Associates and Gary Liss Associates, Zero Waste Action Plan for the City of Glendale, California, December 2010.

The food scrap recovery hierarchy shown above – adopted by the City of Glendale, California – is an example of one that prioritizes reducing waste, rescuing edible food, and decentralized composting over centralized systems.

Austin may perhaps be unique in its official recognition of the benefits of a decentralized composting infrastructure:

"…decentralized composting processes can reduce the carbon footprint of collection and transportation while consuming organics in more localized situations that do not require large organized collection programs.

Figure 1-36: The NYC Compost Project's Master Composter Certificate Course trains community leaders to start community compost sites.

Photo Credit: NYC Compost Project

Highest and Best Use

- **Home-based Composting** – Highest and best use of food scrap, with the lowest carbon footprint.
- **Humus & Mulch** – Second highest end-use with minimal processing requirements.
- **Vermi-compost** – Best processing of compost with the least energy requirements.
- **Aerobic Composting** – Best central processing option with the highest end-use of compost.
- **Anaerobic Digestion** – Final end-use disposal option with energy capture.
- **Landfilling** – Disposal method that often creates unmitigated methane release to the environment.

Lowest End Use

Figure 1-37: City of Austin Highest and Best Use Philosophy

Source: The Austin Resource Recovery Master Plan, 2011

The [Austin Resource Recovery] Department recognizes that, in addition to helping the City achieve its Zero Waste goals, composting also addresses the community's interest in enriching the region's soil, strengthening sustainable food production and completing the food cycle. These additional benefits were identified by the Sustainable Food Policy Board's December 2010 letter to the Austin City Council and were considered while developing the Department's Master Plan."[95]

As a result, the City has adopted a highest and best use philosophy for city collection programs of residential food scraps to guide its planning.[96] See Figure 1-37. In addition to the eventual rollout of a citywide household yard trimmings and food scraps collection program, the Austin Resource Recovery Department (previously the Solid Waste Services Department) is first initiating the following new programs:

- Expanding its home composting incentive program to encourage the development of home and onsite composting; and
- Establishing composting trainings at community gardens and implementing a junior composter and master composter training program.

Locally based composting is important to support local food production and keep our backyards and streetscapes rich in organic matter.

The concept of highest and best use can apply to the finished compost in addition to how the raw organics materials are managed. Compost used for daily landfill cover, for instance, is a high-volume but low-value end market. Backyard composters, community gardens, and urban and rural farms typically use compost produced for onsite soil needs and local food production. There may be no better highest and best use for compost than these closed loop material cycling systems.

Sites distributing compost for offsite uses can of course also support high quality premium end markets for compost. It behooves anyone selling compost to pay attention to the marketing side of the business. According to Ron Alexander, a nationally recognized expert on compost markets, increasing the value of compost can be difficult, as it often doesn't follow typical supply and demand curves. Compost "supply" may increase due to recycling drivers, not because its "demand" has necessarily increased. Composters thus must work hard to increase the value of their products.[97] The factors that influence the value of compost include product quality, volume produced, size of market, distance to market, innate value, perceived value, and competition.[98] Composters should understand what they are selling and what products work for specific applications.[99] Compost for topdressing for the sod industry has a higher value than compost sold as surface mulch. Compost sold for topdressing also costs about half of what sand-based topdressings do (compost is $11.50/acre ver-

Figure 1-38: The US Composting Council's Seal of Testing Assurance (STA) program allows compost producers to label their products to reflect the compost's use or uses. This will allow compost users to clearly identify the types of uses that a compost product will be good for.

Credit: US Composting Council

sus $23.40/acre for sand-based dressing). But compost can fulfill the function of three products used in the management of high quality turf (nitrogen fertilizer and fungicide in addition to top dressing). Thus, producers could be getting much more for their compost sold as a topdressing if they priced their product based on its replacement value.[100] Ron Alexander recommends that the industry collectively do a better job of evaluating the economics of marketing options and potential product replacement values.

In order to recycle organic materials into high-value compost, composters have to produce high-quality compost suitable for the desired end market. Buyers may be concerned with weed seed content, soluble salts, pathogens, pH, nutrient value, and level of organic matter.[101] Compost quality requirements can differ significantly depending on the end use.[102] Compost producers may make more money selling to high-quality compost to greenhouses and nurseries, but if the product causes problems, the compost producer could be liable for damage. Poor nutrient content, immaturity, or chemical contamination (such as with persistent herbicides) can cause problems. Other markets such as for field crops, turf, or erosion control, may be able to use compost that isn't fully mature, or has pH or nutrient values that would not work in other settings.[103]

Policies and programs to support composting and compost use ought to support highest and best use wherever possible. California's waste reduction and recycling law, AB939, has allowed the use of compost as alternative daily landfill cover to count as recycling, thereby undermining the use of compost for other markets. It exemplifies how policies that intended to encourage diversion of green waste actually hampered the development of quality compost for high-quality markets. In contrast, policies such as state preferable purchasing specifications for compost meeting the Seal of Testing Assurance (STA), can encourage production of consistently high-quality compost for high-end end uses. The US Composting Council's STA Program is a compost testing, labeling and information disclosure program.[104] Certified compost products are analyzed for pH, soluble salts, nutrient content, moisture content, maturity, stability, particle size, pathogens, and trace metals. The labeling program provides information to compost producers and users to determine if the compost they are considering is suitable for the use that they are planning. Reliable information on the quality of compost will help support best use. □

End Notes

[1] Robert Rynk et al., *On-Farm Composting Handbook* (Ithaca, New York: PALS, 1992).

[2] William Darlington, Soil & Plant Laboratory, "Compost – A Guide to Evaluating and Using Compost Materials as Soil Amendments," undated. Available online: http://www.soilandplantlaboratory.com/pdf/articles/CompostAGuideForUsing.pdf.

[3] See http://compost.css.cornell.edu/OnFarmHandbook/apa.taba1.html for tables of characteristics of various feedstocks and http://cwmi.css.cornell.edu/composting.htm for instructions on how to make a compost recipe

[4] See Philly Compost's Neighborhood Compost Map at http://www.phillycompost.com/Map.html for an example of a community mapping project featuring cooperative backyard systems; accessed Sept. 18, 2013

[5] Personal Communication, John Jaimez, Organics & Recycling Specialist, Hennepin County, Minnesota, August 23, 2013

[6] Personal Communication, Seth Burdick, The Dirt Factory, Philadelphia, August 26, 2013 and http://universitycity.org/dirt-factory, accessed Sept. 18, 2013

[7] Personal Communication, Dave Smith, Otter River Farm, Winchendon, Massachusetts, August 1, 2013 and http://blackgoldcompost.net/, accessed Sept. 18, 2013

[8] California Integrated Waste Management Board, Enforcement Agency Notification, Case No. 21-AA-0058, May 2007 and http://www.mcevoyranch.com/the-ranch/farming-practices, accessed Sept. 18, 2013

[9] Katrina Mendrey, "Correctional Facility Composting in Washington State," *BioCycle*, August 2013, p. 32

[10] Coker Composting & Consulting, "Composting Alternatives Evaluation," prepared for the Wasatch Integrated Waste Management District, January, 2012; also personal communication, John Bouey, Managed Organics Recycling, April 4, 2013

[11] Black Bear Composting, http://www.blackbearcomposting.com/, accessed Sept. 20, 2013

[12] Peninsula Compost Group, http://www.peninsulacompostcompany.com/facilities/WORC.html, accessed Sept. 20, 2013

[13] Matt Ewadinger, Brian Rosa, and Tom Rhodes, "Enzyme Producer Grows Greener With Composting," *BioCycle*, December 2006, p. 24

[14] US Environmental Protection Agency, Office of Resource Conservation and Recovery, *Municipal Solid Waste Generation, Recycling, and Disposal in the United States, Tables and Figures for 2012*, February 2014, pp. 3-4.

[15] Tissue, paper towels, paper plates and cups represented 4.7 million tons disposed in 2008. In 2012 2.7 million tons of corrugated cardboard and another 6.4 millions tons of paper packaging were disposed. US EPA. *Municipal Solid Waste Generation, Recycling, and Disposal in the United States, Tables and Figures for 2012*, pp. 19, 24.

[16] Hummel, R., C. Cogger, A. Bary and B. Riley. 2010. Creating high value potting media from composts made with

biosolids and carbon-rich organic wastes. WA DOE publication number 09-07-069 https://fortress.wa.gov/ecy/publications/publications/0907069.pdf

[17] Adhikari, M., K.P. Paudel, N.R. Martin Jr. and W.M. Gauthier, Economics of dairy waste use as fertilizer in central Texas. Waste Manage 25:1067-1074; Paudel, K.P., and C.S. McIntosh. 2005. Country report: Broiler industry and broilet litter-related problems in the southeastern United States. Waste Manage 25: 1083-1088; and Saam, H., J.M. Powell, D.B. Jackson-Smith, W.L. Bland, and J.L. Posner. 2005. Use of animal density to estimate manure nutrient recycling ability of Wisconsin dairy farms. Agric. Sys. 84:343-357.

[18] Paudel and McIntosh, 2005.

[19] "Background: Corn," US Department of Agriculture Economic Research Service web site, http://www.ers.usda.gov/topics/crops/corn/background.aspx#.U0oMKcfrap0.

[20] Fronning, B.E., K.D. Thelen, and D.H. Min. 2008. Use of manure, compost, and cover crops to supplant crop residue carbon in corn stover removed cropping systems. Agronomy J. 100:6: 1703-1710; and Reddy, N., and Y. Yang. 2005. Biofibers from agricultural byproducts for industrial applications. Trends in Biotech. 23:1:22-27.

[21] "Wheat Data: Overview," US Department of Agriculture Economic Research Service web site, http://www.ers.usda.gov/data-products/wheat-data.aspx#.U0oPQ2BxXy9.

[22] Biswas, A., Berfield, J.L., Saha, B.C., Cheng, H.N. 2013. Conversion of agricultural by-products to methyl cellulose. Industrial Crops and Products. 46:297-300.

[23] Dieball, J. 2010. A comparison between cornstalk and soybean straw for bedding used for hogs and their relative nutrient value for fertilizer. Greenbook. Minnesota Department of Agriculture. Sustainable Agriculture and IPM Program http://www.mda.state.mn.us/protecting/sustainable/greenbook/~/media/Files/protecting/sustainable/greenbook2010/gb2010-dieball.ashx

[24] North East Biosolids & Residuals Association, http://www.nebiosolids.org.

[25] Loop, Turn Your Dirt Around
See website http://www.loopforyoursoil.com

[26] U.S. Department of Agriculture, Natural Resource Conservation Service, Conservation Practice No. 317, Composting Facility, May 2002

[27] Environment Canada, "Technical Document on Municipal Solid Waste Organics Processing," 2012, p. 5-13

[28] Vertical bioreactors are rarely used anymore due to difficulties maintaining aerobic conditions in a large vertical mass of composting organics

[29] WormMainea web site, http://wormmainea.blogspot.com/2010/05/building-raised-bed.html, May 8, 2010.

[30] "Worms Produce Another Kind of Gold for Growers," *New York Times*, Dec. 31.2012

[31] Van Opstal, B. "Evaluating AD System Performance for MSW Organics," *BioCycle*, Vol. 45, No. 11, November 2006, p. 35-39, and "Managing AD System Logistics for MSW Organics," *BioCycle*, Vol. 45, No. 12, December 2006, p. 39-43.

[32] "High Solids Anaerobic Digestion + Composting In San Jose," *BioCycle*, March/April 2014, Vol. 55, No. 3, p. 42; "Solid Waste District Pilots Dry Fermentation Digester, November 2013, Vol. 54, No. 11, p. 32.

[33] Gershman,Brickner & Bratton/Coker Composting & Consulting, "Draft Compost Facility Plan", prepared for Detroit Shoreway Community Development Organization, October 2013

[34] Mr. Adam Brent, CEO, Cocoa Corp., personal communication, January 23, 2014. Mr. Brent has recently secured $2.5m in start-up capital financing for his new composting facility and company in MI.

[35] Mr. Josh Truehart, Lower East Side Ecology Center, personal communication, August 20, 2013

[36] Mr. Cory Ballew, Hill City Garden and Compost, personal communication, August 23, 2013

[37] Mr. Ken Newman, Managing Member, Royal Oak Farm LLC, personal communication, January 31, 2013

[38] Bobby Elliott and Dan Leif, "Portland Scales Back on Commercial Organics Program," *Resource Recycling*, April 9, 2014.

[39] "Micro-Plastics in Compost: Environmental Hazards of Plastic-Coated Paper Products," Woods End Laboratories & Eco-Cycle, 2011. Available online at https://www.ecocycle.org/specialreports/microplasticsincompost.

[40] California Agricultural Briefing, 2002. Composters sue Dow AgroSciences over contamination with clopyralid http://subscript1.bna.com/pic2/caag.nsf/id/RSAR-5HUJH2?OpenDocument

[41] US Composting Council, Position Statement: Persistent Herbicides, 2013. http://compostingcouncil.org/persistent-herbicides/.

[42] "Food Waste Composting: Institutional and Industrial Applications," University of Georgia (UGA) College of Agriculture and Environmental Sciences, accessed October 2013, http://www.caes.uga.edu/publications/pubDetail.cfm?pk_id=6288

[43] Personal communication, Rick Lee, Blessing Greenhouses and Compost Facility, February 2013.

[44] Composting Council Research and Education Foundation, A Watershed Manager's Guide To Organics: The Soil And Water Connection (1997).

[45] UGA College of Agriculture and Environmental Sciences, Op. Cit.

[46] Webinar: "Measuring the Economic Impact of Organics Diversion and Product Manufacturing," Al Rattie, United States Composting Council (USCC) Director of Market Development, March 2013.

[47] "Why Build Healthy Soil," Washington Organic Recycling Council (WORC), accessed October 2012, http://soilsforsalmon.org/why.htm and Washington State Department of Ecology, *2012 Stormwater Management Manual for Western Washington* (2012), 5-8, accessed October 2013, https://fortress.wa.gov/ecy/publications/publications/1210030.pdf

[48] "Low Impact Development," Low Impact Development Center, accessed October 2013, http://www.lowimpactdevelopment.org/
[49] "Low Impact Development Technologies," National Institute of Building Sciences Whole Building Design Guide, accessed October 2013, http://www.wbdg.org/resources/lidtech.php
[50] WORC, Op. Cit.
[51] Composting Council Research and Education Foundation, A Watershed Manager's Guide To Organics: The Soil And Water Connection (1997).
[52] WORC, Op. Cit.
[53] Personal communication, Rod Tyler, Filtrexx International, January 2013.
[54] Personal communication, Rod Tyler, Filtrexx International, LLC, January 2013.
[55] "Buy-Compost.Com," United States Composting Council (USCC), accessed October 2013, http://buycompost.com/
[56] Ibid.
[57] "Silviculture Program," Minnesota Department of Natural Resources, accessed October 2013, http://www.dnr.state.mn.us/forestry/ecs_silv/index.html
[58] "Silviculture Applications With MSW Compost," *BioCycle,* October 2005
[59] "Tree Planting Statistics for the United States," About.com, accessed September 2013, http://forestry.about.com/cs/treeplanting/a/tree_plt_stats.htm
[60] USCC, *Field Guide to Compost Use* (2001) available online at http://compostingcouncil.org/admin/wp-content/plugins/wp-pdfupload/pdf/1330/Field_Guide_to_Compost_Use.pdf
[61] Ibid., p. 20
[62] Ibid., p. 34
[63] Ibid., p. 38
[64] Ibid., p. 42
[65] "Using Compost on Athletic Fields,"The Ohio State University, accessed September 2013, http://buckeyeturf.osu.edu/index.php?option=com_content&view=article&id=648&catid=1:latest-news&Itemid=170
[66] Ibid.
[67] "Compost Use On Athletic Fields And Golf Courses,"*BioCycle,* October 2013, p. 30
[68] Ibid.
[69] Bolan, N.S., A. Kunhikrishnan, and R. Naidu. 2013. Carbon storage in a heavy clay soil landfill site after biosolids application. Sci. Tot. Environ. 465:216-225.
[70] Brown, S. and M. Cotton. 2011. Changes in Soil Properties and Carbon Content Following Compost Application: Results of On-farm Sampling. Compost Sci. Util. 19:88-97.
[71] Brown, S., A. Carpenter, and N. Beecher. 2010. Calculator tool for determining greenhouse gas emissions for biosolids processing and end use. Environ. Sci. & Tech. 44: 9505-9515.
[72] Fronning, B.E., K.D. Thelen, and D.H. Min. 2008. Use of manure, compost, and cover crops to supplant crop residue carbon in corn stover removed cropping systems. Agronomy J. 100:6: 1703-1710.
[73] Shrestha, R.K., R.Lal, and B. Rimal. 2013. Soil carbon fluxes and balances and soil properties of organically amended no-till corn production systems. Geoderma 197-8: 177-185.
[74] Spargo, J.T.; Alley, M.M.; Follett, R.F.; Wallace, J.V. Soil carbon sequestration with continuous no-till management of grain cropping systems in the Virginia coastal plain. *Soil Till. Res.* 2008,100:133-140.
[75] Sukkariyah, B.F.; Evanylo, G.; Zelazny, L.; Chaney, R.L. Cadmium, copper, nickel, and zinc availability in a biosolids-amended Piedmont soil years after application. *J. Environ. Qual.* 2005, 34:2255-2262.
[76] Tian, G.; Granato, T.C.; Cox, A.E.; Pietz, R.I.; Carlson, Jr., C. R.; Abedin, Z. Soil carbon sequestration resulting from long-term application of biosolids for land reclamation. *J. Environ. Qual.* 2009, 38:61-74.
[77] Trlica, A. and S. Brown. 2013. Greenhouse gas emissions and the interrelation of urban and forest sectors in reclaiming one hectare of land in the Pacific Northwest. Environ. Sci. Technol., 2013, 47 (13), pp. 7250–7259.
[78] Brown et al., 2010; Trlica and Brown, 2013.
[79] Allen, H.L., S.L. Brown, R. Chaney, W.L. Daniels, C.L. Henry, D.R. Neuman, E. Rubin, J.A. Ryan, and W. Toffey. 2007 The use of soil amendments for remediation, revitalization and reuse US EPA EPA 542-R-07-013.
[80] Brown, S., M. Sprenger, A. Maxemchuk and H. Compton. 2005. An evaluation of ecosystem function following restoration with biosolids and lime addition to alluvial tailings deposits in Leadville, CO. J. Environ. Qual. 34:139-148.
[81] Pepper, I.L.; Zerzghi, H.G.; Bengson, S. A.; Glenn, E.P. Revegetation of Copper Mine Tailings Through Land Application of Biosolids: Long-Term Monitoring. *Arid Land Res. Manage.* 2013, *27*:3:245-256.
[82] Roberts, J.A.; Daniels, W.L.; Burger, J.A.; Bell, J.C. Early stages of mine soil genesis as affected by topsoiling and organic amendments. *Soil Sci. Soc. Am. J.* 1988, *52*:3:730-738.
[83] Sopper, W.E. *Municipal sludge use in land reclamation*. Lewis Publ.: Chelsea, MI, 1993.
[84] Trlica and Brown, 2013, Op. Cit.
[85] Brown et al., 2010, Shrestha et al., 2013; Spargo et al., 2008; Sukkariyah et al., 2005, Tian et al., 2009; Trlica and Brown, 2013, Op. Cit.
[86] DeLonge, M.S., R. Ryals, and W.L. Silver. 2013. A lifecycle model to evaluate carbon sequestration potential and greenhouse gas dynamics of managed grasslands. Ecosystems. 16: 963-979.
[87] Fronning et al., 2008, Op. Cit.
[88] Spargo et al., 2008, Op. Cit.
[89] Brown, S., C. Cogger, and E. Miltner. 2012. Soil carbon sequestration potential in urban areas. p. 173-196. In R. Lal and B. Augustin (ed.) Carbon Sequestration in Urban Ecosystems. Springer, Berlin.
[90] Charlesworth, S.M., E. Nnadi, O. Oyelola, J. Bennett, F. Warwick, R. Jackson, and D. Lawson. 2012. Laboratory

based experiments to assess the use of green and food based compost to improve water quality in a Sustainable Drainage (SUDS) device such as a swale. Sci. Total. Environ. 424:337-343.

[91] UGA College of Agriculture and Environmental Sciences, Op. Cit.

[92] Ibid.

[93] Bob Barrows, "Briefing Paper: Best Management Practices for Discarded Food Scraps," Oregon Department of Environmental Qualify, November 2011. http://www.deq.state.or.us/lq/pubs/docs/sw/2050vision/BriefingPaperDiscardedFoodScraps.pdf

[94] Laurel E. Rowse, "Design of Small Scale Anaerobic Digesters for Application in Rural Developing Countries," thesis submitted, College of Engineering, University of South Florida, November 2011. http://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=4519&context=etd

[95] City of Austin, Resource Recovery Department, The Austin Resource Recovery Master Plan, December 11th, 2011. pp. 105-106. Available online: http://www.austintexas.gov//sites/default/files/files/Trash_and_Recycling/MasterPlan_Final_12.30.pdf

[96] Ibid, p. 107.

[97] Ron Alexander, "Strategies for Increasing the Value of Biosolids Compost," R. Alexander Associates, Inc., Apex, North Carolina, 2004. http://www.alexassoc.net/articles/Compost%20End%20Use/WEF%20Increasing%20Dollar%20Value.pdf.

[98] Ibid.

[99] Ron Alexander, "Commercialization and Marketing of Compost," presentation March 14, 2012. http://www.recyc-quebec.gouv.qc.ca/Upload/publications/Mici/j-matorg-14-mars-2012/4a-Ron-Alexander.pdf.

[100] Ron Alexander, "Strategies for Increasing the Value of Biosolids Compost."

[101] "Marketing Composts and Meeting Consumer Needs," Compost Fact Sheet #1, Cornell Waste Management Institute, Department of Crop and Soil Sciences, Cornell University. 2004/2005/. http://cwmi.css.cornell.edu/compostfs1.pdf

[102] Ibid.

[103] Ibid.

[104] For more information, see USCC's Seal of Testing Assurance web site at http://compostingcouncil.org/seal-of-testing-assurance/.

Section

2

Why Compost?

Overview of Drivers for Composting and Composting More

Unsustainable patterns of wasting drive climate change, resource depletion, habitat destruction, and a range of other environmental crises. The US disposes of 164 millions tons of garbage per year. Of this, 21% represents food scraps, 9% is yard trimmings, and another 9% is wood material. The lion's share was landfilled (135 million tons).[1] When landfilled, biodegradable organic materials are a liability as they break down and produce methane, a greenhouse gas 72 times more potent than carbon dioxide in its global warming strength (over a 20 year time horizon).[2] Shifting toward a decentralized recycling infrastructure addresses these environmental threats and forms the basis for strong local economies that operate in harmony with nature.

At the same time we throw away valuable organic materials, our soils suffer from topsoil loss and erosion, which in turn leads to severe watershed problems and threatens our ability to sustain life on earth. Excess fertilizers from farms and suburban lawns, and sediment from construction projects wash off the land and into our waterways every time it rains. Soil erosion also reduces the ability of soil to store water and support plant growth.

The good news is that many of these problems can be mitigated by expanding the use of compost, which adds needed organic matter to soil, improves plant growth, cuts water use, reduces reliance on chemicals, and helps prevent nutrient-runoff and soil erosion. In short, advancing composting and compost use is a key sustainability strategy to create jobs, protect watersheds, reduce climate impacts, improve soil vitality, and build resilient local economies.

Key Drivers

Key drivers for expanding composting and other forms of organic material recovery are summarized below:

Feeding the Hungry

Much of what we set out at the curb is edible food that can be rescued. In the US, 31% – or 133 billion pounds – of the available food supply at the retail and consumer levels in 2010 went uneaten.[3] Another study found that a shocking 40-50% of all food ready for harvest never gets eaten.[4] This is especially disturbing given that nearly 50 million Americans, including 16 million children, are food insecure, meaning they lack access to enough food for an active, healthy life.[5] Composting programs can be aligned with efforts to reduce food waste and rescue edible food. There is a vigorous national movement committed to food rescue, whether harvesting surplus or unmarketable crops from farmers' fields (gleaning), diverting excess food from restaurants and catered events, or recovering food that may not be saleable because it is bruised, blemished, or past its "sell by" date. Food rescue simultaneously addresses issues of waste and poverty, offering fresh food to those in need.

Resources Dedicated to Food That Never Gets Eaten in the US

- 25% of all freshwater used in the US
- 4% of total US oil consumption
- $750 million per year in disposal fees
- 33 million tons of landfill waste

Source: Food Waste Reduction Alliance, Best Practices & Emerging Solutions Toolkit, Spring 2014, Volume 1.

Enriching and Building Healthy Soil

Compost adds needed organic matter to soil, prevents soil erosion, sequesters carbon in soil, improves plant growth, reduces agricultural water use by 10%, and reduces reliance on chemical pesticides and fertilizers.

Strengthening Sustainable Food Production and Completing the Food Cycle

Locally produced compost is a valuable soil amendment for local food production and cycles food scraps back to the soil.

Increasing Demand for Green Infrastructure

Green building design is driving low-impact development (LID) management practices that combine native soil, compost, plants, and beneficial microorganisms to filter, retain, and infiltrate stormwater runoff from developed construction sites.

Creating Green Jobs and Sustaining Local Manufacturing Businesses

Composting sustains more jobs than disposal facilities on a per-ton basis. Compost facilities manufacture soil amendments. Many of the jobs have low barriers to entry.

Reducing Solid Waste Management Costs

Transportation costs to and tip fees at compost facilities are often lower than landfills and incinerators, saving the private and public sector money. Food scraps are one of the largest and heaviest portions of the waste stream making their recovery increasingly cost-effective compared to disposal.

Curbing Landfill Methane Emissions and Sequestering Carbon

Landfills are a top source of methane, a greenhouse gas many times more potent than carbon dioxide. Biodegradable materials are a liability when landfilled but a valuable asset when composted. When added to soil, compost sequesters carbon.

Producing Renewable Energy Via Anaerobic Digestion

Anaerobic digestion of segregated organics generates biogas, a renewable fuel. Unlike trash combustion technologies, anaerobic digestion is a microbiological process that the environmental community supports. It is compatible with composting. Appendix C describes systems available and examples of operating sites.

Figure 2-1: The Red Hook Community Farm in Brooklyn, NY, accepts and processes food scraps as part of the NYC Compost Project. It is home to New York City's largest community based compost program run entirely by renewable resources of human or solar power. The compost program processes over 225 tons per year of organic material, and runs a job training program for unemployed young people living in public housing. The Farm is run by Added Value, a non-profit that uses composting and food production as a platform to empower community youth and connect them to broader, universal environmental justice issues such as climate change.

Photo credit: Red Hook Community Farm

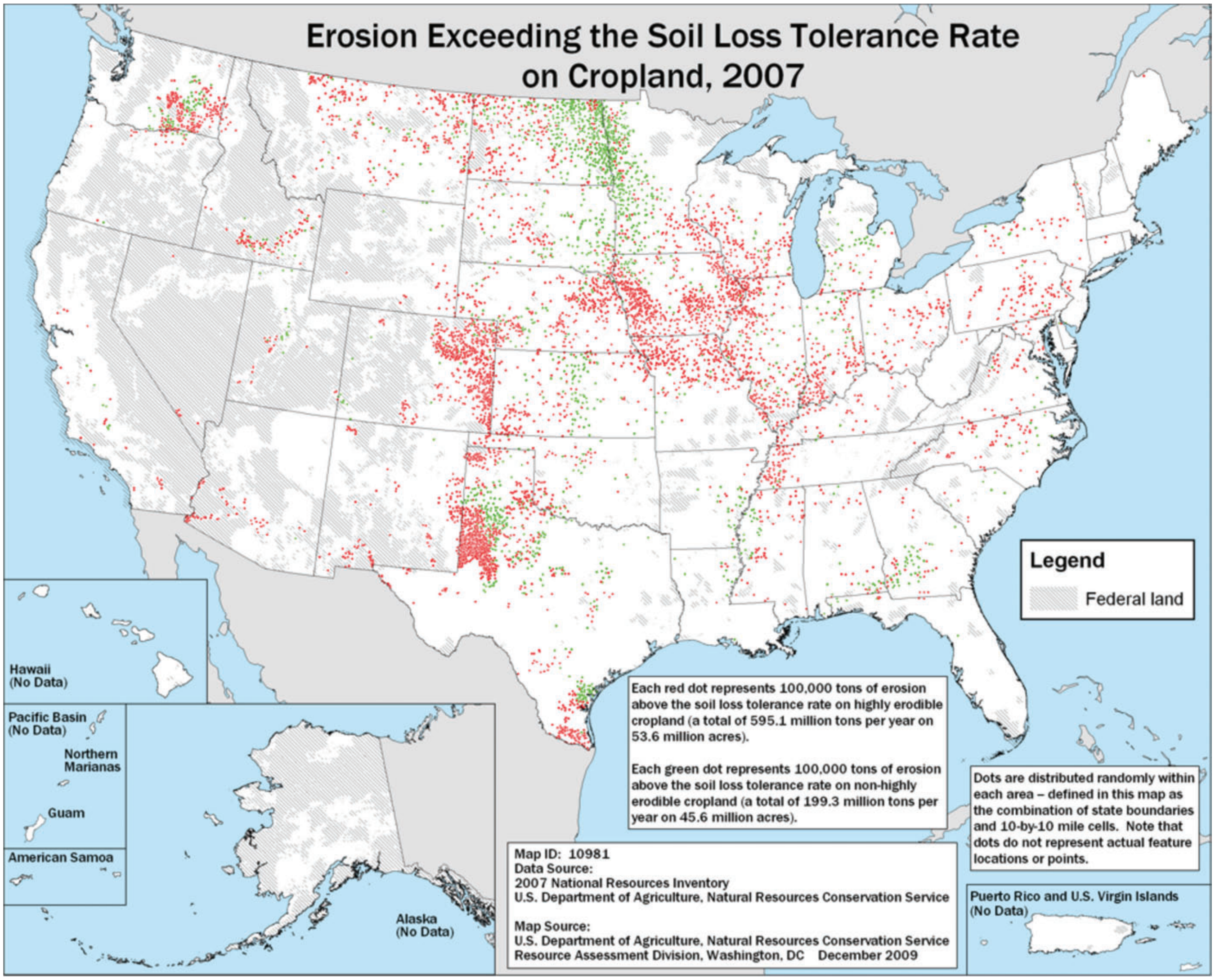

Figure 2-2: In 2007, the latest published data, 99 million acres (28% of all cropland) were eroding above soil loss tolerance rates.

Source: 2007 National Resources Inventory – Soil Erosion on Cropland, Natural Resources Conservation Service, April 2010, p. 4

Increasing Regulations at the Local and State Levels

The number of cities, counties, and states with goals and regulations impacting food waste is growing. Some cities such as San Francisco have made participation in source-separated organics collection programs mandatory. New York City passed a law effective July 2015 that will require large foodservice establishments to recover food waste. Several states – Massachusetts, Connecticut, and Vermont – are now requiring commercial food waste generators to divert organics from disposal. Dozens of cities have restricted the use of polystyrene in foodservice ware in favor of compostable products.

Compost to Improve Soil

Most of the planet is not living. There is only a thin layer of the Earth – its soil – where life is possible. Soil is a living ecosystem and vital to human survival. One-third of the world's arable land has been lost to soil erosion and continues to be lost at an alarming rate.[6] In the US, 99 million acres (28% of all cropland) are eroding above soil tolerance rates, meaning the long-term productivity of the soil cannot be maintained and new soil is not adequately replacing lost soil.[7] See Figure 2-2. Erosion reduces the ability of soil to store water and support plant growth. About 60% of soil that is washed away ends up in rivers, streams and lakes, contaminating waterways with fertilizers and pesticides. Nationally, soil is being swept and washed away 10 to 40 times faster than it is being replenished, destroying acres of cropland, despite the fact that the need for food and other agricultural products continues to grow.[8] The economic impact of soil erosion is enormous. Our soils are now starved for organic matter. When topsoil is lost, nutrients and organic matter needed by crops and vegetation are removed along with it because erosion tends to remove the less dense soil constituents such as organic matter, clays, and silts that are often the most fertile part of the soil.[9] Of particular concern is the trend to-

Figure 2-3: Soil erosion in the Red Bayou watershed, Caddo Parish, LA.

Photo credit: Natural Resources Conservation Service

ward more extreme weather patterns – droughts and heavy rainfall – that are now exacerbating soil erosion. A Soil and Water Conservation Society study concluded that conservationists should be seriously concerned about the implications of climate change for the conservation of soil and water resources in the US.[10] While there are a number of soil conservation strategies such as conservation tillage, contour farming, cover crops, and wind breaks, increasing the level of organic matter is vital to soil quality. The best way to increase the organic matter in soil is to amend it with compost. Amending soil with compost improves soil's ability to retain water and thus avoid soil erosion.[11]

Improved Soil Quality and Structure

Compost improves soil quality and structure. Compost's organic matter is the catalyst for the overall health of the entire soil ecosystem. Organic matter can be considered the soil's fuel source, as billions of microorganisms feed on it. This microbial process produces room for stormwater infiltration, drainage, and moisture-holding capacity and a strong, stable soil structure.[12] These passageways and a higher bulk density also allow plant roots to establish and expand.[13] This is particularly important for disturbed and compacted soils where compost amendment rejuvenates degraded soils to native-like conditions, providing food and shelter for these beneficial organisms, and "restarting the soil ecosystem."[14] Because soil organic matter consists of 10 to 1,000 times more water and nutrients than soil minerals, the many microbes and organisms can thrive.[15] In addition, compost makes the soil more fertile for plant growth by controlling pH levels, increasing buffering capacity against pH change. Research also shows that the type of organisms found in compost can curtail soil-borne diseases and plant pathogens like pythium and fusarium as well as nematodes.[16]

Figure 2-4: The documentary movie Symphony of the Soil explains the importance of soil to life and features composting as a strategy for building soil fertility and health.

Source: www.symphonyofthesoil.com

Erosion and Sedimentation Control

Using compost as a soil amendment significantly reduces erosion and sedimentation. This is in large part attributed to a material in compost called humus. Humus functions as a glue that keeps soil particles stuck together and resilient to eroding forces. Thus, adding compost to existing soil changes its properties, improving its binding ability.[17] As the soil properties are altered, the surface structure becomes stabilized and "less prone to crusting and erosion."[18] Best management practices recommend amending landscape beds with a minimum organic matter content of 10% dry weight (or 30-40% by volume of compost), and turf grasses with a minimum organic matter content of 5% dry weight (equivalent to 15-25% by volume of compost).[19] Mixing in the proper amount of compost into native soils provides resistance to erosion and min-

Figure 2-5: The Montgomery County, MD RainScapes Rewards Rebate program requires 3 inches of compost for its conservation landscape projects, incorporated to create a 6-12 inch improved soil layer.

Photo credit: Montgomery County Department of Environmental Protection

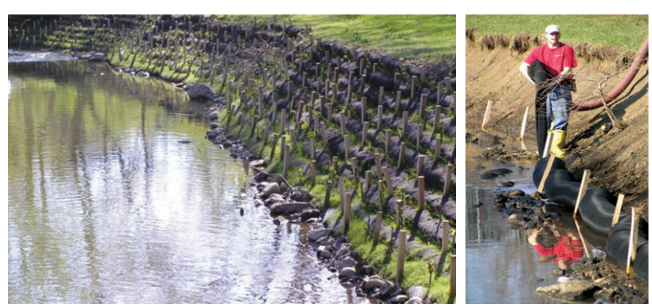

Figure 2-6: MCS Inc. streambed restoration project using compost.

Photo credit: MSC Inc., www.mcsnjinc.com imizes sediment-carrying runoff by as much as 50%. In addition to soil stabilization, the improved soil structure enables greater infiltration, capturing water runoff and sediment.[20]

Improved Water Retention

The high organic matter content in compost (40-60%) increases water infiltration rates and the soil's ability to retain water.[21] Microbial organisms in the soil create pore spaces for air and water, increasing permeability and storage capacity. Furthermore, the same binding properties in humus that reduce erosion retain water as well. Compost can hold three to five times its weight in water.[22] It can also "increase water storage by 16,000 gallons per acre foot for each 1 percent of organic matter."[23] This allows rainwater that would normally be lost through evaporation or runoff to remain in and replenish ecosystems. Thus, integrating compost into existing or rebuilt landscapes lowers irrigation requirements (by up to 50% in the summer) and runoff rates, which are typically higher in developed zones.[24] Compared to other soil amendments, research also indicates that compost has a higher absorption and storage rate than raw manure, anhydrous ammonia, and commercial fertilizer.[25]

Reduced Chemical Needs (Fertilizers, Pesticides, Fungicides)

Because the type and amount of organic matter present in the soil impacts plant health, compost can reduce the need to use fertilizers and pesticides.[26] First, the improved cation exchange capacity (CEC) of compost makes nutrients available to plants over a much broader range of pH than soils without compost.[27] Amending soil with compost creates a controlled, slow-release of phosphorous, potassium, sulfur and various other "micronutrients" that are critical to plant survival. These nutrients are also less likely to be lost through leaching as the stable organic matter in compost steadily allows plants to take what they need.[28] This offers low-maintenance attractive landscapes for home and property owners while reducing polluted runoff. In sum, an active sub-soil food web and reduced soil compaction create an overall healthy ecosystem, resulting in fewer required chemicals.[29]

Compost to Protect Watersheds

By improving soil ecosystems, compost can help states meet total maximum daily load (TMDL) limits.[30] In an effort to restore impaired water bodies throughout the country, the federal Clean Water Act requires states to develop TMDLs (i.e. the maximum amount of a pollutant that a water body can receive and still meet state water quality standards) as part of their Watershed Implementation Plans (WIPs).[31] In 2010 the US Environmental Protection Agency established, for example, the Chesapeake TMDL, a historic and comprehensive "pollution diet" and largest TMDL ever established.[32] Because most of the Chesapeake Bay and its tidal waters are impaired due to excess nutrient pollution and sedimentation,

Figure 2-7: A tubular check dam made from compost intercepts stormwater to slow the flow velocity, while filtering sediment and pollutants. The water below the check dam is noticeably clearer and cleaner.

Photo credit: Filtrexx International LLC

Figure 2-8: The above bioswale is a shallow landscape depression or channel used to convey, slow, and filter stormwater. Bioswale installations use organic matter and vegetation to create low-impact development (LID) that can serve as pre-treatment or post-treatment for stormwater containment systems while reducing runoff volume and peak flows.

Photo credit: Filtrexx International LLC

the Chesapeake TMDL is designed to achieve significant reductions in nitrogen, phosphorous, and sediment. Specifically, the Chesapeake TMDL mandates a 25% reduction in nitrogen, a 24% reduction in phosphorous, and a 20% reduction in sediment by the year 2025. Restoring the Bay watershed to meet these targets requires effective non-point source pollution control. Runoff from agricultural, urban and suburban lands carries nutrients, sediment and other pollutants to local waterways, causing eutrophication and harming aquatic life.[33] Integrating compost and compost-based products into the region's soils is an effective way to protect the watershed, while providing a number of additional benefits such as promoting higher crop yields, reducing greenhouse gases through carbon sequestration, diverting discarded biodegradable material from the waste stream, and creating "green" jobs.

Although compost itself contains some nitrogen and phosphorous, it can mitigate nutrient problems by preventing soil erosion and runoff in the first place, and by converting nitrogen into a more stable and less mobile form and phosphorous

Figure 2-9: (left) Compost blanket being applied to steep roadway embankment, (right) Vegetation thriving after installation.

Photo credit: Denbow, www.denbow.com

into a less soluble form. Compost's pollution reduction qualities led the US EPA to include compost-based strategies on its National Pollution Discharge Elimination System menu of stormwater best management practices.[34]

One of compost's greatest benefits is its ability to treat nonpoint source pollution. Compost can manage nutrient stormwater and agricultural runoff by serving as a filter and sponge. Its high porosity and permeability allow contaminated stormwater to infiltrate at much higher rates than most existing soils, especially those compacted via human development.[35] Once in compost-amended soil, toxins and pollutants begin to break down. Compost immobilizes and degrades pollutants, improving water quality and has the ability to bind heavy metals, pesticides, herbicides, and other contaminants, reducing both their leachability and absorption by plants.[36] Biofiltration media like compost reduces contamination of urban pollutants by an astounding 60 to 95%.[37]

Amending soils with compost, and implementing compost-based green infrastructure practices yield significant cost savings. One study indicated that under a 3-inch/24-hour period storm, a typical 10-acre development with a compost blanket (i.e. a layer of loosely applied compost) would reduce runoff volume as compared to an impervious site and avoid $181,428 per year in water treatment costs. If the runoff was treated on-site with a stormwater management pond, the compost blanket application equates to a cost reduction of $697,800, avoiding the need for a larger pond to accommodate an increased volume of water. These savings are attributed to the significantly lower curve number (CN) of the compost blanket. A curve number is a value attributed to a given watershed surface based on the percentage of runoff volume generated from rain falling on that surface. Impervious surfaces produce a high volume of runoff and therefore have high CNs (CN 98) as compared to the compost blanket which helps mimic a natural surface, thus producing a much lower runoff volume and curve number (CN 55) while reducing pollutant load as well. This can also produce more "fiscally sound municipal governments realizing tax collection gains from increased land values and lower water treatment costs."[38] Many other compost products can reduce the cost of erosion and overburdened stormwater management systems – a cost totaling $44 billion each year in America.[39]

Compost to Protect the Climate

Compost protects the climate in two main ways: it sequesters carbon in soil and it reduces methane emissions from landfills by cutting the amount of biodegradable materials disposed.

Methane is one of the most powerful greenhouse gases. Despite its relatively short life span (12 years) in the atmosphere, the global warming potential of methane over a 20-year time frame is 72 times more potent than carbon dioxide.[40] Thus, reductions of methane emissions can produce significant and immediate progress on meeting short-term greenhouse gas reduction targets.

A significant source of methane is landfill gas generated by the decomposition of organic and biodegradable discards, such as food scraps. Landfill gas is 55% methane with carbon dioxide making up the rest. In 2012 methane represented 9% of greenhouse gas emissions in the US with landfills producing 18% of that amount and manure management contributing another 9%.[41] The California Air Resources Board estimates that landfill gas accounts for 1.5% of California's net greenhouse gas emissions, and manure management, 2.3%.[42] But because of methane's potency, its impact in the short-term is much larger as a share of emissions.

Figure 2-10: ILSR's 2008 report, Stop Trashing the Climate, called for the practice of landfilling and incinerating biodegradable materials such as food scraps, paper products, and yard trimmings to be phased out immediately in order to protect the climate and restore soils.

Credit: Institute for Local Self-Reliance

Much attention is devoted to capturing landfill methane, but not nearly enough on preventing biodegradable materials from entering landfills in the first place. Landfill methane gas capture systems are not an effective technique for preventing the release of methane into the atmosphere. The Intergovernmental Panel on Climate Change acknowledges that over the lifetime of a landfill, gas capture rates could be as low as 20%.[43]

Biological treatment systems such as composting and anaerobic digestion are a win-win alternative to landfilling. Composting not only avoids landfill methane emissions, but also sequesters carbon, improves plant growth, increases the organic matter in soil, and reduces water use by 10% (thus cutting energy required for irrigation). It also reduces the need for fossil-fuel based fertilizers, the production of which contributes significantly to greenhhouse gas emissions. Half of the energy used in agriculture is for making chemical nitrogen fertilizers.[44] All of these benefits will be increasingly relevant in combating climate change. Furthermore, composting has the advantage of being easily implemented on a wide scale within 5 to 10 years.

The top 3.2 feet of the world's soil stores more than three times the amount of carbon held in the atmosphere, two-thirds of which is in the form of organic matter.[45] Soils, however, can release carbon and greenhouse gases to the atmosphere due to unsustainable land management practices, degradation, and decomposition.[46] Incorporating soils with compost, a natural product rich with organic matter, performs many beneficial functions such as improved soil structure and reduced erosion that stabilize and rebuild soil health to inhibit the negative effects of poor, degraded soils, and thus, excessive carbon release.[47]

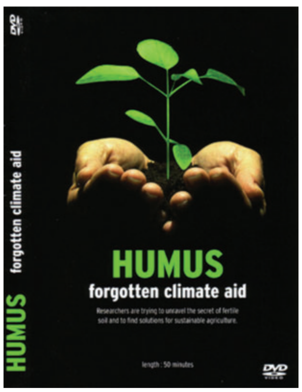

Figure 2-11: The documentary film Humus: Forgotten Climate Aid highlights the connection among soil quality, agriculture, and climate change. See trailer: http://www.c2c-centre.com/library-item/humus.

As the section on Markets and Applications for Compost notes, there is a significant and growing body of evidence that demonstrates the effectiveness of compost to store carbon in soil for a wide range of soil types and land uses. The rate of carbon stored per dry ton of amendment will vary based on the loading rate of amendment, the local climate, and the extent of soil disturbance. Rates ranging from 0.1 to over 1 ton of CO_2 per ton of amendment applied have been reported.[48] The Marin Carbon Project, based in California, for instance, found that rangelands amended with compost could result in significant offsets to greenhouse gas emissions, amounting to over 28 MMg CO_2e when scaled to 5% of California rangelands.[49]

Carbon Credits

Compost's ability to offset greenhouse gas emissions is recognized by carbon credit trading platforms. To tackle the global issue of climate change, carbon credits can now be bought and sold. Carbon credits are credits that rural landowners and others can receive (and then sell for cash payments) by implementing strategies that reduce or offset their carbon emissions. The Climate Action Reserve serves the North American carbon market and establishes standards for carbon offset projects, oversees independent third-party verification bodies, issues carbon credits generated from such projects, and tracks the transaction of the credits over time in a transparent, publicly-accessible system.[50] The Reserve adopted an Organic Waste Composting Project Protocol in June 2010. This protocol, last updated July 2013, provides a standardized approach for quantifying and monitoring the greenhouse gas reductions from projects that offset landfill methane emissions by composting food discards and food soiled paper.[51] (Yard trimmings composted do not qualify as yard trimmings composting is considered already to be common practice.) In March 2014, the Zanker Road Resource Management compost site was one of three recipients of the Climate Action Reserve's Project Developer Awards.[52] This project, located near Gilroy, California, has reduced 42,649 metric tons of carbon dioxide equivalent emissions by composting food and food soiled paper waste.

Other countries have recognized the benefit of composting to store carbon and reduce greenhouse gas emissions. In Australia, the Parliamentary Secretary for Climate Change and Energy Efficiency has authorized the *Carbon Farming Initiative, Avoided Emissions from Diverting Legacy Waste through a Composting Alternative Waste Technology)*. The initiative "enables the crediting of greenhouse gas abatement in the land sector…achieved by either reducing or avoiding emissions or by removing carbon from the atmosphere and storing it in soil or trees."[53]

In North America, amending soil with compost does not yet receive carbon credits. The Climate Action Reserve has been evaluating opportunities to develop carbon offset pro-

Marin Carbon Project

Established in response to the rapid pace of global climate change, the Marin Carbon Project (MCP), based in Marin County, California, focuses on enhancing carbon sequestration in rangeland, agricultural, and forest soils. Project leaders are working towards a goal of stopping and reversing climate change by helping farmers, landowners, and land managers adopt carbon farming. This is a farming method that implements practices (e.g. composting and amending soils with compost) to increase the rate at which carbon dioxide is removed from the atmosphere and converted to plant material and/or soil organic matter, thus, curtailing conventional agricultural practices that accelerate carbon dioxide emissions to the atmosphere (such as tractor driving, tilling, and grazing). Recently, MCP's Implementation Task Force launched its soil carbon program on three demonstration farms, applying compost to nearly 100 acres of rangeland on these farms. The team intends to create a scalable model that can be adapted in the region, the western US and throughout the country.

Source: Marin Carbon Project, www.marincarbonproject.org

Figure 2-12: In 2013 the Marin Carbon Project launched "carbon farming" on three farms in West Marin, CA. After performing extensive baseline soil sampling and rangeland assessment, almost 4,000 cubic yards of compost was applied to nearly 100 acres of rangelands.

Credit: Marin Carbon Project, www.marincarbonproject.org

tocols for activities that increase or avoid loss of organic carbon stored in soils. For instance, in 2010 it evaluated but elected not to pursue a possible protocol for crediting soil carbon sequestration associated with the application of biochar. In 2011, it started but has since suspended exploring a cropland management project protocol. A Forest Project Protocol was adopted in November 2012 that includes a methodology to account for net soil carbon emissions and sequestration in forests. This work may help inform future development of soil carbon protocols for non-forest projects.[54]

With approximately 22% of the US comprising agricultural land and 25% forested, the potential for improved carbon sequestration is enormous if programs like MCP are replicated across the country.[55] As of 2013, MCP has developed a protocol pending approval to qualify their program for carbon credits, a protocol it hopes others can use in California and around the world.[56] Carbon credit exchange may be a critical step in the transition toward increased compost use and carbon sequestration as a climate change strategy. One pertinent positive, as underscored by the European Union's European Commission, is that carbon sequestration is not a difficult process to undertake: "the technique is cost competitive and immediately available, requires no new or unproven technologies, and has a mitigation potential comparable to that of any other sector of the economy."[57] Global powers like the EU have realized that healthy "soil plays a huge role in climate change, because even a tiny loss of 0.1% of carbon emitted into the atmosphere from European soils is the equivalent to the carbon emission of 100 million extra cars on our roads." In the US, promoting carbon sequestration through the use of compost-amended soils provides a ripe opportunity for America to drive expansion of the composting industry (reaping its economic and environmental benefits) while also taking a global leadership role it has yet to assume in the fight against climate change.

Compost to Reduce Waste

Almost half the materials Americans discard – food scraps, yard trimmings, and soiled paper – is compostable. While 58% of the 34 million tons of yard trimmings are recovered for composting, the recovery level for the 36 million tons of food scraps remains low at only 4.8%.[58] Figure 2-13 shows the origins of food waste disposed in the US. Commissioned by the Food Waste Reduction Alliance – an initiative launched by the Grocery Manufacturers Association, the Food Marketing Institute and the National Restaurant Association, this data indicates that the residential sector accounts for 47% of all food waste disposed, followed by the restaurant sector at 37%. Municipal and county government, and private food scrap generators increasingly recognize the importance of diverting food scraps from disposal to reach recycling goals and manage solid waste handling costs. More than 180 communities have now instituted residential food scrap collection programs, up from only a handful a decade ago.[59] Countless supermarkets, schools, restaurants, and other businesses and institutions are also source separating their food scraps for composting.

San Francisco has the largest, most established urban organics recovery program in the US. The program serves both the commercial and residential sectors, which together generate over 600 tons of food scraps and other organic materials each day. The City has adopted a zero waste goal by the

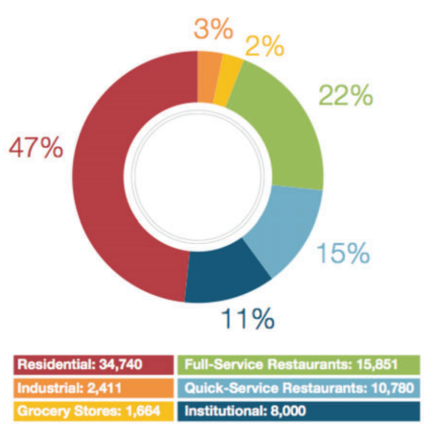

Figure 2-13: Where Food Waste Disposed Originates

Source: BSR data as reported in the Food Waste Reduction Alliance's Best Practices & Emerging Solutions Toolkit, Spring 2014, Volume 1

Figure 2-14: San Francisco has one of the most comprehensive and successful organics recovery programs in the US.

Credit: (left) Institute for Local Self-Reliance, (middle and right) City of San Francisco

year 2020 and has achieved the highest diversion rate of any major city in North America: 80% (1,593,830 tons in 2010) of its discards from landfill disposal.[60] Its composting programs and policies – the heart of its zero waste efforts – demonstrate the potential of composting to achieve high diversion levels. Section 3, Where Is Composting Happening, provides more detail on model programs and policies advancing composting to reduce waste.

Compost to Create Jobs

Composting is a community development tool as well as an environmental strategy. Like reuse and recycling, composting offers direct development opportunities for communities. When collected with skill and care, and upgraded with quality in mind, discarded materials are a local resource that can contribute to local revenue, job creation, business expansion, and the local economic base. Whether on a per-ton basis or on a per-dollar-capital investment basis, composting sustains more jobs than other waste handling options such as landfills and incinerators. But unlike linear disposal systems, composting is ultimately a manufacturing enterprise that produces a value-added product for multiple end markets. Jobs are sustained in each phase of the organics recovery cycle. In addition to the direct jobs at composting facilities, the use of compost supports new green enterprises and additional jobs. Most of the end markets for compost tend to be regional, if not local. Each recycling step a community takes locally means more jobs, more business expenditures on supplies and services, and more money circulating in the local economy through spending and tax payments.

More than 15 years ago, ILSR conducted extensive research on the jobs sustained by reuse, recycling, and composting. On a per-ton basis, we found that composting sustains four times the number of jobs as landfill or incinerator disposal.[61] While a few studies have since been released evaluating jobs and recycling, our per-ton job factors have not been updated and little data exists documenting the jobs through composting. (The US EPA in its February 2014 municipal waste characterization study included our job statistics from 1997.) In 2013, ILSR evaluated the current and potential composting-related jobs in Maryland. Our report, *Pay Dirt: Composting in Maryland to Reduce Waste, Create Jobs & Protect the Bay*, found that:

- Composting (including mulching and natural wood waste recycling) operations in Maryland already sustain more total jobs than the state's three trash incinerators, which handle almost twice as much tonnage.
- Jobs are sustained in each stage of the organics recovery cycle: manufacturing compost as well as using compost.
- On a per-ton basis, composting in Maryland employs two times more workers than landfilling, and four times more than the state's trash incinerators.

Types of Jobs at Compost Sites

- Vehicle Drivers
- Other Equipment Operators
- Supervisors, Management, Administration, Dispatch
- Business Development
- Product Marketing and Development
- Communications, Public Relations
- Accounting

- On a per-dollar-capital investment basis, for every $10 million invested, composting facilities in Maryland support twice as many jobs as landfills and 17 more jobs than incinerators.
- Wages at composting facilities typically range from $16 to $20 per hour.
- In addition to manufacturing compost, using compost in "green infrastructure" and for stormwater and sediment control creates even more jobs. Green infrastructure represents low-impact development such as rain gardens, green roofs, bioswales, vegetated retaining walls, and compost blankets on steep highway embankments to control soil erosion.
- An entire new industry of contractors who use compost and compost-based products for green infrastructure has emerged, presenting an opportunity to establish a new made-in-America industrial sector.

Table 2-1: Jobs sustained by select companies specializing in compost use for green infrastructure

Company, State	FTE Involved With Compost Use	CY Compost Used/Yr Range	Avg.	Compost Used TPY[1]	Est. TPY of Feedstock Material Composted[2]	FTE/10,000 TPY Composted
Filtrexx of Silicon Valley, CA	1.5		2,000	900	2,700	5.6
Sustainable Environmental Consultants, KS	5		17,778	8,000	24,000	2.1
Gold Leaf Group, MD	6		2,146	966	2,897	20.7
Oreg, MD	1	300 - 400	350	158	473	21.2
Eco-Constructors, MO	7		5,000	2,250	6,750	10.4
Eco-Fx, NC	9		10,000	4,500	13,500	6.7
Filtrexx Northeast Systems, NH	6	4,000 - 5,000	4,500	2,025	6,075	9.9
MCS Inc., NJ	4	5,000 - 7,000	6,000	2,700	8,100	4.9
River Valley Organics, PA	10	10,000 - 15,000	12,500	5,625	16,875	5.9
Landscape Contracting and Irrigation Inc., TX	2	2,000 - 3,000	2,500	1,125	3,375	5.9
Soil Express LTD, TX	8	2,760 - 6,455	4,139	1,863	5,588	14.3
USA Erosion Inc., TX	4		10,000	4,500	13,500	3.0
Wims Environmental Construction LTD, TX	7		7,500	3,375	10,125	6.8
Total	70		84,413	37,986	113,958	6.2

CY = cubic yard, FTE = full-time equivalent, TPY = tons per year. [1]Based on average compost density of 900 lbs/cubic yard. Personal communication, Craig Coker, Coker Composting & Consulting. Also, see USCC Field Guide to Compost Use (2001), p. 68. http://compostingcouncil.org/admin/wp-content/plugins/wp-pdfupload/pdf/1330/Field_Guide_to_Compost_Use.pdf. [2]On average, feedstock materials are one-third their original volume when composted. Source: Brenda Platt, Bobby Bell, and Cameron Harsh, Pay Dirt: Composting in Maryland to Reduce Waste, Create Jobs & Protect the Bay (Washington, DC: Institute for Local Self-Reliance, 2013) p. 14. Based on personal communication with company representatives.

- Utilizing 10,000 tons of finished compost annually in green infrastructure can sustain one new business. For every 10,000 tons of compost used annually by these businesses, 18 full-time equivalent job can be sustained.
- For every 1 million tons of organic material composted, followed by local use of the resulting compost in green infrastructure, almost 1,400 new full-time equivalent jobs could potentially be supported. These 1,400 jobs could pay wages from $23 million to $57 million each year.
- Composting and compost use represent place-based industries that cannot be outsourced abroad.

One company that has been an industry leader in compost-based products for erosion control and stormwater management is Filtrexx International. Filtrexx has dozens of patents for numerous products such as compost blankets, compost filter socks, and other mesh-containment systems. It has spent over $25 million on market development, research, and design since its inception in the year 2000. Today, Filtrexx and its trained installers use approximately 2 million cubic yards of recovered organics annually. Spread across one hundred Filtrexx certified installers, this is approximately 20,000 cubic yards (or 10,000 tons) per installer per year. Thus, 10,000 tons of compost can sustain one new business.[62]

Table 2-1 presents employment data for 13 companies, spanning Maryland to California, that specialize in using compost for green infrastructure. These 13 companies together employ 70 workers involved with using approximately 38,000 tons per year of compost (84,000 cubic yards of material). In other words, they sustain ~18 positions per 10,000 tons of compost they use each year (or 6 positions per 10,000 tons original materials composted).

Transportation Department Utilization

The Texas Department of Transportation's use of compost exemplifies the economic benefits of developing a compost utilization program. In the late 1990s, TxDOT partnered with the Texas Commission on Environmental Quality (TCEQ) to use compost for roadway projects. The project was fueled by the EPA, which offered a rebate for purchasing compost in an effort to mitigate watershed problems (e.g. nutrient leaching) caused by over application of dairy farm manure.[63] TxDOT's use of compost for roadway projects quickly leaped from using 500 cubic yards statewide each year before the program started, to 400,000 cubic yards purchased in 2003.[64] Today, after a cumulative total of 3 million cubic yards used to date, the TxDOT compost utilization program has become the nation's largest market for compost.[65] Because it is not cost-effective to transport compost far distances, it is an entirely in-state market, keeping dollars within the Texas economy.

What's more, using compost for highway maintenance projects created a whole new industry of subcontractors in Texas who can blow the compost onto varying slopes using truck-mounted pneumatic pumps. While these jobs did not exist at the outset of the program, 12 new contractors emerged within several years.[66] Though this method is quite effective for steep slopes, TxDOT utilized other means as well, such as blade (or disk) application, and biodegradable erosion control logs akin to the Filtrexx system.[67] The various techniques and products offer opportunities for contractors throughout the country to learn a new trade, enhance their skills, and establish niche markets.[68] Companies like Landscape Contracting and Irrigation Inc., Wims Environmental Construction LTD, and USA Erosion Inc. all found new work through the

TxDOT program. Bert Lary, President of Landscape Contracting and Irrigation averages 2,000 to 3,000 cubic yards of compost use per year. He has two full-time equivalent (FTE) employees but requires up to six to eight employees on any given compost job.[69] Wims Environmental in Balch Springs, Texas, regularly employs 25-30 staffers and provides special trade services such as silt fence erosion control applications. The TxDOT program fostered opportunities to use innovative compost-based systems, as the company's compost use more than doubled in the past decade. Today, Wims uses 7,500 cubic yards annually, and dedicates a quarter of its employees to compost-use operations.[70] In Royse City, Texas, USA Erosion Inc. employs 30 to 35 FTE employees, four of whom work on compost projects.[71]

Driving the industry, Filtrexx is now extending its certification courses beyond installers to include designers in the field of engineering, architecture, landscape architecture and land planning. As more municipalities realize the benefits of using compost for land applications, demand for trainers themselves will likely grow. According to Rod Tyler, Filtrexx Founder and CEO, each company certified under his program requires an educator, which is often a Filtrexx representative, but could mean a new position on the installer's team. In addition to Filtrexx's 15 staff members, 15 additional employees work at its factory, manufacturing the company's compost-based filter "Soxx." "All new jobs," says Tyler (and American manufacturing jobs at that).[72]

In the Mid-Atlantic, Filtrexx installers, other businesses, and government agencies using compost are contributing to the region's economy and demonstrating the potential for industry growth through innovation. Envirotech Environmental Consulting, Inc. and Blessings Blends are two companies doing this on the Delmarva Peninsula. As a Filtrexx certified installer, Envirotech has 17 employees working on projects in Delaware and Maryland's Eastern Shore. Since the company began using Filtrexx products in 2009, this new aspect of its business has produced a $70,000-$100,000 increase in annual revenue, says Wes Allen, Director of Operations.[73] Just down the road from Envirotech in Milford, Delaware, is Blessing Greenhouses and Compost Facility, producer of Blessings Blends premium compost. While Blessings is a composting facility, its contribution to the region's economy and environment are noteworthy. The facility is the largest organic waste handler on Delmarva, solely committed to turning poultry manure waste into a marketable value-added product.[74] Using a proprietary in-vessel system with an "enviro-cover," Blessings converts the poultry litter into a more stable, finished compost, that is less likely to lose nutrients through leaching and runoff, and can be returned to the same farmers that produced the litter. As a result, owner Bruce Blessing has created 12 green jobs that benefit local agriculture in a closed-loop system, while supporting many more jobs in various industries including horticulture and turf projects.[75] Envirotech is just one company that has previously used Blessings Blends for its projects, which demonstrates how recovered organics can support business and extend the life span of resources, rather than reaching a final resting place at a landfill or incinerator.[76]

Figure 2-15: MCS Inc. worker installing growing media made from compost on green roof.

Photo credit: MCS Inc., www.mcsnjinc.com

Furthermore, some companies using compost state that they have experienced success in a fairly short period of time and continue to grow. Filtrexx-certified MCS Inc. in Williamstown, New Jersey, is one of them. In its third year of existence, MCS sells between 5,000-7,000 cubic yards of compost per year and employs four FTE employees. Erosion control and the Filtrexx system are the backbone of its company as both an installer and manufacturer of the products. Projects have spanned from homeowner lawn bioremediation, green roofs (see Figure 2-15), and bioretention basins to highway slope stabilization with Delaware's Department of Transportation. Most MCS business is done at the manufacturing facility in New Jersey and in the Greater Philadelphia Area (Pennsylvania is the world leader in filter sock production) but opportunities are increasing elsewhere, such as working on Total Maximum Daily Loads (TMDLs) education projects with the Department of the Environment in Washington, DC (DDOE).[77]

Table 2-2: Jobs, composting vs. disposal

Type of Operation	Jobs/ 10,000 TPY	FTE Jobs/ $10 Million Invested
Composting sites[a]	4.1	21.4
Compost use	6.2	n/a
Total composting & compost use	10.3	
Disposal Facilities		
Landfilling	2.2	8.4
Burning (with energy recovery)	1.2	1.6

TPY = tons per year, FTE = full-time equivalent. [a]Includes mulching and natural wood waste recycling sites. Source: Brenda Platt, Bobby Bell, and Cameron Harsh, Pay Dirt: Composting in Maryland to Reduce Waste, Create Jobs & Protect the Bay (Washington, DC: Institute for Local Self-Reliance, 2013) p. 17. Incinerator data based on Eileen Berenyi, Governmental Advisory Assoc. Inc., *2012-2013 Municipal Waste to Energy in the United States Yearbook & Directory*. Westport, Connecticut. 2012.

Table 2-3: Potential new jobs by composting 1 million tons of organics

Option	FTE Jobs
Burning	120
Landfilling	220
Composting	740
Compost Use	620
Total Composting	1,360

Composting jobs based on one-third tonnage composted at small facilities, one-third at medium-sized facilities, and one-third at large facilities. Compost use jobs based on data from 13 companies using compost for soil erosion control, stormwater management, and other green infrastructure applications. Source: Brenda Platt, Bobby Bell, and Cameron Harsh, *Pay Dirt: Composting in Maryland to Reduce Waste, Create Jobs & Protect the Bay* (Washington, DC: Institute for Local Self-Reliance, 2013) p. 17.

Table 2-2 compares the job creation benefits of both *composting* and *compost use* to disposal options in Maryland. When taking into account the potential jobs that could be sustained by utilizing compost in-state for green infrastructure, on a per-ton basis, composting and compost use would sustain 5 times more jobs than landfilling and 9 times more jobs than incineration.

Based on our research for Maryland, if every 1 million tons of organic materials now disposed were instead composted at a mix of small, medium, and large facilities and the resulting compost used in-state, almost 1,400 new full-time equivalent jobs could potentially be supported, paying wages ranging from $23 million to $57 million. In contrast, when disposed in the state's landfills and incinerators, this tonnage only supports 120 to 220 jobs. See Table 2-3.

Additional research on the total jobs, economic output and wages that could be supported by expanding composting is warranted to corroborate ILSR's findings in Maryland.

Compost to Build Community

When composting is small scale and locally based, it has the potential to build and engage the community. Locally based composting circulates dollars in the community, promotes social inclusion and empowerment, greens neighborhoods, builds healthy soils, supports local food production and food security, embeds a culture of composting know-how in the community, sustains local jobs, and strengthens the skills of the local workforce. When materials are collected and transported out of the community for processing, few if any of these benefits are realized at the local level.

In addition, community-based operations can move from concept to operation in a relatively short timeframe, and typically are welcome in the neighborhood where they are started. The process of siting and permitting larger-scale composting sites can be time and capital intensive. The exciting news is that many community-scale composting operations are flourishing across the country.

ILSR collaborated with the Highfields Center for Composting in Hardwick, Vermont, to produce a guidebook on community-scale composting. *Growing Local Fertility: A Guide to Community Composting* describes more than 30 successful initiatives, their benefits, how these initiatives can be replicated, key start-up steps, and the need for private, public, and nonprofit sector support. More information on model programs is provided in Section 3: Where Is Composting Happening.

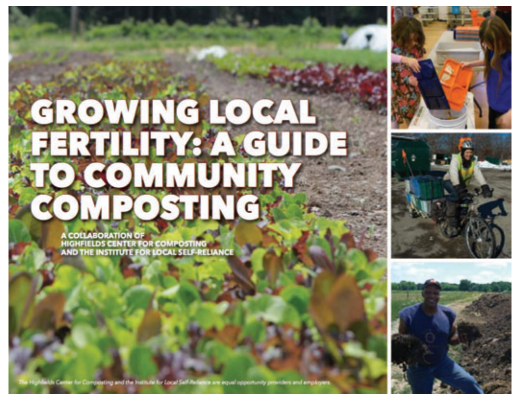

Figure 2-16: This new guide from ILSR and the Highfields Center for Composting features more than 30 community composting programs across the US.

Credit: ILSR and the Highfields Center for Composting

Core Principles

Many but not all community composting programs are non-profit mission driven enterprises. The distinguishing feature of community composting is keeping the process and product as local as possible while engaging the community through participation and education.

Community composting programs are those that strive to meet the following core principles:

Resources Recovered: Waste is reduced; food scraps and other organic materials are diverted from disposal and composted.

Locally Based and Closed Loop: Organic materials are a community asset, and are generated and recycled into compost within the same neighborhood or community.

Organic Materials Returned to Soils: Compost is used to enhance local soils, support local food production, and conserve natural ecology by improving soil structure and maintaining nutrients, carbon, and soil microorganisms.

Community-Scaled and Diverse: Composting infrastructure is diverse, distributed, and sustainable; systems are scaled to meet the needs of a self-defined community.

Community Engaged, Empowered, and Educated: Compost programming engages and educates the community in food systems thinking, resource stewardship, or community sustainability, while providing solutions that empower individuals, businesses, and institutions to capture organic waste and retain it as a community resource.

Community Supported: Aligns with community goals (such as healthy soils and healthy people) and is supported by the community it serves. The reverse is true too. A community composting program supports community social, economic, and environmental well-being.

Growing Power exemplifies how locally based composting builds community. Based in Milwaukee, it is a national non-profit organization and land trust whose mission is to support people from diverse backgrounds, and the environments in which they live, by helping to provide equal access to healthy, high-quality, safe and affordable food for people in all communities. Growing Power implements this mission by providing hands-on training, on-the-ground demonstration, outreach and technical assistance through the development of community food systems that help people grow, process, market and distribute food in a sustainable manner. Growing Power combines organic discard processing, food growing in urban and rural settings, nutrition education and business acumen to communities often neglected by traditional food and distribution networks.

ECO City Farms in Edmonston, Maryland, has a similar mission. It seeks to create a community where residents have greater access to affordable, healthy foods and enhanced opportunities for active living. People power, often in the form of volunteers, make this urban farm possible. Each year volunteers contribute an estimated 1,000 hours to support farm activities, including composting. "Volunteers are extremely important," according to Benny Erez, ECO City Farms' Senior Technical Advisor, "not only to actually help the small operation but they provide connection to community. With volunteers you can actually create community." David Buckel at Red Hook Community Farm in Brooklyn notes, "many participants also value the opportunity to build community by forging new relationships at the compost site that can widen support networks and trigger collective action on other issues of concern in the community." Lisa Valdiva with the North Carolina Community Garden Partners defines community-based composting as composting on a small scale where numerous people, businesses and organizations from the community are involved. In Brooklyn, the Myrtle Village Green Community Garden accepts compostable material from over 100 families as well as local businesses. People of different ethnic, religious, and linguistic backgrounds are finding common ground through collective labor. This is a common thread in many community gardens and urban farms that compost and grow local food. Involving volunteers and community participants builds empowerment, cultivates a sense of ownership, and enhances the capacity of communities to effectively manage their own waste.

Figure 2-17: The North Carolina Community Garden Partners is a statewide network of community gardens. The organization provides education and resources for community gardens including compost trainings.

Another common thread is participation by and education of children in the art and science of composting. Composting done in conjunction with community and school gardens provides a full soil-to-soil loop that few students would experience otherwise. Young composters grow into old composters, and students are instrumental in spreading compost awareness and experience throughout the entire community. Investment in training and education of today's youth will have a long-term payback for composting efforts in the future.

End Notes

[1] US EPA, Office of Resource Conservation and Recovery, *Municipal Solid Waste Generation, Recycling, and Disposal in the United States, Tables and Figures for 2012*, February 2014. Available online: http://www.epa.gov/waste/nonhaz/municipal/pubs/2012_msw_dat_tbls.pdf

[2] Brenda Platt, David Ciplet, Kate Bailey, and Eric Lombardi, *Stop Trashing the Climate* (Washington, DC: Institute for Local Self-Reliance, 2008).

[3] Jean C. Buzby, Hodan Farah Wells, and Jeffrey Hyman, *The Estimated Amount, Value, and Calories of Postharvest Food Losses at the Retail and Consumer Levels in the United States* (USDA, February 2014).

[4] Jeff Harrison, "Study: Nation Wastes Nearly Half Its Food" (The University of Arizona, November 18, 2004), citing research by Timony W. Jones.

[5] Food Waste Reduction Alliance, Best Practices & Emerging Solutions Toolkit, Spring 2014, Volume 1. Available online at http://www.foodwastealliance.org/wp-content/uploads/2014/04/FWRA_Toolkit_FINAL_0415141.pdf. Also see Alisha Coleman-Jensen, Mark Nord, and Anita Singh, "Household Food Security in the United States in 2012," US Department of Agriculture Economic Research Service, Economic Research Report No. (ERR-155), September 2013. Available online at http://www.ers.usda.gov/publications/err-economic-research-report/err155/report-summary.aspx#.U1dw8sfrap1.

[6] Taolin Zhang and Xingxiang Wang, Institute of Soil Science, Chinese Academy of Sciences, Nanjing, "Erosion and Global Change," *Encyclopedia of Soil Science*, 2006, p. 536.

[7] *2007 National Resources Inventory – Soil Erosion on Cropland*, Natural Resources Conservation Service, April 2010, p. 4. Available online at http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_012269.pdf.

[8] Susan S. Lang, "'Slow, insidious' soil erosion threatens human health and welfare as well as the environment, Cornell study asserts," Online Chronicle, University of Cornell, Ithaca, New York, March 20, 2006. Available online: http://www.news.cornell.edu/stories/march06/soil.erosion.threat.ssl.html

[9] "Crop Production," *Ag 101 Web Site*, US EPA, accessed December 2013, http://www.epa.gov/oecaagct/ag101/printcrop.html.

[10] Soil and Water Conservation Society. 2003. *Conservation Implications of Climate Change: Soil Erosion and Runoff from Cropland*. Ankeny, IA: Soil and Water Conservation Society.

[11] Composting Council Research and Education Foundation, A Watershed Manager's Guide To Organics:The Soil And Water Connection (1997).

[12] WORC, Op. Cit.

[13] Composting Council Research and Education Foundation, Op. Cit., p. 8.

[14] WORC, Op. Cit.

[15] "Soil Quality Technical Note No. 5, Managing Soil Organic Matter: The Key to Air and Water Quality," USDA, Op. Cit.

[16] Composting Council Research and Education Foundation, Op. Cit., p. 8.

[17] Composting Council Research and Education Foundation, Op. Cit., p. 8.

[18] "Soil Quality Technical Note No. 5, Managing Soil Organic Matter: The Key to Air and Water Quality," United States Department of Agriculture NRCS-SQI, accessed October 2012, http://soils.usda.gov/sqi/concepts/soil_organic_matter/files/sq_tn_5.pdf

[19] Washington State Department of Ecology, https://fortress.wa.gov/ecy/publications/publications/1210030.pdf

[20] WORC, Op. Cit.

[21] "The Science and Practice of Sustainable Sites: Practical Implementation of Soil Protection & Restoration," WA Chapter of the ASLA, UW Botanic Gardens, and Seattle Public Utilities 9/27/11 Seminar Presentation, accessed October 2012, http://depts.washington.edu/uwbg/docs/sites/Sites_Soil_McDonald_Stenn_Berger.pdf

[22] See, for example, United States Composting Council (USCC), "Specify and Use COMPOST for LEED & Sustainable Sites Projects: A Natural Connection," accessed June 2014, available online at http://compostingcouncil.org/admin/wp-content/uploads/2012/10/LEED-and-SITES-credits-for-compost.pdf

[23] "Drought Resistant Soil, Agronomy Technical Note," Appropriate Technology Transfer for Rural Areas (ATTRA), NCAT, USDA, accessed December 2012, http://www.clemson.edu/sustainableag/IP169_drought_resistance.pdf

[24] WORC, Op. Cit.

[25] Composting Council Research and Education Foundation, Op. Cit., p. 14.

[26] Ibid, p. 8.

[27] "Field Guide to Compost Use," The US Composting Council, accessed May 2013, http://compostingcouncil.org/admin/wp-content/plugins/wp-pdfupload/pdf/1330/Field_Guide_to_Compost_Use.pdf

[28] Composting Council Research and Education Foundation, Op. Cit., p. 8.

[29] WORC, Op. Cit.

[30] "About west marin compost," West Marin Compost, accessed December 2012, http://westmarincompost.org/?page_id=225

[31] "What is a TMDL," US EPA, accessed February 2013, http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/overviewoftmdl.cfm#responsibility

[32] "Frequently Asked Questions about the Bay TMDL," US EPA, accessed February 2013, http://www.epa.gov/reg3wapd/tmdl/ChesapeakeBay/FrequentlyAskedQuestions.html

[33] "Frequently Asked Questions about the Bay TMDL," US EPA, Op. Cit.

[34] "NPDES: Compost Blankets," US EPA, accessed April

2013, http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=118

[35] "USCC factsheet: Using Compost Can Reduce Water Pollution," U.S. Composting Council, accessed October 2012, http://compostingcouncil.org/admin/wp-content/uploads/2010/09/Using-Compost-for-Reducing-Water-Pollution.pdf

[36] Composting Council Research and Education Foundation, Op. Cit., p. 8.

[37] WORC, Op. Cit.

[38] Britt Faucette, "Compost In The Green Infrastructure Toolbox," *BioCycle*, October 2010, p. 33.

[39] Britt Faucette, "Designing with Nature: LID & Pollution Prevention with Compost BMPs," Filtrexx International LLC, Compost BMPs: EPA-WIP/TMDL Challenge Seminar, Annapolis, Maryland, March 2013.

[40] "Beyond Kyoto: Why Climate Policy Needs to Adopt the 20-year Impact of Methane," Eco-Cycle Position Memo, Eco-Cycle, www.ecocycle.org, March 2008.

[41] US EPA, *Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2012* (April 214). Available online at US EPA "Overview of Greenhouse Gases," http://epa.gov/climatechange/ghgemissions/gases.html.

[42] California Air Resources Board, "*California Greenhouse Gas Emissions Inventory: 2000-2009*," December 2011, pp. 14, 17, 23. Available online: http://www.arb.ca.gov/cc/inventory/pubs/reports/ghg_inventory_00-09_report.pdf.

[43] Bogner, J., M. Abdelrafie Ahmed, C. Diaz, A. Faaij, Q. Gao, S. Hashimoto, K. Mareckova, R. Pipatti, T. Zhang, *Waste Management, In Climate Change 2007: Mitigation. Contribution Of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 600. Available online at: http://www.ipcc.ch/ipccreports/ar4-wg3.htm

[44] Deborah Koons Garcia, director, writer, producer, *Symphony of Soil*, documentary movie, 2012. http://www.symphonyofthesoil.com/

[45] "The Benefits of Soil Carbon: Managing soils for multiple economic, societal, and environmental benefits," United Nations Environmental Program, accessed April 2014, http://www.unep.org/yearbook/2012/pdfs/UYB_2012_CH_2.pdf

[46] Ibid.

[47] Bobby Bell and Brenda Platt, *Building Healthy Soils with Compost to Protect Watersheds*, Institute for Local Self-Reliance, Washington, DC, May 2013.

[48] Brown et al., 2010; Trlica and Brown, 2013.

[49] Marcia S. DeLonge, Rebecca Ryals, and Whendee L. Silver, "A Lifecycle Model to Evaluate Carbon Sequestration Potential and Greenhouse Gas Dynamics of Managed Grasslands," *Ecosystems*, Volume 16, Issue 6, September 2013, pp. 962-979. Also see www.marincarbonproject.org.

[50] The Climate Action Reserve, http://www.climateactionreserve.org.

[51] "Organic Waste Composting Project Protocol," The Climate Action Reserve web site, http://www.climateactionreserve.org/how/protocols/organic-waste-composting/.

[52] "Top Developers of Carbon Offset Projects Honored by the Climate Action Reserve," The Climate Action Reserve, press release, March 27th, 2014. http://www.climateactionreserve.org/how/protocols/soil-carbon/

[53] Commonwealth of Australia, *Carbon Credits (Carbon Farming Initiative) Act 2011*, accessed April 2014, http://www.comlaw.gov.au/Details/F2013L00482/Explanatory%20Statement/Text

[54] "Soil Carbon Protocols," The Climate Action Reserve, http://www.climateactionreserve.org/how/protocols/soil-carbon/

[55] "National Land Cover Database," Multi-Resolution Land Characteristics Consortium, accessed April 2014, http://www.mrlc.gov/nlcd06_stat.php

[56] "Rangeland Compost Protocol," Marin Carbon Project, accessed April 2014, http://www.marincarbonproject.org/policy/rangeland-compost-protocol

[57] "Climate change: Commission dishes the dirt on the importance of soil," European Commission, accessed April 2014, http://europa.eu/rapid/press-release_IP-09-353_en.htm?locale=en

[58] US EPA, Office of Resource Conservation and Recovery, *Municipal Solid Waste Generation, Recycling, and Disposal in the United States, Tables and Figures for 2012*, February 2014. Available online: http://www.epa.gov/waste/nonhaz/municipal/pubs/2012_msw_dat_tbls.pdf.

[59] Rhodes Yepsen, "Residential Food Waste Collection in the U.S. – BioCycle Nationwide Survey," *BioCycle*, March 2013, Vol. 54, No. 3, p. 23.

[60] SF Environment, City and County of San Francisco, Zero Waste FAQ website, http://www.sfenvironment.org/zerowaste/overview/zero-waste-faq. Accessed November 2013.

[61] In the 1990s, ILSR documented comprehensive job-to-ton factors based on several research projects it was conducting. For composting, ILSR contacted 53 composters who were handling 662,625 tons per year and employing 266 full-time equivalent workers. In contrast, the 114 disposal facilities documented processed 26,665,713 tons per year and employed 2,816 FTE. Thus, on a per-ton basis, composting employed four times more workers than disposal. The data are summarized in: Brenda Platt and Neil Seldman, Institute for Local Self-Reliance, *Wasting and Recycling in the United States 2000* (Washington, DC: 2000), p. 27.

[62] Personal communication, Rod Tyler, Filtrexx International, LLC, January 2013.

[63] Personal communication, Barrie Cogburn, Texas DOT (retired), January 2013.

[64] "Erosion Control with Recycled Materials," U.S. Department of Transportation Federal Highway Administration, *Public Roads*, 67 (2004): No. 5, accessed December 2012, http://www.fhwa.dot.gov/publications/publicroads/04mar/03.cfm

[65] Barrie Cogburn, Op. Cit.

[66] "Erosion Control with Recycled Materials," U.S. Department of Transportation Federal Highway Administration, Op. Cit.

[67] Barrie Cogburn, Op. Cit.

[68] "Erosion Control with Recycled Materials," U.S. Department of Transportation Federal Highway Administration, Op. Cit.

[69] Personal communication, Bert Lary, Landscape Contracting and Irrigation Inc., February 2013.

[70] Personal communication, Greg Guldahl, Wims Environmental Construction LTD, February 2013.

[71] Personal communication, Duffy McKenzie, USA Erosion Inc., February 2013.

[72] Rod Tyler, Op. Cit.

[73] Personal communication, Wes Allen, Envirotech Environmental Consulting, Inc., January 2013.

[74] Personal communication, Bruce Blessing, Blessing Greenhouses and Compost Facility, December 2012.

[75] Personal communication, Rick Lee, Blessing Greenhouses and Compost Facility, February 2013.

[76] Wes Allen, Op. Cit.

[77] Personal communication, Jason Dorney, MCS Inc., January 2013.

Where is Composting Happening — National Snapshot and Models to Replicate

National Snapshot Overview

What is the state of composting in the US? It depends on how one measures it. Gone are the days when most people were not even sure what composting meant unless they were gardeners or farmers. Today, composting and compost are fairly well recognized. In an article in the *New York Times* in early December about urban school districts becoming more environmentally conscious via their purchasing power, the example was use of compostable plates. "With any uneaten food, the plates, made from sugar cane, can be thrown away and turned into a product prized by gardeners and farmers everywhere: compost."[1]

Without a doubt, recognition of composting is critically important to the success of the industry as a whole. Equally, if not more important, is having the actual composting infrastructure to manage the organic waste streams generated in the US. At this time, that infrastructure is inadequate. For example, state organics recycling officials contacted as part of this project were asked to tally the number of composting facilities in their state

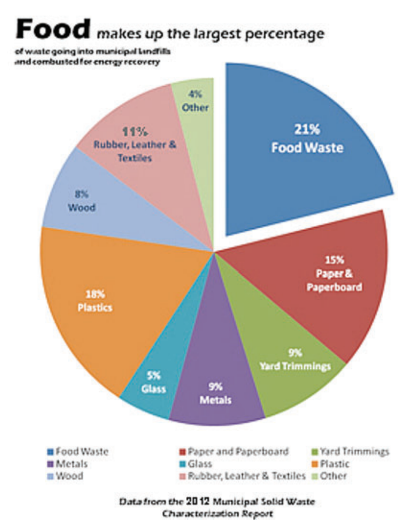

Figure 3-1: Most food waste is landfilled and burned, not composted.

Illustration Credit: US EPA, www.epa.gov/waste/conserve/foodwaste/

Table 3-1: Organics diversion and number of facilities by volume of organics received

State	Total Organics Diverted To Composting (tons)	Diverted Organics As Percent Of Total MSW[1]	Number Of Facilities By Volume Received [tons per year]			
			<5,000	5,000 to <20,000	Over 20,000	All Facilities
Arkansas	227,044		19	6	3	28
California	5,900,000	8.6	50	44	68	162
Colorado	263,549	3.2	10	11	9	30
Connecticut	270,163	8.4	82	45	12	139
Delaware	66,111	6.5	1	0	2	3
Florida	1,450,757	5.0	131	58	40	229
Indiana	272,364	3.4	87	8	3	98
Iowa	1,281,201	47.0	103	3	6	112
Kansas	191,596	5.9	141	5	2	148
Kentucky	na	na	40	1	0	41
Maine	27,944	1.6	82	3	2	87
Maryland	941,261	13.8	na	na	na	na
Massachusetts	660,000	9.0	130	18	3	151
Minnesota	249,949	4.4	na	na	na	na
Mississippi	13,414	0.2	13	3	0	16
Missouri	530,000	na	na	na	na	na
Montana	52,764	3.3	40	4	2	46
Nebraska	150,000	na	na	na	na	na
New Hampshire	na	na	7	2	0	9
New Jersey	535,176	4.2		324		324
New Mexico	74,021	4.0	32	6	0	38
New York	1,006,706	5.5	459	22	9	490
North Dakota	na	na	47	4	0	51
Ohio	987,694	na	279	47	10	336
Oregon	224,275	9.2	20	23	11	54
Pennsylvania	857,739	9.5	na	na	na	na
Rhode Island	111,000	14.0	20	5	2	27
South Carolina	246,624	5.5	99	22	5	126
South Dakota	73,216	11.4	144	2	1	147
Tennessee	500,000	1.5	10	1	1	12
Texas	381,827	1.8	na	na	na	na
Utah	221,374	10.6	10	10	4	24
Vermont	52,411	9.0	11	5	0	16
Virginia	184,702	1.5	7	7	4	18
Washington	1,211,805	13.7	39	12	14	65
Wisconsin	215,000	5.0	231	9	0	240
Wyoming	na		10	3	5	18
All Reporting States	19,431,687	7.8 state average	2,354	713	218	3,285
National organics diversion rate (based only on data from states reporting a diversion estimate)		6.1%				

[1]MSW = municipal solid waste

by volume of material processed (i.e., processing capacity). Three capacity ranges were provided: <5,000 tons/year; 5,000 to <20,000 tons/year; and >20,000 tons/year. A response to this requested breakdown was provided by 31 states: 72% of the 3,285 composting facilities (2,354) in those 31 states are composting less than 5,000 tons/year of materials (Table 3-1). There are 713 facilities in the 5,000 to 20,000 tons/year range. Only 218 facilities are composting more than 20,000 tons/year. States responding to this inquiry include heavily populated states such as California, Florida, Massachusetts, New Jersey, New York, Ohio, Virginia and Washington.

As shown in Table 3-1, 27 of those 31 states also reported the total amount of organics diverted to composting in 2012. In total, those 27 states diverted 16,321,000 tons of organics to composting at 3,166 facilities (the total of 3,285 less the 119 facilities in the four states that did not provide a total amount of organics diverted to composting). That is an average of 5,155 tons/facility/year.

That is the micro level. At the macro level, interest is growing rapidly in diverting more organic waste streams to composting. This is particular true with the source separated food scraps stream. In its most recent report, *Municipal Solid Waste Generation, Recycling and Disposal in the United States: Facts and Figures for 2012*, the US EPA calculates that 36.43 million tons of food scraps were generated in 2012; of that, 1.74 million tons were recovered. In addition, 33.96 million tons of yard trimmings were generated and 19.59 million tons were recovered.[2] Figure 3-1 shows that food waste is 21% of all municipal waste disposed. Clearly, to achieve higher levels of composting in the US, more processing capacity will be needed.

Data Collection Methods

A state-by-state survey was conducted for this project to quantify composting activity in all 50 states, and estimate the amount of organic material discards currently diverted to composting. The survey was conducted by the editors of *BioCycle* due to their many years of experience collecting data on all facets of solid waste management and organics recycling in the US. All but 6 states — Alabama, Hawaii, Louisiana, Nevada, Oklahoma and West Virginia — responded with some or all of the requested information. (A sample of a completed survey questionnaire is provided in Appendix E.) States were asked to only report facilities that are permitted and/or exempt from permitting by their state.

The questionnaire was emailed to state organics recycling officials or solid waste management department staff in fall 2013. States were asked to provide data for calendar year 2012. Followup by either email or telephone was required to clarify data provided or request additional information. States not replying were contacted numerous times to provide data. An extra effort was made to quantify the number of yard trimmings composting operations in the US. *BioCycle* magazine began tracking yard trimmings composting in the late 1980s as part of its annual survey, *The State of Garbage In America*. The last year that *BioCycle* was able to estimate a national number was in its 2006 *State of Garbage In America Report*, which was based on 2004 state data.[3] In order to estimate a national number of yard trimmings composting facilities in this report, *BioCycle* also culled data from state solid waste management reports. This was done for Illinois, North Carolina and Texas.

National Snapshot

The survey questionnaire asked states for the total tons of organics diverted to composting. Thirty-three of the 44 responding states were able to provide a quantity — a total of 19,431,687 tons of organics diverted to composting (Table 3-1). The organic waste streams primarily consist of yard trimmings, food scraps, biosolids and some agricultural waste streams, including manure. Of the states reporting, California had the highest composting tonnage in 2012 (5.9 million tons); Florida had the second highest (1.5 million tons), followed by Iowa (1.3 million tons), Washington State (1.2 million tons) and New York (1.0 million tons). Table 3-2 provides a state ranking by total tons of organics diverted.

It is interesting to compare tonnages of organics diverted to the number of composting facilities. Taking the same 5 states,

Table 3-2. State Rankings , highest to lowest, by total organics diverted[1]

State	Total Organics Diverted To Composting (tons)
California	5,900,000
Florida	1,450,757
Iowa	1,281,201
Washington	1,211,805
New York	1,006,706
Ohio	987,694
Maryland	941,261
Pennsylvania	857,739
Massachusetts	660,000
New Jersey	535,176
Missouri	530,000
Tennessee	500,000
Texas	381,827
Indiana	272,364
Connecticut	270,163
Colorado	263,549
Minnesota	249,949
South Carolina	246,624
Arkansas	227,044
Oregon	224,275
Utah	221,374
Wisconsin	215,000
Kansas	191,596
Virginia	184,702
Nebraska	150,000
Rhode Island	111,000
New Mexico	74,021
South Dakota	73,216
Delaware	66,111
Montana	52,764
Vermont	52,411
Maine	27,944
Mississippi	13,414

[1]33 states (66%) providing information

California reports 162 composting facilities, Florida has 229, Iowa has 112, Washington has 65 and New York has 490. This disparity of total number of facilities and total tons of organics diverted to composting illustrates why it is important to focus on the actual processing capacity of permitted or exempt operations. For example, of New York's 490 facilities, 459 process less than 5,000 tons/year of organics. In comparison, CalRecycle — the state agency most involved with composting in California — reported that the state has a total of 91 permitted composting facilities, along with 197 composting projects on-site at institutions, 50 on farms and 22 other composting facilities that are not on farms but process manure and green waste (green waste is primarily yard trimmings). Of the 163 facilities (not including the on-site at institutions), a total of 68 facilities compost about 90% (5.3 million tons) of all organic waste diverted to composting in California.

Finally, the proportion of yard trimmings in the total tons of organics diverted should be noted. Again looking at these top five composting states (by tons diverted), of the 5.9 mil-

Table 3-3: Composting facilities by feedstock types (all states reporting)

State	Yard Trimmings	Food Waste	Mixed Organics[1]	Mixed MSW	Biosolids	On-Site Institutions	On-Site Farms/Ag	Other (Misc.)
Alaska	0	0	0		2	0	0	
Alabama								
Arizona	4				3			
Arkansas	20	1			4	1	1	
California	48	26		2	15	197	50	22[2]
Colorado	2	2	0		11	4	39	
Connecticut	109	3	0		1		26	
Delaware	0	2	0		1			
Florida	257	2	8		29			1 (manure)
Georgia	1	1	0		4	4	13	
Hawaii								
Idaho	7	4	0		2	2	0	2 (mortalities)
Illinois	42	21						
Indiana	119	11			3			
Iowa	86	7	7		2	7		
Kansas	103	11	13		2	12	31	5 (paunch, sludges)
Kentucky	35		2		2		1	
Louisiana								
Maine	52	10	0		18	2	25	
Maryland	7	4	0		1	0	1	
Massachusetts	221	27		2	13		70	
Michigan	119	7						
Minnesota	129	9		1	0	5		
Mississippi	9	3	4		0	0	0	
Missouri	18	6			2			
Montana	30	1		1	7	10		
Nebraska	10	0	2		6	0	1	
Nevada								
New Hampshire		9	0		4			
New Jersey	295	1	0		5	9	1	
New Mexico	16		10		9	2		3 (offal)
New York	329	45		1	23	50	42	
North Carolina	16	7			4	9	2	
North Dakota	43	0	0		0	exempt	exempt	3 (manure, oily waste)
Ohio	299	20		1	3		59	5 animal mort; 3 industrial
Oklahoma								
Oregon	44	10	0		5		25	
Pennsylvania	350	25	8		9	19	13	
Rhode Island	22	3	0		2		0	
South Carolina	107	1	1		3	exempt	exempt	
South Dakota	146	0		1				
Tennessee	3	2		1	1	exempt	exempt	
Texas	33	4			10			
Utah	18	4	0		1	1		
Vermont	1	13	7		3		na	
Virginia	8	1	7		1	1	exempt	
Washington	45	29			25			
West Virginia								
Wisconsin	225	14		1			exempt	
Wyoming	25	1	18		2	2	exempt	
Totals for all reporting states	3,453	347	87	11	238	337	400	41

[1]Mixed organics = Includes facilities handling multiple organics streams beyond yard trimmings and food waste. [2]Manure, yard trimmings, manure and yard trimmings not on farms.

lion tons composted in California, yard trimmings comprised 3.7 million of the total tons of organics composted; manure comprised 1.2 million tons, biosolids represented 665,000 tons and food scraps were 270,000 tons. In Florida, yard trimmings accounted for 1.1 million of the 1.5 million tons composted. In Iowa, yard trimmings account for 1.2 million of the 1.3 million tons diverted. In both Washington and New York, yard trimmings account for most of the material composted.

Composting Facility Totals

The survey questionnaire requested composting facility data in two ways: number of composting facilities by size (Table 3-1) and number of permitted and/or exempt composting facilities by feedstock type (Table 3-3). The total number of facilities reported based on size, as noted in Table 3-1, is 3,285 (31 states reporting). However, when tallied by facilities/feedstock type, the total number of composting facilities is 4,914 (44 states reporting). The totals are divided as follows (see Table 3-3): Yard trimmings: 3,453; Food waste: 347; Mixed organics (combinations of various organic waste streams): 87; Mixed waste composting (unsorted solid waste): 11; Biosolids: 238; Composting on site at institutions: 337; Composting on site on farms/agricultural operations: 400; Miscellaneous: 41. Figure 3-2 shows a breakdown by type.

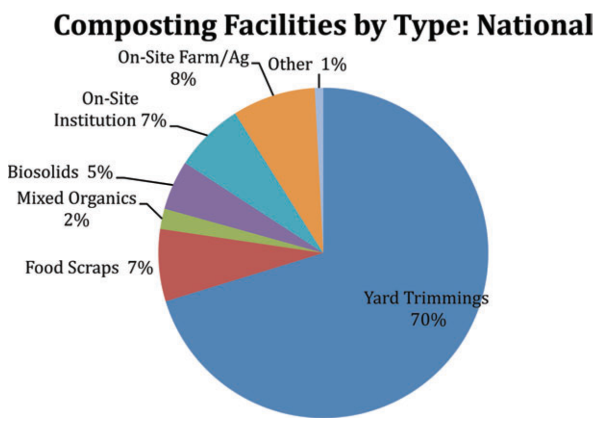

Figure 3-2: Yard trimmings compost sites represent 70% of the 4,914 total compost sites reported.

Source: BioCycle 2014

Yard Trimmings

This survey identified a total of 3,453 yard trimmings composting facilities in the US. Table 3-4 provides a ranking of the states. Pennsylvania reports the highest number of yard trimmings composting facilities (350), followed by New York (329), Ohio (299), New Jersey (295), Florida (257), Wisconsin (225) and Massachusetts (221).

As noted earlier, this is the first time in 10 years that a national figure for the number of yard trimmings composting operations in the US has been determined. In 2006, *BioCycle* identified a total of 3,357 facilities, which was 2004 data.[3] Over this 10-year span, the number of yard trimmings facilities in the US has remained almost the same.

Table 3-4: State rankings, highest to lowest, by compost feedstock: yard trimmings[1]

State	Yard Trimmings Facilities Reported
Pennsylvania	350
New York	329
Ohio	299
New Jersey	295
Florida	257
Wisconsin	225
Massachusetts	221
South Dakota	146
Minnesota	129
Indiana	119
Michigan	119
Connecticut	109
South Carolina	107
Kansas	103
Iowa	86
Maine	52
California	48
Washington	45
Oregon	44
North Dakota	43
Illinois	42
Kentucky	35
Texas	33
Montana	30
Wyoming	25
Rhode Island	22
Arkansas	20
Missouri	18
Utah	18
New Mexico	16
North Carolina	16
Nebraska	10
Mississippi	9
Virginia	8
Idaho	7
Maryland	7
Arizona	4
Tennessee	3
Colorado	2
Georgia	1
Vermont	1

[1]43 states (86%) providing information

Food Scraps

A total of 347 food scrap composting facilities were identified by this survey. There is a risk of some double counting with the total number of yard trimmings composting operations, as most food scrap composting sites also receive yard trimmings from municipalities, commercial landscapers and homeowners. Table 3-5 provides a ranking of food scrap composting facilities by state. New York reports the highest number (45), followed by Washington (29), Massachusetts (27), California (26), Pennsylvania (25), Illinois (21), and Ohio (20).

As noted earlier, interest in diverting source separated food residuals from landfill disposal has grown rapidly in the US.

Table 3-5: State rankings, highest to lowest, by compost feedstock: food waste[1]

State	Food Waste Facilities Reported
New York	45
Washington	29
Massachusetts	27
California	26
Pennsylvania	25
Illinois	21
Ohio	20
Wisconsin	14
Vermont	13
Indiana	11
Kansas	11
Maine	10
Oregon	10
Minnesota	9
New Hampshire	9
Iowa	7
Michigan	7
North Carolina	7
Missouri	6
Idaho	4
Maryland	4
Texas	4
Utah	4
Connecticut	3
Mississippi	3
Rhode Island	3
Colorado	2
Delaware	2
Florida	2
Tennessee	2
Arkansas	1
Georgia	1
Montana	1
New Jersey	1
South Carolina	1
Virginia	1
Wyoming	1

[1]41 states (82%) providing information

This is reflected in both federal and state policies. At the federal level, food waste reduction initiatives include the US EPA's Food Recovery Challenge, and the US Department of Agriculture's and US EPA's US Food Waste Challenge. Both initiatives focus on reducing food loss and food waste, recovering edible food for human consumption and then recycling food not edible by humans for animal feed, composting and energy generation. The EPA's Food Recovery Challenge has focused on the grocery industry, colleges and universities, and sports and entertainment venues among others. The joint USDA/EPA Challenge targets producer groups, processors, manufacturers, retailers, communities, and other government agencies. These federal initiatives have been effective at raising awareness about the amount of food wasted in the US, as well as encouraging generators of food waste to divert this waste stream from disposal.

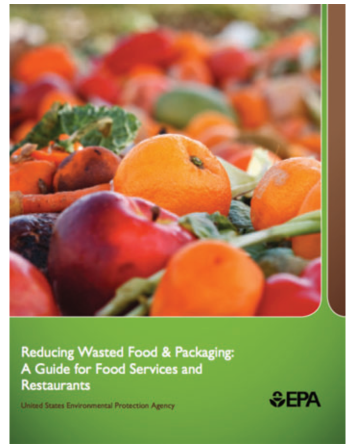

Figure 3-3: US EPA produced this guide to help reduce food waste at foodservice establishments.

Source: www.epa.gov/waste/conserve/foodwaste/tools

At the state level, policies have been enacted to encourage or require diversion of source separated organics. Over 20 states enacted bans on disposal of yard trimmings in landfills many years ago. More recently, a handful of states have established food waste disposal bans. Connecticut's and Massachusetts' laws cover commercial food waste streams. Vermont's law covers both residential and commercial, phased in over the years 2014 to 2020. Commercial generators are required to comply first; residential organics diversion is required by 2020.

How effective are bans at driving diversion to composting? In general, it is widely accepted that state yard trimmings disposal bans have reduced the amount of yard trimmings flowing to landfills, especially the stronger bans. (Some state bans, such as Nebraska's, have loopholes, allowing yard trimmings to be landfilled, for instance, if landfills have gas recovery systems; others target only leaves such as New Jersey's.) State regulators in Connecticut, Iowa, Massachusetts, and Wisconsin consider their bans successful in cutting the amount of material landfilled.[4] Twelve of the states that have yard trimmings disposal bans were home to almost two-thirds of all reported composting facilities.

But disposal bans are certainly not the only mechanism for driving composting. Of the top five states in terms of diversion of organics to composting, only Iowa has a ban on disposal of yard trimmings in landfills. (Florida had a ban in place until it was repealed by the state legislature several years ago.) While California doesn't have a disposal ban on organics, it passed a waste diversion law in 1999 — AB939 — that required jurisdictions to divert 50% of the waste stream by 2000 or be subject to fines. The waste diversion goal has been effective at establishing local organics diversion programs — for both yard trimmings and food scraps.

The ability of a ban to drive further establishment of composting (and anaerobic digestion) infrastructure will be put to the test over the next several years, especially in Massachusetts where the state's commercial organics disposal ban did not set a "proximity rule" for compliance, i.e., where food waste generators only need to comply if there is a permitted (or exempt for permitting) composting facility within 20 miles of their establishment(s) as is the case in Connecticut and Vermont (at this juncture). In terms of composting, only 23 facilities (as of January 2013) were permitted to process a combined total of approximately 150,000 tons/year of food waste.[5] Massachusetts anticipates that its commercial organics disposal ban will yield an additional 350,000 tons to be diverted, thus substantial new industrial-scale organics processing facilities are necessary. As can be seen in Table 3-1, the majority of composting facilities in Massachusetts are processing less than 5,000 tons/year of organic waste streams.

One opportunity to create more infrastructure for food scrap composting is to utilize existing yard trimmings composting facilities. Typically, the first step in the process to make that conversion is obtaining a permit to compost food scraps. Many states have a permit by rule status for yard trimmings composting, only requiring the facility to register and comply with basic nuisance and ground and surface water protection requirements. Some states allow small amounts of food scraps to be received under that permit, e.g., to compost food scraps diverted at a community event. However, receiving regular deliveries of food scraps typically bumps a yard trimmings facility up into a different permitting status. To comply, sites may need to upgrade their composting pad to protect ground water, and have the capability to receive and incorporate the food scraps within several hours of receiving the material at the composting site.

Figure 3-4: Many existing yard trimmings composting sites could expand to compost food residuals. This guide details best management practices.

Source: US Composting Council

Many of the 3,453 yard trimmings composting operations in the US are not staffed or equipped to comply with requirements for receiving food scraps, nor are the materials receiving and composting pads adequate to manage incoming feedstocks with higher moisture content. And many of these operations are municipally-owned and operated. For example, lists of permitted yard trimmings composting sites can be found on state solid waste management office websites. The majority of the owners are municipalities and counties. Upgrading and staffing sites to manage source separated food scraps requires a capital investment, and frequently is not within the municipal budget. (We note, however, that capital investment for other solid waste management systems such as trash incinerators and landfills require significantly higher capital investment than what is needed to develop food scrap composting capacity.)

While some municipally-owned composting facilities have been upgraded (both permit- and equipment-wise) to process source separated food scraps, the majority of food scrap composting capacity is at privately owned facilities. For example, *BioCycle*'s 2013 Nationwide Survey, "Residential Food Waste Collection in the US, identified 183 residential food waste collection programs.[6] California and Washington have almost 50% of the curbside programs identified (62 and 60, respectively). The *BioCycle* survey asks which composting facility services a community's program. In California, the residential food waste programs are serviced by 11 private composting facilities and two municipally operated sites. In Washington State, there are 60 residential food waste collection programs, all serviced by private companies (6 composters in total).

The expectation, at least for the foreseeable future, is that any significant expansion of composting capacity for source separated food scraps will be done by privately operated composting facilities. Some states have been proactive in revising their composting regulatory structure to streamline permitting of existing yard trimmings composting facilities that want to start processing food scraps. For example, Ohio revised its composting rules several years ago to aid in this transition.[7]

Biosolids

The state-by-state survey identified a total of 238 biosolids composting facilities in the US (Table 3-3). Biosolids are the separated solids generated during treatment of municipal wastewater. This reported number is a slight decline from a nationwide survey conducted by *BioCycle* in 2010.[8] That survey identified 258 biosolids composting facilities in operation. Prior to its 2010 national survey, the last year *BioCycle* conducted a national survey of biosolids composting in the US was in 1999, based on 1998 data. At that time, there were 274 operating facilities in the US. One of the most important takeaways from *BioCycle*'s 2010 survey was how popular the finished compost is with residents and commercial landscapers and golf courses. In most cases, all the compost produced was distributed (and typically sold versus given away).

Table 3-6 provides a ranking of states by number of biosolids composting facilities. Florida reports the highest number (29), followed by Washington State (25), New York (23), Maine (18), California (15) and Massachusetts (13).

Table 3-6: State rankings, highest to lowest, by compost feedstock: biosolids[1]

State	Biosolids Facilities Reported
Florida	29
Washington	25
New York	23
Maine	18
California	15
Massachusetts	13
Colorado	11
Texas	10
New Mexico	9
Pennsylvania	9
Montana	7
Nebraska	6
New Jersey	5
Oregon	5
Arkansas	4
Georgia	4
New Hampshire	4
North Carolina	4
Arizona	3
Indiana	3
Ohio	3
South Carolina	3
Vermont	3
Alaska	2
Idaho	2
Iowa	2
Kansas	2
Kentucky	2
Missouri	2
Rhode Island	2
Florida	2
Connecticut	1
Delaware	1
Maryland	1
Tennessee	1
Utah	1
Virginia	1

[1]40 states (80%) providing information

State Programs to Support Composting

Aside from some grant funds available from the US Department of Agriculture/Natural Resources Conservation Service for on-farm composting sites for equipment and some infrastructure via its EQIP program (Environmental Quality Incentives Program,[9] there are no federal grant or loan programs for composting facilities. About 25 years ago, in anticipation of closure of substandard landfills under the then new Subtitle D regulations, states started getting proactive about establishing composting infrastructure, especially for yard trimmings. As noted earlier, this is the timeframe when over 20 states adopted some type of disposal ban on yard trimmings (mostly between 1988 and 1996). As part of being proactive, state legislatures passed recycling goals, and state solid waste management agencies established grant and educational programs, and hired staff to service those programs and offer technical assistance. In many states, grants were funded by a per ton surcharge on municipal solid waste disposed.

Fast forward to today, and the picture is much different. That push to build composting and recycling infrastructure lasted through most of the 1990s, but then started to wane — especially as large, regional Subtitle D-compliant landfills replaced local landfills. Trash began flowing long distances by rail and truck, a scenario that still exists today. The US has no shortage of landfill capacity, although some individual states, e.g., Massachusetts, are running out. While some states still have recycling or waste diversion goals or mandates, only California actually has a mechanism to fine noncompliant jurisdictions.

The snapshot questionnaire asked states to provide an update on their programs to support composting. As can be seen in Table 3-7, states were asked to provide yes/no answers to the following categories: Grants; Loans; Technical assistance; Diversion mandates; Disposal bans; Outreach and education; and Operator training courses. Only 14 of the 39 states reporting have a grant program, and only 7 have a loan program. Most of the states reporting (34 of 39) provide technical assistance. Only 9 states have diversion mandates, and 18 of the 39 indicate their state has a disposal ban. Thirty-one states have outreach and education programs, and 15 states offer operator training courses.

This lack of funding via grants and loans to help establish or expand composting infrastructure is discouraging in light of the critical need for more organics processing capacity in the US. In addition, many states have cut the number of full-time employees dedicated to composting, i.e., state organics recycling specialists often are giving other programs to manage that are unrelated to composting and organics management. The Ohio Environmental Protection Agency and the California Department of Resources Recycling and Recovery (CalRecycle) stand out as two exceptions to this trend. Massachusetts, which is getting ready to enforce its commercial organics disposal ban in fall 2014, has contracted much of its technical assistance for composting to a nonprofit organization, so has not added staff at the agency level.

Model Public Policies

What Is A Model Program?

The Miriam-Webster dictionary defines model as "an example for imitation or emulation." When it comes to composting, which for the purpose of this discussion includes the generation, separation and collection of organic waste streams (organics) as well as the actual composting, what may be a model program in one location might never work in another location. For example, the rapid expansion of residential food scrap collection and composting in the Bay Area of California was due in part to jurisdictions already using 65- or 90-gallon carts for curbside green waste collection. Green waste is generated year-round in this region of the US, thus the curbside collection service is offered weekly. Households were permitted to add food scraps to their green waste carts.

Table 3-7. Programs to support composting: state-by-state summary

State	Grants	Loans	Technical Assistance	Diversion Mandates	Disposal Bans	Outreach & Education	Operator Training Courses
Alaska	No	No	Yes	No	No	Yes	No
Arizona	No	No	No	No	No	No	No
Arkansas	No		Yes	No	Yes	Yes	No
California	No	Yes	Yes	Yes	No	Yes	No
Colorado	Yes	No	Yes	No	No	Yes	No
Connecticut	No	No	Yes	Yes	Yes	Yes	No
Delaware	No	No	Yes	No	Yes	Yes	No
Florida	No	No	Yes	No	No	Yes	No
Idaho	No	No	Yes	No	No	Yes	Yes
Indiana	No	No	No	No	Yes	No	No
Iowa	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Kansas	Yes	na	Yes	No	No	Yes	Yes
Kentucky	No	No	Yes	No	No	No	Yes
Maine	No	Yes	Yes	No	No	Yes	Yes
Maryland	No	No	No	Yes	Yes	No	No
Massachusetts	Yes	Yes	Yes	Yes	Yes	Yes	No
Minnesota	Yes	Yes	Yes	No	Yes	Yes	Yes
Mississippi	Yes	No	Yes	No	No	Yes	No
Montana	No	No	Yes	No	No	Yes	Yes
Nebraska	Yes	No	Yes	No	Yes	Yes	No
New Hampshire	No	No	Yes	No	Yes	Yes	Yes
New Jersey	No	No	Yes	Yes	Yes	No	Yes
New Mexico	Yes	Yes	Yes	No	No	Yes	Yes
New York	Yes	No	Yes	No	No	Yes	No
North Carolina	Yes	No	Yes	No	Yes	Yes	Yes
North Dakota	No	No	Yes	No	No	Yes	Yes
Ohio	Yes	No	Yes	No	Yes	Yes	No
Oregon	No	No	Yes	No	No	Yes	No
Pennsylvania	No	No	Yes	No	Yes	No	No
Rhode Island	No	No	No	No	No	No	No
South Carolina	No	No	Yes	No	Yes	Yes	No
South Dakota	Yes	Yes	Yes	No	Yes	Yes	No
Tennessee	Yes	No	Yes	Yes	No	Yes	No
Utah	No	No	No	No	No	No	No
Vermont	No	No	Yes	Yes	Yes	Yes	Yes
Virginia	No	No	Yes	No	No	Yes	No
Washington	Yes	No	Yes	No	No	Yes	Yes
Wisconsin	No	No	Yes	No	Yes	Yes	Yes
Wyoming	No	No	Yes	No	No	Yes	No
States Reporting Programs (total of 39 states responding)	14	7	34	8	18	31	15

In other parts of the US, where green waste is generated seasonally, many jurisdictions offer fall leaf collection and have drop-off locations for yard trimmings open at other times of the year. Carts for yard trimmings are not distributed to households, thus only a handful of jurisdictions outside of geographic regions with year-round green waste generation are serviced with curbside collection of food scraps. Communities with curbside programs for residential food scraps may give households 13- or 20-gallon green carts for food waste setouts.

The bottom line is that what may be a model for food scrap diversion in communities where households already have carts for green waste — and year-round collection service — may not be a model at all for communities with seasonal green waste generation. But while the program skeleton may vary by geographic or climatic regions, other elements apply universally. Our intent is to highlight the models and practices that we believe apply universally.

Model Policies

In the late 1980s, with anticipation that many substandard landfills would have to be closed by 1994 (when EPA Subtitle D standards took effect), states around the country began passing laws to mandate municipal recycling programs. States established recycling goals and deadlines for meeting those goals. The most aggressive mandate was adopted in California; AB 939, passed in 1989, required jurisdictions to divert 25% of municipal solid waste from landfills by 1995 and 50%

by 2000. Jurisdictions not meeting those diversion rates could be subject to fines.

Many states also created funding programs to subsidize purchases of equipment required to implement curbside and drop-off recycling services, materials recovery facilities and sites for composting leaves, grass, brush and other yard trimmings. In a number of states, those funding programs — typically in the form of grants — were financed by surcharges on landfill tipping fees, e.g., $4/ton of the tipping fee was used to capitalize the grant programs.

During this period, states recognized that yard trimmings are generated and managed separately from typical household waste and thus could be collected and managed separately without a lot of difficulty. In addition, these materials are bulky and were perceived as using up valuable landfill space that should be "reserved" for garbage. As a result, about 20 to 25 states passed disposal bans on all or some materials that comprise yard trimmings (e.g., New Jersey only banned leaves from disposal). The net result of these legislative actions was a rapid rise in yard trimmings composting facilities in those states: 1988—651; 1990—1,407; 1992—2,981.[10]

By the mid 1990s, it became evident that the closure of local, substandard landfills did not require aggressive legislative action to save landfill capacity for trash and divert recyclable and compostable materials from disposal. Instead, large regional landfills replaced local disposal sites, and the practice of long-hauling municipal solid waste (MSW) out-of-state when local capacity does not exist became the norm. The net impact on stimulus programs for recycling and composting was that most states let their recycling and diversion goals and deadlines sunset, and in many cases, grant programs were minimally funded or eliminated. Most states with disposal bans for yard trimmings have continued that policy, although in recent years, several of those have been rescinded (Florida and Georgia).

There is no question that disposal bans and mandates with penalties imposed for noncompliance are very effective tools to establish organics diversion programs. Other public policy tools include local government incentives, grants and low-interest loans, streamlined state permitting for composting facilities to compost other organic waste streams such as source separated food scraps, and initiatives to increase compost purchases such as compost procurement by state Departments of Transportation.

Spotlight

The Town of Brattleboro, Vermont expanded its residential food waste collection pilot in May 2013 to service 800 households. The initial pilot began in summer 2012 and included 150 volunteer residences out of the 2,800 already serviced by the town's contract trash and recycling hauler, Triple T Trucking. A primary goal of the first pilot was to identify the best container for curbside pickup of compostables. In the expanded (and still voluntary) program, households place food scraps in either 13-gallon totes purchased from ORBIS or 21-gallon IPL carts for larger families. The totes are available from the town and participants are given a list of acceptable organic materials, with yard trimmings excluded, hence the smaller carts. Residents also have the option of using any container with a locking lid, such as 5-gallon buckets. All food scraps as well as pet waste, soiled paper, waxed corrugated and pizza boxes are accepted. This material is collected weekly using a modified sideloading recycling truck. "A third compartment was added for food waste," explains Robert Spencer, Executive Director of the Windham Solid Waste District, which includes Brattleboro. "WSWD has a dual stream materials recycling facility that processes commingled containers and commingled paper. The collection truck already had compartments for the containers and paper." The food waste and soiled paper are composted at WSWD's composting site, located at the District's closed landfill.

Figure 3-5: Brattleboro's composting program accepts a wide range of paper in addition to food scraps.

Source: Windham Solid Waste District (VT), www.windhamsolidwaste.org

Diversion Goals With Teeth

California's AB 939 not only mandated local jurisdictions to meet numerical diversion goals of 25% by 1995 and 50% by 2000, but also established an integrated framework for program implementation, solid waste planning, and solid waste facility and landfill compliance. Key components of AB 939 include:

- No sunset clause.
- Legislation was signed affording local jurisdictions time extensions to meet the mandate. Grant extensions of up to five years beyond 2000 were given to jurisdictions that were struggling to meet the mandate but had in place a plan to comply with the law within the period of the extension.
- Penalties for noncompliance with the goals and timelines set forth within AB 939 can be severe, since the bill imposes fines of up to $10,000 per day on cities and counties not meeting these recycling and planning goals.

California's AB 341 established a new statewide goal of reducing, recycling or composting 75% of the state's waste by 2020. CalRecycle's interim report (October 2013) on AB 341 delineates priorities for achieving the 75% goal. One is "moving organics out of landfills."[11]

Spotlight

Seattle: In 2009, Seattle's mandatory food waste participation program came into effect. The program directed single-family households to participate in either curbside food and yard waste collection or backyard composting. Households were exempted from mandatory green cart service if they state they compost their food waste at home. Over 99% of single family households in King County can now recycle food scraps and food soiled paper in their curbside yard waste bin. Starting March 30, 2009, Seattle Public Utilities began offering three sizes of green cart, adding the smaller Norseman 13-gallon ($3.60/month) and 32-gallon ($5.40/month) to its standard offering of 96-gallon ($6.90/month). The city also switched to weekly organics collection from biweekly, and began allowing all food scraps, including meat and dairy (vegetative food waste has been allowed since 2005). The City banned most types of polystyrene for foodservice in January 2009 and implemented requirements effective July 2010 that all food service products designed for one-time use be replaced with recyclable or compostable items. In Seattle, virtually all foodservice establishments now use compostable ware; even food trucks have bins to collect compostables. Dick Lily with the City of Seattle credits the wide availability of compostable service ware, which went from 70 products to 700 in 3 years, and now has reached more than 3,700, for enabling his City's packaging requirements to work.[12]

McDonald's | Northgate Mall | Dick's Drive In | Flair Taco — taco truck

Subway | Starbucks Coffee | Rancho Bravo — taco truck | Safeco Field

Figure 3-6: Seattle's composting infrastructure and foodservice packaging requirements have led to widespread implementation of composting collection systems throughout the city.

Table 3-8: State food waste bans and recovery requirements at a glance

	Connecticut	Massachusetts	Vermont
Affected food waste generators and date policy effective:			
>104 tpy	1/1/2014		7/1/2014
>52 tpy	1/1/2020	10/1/2014	7/1/2015
>26 tpy			7/1/2016
>18 tpy			7/1/2017
>0 tpy			7/1/2020
Generators affected if organics recovery facility is located within:			
20 miles	x		Through 2020 [1]
No exemption for distance		x	
Terminology	Source-Separated Organic Material	Commercial Organic Material	Food Residuals
Sectors affected	Commercial and industrial venues	Commercial, industrial, and institutional venues	All generators, including residential sector

tpy = tons per year. [1]Starting in 2020, all food residual generators must recover food residuals regardless of distance from organic material recovery facilities.
Source: Institute for Local Self-Reliance, 2014.

Spotlight

San Francisco has the largest, most established urban organics recovery program in the US. The program serves both the commercial and residential sectors, which together generate over 600 tons of food scraps and other organic materials each day.[13] These materials are processed at the Jepson-Prairie Organics Composting Facility located in a rural area 70 miles north of San Francisco. The program's great success is due in part to a partnership among the City of San Francisco, its residents and commercial and institutional sectors, and the City's contracted hauler, Recology.[14] California's 1989 AB 939 law requiring municipalities to divert 50% from landfills by 2000 – or face a $10,000 fine if they didn't develop a plan for this diversion level – was also a factor in the program's success, as it provided a favorable climate for the pursuit of the City's ambitious diversion goals.[15]

Organics collection was first implemented in the commercial sector, starting with the wholesale produce district in 1996 and eventually reaching commercial establishments throughout the city. In 1998 and 1999, pilot programs were put in place to test the residential collection of food scraps and soiled paper, in addition to yard trimmings. The residential program then expanded to single-family households throughout the city over a period of four years. Participation became mandatory in October 2009. The first of its kind in the US, the ordinance requires residents and businesses to separate organics and recyclables from the garbage. San Francisco has a three-stream collection system for the residential sector; compostable organics, single-stream recyclables, and trash are collected separately in color-coded carts. Organics are collected weekly on a year-round basis, as are recyclables and trash, the latter two in a separate split-bodied, side-loading compactor truck. The City distributes two types of kitchen containers to facilitate source separation of compostables. It also instructs residents to use only compostable liners, such as paper bags or compostable plastic bags, which are available at more than 80 retail outlets in San Francisco.[16] Collected organics are taken to a transfer station run by Recology. The material is then loaded into trailers and delivered to the Jepson-Prairie facility.[17] The commercial sector is about 95% compliant with the mandatory composting participation requirement (>14,000 participating). Over 95% of multifamily buildings are compliant (about 8,500).[18]

Figure 3-7: The City of San Francisco was the first major US city to provide weekly curbside collection of food scraps. There are now more than 180 residential programs.

Source: City of San Francisco

Statewide Disposal Bans

Since the flurry of statewide disposal bans on yard trimmings adopted in the 1990s, there has been little to no activity in terms of bans on organic waste disposal. Recently, however, several New England states — Vermont, Connecticut and Massachusetts — have adopted bans on source separated organics. See Table 3-8. Vermont's law applies to all municipal organic waste streams, including residential; Connecticut and Massachusett's laws only apply to the commercial and institutional sectors. In addition to keeping methane-emitting organic wastes out of the landfill, the disposal bans also help ensure a flow of organics to composting and anaerobic digestion facilities.

Connecticut: Modifications to Connecticut's source separated organics diversion rule were signed into law in June 2013. Public Act 13-285, "An Act Concerning Recycling and Jobs," inserted substitution language in the original rule passed in 2011 that specifies dates for compliance.[19] A primary motivation was to assure developers and operators of composting and anaerobic digestion projects that source separated organic materials would be available for processing if they opened and/or expanded facilities in Connecticut. "On and after January 1, 2014, each commercial food wholesaler or distributor, industrial food manufacturer or processor, supermarket, resort or conference center that is located not more than 20 miles from an authorized source separated organic material composting facility that generates an average projected volume of not less than 104 tons/year of source separated organic material" has to source separate these materials and ensure they are recycled at "any authorized" source separated composting facility with capacity. "On and after January 1, 2020," all generators listed in the categories above that are located not more than 20 miles from an authorized facility must comply — regardless of how much organic waste they produce.

Massachusetts: In July 2013, the Massachusetts Department of Environmental Protection announced — in draft form — a ban on direct disposal of food waste in landfills or incinerators. This applies to entities that dispose of one ton or more per week of food waste, such as supermarkets, universities, hotels, hospitals and other larger-scale generators. The ban is scheduled to go into effect in October 2014.[20] The ban provides assurance to the composting and anaerobic digestion industries that feedstock will be available, which helps in project financing. Low interest state loans also will be made available to project developers, although these are targeted primarily at anaerobic digestion projects.

Vermont: The Act 148 Universal Recycling Law, passed in June 2012, focuses on recyclables and organics.[21] The law uses a phased approach to compliance to allow development of infrastructure. Act 148 bans disposal of mandated recyclables by 2015; leaves and yard trimmings and clean wood by 2016; and food residuals by 2020. The mandates parallel collection by facilities/haulers that collect municipal solid waste (MSW); collection for leaves and yard trimmings is required by 2015/2016, and food residuals by 2017. There also are phased in mandates for larger generators to divert food residuals, if there is a facility within 20 miles, by the following deadlines: 2014 for generators >104 tons/yr; 2015 for generators >52 tons/yr; 2016 for generators >26 tons/yr; 2017 for generators >18 tons/yr. By 2020, all food residuals, including from households, must be diverted with no provision for distance. Act 148 also provides incentives to divert materials and choices for managing waste by requiring municipalities to implement variable rate pricing (e.g., pay as you throw, discussed below) for MSW from residential customers, based on volume or weight, by 2015.

Disposal bans continue to emerge. For example, on December 19, 2013, the New York City Council passed legislation requiring commercial food scraps from the largest food service establishments to be recycled. And on December 30, outgoing Mayor Michael Bloomberg signed the bill into law. The legislation, Introductory No. 1162-A, requires restaurants and other food service establishments of a certain size or number within New York City, and other commercial operations that generate significant food waste, to source separate their organic waste by July 1, 2015.

In Rhode Island, legislation was introduced in early 2014 that would institute similar requirements as Connecticut. Nonresidential generators of food scraps and organic waste would be required to divert the material from the landfill, beginning with the largest-volume producing facilities in 2015, and phasing in smaller generators over subsequent years. The bill states that as of 2015, nonresidential generators of 52 tons of organic waste per year (1 ton/week) must divert that material to an organics recycling facility, as long as a permitted facility is located within 20 miles of the generator, and is willing to accept the material. Another bill was introduced in Maryland during the 2014 legislative session but failed to pass. The Maryland bill targeted large-scale generators of 104 tons/year or more with requirements for separation if receiving facilities existed within 30 miles.

Composting Regulations

As noted earlier, states are starting to modify their regulations to facilitate composting of source separated organics. Massachusetts, Ohio, Oregon and Washington are examples of several states which recently revised composting rules to create distinct categories for source separated organics that include food waste. The permitting and site approval process in this tier is designed to be more streamlined and less costly. One reason for the lack of more facilities accepting food scraps is an inadequate regulatory structure to facilitate the development of new operations. In ILSR's August 2012 survey of Maryland composters, regulations and permitting were the most frequently cited challenges to facilities' financial viability and their opportunities for expansion.[22]

In 2013, the US Composting Council released a Model State Compost Rule Template to guide states on developing and/or revising composting rules for source separated organic waste streams. The template was developed by a stakeholder group comprised of state composting regulators, composters, advocacy groups and consultants.

Grants & Loans

Fewer states offer financial assistance in the form of grants to composting programs than had traditionally been the case in the 1990s, as was discussed in the national snapshot summary earlier in the section (Table 3-7). One state that continues to provide grants is Ohio. The Ohio Environmental Protection Agency's Market Development Grant (MDG) program provides financial assistance to recycled material processors and product manufacturers operating within Ohio.[23] Funding is available to purchase equipment and conduct applied research and development that will strengthen markets for recyclable materials. Eligible projects may target postconsumer, post-commercial and post-industrial recycled material. Eligible applicants include Ohio cities with a population greater than 50,000; counties and solid waste management districts or solid waste management authorities. These applicants apply on behalf of local businesses. The maximum grant amount is $250,000 for recycling market development projects. Testing, research and development projects may receive a maximum of $75,000. Applicants must demonstrate that the local business will provide a financial contribution to the project equal to the amount requested in division grant funds. The match should be a cash contribution or a documented line of credit dedicated to the project.

California has announced the development of a new Organics Grant Program. The Governor's Draft Budget, released January 2014, includes $30 million in fiscal year 2014/15 for CalRecycle to provide financial incentives for capital investments in composting/anaerobic digestion infrastructure and recycling manufacturing facilities that will result in reduced greenhouse gas emissions. Grants and loans will be targeted to build or expand the organics recovery infrastructure or to reduce food waste in California. About $15 million will be available for "organic grants" (up to $3 million maximum per award) and another $10 million for a greenhouse gas reduction loan program. The proposed scoring criteria for grants will favor projects with high greenhouse gas reduction potential and tonnage of material diverted from disposal. The competitive loan program will offer up to $5 million loans with a 25% required match at a 4% interest rate. Applications are expected to be available May 2014 with a due date of January 2015. Eligible projects will include construction, renovation or expansion of organic facilities and eligible costs will include purchase of equipment and machinery as well as real estate improvements.[24]

Hauler Incentives

Local jurisdictions use tools such as exemptions from solid waste taxes and fees for waste haulers with programs to collect and divert recyclables and compostables. One of the first, to *BioCycle*'s knowledge, was when the City of San Jose (CA) created recycling incentive fees for contracted haulers in the early 1990s. Among the stipulations was that the contractors had to pay their own disposal fees for wastes not recycled (about $30/ton at the time), encouraging them further to minimize landfilled wastes. San Jose also let the contractor retain all the revenues from the sale of recyclables.[25]

More recently, local solid waste agencies have been offering a reduced tipping fee at their composting facilities for source separated loads of organics. This applies primarily to the commercial sector (versus contracted franchise haulers who typically pay a negotiated tip fee) to create an incentive for the haulers to offer organics collection. For example, in Charleston County, South Carolina, the tipping fee for food and organic waste at the composting facility is $25/ton, compared to $66/ton for traditional waste that is dumped at the landfill.[26] In San Diego (CA), there is about a $30/ton differential between loads of commercial source separated organics and trash.[27]

Variable Rate Fees For Collection Service

A tried-and-true policy to incentivize participation in residential recycling and composting programs are variable rate fees, most commonly referred to as Pay-As-You-Throw (PAYT), although the US EPA is trying to rebrand these programs as SMART (Save Money and Reduce Trash).[28] Typically, trash collection is priced at a higher fee than recyclables and source separated organics, and in some cases, there is no fee for recyclables collection. Households typically have a choice of varying sizes of trash containers, with the collection fee reduced as the size of the container is reduced.

When the City of Portland, Oregon rolled out its new residential curbside collection program in 2011, the frequency of trash collection was reduced to every other week, with recycling and compostables collection on a weekly basis. All household organic wastes, excepting for diapers and pet waste, can go into the organics cart. Garbage roll carts come in 20-gallon, 35-gallon, 60-gallon and 90-gallon sizes and are provided by a household's selected garbage and recycling company. Weekly composting and recycling are available with standard garbage service. The monthly fee for biweekly trash collection and weekly composting and recycling service is as low as $24.75 for a 20-gallon rolled cart and as high as $43.30 for a 90-gallon cart.[29]

In the City of San Francisco, the basic monthly rate for the weekly collection of a 32-gallon trash container has been $27.91. The blue (recycling) and green (organics) carts are picked up at no additional charge. Households that recycle enough to consistently reduce their weekly trash volume to 20-gallons or less, have been eligible for a 23% discount off the standard 32-gallon can rate.[30]

To date, Portland is the only city in the US that has every-other-week trash collection. The practice has become more common in European countries, and has been adopted by some municipalities in Canada (e.g., Toronto). Less than weekly trash collection provides a direct incentive to place all organic wastes in the compostables cart to avoid generation of odors and flies in the trash cart.[31,32]

Compost Markets: Purchasing Incentives, Specifications

Compost competes in the marketplace with traditional soil amendment and fertilizer products. Compost adds needed organic matter to the soil and provides critical properties such as moisture retention, improved infiltration of surface water, slow-release nutrients and disease suppression. A rapidly growing market for compost-based products is in green infrastructure applications such as bioretention swales, green roof media, and erosion and sediment control.

Over time, compost has been recognized in some federal procurement guidelines developed for "green" and/or biobased products. For example, the US Department of Agriculture's BioPreferred program includes a biobased product label for compost. The USDA BioPreferred program has two major initiatives: Product Labeling, where USDA certifies and awards labels to qualifying products to increase consumer recognition of biobased products; and Federal Procurement Preference, where USDA designates categories of biobased products that are afforded preference by Federal agencies when making purchasing decisions (www.biopreferred.gov). The Biobased Product Label verifies that the product's amount of renewable biobased ingredients meets or exceeds the prescribed USDA standards. Biobased products are goods composed in whole or in significant part of agricultural, forestry or marine materials. Ongoing lab testing and monitoring by the USDA assures the label standards are maintained. Compost, in the Mulch and Compost Materials category, must have a minimum biobased content of 95%.

Spotlight

C&C Peat Company: In 2012, the C&C Peat Company in Okahumpka, Florida earned the USDA Certified Biobased Product Label for its Regular AA Compost.[33] C&C Peat is a family-owned and operated horticultural business established in 1981 to sell potting soil and other soil amendments. It started producing compost in the early 2000s, and ramped up production and quality when it built a new facility in 2007. Because the company had far more composting capacity than a market for its compost products, it sought out government bids such as Department of Transportation projects. C&C Peat learned quickly that being certified as biobased assisted in winning more bids.

Spotlight

Washington State Post-Construction Soil Quality and Depth BMPs: The BMP establishes the following minimum soil quality and depth standards, which are met by amending soils with organic matter (e.g. compost): "A topsoil layer with a minimum organic matter content of 10% dry weight [30-40% compost amendment by volume] in planting beds, and 5% [15-25% compost amendment by volume]… in turf areas, and a pH from 6.0 to 8.0… or matching the pH of the original undisturbed soil. The topsoil layer shall have a minimum depth of eight inches…"[36] King County, Washington is one jurisdiction that has adopted this guideline as policy in King County's Code 16.82 – "Clearing and Grading Regulations," which can serve as a model for other local governments.[37]

Spotlight

Leander, Texas requires compost for new turfgrass plantings: Originally implemented as a water conservation ordinance, the current regulation promotes soil and watershed health by maintaining appropriate water consumption levels and creating more sustainable landscapes through minimum compost content and soil depth requirements. All new landscapes are required to have a minimum of 6 inches of soil depth in areas planted with turfgrass, consisting of 75% soil blended with 25% compost.[38]

Spotlight

Greeley, Colorado requires new lawns to incorporate compost: For over a century, the City of Greeley, Colorado has enforced water restrictions but in recent years has realized the added benefit of compost-amended soils.[39] Greeley's Public Services – Section 14.08.195 through 14.08.310 requires anyone installing a new lawn to use 4 cubic yards of compost per 1,000 square feet of area, incorporated at a depth of 6 inches.[40] According to Ruth Quade, the City's Water Conservation Coordinator, "you can drive through a new development (in March/April) and tell just from appearance the lawns that were amended and the ones that weren't."

Spotlight

Montgomery County, Maryland's RainScapes Program incentivizes compost-amended soils: Montgomery County is implementing policies to reduce non-point source pollution and enhance stormwater management through its RainScapes Rewards Rebate program. The initiative was set forth to comply with the EPA's National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit Program, as part of an overarching effort to meet the goals of the Clean Water Act.[41] The RainScapes Rewards program currently calls for amending soil with compost as a best management practice for rain garden projects, and requires a 3-inch layer of compost for all conservation landscapes.[42] RainScapes offers property owners a substantial rebate for low impact development (LID) installations: up to $2,500 for residential properties, and up to $10,000 for commercial/institutional/multifamily properties. The program has been replicated by the City of Rockville and City of Gaithersburg in Maryland.[43] The Montgomery County Department of Environmental Protection is the lead department coordinating a multi-agency effort to comply with the stormwater permit issued to the County by the Maryland Department of the Environment.[44]

Figure 3-8: Montgomery County, MD's RainScapes Program offers substantial rebates to property owners who install rain gardens and other conservation landscapes. The program incentivizes the use of compost.

Credit: Montgomery County DEP RainScapes Program

At the state level, a number of Departments of Transportation (DOT) have specifications for compost-based products for erosion and sediment control and storm water management. In almost all cases, the specifications require that the compost be certified under the US Composting Council's Seal of Testing Assurance (STA).

At the local level, municipalities — as part of their compliance with the federal Clean Water Act storm water rules — are utilizing green infrastructure tools such as green roofs and bioretention swales to manage storm water. In July 2013, Washington, DC's Department of Environment (DDOE) finalized new storm water regulations that rely in part on storm water retention.[34] In its best management practices (BMP) guide for achieving water retention, compost is an element of several of the BMP groups, including green roof growing media, bioretention media, compost-amended grass channel (amended to a one foot depth), dry swale filter (compost-amended on top 4-inches), constructed wetlands (compost-amended planting holes) and compost-amended trees. In DDOE's filter media criteria for bioretention, organic matter is a required constituent in the soil media; "well-aged clean compost" is used to describe organic matter.

In Washington State, the BMPs in the Washington State Department of Ecology (DOE) *Stormwater Management Manual for Western Washington* are taking effect as town and county governments around western Washington update their local stormwater codes. These local updates are required to comply with NPDES ("National Pollution Discharge Elimination System") municipal storm water permits, which are issued by DOE as required by the federal Clean Water Act. Most western Washington towns and counties are including soil best practices equivalent to the State's BMP T5.13 "Post Construction Soil Quality and Depth," which requires preserving site topsoil and vegetation where possible, reducing soil compaction, and amending disturbed soils with compost to restore healthy soil functions.[35]

A small number of cities are requiring new lawns to incorporate compost as a water-saving measure (Leander, Texas, and Greeley, Colorado). Montgomery County, Maryland's RainScapes Program incentivizes the use of compost in raingardens and new landscapes. These innovative programs and policies could easily be adopted across the country.

Measurements and Financial Assessment Tools

Having the tools to measure the effects of policies that encourage organics diversion is critical to tracking progress and assessing program effectiveness. State municipal solid waste characterization studies create a baseline for how much of the waste stream is disposed, recycled, composted and combusted. These studies guide and prioritize policy development.

CalRecycle, California's state solid waste management agency, periodically conducts statewide waste characterization studies to update information on the types and amounts of materials in California's waste stream. It has just launched its 2014 study, which will be critical in guiding policy and program development to meet the state's 75% waste diversion goal by 2020. The most recent waste characterization study was conducted in 2008.[45] Organics comprised almost a third of the state's overall disposed waste stream; food waste represented the largest portion of waste still disposed (15.5% or 6.2 million tons). This data not only measures the progress made in organics diversion since the previous waste characterization study, but also indicates that more had to be done policy-wise to meet California's 75% diversion goal as well as its ambitious greenhouse gas emissions reductions established in the state's Global Warming Act of 2006.

"To achieve our 75 percent goal, CalRecycle estimates California will need to move about 22 million more tons of organics and other recyclables from disposal to recycling annually," stated CalRecycle Director Caroll Mortensen in a March 2013 *BioCycle* article.[46] "Aside from other challenges this presents, including dramatically steeper commitments by the residents and businesses of our state, additional diversion of this magnitude will require doubling the current organics infrastructure and expansion of recycling and remanufacturing in California." As mentioned above, in his proposed budget for 2014, California Governor Jerry Brown included $30 million in greenhouse gas reduction funds to distribute through a competitive program with a focus on new and expanded California composting and anaerobic digestion facilities.[47]

Seattle Public Utilities completes an annual recycling report for the city, as part of its compliance with a 2007 City Council Resolution that set Seattle's goal to reach 60% recycling of municipal solid waste (MSW) by 2012, and 70% by 2025.[48] In February 2013 the city council adopted revised recycling goals in its "Seattle's Solid Waste Plan 2011 Revision." The revised goals for municipal solid waste (MSW) are to: recycle 60% by the year 2015, and to recycle 70% by 2022. Seattle's recycling rate is the percentage of MSW diverted from the landfill by reuse, recycling and composting. Seattle's 60% goal combines separate goals for each of the four primary MSW sectors: single family residential, multifamily residential, self-haul, and commercial. The specific recycling goals for each sector are different since waste stream materials, opportunities to recycle, and likelihood of participation vary between the sectors. This level of detail is a useful tool in measuring the effectiveness of service, outreach and education. It measures organics managed onsite by Seattle residents (yard debris and food scraps) as well as all garbage, organics, and recyclables that businesses and residents set out for collection and all garbage, organics, and recyclables hauled to the city's recycling and disposal stations for reuse, recycling or composting.

Model Programs: Organics Separation, Collection & Composting

The very first step when establishing an organics diversion program is to take inventory of the community assets that will facilitate successful deployment of an organics diversion and composting program. By their nature, organic wastes can be unruly. Tree limbs and branches are bulky. Fallen leaves are compact and dense. And food waste is wet, heavy and can liquefy very quickly. Therefore determining how to separate, contain and collect and transport these materials is critical to the success of every organics diversion program.

Organic waste streams have to travel from the point of generation to the point of processing (composting, anaerobic digestion, livestock feeding, etc.). Ideally, the distance between those two points is as minimal as possible to lesson the carbon footprint of organics diversion. Composting where the organics are generated is ideal, whether that is in a residential backyard, a neighborhood community garden, school grounds, community composting facility, or institutional and corporate campuses.

For a host of reasons (e.g., space and labor constraints, urban density) composting on-site or in the neighborhood where the organics are generated isn't always feasible. Where it is feasible, most neighborhood sites do not accept discarded meat and dairy products or compostable soiled paper or other food packaging. Off-site composting will thus be needed to provide additional capacity and accept a wider range of materials. This is where community assets are inventoried, starting with composting options as close to the point of generation as possible. These options may include:

- Municipal properties with access to equipment such as front-end loaders, e.g., landfills with closed cells, public works yards
- Existing yard trimmings and/or biosolids composting site that can be modified/upgraded to receive additional organics wastes such as food scraps
- Commercial properties such as nurseries, wood recycling and landscaping yards
- Agricultural operations
- Industrial operations such as quarries, warehouses
- Brownfields

As with any project, local zoning and public health regulations, and state permitting requirements — including solid waste, air, water and storm water — need to be front and center as composting sites are developed or expanded.

Examples of successful composting facilities are plentiful. And feedstocks composted range from the typical MSW and wastewater organics (leaves, brush, grass clippings, food scraps, soiled and nonrecyclable paper, biosolids) to the "exotic" (road kill, whales, pizza dough). Each scale of composting has its own set of successful composting practices, all based on the same fundamental composting principles outlined elsewhere in this report. Model composting projects are ones that no matter the scale, the operators and owners respect and follow the principles of composting. Years ago, *BioCycle* coined the phrase, "there is no good excuse for a poorly run composting facility." For example, one of the most frequently cited causes of facility failures are odors; if operators are following the core principles and practices, persistent nuisance-causing odors should not be generated.

What gets in the way of successful operations typically fall into several general categories of pitfalls that include: Finances (leading to a host of potential problems, including excess reliance on tipping fees and lack of necessary equipment); untrained operators; contaminated feedstocks; site location (including proximity to neighbors); and political whims. These pitfalls can be hard to avoid, especially in the current climate where the public sector relies on the private sector to build, own and operate the facilities without providing financial incentives other than long-term contracts for feedstocks. These contracts are typically bid competitively, and may be awarded on the lowest cost per ton basis to compost the organics. This can lead to cutting corners on necessary capital investments and/or site improvements.

The reality of facility siting has led many composting facility developers to select more remote sites where land may be less expensive. Environmental and public health impacts still need to be addressed, and experience has shown that no matter how remote the site, there will always be a concerned public that needs to be engaged to win support for the project. Remote sites also require further transport of the wet and heavy organic materials, which has its own set of costs and environmental impacts.

In short, source separation of organics, provides tangible rewards for changing behavior. Households and businesses can witness their trash shrinking by downsizing to smaller carts or less frequent set-out in the case of households, and downsizing from compactors to small dumpsters that are serviced less frequently in the case of businesses and institutions. When households become involved in composting, either at home or in the community, they reap the further reward of the finished compost.

The remainder of this section is divided into residential organics collection and composting and commercial and institutional organics collection and composting. For both sectors, minimizing the amount of organics generated is a fundamental first step in any model program.

Residential Organics

Source Reduction

In terms of yard trimmings, established practices for source reduction include grass cycling by leaving grass clippings on the lawn, and mulching leaves where they are not too thick on the property. Lawnmowers can be equipped with mulching mower blades to facilitate grass cycling and mulching.

Source reduction on the food scraps side is just starting to be addressed at the household level. Government agencies and some nonprofit organizations are educating consumers about changing their food purchasing habits to reduce wasted food, as well as improving understanding of "sell by" and "use by" dates.[49] In 2011, the US EPA laid the groundwork for an initiative to address household food waste, building on what the agency had learned in its Food Recovery Challenge targeted at businesses and institutions. The first step in reducing the amount of wasted food is measuring what gets thrown away. This immediately builds awareness of how much food is going to waste, and thus is a strong motivator to address the practice. US EPA's "Food: Too Good To Waste" (FTGTW) program has been rolled out on a pilot basis in

Figure 3-9: Contra Costa County, California has offered a $50 price discount coupon and a $20 mail-in rebate (program now expired) for an electric lawn mower through a local hardware store.

Source: www.co.contra-costa.ca.us/depart/cd/recycle/mower.htm

Figure 3-10: When left on the lawn, grass clippings provide the soil with valuable nutrients. Many communities have developed "Don't Bag It" lawn care outreach programs.

Credit: Montgomery County, Maryland, www.montgomerycountymd.gov/SWS/grasscycling/

Figure 3-11: The US EPA's new "Food: Too Good Waste" program aims to reduce wasteful household food consumption by focusing on social marketing incentives and messages to consume less by wasting less food.

Credit: US EPA

communities.[50] From the FTGTW pilot projects, tools aimed at enabling other communities to launch their own programs were developed. These include: A research report, implementation guide, shopping list template, produce storage guide (because the pilots found a lack of knowledge among consumers), and posters that tell the story of why food waste is important. The tool kit includes an "Eat Me First" refrigerator box that encourages eating up what is about to go past its prime. Saving money is another motivator: According to USDA, a family of four can save approximately $2,275 a year by making simple changes in how they shop and store food.

Household Participation

Experience in West Coast cities has shown that even when households are given the opportunity to add food scraps to their green waste bin, they may not participate. Reasons for lack of participation include the "yuck" factor (food scraps, when stored, can get wet, slimy and have an odor); lack of awareness that the opportunity exists, despite ambitious outreach and education programs; no financial motivation; and no penalties for choosing not to participate. As noted in the policies section, variable rate fees for trash, as well as less than weekly trash collection, push households to increase set out of food scraps. The City of Hutchinson, Minnesota, for example, has biweekly garbage collection that is offered as part of an aggressive PAYT fee structure.[51] That approach is credited with bringing the city high participation in the organics diversion program. Many municipalities also provide households with a 2-gallon container for use in their kitchens, along with an initial supply of compostable liners.

Drop-off Locations

Increasingly, urban dwellers have an opportunity to drop their household food scraps off at neighborhood farmers' markets, community gardens and public transit locations. In New York City, for example, one community garden has a membership solely for residents that want to bring their food scraps. They volunteer to assist with composting, or pay a higher fee to only drop off. Many of the Greenmarkets in New York City also are collection points for household food scraps.[52] Most of these materials are taken to a handful of stand-alone, medium-scale community composting sites in Manhattan, Queens and Brooklyn. With more than 200 community composting sites (primarily at community gardens) and 8 to 10 medium-scale operations in the five boroughs, New York City is a unique model. Much of this work has been supported by the NYC Department of Sanitation's NYC Compost Project.[53] Composting methods range from a single tumbler or 3-bin systems at community gardens to windrows and aerated static piles at some of the medium-scale sites. The latter are receiving upwards of 5 tons/week of household food scraps.

Figure 3-12: The nonprofit GrowNYC started the Greenmarket Food Scrap Collection program, which allows residents to drop off their food scraps at 35 of the 54 GrowNYC Greenmarket locations. The scraps go to local community compost sites, almost all of which are supported by NYC's Department of Sanitation's NYC Compost Project.

These food scraps drop-off opportunities are happening in smaller communities as well. The Western Lakes Superior Sanitary District based in Duluth, Minnesota has had several drop-off locations for food scraps and approved compostable products for a number of years. Brattleboro, Vermont had a drop-off site for many years before it started its residential curbside service for food scraps. Use of drop-off sites for household organic waste streams is not new. Thousands of communities in the US have drop-off locations for only yard trimmings (and may also have fall leaf collection).

Expanding Collection Access: Private Subscription Services

Over the past few years, entrepreneurs have started offering subscription services to households for food scraps collection. One of the first was Compost Cab in Washington, DC.[54] Households pay a fee for weekly service; they are given 5- to 7-gallon buckets (a full one is swapped out for a clean one) and can include all food scraps. Some of the companies include delivery of a free 5-gallon bucket of compost as part of the package. As with the growing number of food scraps drop-off locations, private subscription services help create the food scraps diversion "behavior," which is beneficial if/when municipalities begin to offer curbside collection of residential food scraps. These subscription services have begun to expand rapidly around the country, including one co-owned by a 9-year old who uses a bike with a trailer to collect food scraps and bring them to homes in the neighborhood with backyard composting bins![55]

Community Composting, Community Benefits: The growing trend of drop-off opportunities in communities of varying sizes, especially where residents don't have an opportunity, or time, to compost at home, is building a sense of community and pride. Community composting and its related benefits is discussed in Section 2. One trend not covered in Section 2 is the growing number of food rescue organizations and food banks planting community gardens and composting food scraps from the food bank, and using the compost in the gardens. This is taking place at the Mid-Ohio Food Bank in Columbus, where there also is a kitchen onsite where community members can learn cooking skills with fresh ingredients.

Overall, households that participate in the subscription services and drop-off programs are more cognizant of the importance of keeping contaminants such as plastic bags and twisty-ties out of the food scraps. This is especially true if these same people are using the compost produced, or are volunteering at a community composting operation. In a Commentary in *BioCycle*, David Buckel, a community composting consultant in New York City, referred to composting as the "gateway drug":

> "'Community composting' is a term for a type of composting that recycles organic material as locally as possible, and is scaled to fit a community-based environment like a neighborhood or college. …. They [community composters] rely on urban volunteers who enjoy outdoor manual labor that greens their community. Many volunteers get hooked on composting, the gateway drug to the broader world of recycling, because composting is one of the few volunteer jobs that gets people directly involved in creating value with recyclables. And they become vigilant about contaminants because they are picking stuff out of tons of material with their own hands."[56]

Commercial, Institutional Organics

The archives of *BioCycle* are filled with how-to information on establishing and managing source separation and composting programs for commercial and institutional organics. In addition, a number of toolkits are in the public domain. Some are older, but still very applicable, such as the State of Massachusetts "Supermarket Composting Handbook,"[57] and the Center for Environmental Technology's "Composting In Restaurants and Schools."[58] The US EPA has a Food Waste Management Tools and Resources website where users can download all types of documents and on-line

Figure 3-13: NRDC produced this guide to to assist stadiums and arenas in increasing their diversion of food and yard wastes for beneficial use.

Credit: Natural Resource Defense Council, www.nrdc.org

Figure 3-14: The Food Waste Reduction Alliance developed this toolkit to help guide companies through the basic steps in food waste reduction.

Credit: Food Waste Reduction Alliance, www.foodwastealliance.org calculators, e.g., a Food Waste Management Cost Calculator and Food Waste Audit log.[59] In spring 2014, two toolkits were released, one by the Food Waste Reduction Alliance that focuses on the food supply chain,[60] and another by the Natural Resources Defense Council focusing on sports venues.[61] Many local jurisdictions also have toolkits, as well as signage and other program implementation materials, which can be downloaded and modified for other commercial and institutional organics diversion programs.

The following is a selection of several lessons learned when it comes to designing source separation programs to divert commercial organics, either on-site at the location where they are generated or at off-site composting facilities.

Reduce and Donate

The most effective source separated organics programs start with source reduction, and then donation of edible food. The City of San Diego Environmental Services Department (ESD), as part of its education of participants in the City's food waste collection and composting program, emphasizes the social and economic benefits of donation of edible food — instead of adding it to the food scrap collection cart. Explains program manager Ana Carvalho of San Diego's ESD: "In a recent analysis of our program we calculated that if at least 15 percent of current participants' food waste was edible and diverted for reuse instead of composting, approximately 666 tons/year of food would be available for food insecure residents and/or other reuse options such as animal feed. Based on the US Department of Agriculture estimate of 1.2 lbs of food/meal, that excess 666 tons of edible food could be turned into 1,109,464 meals/year. In other words, by donating just 15 percent of edible food scraps, we could feed 2.5 meals/individual/day to the 448,000 food insecure individuals estimated by the County of San Diego for 2010. … If all program participants had donated 15 percent of their edible food they would have avoided $14,652/ year on tipping fees at the Miramar Greenery where collected food scraps are composted. Furthermore, Feeding America's Map the Gap 2012 estimates that the cost of a meal in the County of San Diego is $2.68. The savings generated by those 1,109,464 meals/year are equivalent to $2,973,363/year." [62]

No Magic Bullet

In almost all cases, source separated organics diversion programs will be replacing traditional trash disposal practices where the generators merely throw everything into the same container inside, which is then taken outside to a dumpster or trash compactor. Many businesses and institutions have been doing some sorting of recyclables, so are already engaged in a limited amount of source separation behavior. For the most part, however, initiating a source separation program will be a new behavior for everyone involved, from top management to the food and custodial services — and to the waste hauler servicing these establishments.

As interest has grown in food waste diversion — and more recently as a result of organics bans or mandates — a wide variety of technologies and systems is being marketed to generators. Some can be paired with composting, such as food dehydrators and pulpers; others use a combination of equipment (and in some cases enzymes) to slurry the food waste and send it to the sewers.[63] These systems are marketed as alternatives to composting, pitched as eliminating the need to store separated food waste on-site, and pay for hauling costs. At this point, this is a buyer beware situation, with research required on the part of the potential purchaser.

On-site composting systems also are marketed as an option to manage source separated organics. There are many successful on-site composting programs; the majority are at institutions such as college campuses where there is a source of wood chips and yard trimmings to mix with the food waste, and often adequate space for the compost to cure prior to use.

The lesson learned over the years with any equipment marketed to manage source separated organics is: there is no magic bullet. Each situation needs to be carefully evaluated to see if the application is a good fit.

Separation Matters

Anything that ends up in the source separated organics stream that is not an organic material in origin (or in the case of compostable products, manufactured to biodegrade as an organic material), is a contaminant. Common contaminants include film plastics, packaging, twisty ties, latex gloves used in food service and glass. There are costs associated with contaminants in the organics stream, primarily related to their removal and the impact on compost product quality. Some programs allow generators to include wet and soiled paper, waxed corrugated and compostable products. Some only allow food waste. All programs spend a lot of time and effort on training kitchen and custodial staff and collection services about source separation.

An effective tool for training is to photograph source separated organics that have contaminants and/or materials not accepted (photos are taken of the contents in the cart or outside container or upon unloading at the composting site) and immediately email them to the generator. This enables the manager at that establishment to identify the source and do follow up training with employees. One composting company makes sure that any new generator being added to the program is serviced last on the collection route for the first several weeks so that those loads are easy to identify (first off the truck) and examine for contaminants. Other collection and composting companies may reject loads, or else charge the generator a premium for directing a contaminated load to a disposal facility.

Educate and Re-educate

Continual training is necessary to ensure that employees are properly separating out contaminants/materials not accepted and that they are recovering as much of the food waste that is generated. Other factors that need to be addressed with employee training are creating signage in multiple languages, and maximizing the use of pictures of allowed/not allowed materials on the signage. Also important is positive reinforcement and recognition by management to reward the source separation/participation behavior. Bringing employees to the composting site, where they can see how the food scraps they separate are being transformed into compost, pays huge dividends in enthusiasm for the program and proper separation. This also provides generators a first-hand look at the negative impact of contaminants.

Cost Matters

There is a cost associated with establishing effective source separation programs, especially the investment in collection containers and employee training. Often, the organics hauler, the public agency and/or the composter will provide containers as part of the program, as well as assist in training. Frequently, the tipping fee at the composting facility is lower than the landfill tipping fee, providing an incentive to the generator to participate (direct savings or indirect savings via the hauler).

Once generators separate their organic materials from the trash, they typically can reduce both the size of the trash container they have to lease, and the frequency of service. This translates directly into a cost savings for the generator. In addition, program participants frequently mention that separating food scraps into their own seal-tight container, and having this material picked up on a regular schedule, reduces odors and vectors in the area where trash containers are stored.

Eliminate Sources of Contaminants

One way to reduce contamination at the source is to eliminate the sources of contamination. Increasingly, restaurants, sports venues, convention centers, college campuses and schools are switching to bulk condiment containers, wooden stirrers instead of plastic, compostable cups and serviceware, and related purchasing practices. Along with robust recycling initiatives and proactive source separation training, many establishments are able to almost eliminate contamination in the organics stream and significantly reduce the amount of trash generated. □

End Notes

[1] Urban Schools Aim For Environmental Revolution. 2013. *New York Times*, Dec. 2, 2013.

[2] US Environmental Protection Agency, *Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2012*. http://www.epa.gov/waste/nonhaz/municipal/pubs/2012_msw_fs.pdf.

[3] Simmons, P., N. Goldstein, S.M. Kaufman and N.J. Themelis. 2006. The State of Garbage In America: 15th Nationwide Survey. *BioCycle*, Vol. 47, No. 4, p. 26.

[4] Personal communication, July 2013, K.C. Alexander, Organics Recycling Specialist, CT DEEP; Amy Buckendahl, Environmental Specialist, Iowa Dept. of Natural Resources; Sumner Martinson, Composting Program Director. Massachusetts Dept. of Environmental Protection; and Brad Wolbert, Chief, Recycling and Solid Waste Section, Wisconsin Dept. of Natural Resources.

[5] Neale, Z. 2013. The Massachusetts Waste Conundrum. *BioCycle*, Vol. 54, No. 2, p. 35.

[6] Yepsen, R. 2013. Residential Food Waste Collection In The U.S.: BioCycle Nationwide Survey. *BioCycle*, Vol. 54, No. 3, p. 23.

[7] Ohio Environmental Protection Agency. 2012. Class II Composting Facility Requirements. (http://www.epa.ohio.gov/portals/34/document/guidance/gd_667.pdf)

[8] Beecher, N. and N. Goldstein. 2010. Biosolids Composting In The United States: BioCycle Nationwide Survey. *BioCycle*, Vol. 51, No. 12, p. 35.

[9] USDA Natural Resources Conservation Service. Financial Assistance. http://www.nrcs.usda.gov/wps/portal/nrcs/main/ia/programs/financial/eqip/

[10] Simmons, P., N. Goldstein, S.M. Kaufman and N.J. Themelis. 2006. The State of Garbage In America: 15th Nationwide Survey. *BioCycle*, Vol. 47, No. 4, p. 26.

[11] See Caroll Mortesen, Director, CalRecycle, "Request for Approval" memo on the proposed eligibility criteria and evaluation process for the Greenhouse Gas Reduction Grant and Loan Program, March 18th, 2014. Available at: http://www.calrecycle.ca.gov/Actions/Documents%5C25%5C20142014%5C1063%5Csigned%20RFA-GHG%20Grant%20%20Loan%20Programs.pdf

[12] See City of Seattle Public Utilities web page: Food Service Packaging Requirements at http://www.seattle.gov/util/forbusinesses/solidwaste/foodyardbusinesses/commercial/foodpackagingrequirements/.

[13] San Francisco Environment, *Composting*, http://www.sfenvironment.org/our_programs/topics.html?ssi=3&ti=6 (accessed August 2011)

[14] Dan Sullivan, "Zero Waste on San Francisco's Horizon," *BioCycle*, July 2011, p. 28.

[15] "Food Scraps Programs in the United States," *BioCycle*, Op. Cit., p. 29.

[16] Jepson Prairie Organics, *Compost Process*, http://www.jepsonprairieorganics.com/compostprocess.htm (accessed July 2011)

[17] Peter Anderson, Gary Liss, and Peter Sherman, Beyond Recycling: *Composting Food Scraps and Soiled Paper*, Center for a Competitive Waste Industry with Gary Liss and Associates, Janaury 2010, pp. 32-33.

[18] Presentation by Jack Macy, City of San Francisco Environment Dept., BioCycle REFOR14 WEST, April 9, 2014.

[19] State of Connecticut Public Act No. 13-285, An Act Concerning Recycling and Jobs. http://www.cga.ct.gov/2013/act/pa/pdf/2013PA-00285-R00SB-01081-PA.pdf.
[20] MA Office of Energy and Environmental Affairs. Patrick Administration Announces Plan to Ban Disposal of Commercial Food Waste. http://www.mass.gov/eea/pr-2013/commercial-food-waste-ban.html
[21] Act 148: Vermont's Universal Recycling Law. http://www.anr.state.vt.us/dec/wastediv/solid/act148.htm
[22] Brenda Platt, Bobby Bell, and Cameron Harsh, *Pay Dirt: Composting in Maryland to Reduce Waste, Create Jobs, & Protect the Bay* (Washington, DC: Institute for Local Self-Reliance, May 2013), pp. i-ii.
[23] Ohio EPA Market Development Grant Application Handbook. http://epa.ohio.gov/Portals/51/Recycle/Grants/2014/2014%20MDG%20Application.pdf
[24] See CalRecycle webpage: Proposed Greenhouse Gas Reduction Grant and Loan Programs. Accessed April 2014. http://www.calrecycle.ca.gov/Climate/GrantsLoans/
[25] CalRecycle: Incentive Programs for Local Government Recycling and Waste Reduction, Case Study: San Jose. http://www.calrecycle.ca.gov/LGCentral/Library/innovations/Incentives/SanJose.htm
[26] Farrell Tucker, M. 2013. Charleston County Fosters Food Waste Composting. *BioCycle*, Vol. 54, No. 1, p. 47.
[27] City of San Diego Environmental Services Department Refuse Disposal Fees. http://www.sandiego.gov/environmental-services/miramar/fees/index.shtml
[28] Information on PAYT programs: http://www.epa.gov/epawaste/conserve/tools/payt/index.htm
[29] City of Portland, Oregon Rates, Service Options and Container Set-out Information. https://www.portlandoregon.gov/bps/article/402981
[30] Recology (City of San Francisco service provider) Residential Rates. http://www.sunsetscavenger.com/index.php/for-businesses/commercial-rates?id=575
[31] Gorrie. P. 2012. Making The Move To Alternate Week Trash Collection. BioCycle. Vol. 53, No. 8, p. 25.
[32] Riggle, D. 2013. Alternate Weekly Waste Collection Works. *BioCycle*, Vol. 54, No. 7, p. 52.
[33] Okahumpka, Florida: Compost Earns Biobased Product Label. *BioCycle*, Vol. 53, No. 12, p. 14.
[34] Johnston, M.W. 2013. Green Infrastructure Incentives in Nation's Capital. *BioCycle*, Vol. 54, No. 9, p. 25.
[35] BMP T5.13 Post Construction Soil Quality And Depth. In The Stormwater Management Manual For Western Washington. http://www.buildingsoil.org/tools/Soil_BMP_text.pdf
[36] Washington State Department of Ecology, *2012 Stormwater Management Manual for Western Washington* (2012), 5-8, accessed January 2013, https://fortress.wa.gov/ecy/publications/publications/1210030.pdf
[37] "Achieving the Post Construction Soil Standard," King County Department of Development & Environmental Services, Washington, accessed November 2012, http://your.kingcounty.gov/ddes/forms/ls-inf-SoilPostConStd.pdf
[38] City of Leander Code of Ordinances, Article VI, Section 1, City of Leander, Texas, accessed October 2012, http://www.leandertx.org/page.php?page_id=152
[39] Personal communication, Natalie M. Stevens, City of Greeley Water Department, Greeley, Colorado, July 2012.
[40] Greeley's Public Services, Section 14.08.195 through 14.08.310, accessed September 2012, http://www.colocode.com/greeley/greeley_14.pdf
[41] "Stormwater Regulations: NPDES MS4 Permit," Montgomery County Department of Environmental Protection (DEP), accessed February 2013, http://www6.montgomerycountymd.gov/dectmpl.asp?url=/content/dep/water/npdes.asp
[42] Personal communication, Ann English, Coordinator, RainScapes Program, Montgomery County DEP, January 2013.
[43] "RainScapes Program," Montgomery County DEP, accessed January 2013, http://www6.montgomerycountymd.gov/dectmpl.asp?url=\content\dep\water\rainscapes.asp
[44] "Stormwater Regulations: NPDES MS4 Permit," Montgomery County DEP, Op. Cit.
[45] California 2008 Statewide Waste Characterization Study. 2009. http://www.calrecycle.ca.gov/Publications/Documents/General/2009023.pdf
[46] Mortensen, C. 2013. Next Frontier of Organics Recycling in California. *BioCycle*, Vol. 54, No. 3, p. 29.
[47] CalRecycle. Proposed Greenhouse Gas Reduction Grant and Loan Programs. 2014. www.calrecycle.ca.gov/Climate/GrantsLoans/
[48] Seattle Public Utilities 2012 Recycling Rate. 2013. http://www.seattle.gov/UTIL/groups/public/@spu/@garbage/documents/webcontent/01_026636.pdf
[49] Kelleher, M. and J. Robins. 2013. What Is Waste Food. *BioCycle*, Vol. 54, No. 8, p. 36.
[50] Johnston, M. 2013. Getting The Public Tuned In To Food Waste Reduction. *BioCycle*, Vol. 54, No. 11, p. 17.
[51] Yepsen, R. 2013. Residential Food Waste Collection In The U.S.: BioCycle Nationwide Survey. *BioCycle*, Vol. 54, No. 3, p. 23.
[52] Goldstein, N. Greenmarkets Facilitate Food Scraps Diversion In NYC. 2014. *BioCycle*, Vol. 55, No. 2, p. 20.
[53] Goldstein, N. 2013. Community Composting In New York City. *BioCycle*, Vol. 54, No. 11, p. 22.
[54] Washington, DC: Organics Ride In The Compost Cab. 2011. *BioCycle*, Vol. 52, No. 5, p. 22.
[55] Clark, N. 2014. Entrepreneurs See Opportunity In Food Scraps Collection. *BioCycle*, Vol. 55, No. 3, p. 71.
[56] Buckel, D. 2013. Why Big and Small Organics Recyclers Need Each Other. *BioCycle*, Vol. 54, No. 7, p. 62.
[57] *Supermarket Composting Handbook*. 2003 and 2005. http://www.mass.gov/eea/docs/dep/recycle/reduce/m-thru-x/smhandbk.pdf
[58] Composting in Restaurants And Schools. 2003. http://www.cetonline.org/wp-content/uploads/2013/03/

Composting-in-Restaurants-and-Schools-CET.pdf

59 US EPA: Food Waste Management Tools and Resources. 2014. http://www.epa.gov/foodrecovery/fd-tools_rescrs.htm

60 Food Waste Reduction Alliance: *Best Practices & Emerging Solutions Toolkit*. 2014. http://www.foodwastealliance.org/wp-content/uploads/2014/04/FWRA_Toolkit_FINAL_0415141.pdf

61 Natural Resources Defense Council: *Guide To Composting At Sports Venues*. http://www.nrdc.org/greenbusiness/guides/sports/files/sports-venue-composting-guide.pdf

62 Carvalho, A. 2013. Food Recovery In San Diego. *BioCycle*, Vol. 54, No. 3, p. 33.

63 Neale, Z., Op. Cit.

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Section
4

How to Advance Composting

How to Grow Composting in the US

Every state in the union can increase the recovery of yard trimmings, food scraps, and other organic materials. Many are actively doing so. Almost 20 states have or are in the process of revising their permitting regulations for compost facilities. Every state in the union can also increase its use of compost and through purchasing policies and specifying best management practices can encourage the production and utilization of high-quality compost for high-quality applications. We can also do better at monetizing the benefits of compost, such as its ability to sequester carbon in soils, in order to incentivize the industry. In the absence of strong federal policy, local and state government can set zero and specific food waste recovery goals, and they can tie their composting goals to soil health, watershed preservation, climate protection, and waste reduction goals.

There are many strategies to advance composting in the US. Solid scientific research is needed to demonstrate composting's benefits. The US Composting Council's Research and Education Foundation, for instance, is actively seeking support to compile and improve data related to storm water discharge from composting facilities, propose standards and specifications for compost use in green roof media, and demonstrate water saving with compost use across different soil/climate/crop scenarios. An accurate estimate of the number of composting and digestion facilities in the US and evaluation of both the direct and indirect economic benefit from the existence of these organics recycling facilities is needed to support economic development efforts to expand the industry. Further research to document the actual impacts (social, environmental, economic) of small-scale community composting facilities is also warranted.

New rules and policies are very effective means for growing composting. Pages 82 to 85 (see "Policy Opportunities and Needs" below) outline a menu of local and state policies that could be implemented to further composting and compost production. Also needed is financial modeling to provide valid data for investors and other interested parties. Training is crit-

Figure 4-1: Soil is a precious resource. It is the thin outermost layer of the Earth's crust that forms the basis for existence of life on this planet.

Photo credit: Snohomish Conservation District, Betterground.org ical to the success of composting, regardless of the size. The development of professional compost science, engineering and usage programs at state land-grant colleges in the US could be funded to both raise the professionalism of the industry and to create a cadre of graduates that can help run and expand composting facilities. The sidebar on page 81 captures the particular need for trained operators at small-scale sites.

National Soils Policy

But perhaps nothing is more important to advancing composting and compost use than reinvigorating the movement to promote a national soil policy. In 1975, Jerry Goldstein, the founder of BioCycle, suggested that a National Humus Program was vital: "As we enter the Bicentennial Year, let's suggest to our politicians and policy makers that we should include in the celebration the vow to build up the soil humus content of the nation with all kinds of organic wastes. Perhaps we can even get our candidates in 1976 to include a Humus Plank in their presidential platforms." Ten months later (February 1976), a "Special Action Issue" of Environmental Action Bulletin (EAB) (a newsletter that Goldstein edited) was titled, "The National Soil Fertility Program," expanding on the concept of the National Humus Program. The issue included a "self-mailer" that readers could use to send comments to the two Congressmen, Rep. Fred Richmond (D-NY) and Rep. James Jeffords (R-VT), who agreed to shepherd the program through the House Agriculture Committee. The self-mailer explained that The National Soil Fertility Program (NSFP) "shall be our national policy to encourage the return of soil-building organic matter to our country's farmlands and to reclaim that land rendered unproductive by mining, abandonment, erosion and other consequences of our society's climb to affluence."[1]

Rep. Richmond, the only member of the House Agriculture Committee at the time representing a totally urban constituency, noted that "the consumers definitely have a real stake in farming and farm policy. And that means a soil policy. The NSFP will directly affect urban residents. Fertile soils mean that less fossil fuel input is necessary to produce any given crop and, with the price of energy the way it is, this will translate into food at a moderate cost … We also must convince the city administrators to accept their place in the nation's total food chain. In a truly national food policy, cities must recycle both solid wastes and sewage sludge back to the land."[2]

The wrap-up by Jerry Goldstein on the NSFP is startling in its prescience: "The National Soil Fertility Program emphasizes that organic waste should be used under a priority system that puts composting first. To burn it is to condemn our nation's soils to a continued loss of organic matter, increased soil erosion and a loss of the vitality and life-sustaining force of those soils."[3] Fast forward to February 19, 1977, when an update appeared in EAB on the NSFP legislation: "During 1976, major provisions of the National Soil Fertility Program were successfully inserted into the Democratic Party's platform, with backing from then-candidate Carter. Now the program has reached legislative form …. The following wording is from Sec. 6, par. 56 of H.R. 75, sponsored by Rep. E. de la Garza (D-TX), a ranking member of the House Agriculture Committee. The bill is also known as the Land and Water Resource Conservation Act of 1977:

"[The bill calls for] investigation and analysis of the practicability, desirability, and feasibility of collecting organic waste materials, including manure, crop and food wastes, industrial organic wastes, municipal sewage sludge, logging and wood manufacturing residues, and any other organic refuse, compost-

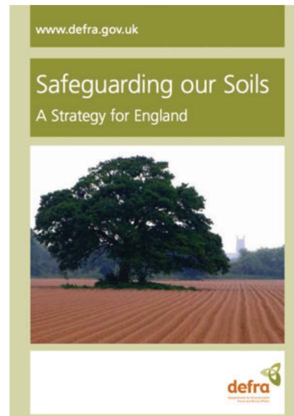


Figure 4-2: England's soil strategy recognizes the benefits of compost.

Source: www.gov.uk

Spotlight

Recycling Every Drop Of Organics: An article in March/April 2014 BioCycle, "Compost And Mulch Aid Drought Survival" by Dr. Sally Brown of the University of Washington, makes the case for using compost, mulch, biosolids, manures and other organics as a drought survival tool. The article used California and Washington as cases in point. Wrote Brown: "The problem in California and elsewhere is that there aren't enough organics to go around. Let's use the case of the almond trees in California for our rough calculations, and focus only on how much yard trimmings, food scraps and biosolids are available. Each person generates about 60 dry pounds each of biosolids and food scraps, and 1.5 times that quantity of yard trimmings, annually. If the food waste and yard trimmings are composted, that makes about 75 lbs of compost per person. There are 38 million people in California. That translates into annual production of about 1.1 million tons of biosolids and 1.4 million tons of compost, coming to a little over a ton of compost per year for each acre of almonds — well under what should be applied (4-6 tons per acre per year). In 2012, there were 1.5 million acres of hay harvested in California. This equates to less than a ton of biosolids per acre of hay — again, well under the agronomic application rate of 3-5 tons per acre per year. ….. The bottom line is that California and other states with large agricultural economies should be recycling every drop of organics — a well-documented and proven step for addressing drought conditions."

Spotlight

National Soils Act. The benefits of using compost to improve soil and water quality and reduce usage of chemical fertilizers and herbicides have been exhibited many times over. More recently, carbon sequestration has been added to the list of benefits. Less recognized is the role that compost can play in making soils more drought resilient. The US would benefit greatly from a national soils policy, similar in scope to the federal Clean Air and Clean Water Acts. By default, a national soils policy that would, for example, specify a minimal soil organic matter content, would be the single greatest contributor to increased composting in the US as compost is a proven tool in building soil organic matter.

ing or similarly treating such materials, transporting and placing such material on to the land to improve soil tilth and fertility. The analysis shall include projected costs of such collection, transportation and placement in accordance with sound, locally approved soil and water conservation practices."[4]

Now, more than ever, it's time to bring back Jerry Goldstein's campaign for a National Soil Fertility Program. ILSR and *BioCycle* call for a National Soils Act. England has adopted a "soil strategy" that may be model for the US to emulate. Compost is recognized as an important method of increasing levels of organic matter in soil, reducing fertilizer requirements and diverting materials from landfill.[5]

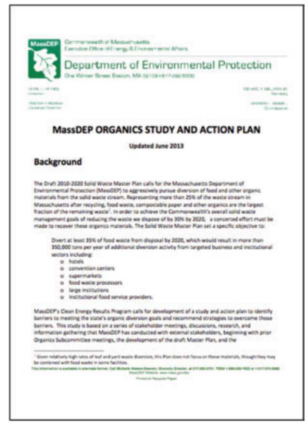
Needed Infrastructure

To grow composting in the US, a more robust collection and processing infrastructure is needed. Venues generating food scraps, for instance, lack collection and separation systems, and collection service providers need places to deliver source-separated organics. There is simply insufficient capacity to handle the food scraps now discarded in the US.

In 2012, the Massachusetts Department of the Environment released its *MassDEP Organics Study and Action Plan*, which identified infrastructure and other needs to address in order to achieve its 35% food waste diversion goal by 2020.[10] Among the barriers identified, the plan outlined how to overcome the following infrastructure shortcomings:

Collection Infrastructure – Lack of Collection and Separation Systems at Generators: Generators need more information, research and technical and financial support to build more robust collection and management systems. To stimulate competition and reduce costs, more collection service is needed. Generators need to know who can provide service and be able to negotiate for service amongst multiple collectors. Haulers of organics need to achieve route density in order to provide competitive collection services. New collection methods and technologies need to be reviewed and tested.

Processing Capacity/ Market Development – Insufficient Processing Capacity & Lack of End-Markets For Products: Once collected, source separated organics must have a place to go.


Department of Environmental Protection

MassDEP ORGANICS STUDY AND ACTION PLAN

Updated June 2013

Background

Figure 4-3: The MassDEP developed an action plan to overcome barriers to organics diversion.

Although Massachusetts has a number of entities accepting organics for processing and this number is growing, additional capacity is still needed. Once processed, finished products need to find a home. Although there are consistent and sufficient outlets for compost, developing and promoting higher value compost products and uses that increase revenue for processors will help drive down overall system costs thereby improving the cost-effectiveness of organics diversion.

Regulatory Reform/Waste Ban – Regulatory Environment that Is Unclear and Considered Cumbersome, Need for Steady Supply of Source Separated Organics: The lack of clear permit pathways for organics processing facilities that employ advanced technology such as anaerobic digestion, and concerns about the applicability of the local site assignment process to such facilities, has been a barrier to the expansion of organics capacity in the Commonwealth. Revising the State's solid waste siting regulations to address these issues will help facilitate development of new and expanded capacity. Public

Spotlight

Financial Modeling for Composting Facilities: Develop financial models for composting facilities that provide valid cost-for-service calculations, as well as facility investment costs. Address "wild cards," e.g., permitting costs and site-related costs that lead to an "abandon site" red flag. Work with lenders and investors to determine costs for debt and equipment, collateral, etc. Outline fixed costs and variable costs. Underpinning this are tried and true BMPs for performance-based composting so that costs to operate successfully are known. For example, determine the percent of capital costs related to optimizing composting, which includes controlling odors, e.g., hard surface, proper equipment for feedstocks being composted, etc., as well as the percent of operating costs related to contaminant removal. It is also worthwhile to investigate ways to offset the economic impact of purchasing carbonaceous bulking agents, including research into the development of clean wood recycling programs, and demonstration of the safety of engineered wood products in composting.

Spotlight

Demonstration Sites and Benefits Analysis of Applying Residuals to Soils. There is a wide range of opportunities for use of organic amendments to improve soils and result in increased carbon storage. For many cases it is not necessary to use composted materials to realize increases in productivity and soil carbon storage. Application of animal manures and Class B biosolids have both been shown to accomplish both of these goals. Soil improvements will normally occur over time with repeated applications of these amendments to meet the nutrient needs of a crop. With the increased use of anaerobic digestion as a means to reduce fugitive emissions and reduce pathogens from animal manures and to produce electricity using a range of feedstocks, there will likely be increased quantities of digestates available for land application. Some studies have found that composting prior to land application reduces the potential for fugitive gas emissions.[6,7,8] However, composting increases costs related to use of organic amendments. The composting process can also result in fugitive gas emissions, although process controls can minimize these. In general, cost and public acceptance are the two most limiting factors for increased use of organic residuals. Use of alternative tools like life cycle assessment and environmental accounting can provide an alternative and typically more sophisticated understanding of the costs and benefits of different end use options for residuals.[9]

A range of demonstration sites that include different residuals and are accompanied by benefits assessments using LCA and other tools may be an excellent way to increase the acceptance of residuals use for a broad range of applications. The largest category of residuals that is being underutilized and mismanaged are animal manures. Here, bringing traditional agricultural organizations as well as private industry into these sites as partners may increase the potential impact of these sites. Further including other environmental groups, such as the Nature Conservancy, that traditionally don't focus on traditional agriculture or urban issues would be a way to increase the visibility of these projects and the understanding of their potential impact.

and private investment in collection systems and processing capacity of organics is contingent on these entities having confidence that a sufficient amount of organic material will be available. While some generators have established programs without a ban, a waste ban is necessary to drive widespread adoption of organics diversion.

The Action Plan lays out an ambitious list of actions to address each identified barrier, from establishing technical assistance and grant/loans programs to promulgating organics ban regulations.

Benefits of Decentralization

What is missing, however, is any recognition of the benefits of a decentralized and diversified infrastructure. Composting can take place at many levels – backyard, block, neighborhood, schoolyard, community, and regional – and in urban, suburban, and rural areas. There are many methods and sizes.

Figure 4-4: Locally based composting builds community and should be supported

Photo credit: NYC Compost Project

Large-scale centralized facilities can serve wide geographic areas and divert significant quantities of organic materials from disposal facilities. Composting locally at the neighborhood or community-scale level yields many other benefits: improved local soils, more local jobs, greener spaces, enhanced food security and fewer food deserts, less truck traffic hauling garbage, increased composting know-how and skills within the local workforce and reinforced in the next generation. When composting is small-scale and locally based, community participation and education can flourish.

ILSR recommends the development of a composting strategy that promotes home composting and small-scale farm and community sites as a priority, followed by onsite institutional systems (particularly at schools) and then development of commercial capacity for remaining organics. Unlike large-scale centralized facilities, small-scale sites do not need waste transfer stations and can be constructed in a matter of weeks instead of years. But small sites need trained operators to avoid the odor and pest pitfalls that might give small-scale and community-based composting a bad name. Also needed are community leaders who can foster community participation in composting as well as awareness of the myriad benefits compost has to offer, which in turn will build support for other significant composting systems like municipal collection.

Support for support community-based and small-scale composting can come in many forms: funding to start pilot programs and purchase equipment, access to land, operator training, development of small-scale equipment, permitting regulations to facilitate small-scale sites, appropriate guidelines, quantification of benefits, and marketing assistance.

Supporting Community Composting: Survey Findings

In October 2013, ILSR identified and surveyed more than 40 community-based composting operations in the US. More than half participated in an online survey, which solicited basic information on materials composted, composting method place, as well as challenges and tips for replication. We followed up with select sites to gather additional information on lessons learned and how to overcome challenges. Table 4-1 lists the core features of 42 programs we identified when conducting research for this report (listed in the order in which they began operation). See Appendix F for a summary of ILSR's survey data. ILSR's companion report, *Growing Local Fertility: A Guide to Community Composting* (produced in collaboration with the Highfields Center for Composting in Vermont), includes more detailed information on the wide range of community composting initiatives flourishing across the country.

For *The State of Composting in the US* report, we specifically asked community composters the following questions: If major national funding was available to support small-scale and

4-1: Select community composting programs, in order of start date

Name	City, State	Start Date	Collection Entre-preneur	Comm. Garden	School	Farm, Urban	Farm, Rural	Drop-Off Network	Off-Site Composter	On-Site Composter	Demo & Training Site	Worker Coop.	Home-Based
Resource Center	Chicago, IL	1983				x				x			
Wasatch Community Gardens	Salt Lake City, UT	1989		x						x			
Lower East Side Ecology Center	Lower East Side, NY	1990							x		x		
Brooklyn Botanic Garden	Brooklyn , NY	1993								x	x		
Growing Power	Milwaukee, WI	1993		x		x				x	x		
NYC Compost	5 boroughs, NY	1993		x				x	x		x		
Queens Botanical Garden	Queens/Flushing , NY	1993								x	x		
Greenway Environmental Services	Poughkeepsie, NY	2000			x				x	x			
Compost Club	Sonoma, CA	2003			x					x			
Red Hook Community Farm	Brooklyn , NY	2003				x				x			
Kingdom View Compost	Lyndonville, VT	2006					x			x			
Pedal People Cooperative	Florence, MA	2007	x									x	
Grow Compost of Vermont, LLC	Waterbury, VT	2008	x				x						
Kompost Kids	Milwaukee, WI	2008	x	x				x		x	x		
Earth Matter	Governors' Island, NY	2009						x		x	x		
BIG! Compost	Queens, NY	2010							x	x			
CommonWealth Urban Farms	Oklahoma City, OK	2010				x				x			
ECO City Farms	Edmonston, MD	2010				x				x			
Univ. of Louisville	Louisville, KY	2010			x					x			
Close the Loop! St. Albans	Northwestern, VT	2011	x		x		x	x		x			
Ferrisburgh Central School	Ferrisburgh, VT	2011			x								
Green NAU Energy Initiative	Flagstaff, AZ	2011			x								
Grow NYC	New York, NY	2011	x					x					
Philly Compost 19125	Philadelphia, PA	2011	x						x				
Dirt Factory/University City District	Philadelphia, PA	2012							x				
Empire Zero	Castleton, NY	2012	x										
Farmer Pirates Co-op/Compost Crew	Buffalo, NY	2012				x				x		x	
Fertile Ground	Oklahoma City, OK	2012										x	x
Myrtle Village Green	Brooklyn , NY	2012		x						x			
NC Comm Gardens Partners	Greensboro, NC	2012		x						x			
We Got Leaves	Shorewood, WI	2012											x
Apple Ledge Farm	Coventry, VT	2013	x				x						
Community Composting Rochester	Rochester, NY	2013	x										
DC Public Schools	Washington, DC	2013			x					x			
DC Urban Greens	Washington, DC	2013				x							
Roots Composting, LLC	Flagstaff, AZ	2013	x						x			x	
The Farm Between	Jeffersonville, VT	2013	x				x						
The NE Kingdom Residential Drop-Off	VT	2013						x					
Univ of Maine	Orono, ME	2013			x					x			
CERO	Boston, MA	2014	x									x	
Lake Region Union High School	Orleans, VT	2014			x								
Tinmouth Compost	Tinmouth, VT	2014	x				x						

Source: Brenda Platt, James McSweeney, and Jenn Davis, G*rowing Local Fertility: Guide to Community Composting* (Institute for Local Self-Reliance and Highfields Center for Composting: April 2014).

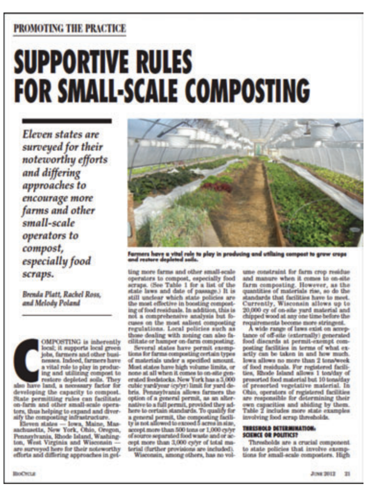
community-based composting, on what do you think this funding should be spent? What specific actions or steps are needed to advance locally based composting? Responses also are in Appendix F; a summary of comments related to training are in the sidebar on page 81. Below is a sampling of the responses:

Technical Assistance and Grants

- "Funding municipalities to offer more technical assistance and money for equipment."
- "Funds to focus on promoting a widely diverse array of models for community composting all over the country, so it is easier to see what leads to success but also easier for communities to choose what works best for them."
- "Define an appropriate scale and a financial structure that allows community-based composting to exist with paid staff."
- "More research and development of equipment appropriate to our scale, e.g., bicycle-powered sifters and shredders"
- "Proper testing infrastructure so it's easy for communities to test their product."

Policies and Standards

- "Local and state officials, such as those who regulate hauling of waste and environmental protection, need to interpret their mandates, or have their mandates changed, to actively support rather than impede community composters. Not only are exemptions needed, but active assistance is needed."
- "There should be a designation and specific regulations for composting operations that fall between 'farm' and 'backyard.' Funding systems for this size and style of operation would also be helpful."



PROMOTING THE PRACTICE

SUPPORTIVE RULES FOR SMALL-SCALE COMPOSTING

Eleven states are surveyed for their noteworthy efforts and differing approaches to encourage more farms and other small-scale operators to compost, especially food scraps.

Brenda Platt, Rachel Ross, and Melody Poland

Farmers have a vital role to play in producing and utilizing compost to grow crops and restore depleted soils.

COMPOSTING is inherently local; it supports local green jobs, farmers and other businesses. Indeed, farmers have a vital role to play in producing and utilizing compost to restore depleted soils. They also have land, a necessary factor for developing the capacity to compost. State permitting rules can facilitate on-farm and other small-scale operators, thus helping to expand and diversify the composting infrastructure.

Eleven states — Iowa, Maine, Massachusetts, New York, Ohio, Oregon, Pennsylvania, Rhode Island, Washington, West Virginia and Wisconsin — are surveyed here for their noteworthy efforts and differing approaches in getting more farms and other small-scale operators to compost, especially food scraps. (See Table 1 for a list of the state laws and date of passage.) It is still unclear which state policies are the most effective in boosting composting of food residuals. In addition, this is not a comprehensive analysis but focuses on the most salient composting regulations. Local policies such as those dealing with zoning can also facilitate or hamper on-farm composting.

Several states have permit exemptions for farms composting certain types of materials under a specified amount. Most states have high volume limits, or none at all when it comes to on-site generated feedstocks. New York has a 3,000 cubic yard/year (cy/yr) limit for yard debris. Pennsylvania allows farmers the option of a general permit, as an alternative to a full permit, provided they adhere to certain standards. To qualify for a general permit, the composting facility is not allowed to exceed 5 acres in size, accept more than 500 tons or 1,000 cy/yr of source separated food waste and/or accept more than 3,000 cy/yr of total material (further provisions are included).

Wisconsin, among others, has no volume constraint for farm crop residue and manure when it comes to on-site farm composting. However, as the quantities of materials rise, so do the standards that facilities have to meet. Currently, Wisconsin allows up to 20,000 cy of on-site yard material and chipped wood at any one time before the requirements become more stringent.

A wide range of laws exist on acceptance of off-site (externally) generated food discards at permit-exempt composting facilities in terms of what exactly can be taken in and how much. Iowa allows no more than 2 tons/week of food residuals. For registered facilities, Rhode Island allows 1 ton/day of presorted food material but 10 tons/day of presorted vegetative material. In Ohio, operators of registered facilities are responsible for determining their own capacities and abiding by them. Table 2 includes more state examples involving food scrap thresholds.

THRESHOLD DETERMINATION: SCIENCE OR POLITICS?

Thresholds are a crucial component to state policies that involve exemptions for small-scale composters. High

BioCycle June 2012 21

Figure 4-5: States can pass rules to encourage on-farm and other small-scale operators to compost.

Photo credit: BioCycle

- "Perhaps property tax abatements for undeveloped real estate converted to community composting operations."

Public Education and Marketing

- "Composting is the foundation of food gardening. Any program to promote composting should be inseparable from a program to increase gardening activity generally."
- "First the policy argument in favor of community composting should be thoroughly developed for multiple audiences, including the general public, national/state/local electeds, and private funders. That will also require some marketing methods, especially videos appropriate for short presentations in public settings or private Board meetings. There's so much talk of access to land, but that issue will resolve considerably when parks and botanic gardens and sanitation departments are sold on the idea — that's when they will start actually looking hard for the land, all the more so when foundations are sold on the idea and starting offering money."
- "Getting people to DO it! Education, Research & Development, distribute small containers for kitchens, where to keep it until pick up, set up an engineering 'challenge' for new technology (using materials readily available from Home Depot), 60 days or less, no electricity, no moving parts, use in vacant lot until developed, flexible, transportable, 12 months a year, insulated"

Impediments/Threats

Despite many compelling drivers, there are a number of obstacles to widespread implementation of composting, particularly decentralized systems. Obstacles include:

- Lack of policies reinforcing the solid waste management hierarchy that prioritizes source reduction and reuse followed by recycling and composting
- Cheap landfill disposal fees
- Deep pockets of the landfill and incinerator industry to lobby effectively for renewable energy subsidies
- Landfill gas recovery companies working to overturn state bans on landfill disposal of yard trimmings
- Increasing consolidation and vertical integration of the organics recovery industry
- Lack of organic material receiving facilities or infrastructure (i.e., composters and anaerobic digesters)
- Lack of affordable compost hauling services
- Out-of-date state permitting regulations for composters and anaerobic digesters that often treat organics recovery facilities as solid waste disposal operations
- Unlimited set-out of residential trash allowed in most communities free of charge
- Lack of training programs and best practice toolkits for backyard, community and onsite composting (see sidebar)
- Difficulty in finding adequate land for composting operations

Trained Community Leaders Needed to Support Locally Based Community Composting

We know there is a demand for community leaders trained in the science and practice of composting, as well as strong interest to become trained. Manhattan's Lower East Side Ecology Center, for instance, has 120 applicants each year for its composter training class but only 25 spots. In addition, they need more leaders to provide technical assistance to the community composting sites they have helped launch.

The need for training was reinforced in a survey ILSR conducted October 2013 of existing locally based small-scale composters. The survey aimed to not only assess tips for replication and best practices, but also to highlight challenges and needs. We found that even the best programs identified operator training as a critical need. When asked what specific actions or steps are needed to advance community-based composting, several responses related to training:

"Compost operator training or other compost educational programs."

"Trainings for community members to ensure they're making quality compost."

"Training Staffing Equipment"

"Technical assistance/community educators"

"Require standards to insure quality operation and product."

"Training, and funding assistance for improved equipment that mitigates odor and vectors is a #1 priority. A trained composter knows the need for proper equipment and systems to ensure an odor free, vermin free operation."

"Technical assistance to manage operations, appropriate guidelines, model systems for urban environment"

"For urban contexts the compost operator trainings have got to be turned inside out and upside down to recognize some realities about how different success looks in an urban context. Such trainings just do not exist at present, at least in full measure. The trainings for urban composters are often bound by the mindset of small community gardens, and even those trainings often fail to address adequately the issues of rats and smells. Adequate training must precede any scaling up of interest in urban community composting, or many well-intentioned folks will expend a lot of energy, money, and time, and then fail. Lastly, once the policy argument is forcefully made, and the new trainings are ready to roll out, we're ready for government funds to focus on promoting a widely diverse array of models for community composting all over the country, so it is easier to see what leads to success but also easier for communities to choose what works best for them."

"Implement educational outreach and technical maintenance training"

Tips for replication also identified training as important:

"Apprentice at a successful site first to make sure you are not just talk and no action, because as profoundly important as composting is, it is hard work when it is done right. Worthy, but hard. And for urban contexts, be certain you will be able to schedule operational tasks sufficient to control odors and rodents and observe an aesthetic standard far higher than for a rural context -- otherwise your impact will be to generate opposition to composting rather than love for it."

"Be sure you have experienced composters as part of the operation. Be sure you understand the systems."

- Difficulty securing tonnage feedstock guarantees for organics receiving facilities (needed to attract investment)
- Lack of information on sources and amounts of food scraps and other compostable materials. Better information on organics generation and disposal is needed to help generators, collectors, and processors of organic materials make sound infrastructure investments.
- For onsite composting, securing the proper mix of ingredients for optimal composting conditions and having trained staff adequately maintain the composting system
- For food scrap generators, ready access to affordable composting services and collection programs that do not overburden staff and customers
- Perception that starting composting is too costly because it involves start-up costs such as new collection bins or containment equipment, training/educating staff and citizens, and separate add-on hauling fees
- Inability of food scrap generators to realize savings on reduced trash collection by renegotiating hauling contracts (especially if hauling is included in lease agreements)
- Poorly operated composting facilities that ultimately give a bad name to composting
- A new class of persistent herbicides called "pyridine and pyrimidine carboxylic acids" that has been designed for use in hayfields, horse pastures, agricultural crop production, golf courses, right-of-ways, and lawns to kill off unwanted weeds and to remain effective for several months to years. When found in compost and soils in minute concentrations

Figure 4-6: While trash burners are presented as green, renewable, economical solutions to waste problems, in reality, these facilities drain financial resources, pollute, undermine waste reduction and economic development efforts, and compete with the introduction of comprehensive food scrap composting systems.

Photo credit: Institute for Local Self-Reliance

Figure 4-7: Persistent herbicide crop damage to tomato plant (top) and eggplant (bottom) at Green Mountain Compost, VT, in 2012. The composter's costs totaled $792,000 from settling complaints, retrieving unsold product, testing and legal assistance, and loss in sales.

Photo Credit: US Composting Council, Position Statement on Persistent Herbicides

(as low as 1 part per billion), these persistent herbicides directly harm a wide range of sensitive crops (e.g., tomatoes and beans), threatening the economic viability of many industries, including the multi-billion dollar composting industry in the United States.11

Policy Opportunities and Needs

Local and state government policies are needed to overcome lack of infrastructure and other obstacles to diverting organic materials from disposal.

Local

- Adopt a highest and best use hierarchy that prioritizes source reduction, food rescue, home-based composting, and community-based and on-farm composting over large centralized composting facilities.
- Start an edible food donation program.
- Promote backyard composting and grasscycling and start a Master Composting training program.
- Target a wide range of yard debris for composting (grass, leaves, brush, garden trimmings, Christmas trees).
- Offer curbside collection service year-round, with option to not collect in/require off-season.
- Ban collection of yard trimmings in plastic bags; require setout in kraft bags or reusable containers.
- Require weekly yard trimmings separation and setout.
- Require landscapers to recover yard trimmings for composting.
- Ban yard trimmings from waste transfer stations, landfills and incinerators.
- Set up drop-off sites for materials not collected at curbside (such as pumpkins, Christmas trees, garden trimmings).
- Give preference in purchasing to locally-produced compost.
- Require all public agencies to adopt yard trimmings reduction practices such as controlled irrigation, precise fertilization usage, grasscycling, selective pruning, onsite composting and mulching/backyard composting, proper organic materials applications, and environmentally beneficial landscape design. Encourage residences, businesses, and institutions to adopt these practices.
- Pilot a residential project to compost food residuals (such as curbside collection with yard trimmings, curbside collection without yard trimmings, or drop-off collection).
- Consider creating a hybrid yard trimmings program that collects some household organics but not the full range covered by most food scrap programs. (Cedar Rapids, Iowa, for instance, allows fruit and vegetable peelings, human and pet hair, paper plates, paper towels, and paper napkins.12)
- Pilot a government cafeteria food residual collection and composting project.
- Pilot composting food residuals and compostable food service ware at public events or publicly sponsored events.
- Require submittal of a composting plan in order to obtain a street closure permit for a public event.
- Implement purchasing specifications for compostable food service ware (such as products must be certified as compostable).
- Integrate plans to incorporate food residual recovery into solid waste management plans.
- Ban the use of non-essential pesticides on all public and private property.
- Maintain a user-friendly comprehensive easy-to-navigate web site dedicated to all aspects of composting from how-to-backyard-compost with rodent-free bins to a list of compost facilities and how to donate edible food.
- Establish compost-amended soil requirements (minimum organic matter content for post-construction disturbed soils).

Figure 4-8: The City of Toronto is one city that bans the set out of yard trimmings in plastic bags.

Flyer credit: City of Toronto

State

- Establish a minimum 75% recycling goal by 2030. (California's 75% goal is helping to expand composting in that state.)
- Adopt a highest and best use hierarchy that prioritizes source reduction, food rescue, home-based composting, and community-based and on-farm composting over large centralized composting facilities.
- Implement a per-ton surcharge on all disposal facilities (transfer stations, landfills, and trash incinerators) to create revenue to fund recycling and composting initiatives and create financial incentives to reduce trash.
- Establish a moratorium on building new trash incinerators (with or without "energy recovery") until new rules regulating composting facilities and programs and policies to support composting are in place.
- Assess sources and amounts of yard trimmings and food scraps to enable organic material generators and processors to make sound infrastructure investments and help direct government programs.
- Develop sector specific best management practices for organics collection programs (supermarkets, hotels, schools, residential, etc.).
- Establish technical assistance and grant programs to divert food scraps from public colleges/universities, hospitals, and correctional facilities and loan programs for private facilities diverting organics.
- Provide financial assistance to existing and potential haulers to initiate organics collection efforts (as long as this financial assistance does not put onsite and small-scale composters at a competitive disadvantage).
- Support efforts to collect organics from residential sources.
- Ban yard trimmings from landfills and incinerators.
- Ban commercially generated organic materials from landfills and incinerators (if organic materials recycling facilities exist within 20 miles of point of generation).
- Ban use of conventional plastic bags for yard trimmings collection in specific metropolitan areas.
- Require all state agencies to adopt yard waste reduction practices such as controlled irrigation, precise fertilization usage, grasscycling, selective pruning, onsite composting and mulching/backyard composting, proper organic materials applications, and environmentally beneficial landscape design. Encourage residences, businesses, and institutions to adopt these practices.
- Require cities and counties or service providers to create the opportunity to recycle, including the establishment of "an effective residential yard debris collection and composting program that includes the promotion of home composting of yard debris, and that also includes either: (a) Monthly or more frequent on-route collection of yard debris from residences for production of compost or other marketable products; or (b) a system of yard debris collection depots conveniently located and open to the public at least once a week…'Yard debris' includes grass clippings, leaves, hedge trimmings and similar vegetative waste generated from residential property or landscaping activities, but does not include stumps or similar bulky wood materials."
- Incentivize use of compostable bags for collection of yard trimmings by allowing tax deductions on State income tax for bag purchases.
- Incentivize use of backyard composting bins by allowing tax deductions on State income tax for backyard bin purchases.
- Launch an education and outreach campaign to highlight composting and compost use.

State Composting Infrastructure Development Policies

- Develop sample zoning ordinances that define composting, composting facilities and acceptable land uses by right, or by conditional approval.
- Assess and support development of onsite food residual management solutions.
  - Research and test onsite collection and treatment technologies: In-vessel composting unit case studies, gather independent evaluations of technologies
  - Support through targeted grants and loans: Grants for capital cost of onsite systems at public facilities, low interest loans for capital cost of onsite systems at private facilities
- Develop FAQ document to address public questions and concerns over different types of facilities/technologies.
- Encourage municipal expansion of existing composting operations and siting of new operations.
- Establish simple certification form for small organics operations at municipal sites.
- Identify financial and technical assistance for companies interested in establishing and expanding composting facilities, including grants, loans, and job training programs.

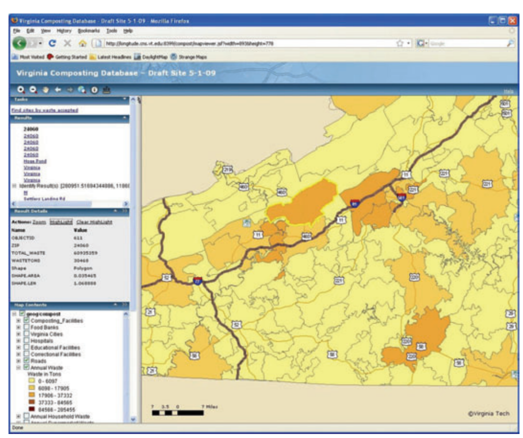


Figure 4-9: By mapping food waste generation by zip code, GIS maps like this one developed by ILSR and VA Tech for Virginia can help collection service plan routes and facilities plan for adequate capacity.

Source: Institute for Local Self-Reliance

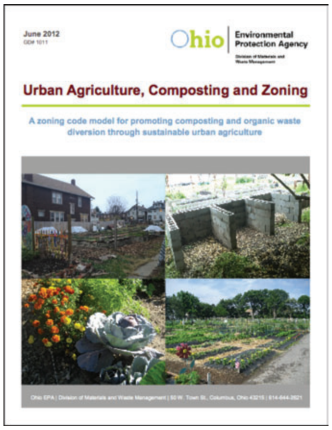


Figure 4-10: The Ohio EPA has produced model code language for zoning officials, municipalities, community groups and other stakeholders to encourage the establishment of community gardens and composting activities in compliance with related local land use and state environmental regulations. Composting is an approved accessory activity at community gardens and urban farms.

Source: Ohio Environmental Protection Agency, www.epa.ohio.gov

- Encourage new private development or expand existing organics management capacity:
  - Provide aggressive low-interest loans
  - Offer pre-permitting assistance
  - Promote more capitalization of and technical assistance to existing farm composting/AD operations to help meet local capacity needs
    - Support new farm operations
    - Leverage and coordinate funding assistance across state financial assistance programs
- Streamline regulations/permitting programs:
  - Adopt performance based permitting regulations for composting facilities (time/temp; air/odors; stormwater quality) that include carve-outs for small-scale and onsite operators
  - Consider operations that collect, process, and recover organic materials as recycling facilities not solid waste facilities (MD House Bill 1440, passed in the 2013 legislative session, authorizes the Maryland Department of the Environment to issue regulations exempting organic material capable of being composted from the definition of solid waste)
  - Provide a clear permitting pathway
  - Allow small on-farm food scraps composting with only registrations, not permits (set appropriate thresholds, e.g., less than 250 tons/year)
  - Increase flexibility for meeting financial assurance by allowing periodic payments into depository financial instruments
  - Require all permitted composting facilities have at least one operator trained via a national, state, or local compost operator training program
  - Train all regulators in the basics of composting and organics diversion

State Compost Usage Encouragement Policies

- Adopt and endorse a variety of compost uses in State guidance and manuals such as soil erosion and sediment control manuals and stormwater design manuals.
- Take affirmative steps to explore and encourage the use of compost and compost products, including as bioretention soils, green roof soils, and for roadway projects and slopes.
- Increase funding to cooperative extensions to develop compost usage and benefit education programs for homeowners and landscapers in counties and municipalities.
- Increase funding to appropriate state agencies to develop compost usage database for web-based downloads of technical information on crop yield increases and disease suppression, sediment loss reduction and erosion prevention, and acid mine drainage remediation due to compost use.
- Require state departments of transportation and other agencies to procure soil amendments by specifying composts certified by the US Composting Council's Seal of Testing Assurance program.
- Develop specifications for high-value applications for high-quality compost products.
- Establish compost-amended soil requirements (minimum organic matter content for post-construction disturbed soils).
- Give preference in purchasing to in-state-produced compost, or even better, require the state to purchase compost from facilities registered and compliant with the state.

Statewide Economic Incentives

- Require "Pay-As-You-Throw" solid waste programs in all municipalities.
- Promote Industrial Revenue Bond programs for composting facility construction capital.
- Encourage Economic Development Authorities to include compost facility sites in their portfolios of industrial sites.
- Monetize greenhouse gas (GHG) emissions reductions from food scraps diversion from landfilling (~ 0.87 MT CO2eq per ton diverted) by acting as carbon credits aggregator and refunding carbon credits to host municipalities.
- Monetize GHG emissions reductions from carbon sequestration due to compost use as a soil amendment (~ 0.35 mt CO2eq reduced/ton used) in same fashion as above.
- Incentivize agricultural usage of compost by allowing income tax deductions for purchase price and income tax credits for reductions in nitrous oxide GHG emissions due to replacement of nitrogen fertilizer usage with compost.
- Explore other tax policy tools to encourage composting.

Other Statewide

- Maintain a user-friendly comprehensive easy-to-navigate web site dedicated to all aspects of composting from how-to-backyard-compost with rodent-free bins to a list of composting facilities and state regulations.
- Target large generators such as by providing handbooks, resources, and technical assistance (e.g., supermarkets, hospitals, schools, state fairs) on how and where to compost.
- Establish a voluntary Supermarket Recycling Program Certification that encourages supermarkets to develop sustainable programs for recycling and reusing organics and other materials.
- Provide compost use training, and compost use specifications and guidance.
- Set tiered materials recovery and waste reduction goals (such as 75% recovery and caps on annual increases in waste generation).
- Implement purchasing specifications for compostable food service ware (such as products must be certified as compostable).
- Prohibit the use of nebulous, false claims like "biodegradable" in plastic packaging by requiring that environmental claims can only be made if the terms used are verified by an existing ASTM standard specification.
- Require each county develop and adopt a recycling plan that includes the recycling of yard trimmings and food residuals.

Figure 4-11: The MassDEP produced a handbook to provide assistance to supermarkets in launching composting programs for food scraps. It has also partnered with the MA Food Association to establish a voluntary Supermarket Recycling Program Certification to encourage supermarkets to develop recycling and composting programs.

Source: MassDEP, www.mass.gov

End Notes

[1] See Nora Goldstein, "Jerome Goldstein, Ecopioneer, 1931-2012, *BioCycle* June 2012, Vol. 53, No. 6, p. 34.

[2] Ibid.

[3] Ibid.

[4] Ibid.

[5] Department for Environment, Food and Rural Affairs (DEFRA), Soils Policy Team, *Safeguarding Our Soils: A Strategy for England*, 2009. Available online https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69261/pb13297-soil-strategy-090910.pdf#page=1&zoom=60,0,854.

[6] DeLonge, M.S., R. Ryals, and W.L. Silver. 2013. A lifecycle model to evaluate carbon sequestration potential and greenhouse gas dynamics of managed grasslands. Ecosystems. 16: 963-979.

[7] Fronning, B.E., K.D. Thelen, and D.H. Min. 2008. Use of manure, compost, and cover crops to supplant crop residue carbon in corn stover removed cropping systems. Agronomy J. 100:6: 1703-1710.

[8] Shrestha, R.K., R.Lal, and B. Rimal. 2013. Soil carbon fluxes and balances and soil properties of organically amended no-till corn production systems. Geoderma 197-8: 177-185.

[9] DeLonge et al., 2013, Op. Cit.; and Brown, S., A. Carpenter, and N. Beecher. 2010. Calculator tool for determining greenhouse gas emissions for biosolids processing and end use. Environ. Sci. & Tech. 44: 9505-9515.

[10] Massachusetts Department of the Environment, *MassDEP Organics Study and Action Plan*, May 10, 2012, updated July 2013, available online at: http://www.mass.gov/eea/docs/dep/public/committee-4/orgplan12.pdf

[11] See for instance, US Composting Council, *USCC Position Statement: Persistent Herbicides*, http://compostingcouncil.org/admin/wp-content/plugins/wp-pdfupload/pdf/9199/USCC%20Position%20Statement%20on%20Persistent%20Herbicides%20FINAL.pdf.

[12] "Yard Waste" web page, Cedar Rapids, http://www.cedar-rapids.org/resident-resources/utilities/solidwaste/yardwaste/Pages/default.aspx

Conclusion

America is at a crossroads.

Our recycling rate has stagnated between 30 and 35% for more than a decade. With compostable material making up one-third to one-half of municipal solid waste, there is an enormous opportunity to achieve higher recycling levels with comprehensive composting. In addition to yard trimmings and food scraps, soiled paper such as pizza boxes and paper towels can be composted. Switching to compostable foodservice ware and packaging would further help divert materials from disposal facilities. Increasing composting and compost use would benefit the US in other important ways too.

At the same time many states struggle to increase their recycling levels, local watersheds continue to suffer from excessive nitrogen and phosphorus levels due to nutrient-laden runoff pollution. Excess fertilizers from farms and suburban lawns, sewage from septic systems, and sediment from construction projects wash off the land and into our waterways every time it rains. When added to soil, compost can help manage these erosion, sedimentation, and stormwater runoff problems. Healthy soils are essential for protecting local watersheds. Naturally occurring (undisturbed) soil and vegetation provide important stormwater functions: water infiltration; nutrient, sediment, and pollutant adsorption; sediment and pollutant biofiltration; water interflow storage and transmission; and pollutant decomposition. These functions are largely lost when development strips away native soil and vegetation and replaces them with minimal topsoil and sod. Organic matter is vital to soil quality and amending soil with compost is the best way to increase the organic matter in soil, which improves soil's ability to retain water.

Expanding the use of compost for stormwater and erosion control and in green infrastructure such as green roofs and rain gardens will create a new business sector throughout the US. For every 10,000 tons of compost used per year, about 18 jobs are sustained.[1] This is in addition to the jobs that could be created by expanding the manufacturing of compost at composting sites.

There are countless farmers who could potentially start composting if they were trained and could navigate zoning and other regulations. Expansion of backyard composting would reduce municipal government costs to collect and handle material and retain valuable organic matter in our neighborhood soils.

Farmer Ned Foley of Two Particular Acres exemplifies the benefits of encouraging on-farm composting. He uses half the compost he produces on his farm and sells the other half, diversifying his farm income. At the same time, he no longer buys fossil-fuel-based fertilizers for $800/ton. He has also created 1.5 equivalent full-time equivalent jobs through composting urban food scraps from Philadelphia as well as agricultural materials from neighboring farms.

Source: Institute for Local Self-Reliance

The creation of a comprehensive food recovery strategy would ensure that edible organics are diverted to those who need them most.

However, despite best intentions, composting and compost use will ultimately be limited if disposal fees remain cheap, new trash incinerators are built (under the false guise of providing renewable energy), persistent herbicides remain on the market, and policies are not passed to support the development of adequate infrastructure.

Incinerators need waste to make good on bond obligations. While incinerators are presented as green, renewable, economical solutions to waste problems, in reality, these facilities drain financial resources, pollute, undermine waste reduction and economic development efforts, and compete with the introduction of comprehensive food scrap composting systems.

Composting operations, on a per-ton and a per-dollar-capital-investment basis, sustain more jobs than landfills or incinerators. For every 10,000 tons per year flowing to an incinerator, one job is sustained. A 2013 ILSR study, focused on Maryland, indicates that landfills sustain two jobs per 10,000 tons per year landfilled. In contrast, composting operations sustain four jobs for every 10,000 tons per year they handle.[2]

Hundreds of new jobs could be created if organic material was diverted from landfills and incinerators to composting facilities. The potential job creation would increase if a diverse composting infrastructure was developed, that included many small- and medium-sized operations. The study found that if every 1 million tons of organic materials now disposed were instead composted at a mix of small, medium, and large facilities and the resulting compost used in green infrastructure, almost 1,400 new full-time equivalent jobs could potentially be supported, paying wages ranging from $23 million to $57 million. In contrast, when disposed in landfills and incinerators, this tonnage only supports 120 to 220 jobs.

ILSR recommends a comprehensive composting strategy: one that promotes home composting and small-scale farm and community sites as a priority, followed by on-site institutional systems and then development of commercial capacity for remaining organics. In the absence of strong federal policy, local and state government can set specific food waste recovery goals, and they can tie their composting goals to soil health, watershed preservation, climate protection, and waste reduction goals. The US has millions of acres of marginalized land starving for organic matter. Just applying 1/2 inch of compost per year to the 99 million acres of cropland eroding above soil tolerance levels would require about 3 billion tons of compost. There is not enough compost to meet this need. No organic scrap should be wasted. We need to recycle every potato peel. Indeed, reinvigorating the movement for a national soils policy may be the most important strategy for advancing compost production and use in the US. □

End Notes

[1] Brenda Platt, Bobby Bell, Cameron Harsh, *Pay Dirt: Composting in Maryland to Reduce Waste, Create Jobs, & Protect the Bay* (Washington, DC: Institute for Local Self-Reliance, 2013), p. 40.

[2] Platt, et al., *Pay Dirt*, pp. 39-40.

Appendix A

Aerated Static Pile (ASP) Compost Systems

Individual ASP

Individual ASP systems are stand-alone piles in which each pile is serviced by a dedicated blower or aeration system.

Spotlight

Figure A-1 shows the system at Blue Hen Organics on the Delmarva Peninsula in Frankford, Delaware (approximately 50 miles south of Dover, DE). This 30,000-tons/year facility takes in yard trimmings, food scraps, and residuals from the Peninsula's well-developed poultry raising industry. The food scraps and poultry residuals are mixed with woody material produced by the on-site vegetative materials grinder and piled into individual ASPs for two weeks. After two weeks, the piles are broken down, remixed and fresh ASPs are built for another two weeks. This improves process control and material homogenization. After the second ASP period, the compost is moved to curing in windrows on the sites.

Figure A-1: Individual ASP at Blue Hen Organics (DE)

Photo credit: Coker Composting & Consulting

Extended Aerated Static Pile

ASPs can be configured to be adjacent to each other, without separating walls. Known as extended aerated static pile, this configuration is commonly found in larger facilities. Extended ASP systems are based on building new aerated static piles immediately adjacent to previously-built piles, so that they share a common "wall" (see Figure A-2). These systems can use space more economically than individual ASPs.

Fabric-Covered ASPs

Covered ASP systems consist of covering ASP piles with either biogenic or synthetic covers, with biogenic covers including compost (screened and unscreened), wood chips, sawdust, hay/straw, and similar materials. The porosity of a biogenic cover greatly influences odor-reducing capability. Synthetic covers include polyethylene tarpaulins, flexible vinyl fabrics (recycled billboards), polyethylene fleece blankets, and expanded polytetrafluoroethylene (ePTFE) covers, although any water-repellent fabric cover will meet some of the goals. See Figures A-3 and A-4. Covered ASPs are essentially batch systems, in that once the pile is built it remains undisturbed in place for the duration of active composting and/or curing. (Some facilities will uncover and agitate the piles during the active composting phase, adjust moisture if necessary, and then recover.) 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 are suitable for the same applications as individual ASPs. They can scale from a few thousand tons per year to over 200,000 tons per year. Technology providers of covered ASP systems include Engineered Com-

Figure A-2: Extended ASP system at the Western Lake Superior Sanitary District in Duluth, MN

Photo credit: WLSSD

Figure A-3: Fabric-covered ASP system in Howard County, MD. This is a negatively aerated AC Compost System from Engineered Compost Systems (ECS). Feedstocks are yard trimmings and food scraps collected from residential sources. The initial capacity is 7,500 tons per year, but an expansion to 45,000 tons per year is planned.

Photo credit: Coker Composting & Consulting

Figure A-4: GORE Micropore fabric-covered ASP

Photo credit: W.L. Gore Co., Newark, DE

post Systems (induced draft), GORE® Cover technology manufactured by W. L Gore & Associates (forced draft), and Managed Organics Recycling (forced draft).

Bunker ASP Systems

Figure A-5 shows bunker ASP systems. These systems operate most efficiently when enough feedstocks are on hand to fill a bunker in two days, so the normal 30-day active composting period results in rows of bunkers adjacent to each other, often split into two sections facing each other with a common aisle. These can be positive aeration systems, where a biogenic cover, usually compost, is placed on the top of the bunker pile for odor management; or negative aeration systems, where exhaust air is directed to a biofilter for treatment.

Figure A-5: Several facilities have been built using concrete bunkers to separate individual ASPs into rectangular-shaped piles by poured concrete or concrete block walls. The primary advantage of bunkers over piles is the vertical capacities gained by the separating walls compared to angle-of-repose individual piles.

Photo credit: (left) Coker Composting & Consulting, (right) Green Mountain Compost

Spotlight

An example of an operating bunker ASP system is Green Mountain Compost (www.greenmountaincompost.com), which operates the 5,200-tons/year facility built by the Chittenden Solid Waste District in Williston, Vermont. This facility used poured concrete walls; the positive aeration system was built below the finish floor elevation in the concrete slab. These bunkers are covered with a pavilion-style roof, installed primarily to improve process control and to minimize storm water quality impacts.

Containerized (Enclosed) ASP Systems

Enclosed ASP systems are also available in several configurations, including tunnels, rectangular containers, bins, and bags. These vary in application suitability and scale, with tunnels generally being higher-capacity systems better suited to municipal and commercial applications, while containers, bins and bags are more suited to smaller capacities and can be used on-farm and on-site, in addition to municipal and commercial activities. Costs tend to be higher for tunnels, containers and bags, which are normally purchased from a technology provider. Like other ASP systems, piles are built and managed using rubber-tired loaders and skid steer loaders, although some larger facilities will use feed-in conveyors.

Small-scale aerated compost bins are available that are suitable for community, on-site, on-farm, and smaller-scale municipal applications. These tend to be batch-oriented systems, capable of composting 3-20 CY per batch (or per bin). Multiple bins can be arrayed for larger capacities. Each bin is equipped with a small blower and aeration device (Figure

Figure A-6: Community-scale aerated compost bins in Fairfax, VA

Photo credit: O2 Compost

Spotlight

St. John's University in New York City uses a larger O2 Compost Aerated Bin to compost food scraps, garden residuals, and landscape trimmings (Figure A-7). They recently achieved a Gold Rating with the Association for the Advancement of Sustainability in Higher Education STARS Program, in part because of their efforts to collect food scraps from university dining halls and coffee shops, compost it on campus, and utilize the finished compost in sustainable landscape practices and in a student organic garden. By composting on-site, St. John's has reduced its carbon footprint by eliminating the need for the Department of Sanitation to transport food discards to a landfill, thereby significantly reducing both truck exhaust and the production of landfill greenhouse gases.

Figure A-7: O2 Compost Aerated Bins at St. John's University, New York City

Photo credit: O2 Compost

Spotlight

An example of an operating facility using Ag-Bag EcoPOD® technology is Nu-Earth Organics in Waukegan, Illinois. Located on a 5.5-acre site in a well-developed suburban area, Nu-Earth uses Ag-Bag technology to compost about 10,000 tons/year of yard trimmings. The Oakland Zoo composts manure and animal bedding from its herbivores along with fruit and vegetable scraps and coffee grounds from its kitchens using the Ag-Bag system. The contractor handling the food scraps recycling for the City of San Francisco used this technology from 2005-2009, but it (Recology) has since converted to the ECS AC Composter system.

Figure A-8: Ag-Bag EcoPOD®

Photo credit: Ag-Bag International

A-6). These are available from technology providers such as O2 Compost (http://www.o2compost.com/). These systems are filled and emptied either manually or with a small skid-steer loader or tractor. They are reasonably priced, and are available either as entire systems, or as do-it-yourself kits that are constructed with local resources and labor (about $1,000 in materials costs).

Another form of containerized ASP involves modified silage bags. Ag-Bag International (www.ag-bag.com), a maker of silage equipment, developed a composting system by modifying silage production systems for livestock feed. The equipment normally used to create silage tubes for feed storage was adapted to create an in-vessel, static aerated-pile composting system. The Ag-Bag composting system uses a tubular, flexible plastic sleeve to enclose the compost materials. These compost tubes are sold under the brand name EcoPODs®. Figure A-8 illustrates this technology. These are suitable for on-site, on-farm, municipal, industrial, and commercial applications, and are scalable by increasing the number of bags. Like all ASP systems, proper feedstock conditioning and mixing is important. EcoPOD® is made from low-density polyethylene plastic and is a single-use bag. The EcoPOD® comes in 5-foot, 10-foot and 12-foot diameters and is 200 feet long. Each bag has a capacity of between 250 and 1,000 CY. A specialized machine is used to load the bags. A blower connected to a perforated plastic tube provides aeration. As the materials are pressed into the EcoPOD®, perforated polyethylene pipe is unreeled and fed throughout the length of the plastic tube. Active composting is 8-12 weeks followed by 30-60 days of curing.

Roll-off containers have been modified to serve as ASP containers. Both ECS and Green Mountain Technologies offer a form of this container ASP system. Like the bag system, these are batch systems so multiple units are needed for most applications. They are suitable for smaller-scale municipal, commercial and industrial applications. The units are filled with either a rubber-tired or skid-steer loader, or by a specially designed loading conveyor. The aeration system is installed in a false floor and these units can operate in positive, negative, or reversing aeration mode, with exhaust air treated by a biofilter, if needed. Lifting trucks similar to those used with roll-off containers are used to empty the containers. The ECS container system is the CV Composter (see Figure A-9).

Spotlight

The wastewater treatment plant in Livingston, Montana, uses the ECS CV Composter to compost biosolids with wood chips. The facility consists of four 40-cubic-yard CV Composter Vessels, a 475^{ft3} Luck/Now compost mixer, a loading conveyer, process monitoring with Comptroller™ (aeration control and data monitoring system), and a biofiltration system. The in-vessel retention time for composting in the CV unit is about 21 days, followed by curing. One full-time employee operates the facility, which produces 1,467 cubic yards of compost per year.

Figure A-9: ECS containerized CV Composter uses insulated 40 cubic yard vessels with stainless steel interiors

Photo credit: Engineered Compost Systems

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Appendix B

Bioreactor Compost Systems

Horizontal Bioreactors

Horizontal bioreactors are often dynamic systems, in that forced aeration is supplemented by internal turning or agitation. They tend to be operated in continuous mode, rather than the batch mode of the static bioreactors, such as enclosed aerated static pile systems. They tend to have smaller capacities and are modular, so are suitable for community, on-site, and on-farm applications. The smaller-scale systems are appropriate for small institutions including schools, hospitals and nursing homes, and commercial establishments such as grocery stores, hotels, businesses with cafeterias, and restaurants.[1] They are suited to capacities of less than 20,000 lbs/day of source-separated organics.[2] See Figure B-1 for sample systems.

Figure B-1: Green Mountain Technologies Earth Tub & Earth Flow

Photo credit: Green Mountain Technologies, Inc.

These systems tend to have integrated control systems that monitor process parameters like temperature and oxygen (or carbon dioxide). A mixing and loading hopper/conveyor and a biofilter for exhaust odor management are often included. Material is moved through the bioreactor by various means, including moving floors, spinners, augers, and similar dry materials transport devices. The sizes of these units vary by capacity, with smaller units able to fit into one parking stall, while larger units are 12-15 feet wide and have lengths greater than 20 feet. Technology providers and their reactor brands include:

- Green Mountain Technologies – Earth Tub, Earth Flow
- North American Trading House – The Rocket Composter
- Vertal – Big Hanna
- Hot Rot Organic Solutions – Hot Rot

Another horizontal bioreactor is made by a Swedish company, Susteco AB, and sold as Big Hanna (http://www.bighanna.com). The composter is essentially a horizontally orientated cylinder with stationary rear and front-end caps. The cylinder with composting material is rotated and the material is turned over and ventilated periodically. It is a continuous flow system. Depending upon the amount and the composition of waste material a range of choices can be made regarding waiting time between turns, length of turning period, ventilation intensity and filling level. There are five models available, ranging in capacity from about 9 tons/year to about 70 tons/year.

Food waste and sawdust (pellets) are fed into the front gable and as they enter the cylinder, they push forward the

Spotlight

Colorado State University's (CSU) Housing & Dining Services invested in a GMT Earth Flow system. This fully enclosed, in-vessel compost system is located at the Foothills Campus in Fort Collins, three miles west of the main campus. They purchased the unit as an alternative to trucking food scraps more than 50 miles one-way to a private merchant composter. The 30-foot long Earth Flow is capable of composting more than one ton of biodegradables per day. The system dramatically speeds the process of aerobic decomposition and is able to compost food scraps in 14-21 days. The composter is the size of a large roll-off dumpster with a greenhouse roof for passive solar gain and a unique traveling auger design (see Figure B-2), which simultaneously mixes the composting material and transports it slowly from one end of the vessel to the other. The composter is powered with electricity generated by nearby solar panels. Pulped food discards (including meat, dairy, bones and paper products) from two dining centers are composted in the Earth Flow with bulking material generated from the CSU Equine Center. Finished compost is used in landscaping projects on campus. Waste is loaded into one end of the vessel by placing a roll cart on an automated loader. The control panel allows the operator to select the number of times per day that the compost is mixed as well as automatically adds moisture to the compost. Finished compost cures outside of the system in piles for several weeks before being used as a soil amendment on campus.

Figure B-2: Auger inside GMT Earth Flow

Photo credit: Green Mountain Technologies, Inc.

Spotlight

At Rippowam Cisqua School (RCS) in Bedford, New York, in 2011 students started separating organics, mostly post-consumer food scraps at the dining hall. The idea behind this initiative was to help students see first-hand that food discards could be sent to an offsite facility to create compost, and then add nutrients back into the soil, closing the loop. RCS found a hauler, which was able to transport the material to an offsite composting facility. Hauling costs to transport the food scraps to that facility soon became too expensive, thereby leading RCS to decide to compost on-site and buy a Rocket® composter. See Figure B-3. The school also wanted to use the Rocket® composter as a learning tool. RCS students scrape the food from their plates into collection bins, and then feed the food scraps along with wood chips into the Rocket® composter. RCS students are learning how to compost on-site and how to use the compost to produce rich soil for their school garden, while diverting wasted food from landfill disposal. The school saves approximately $2,000 a month in avoided hauling costs to the composting facility.

Figure B-3: The Rocket Composter

Photo credit: North American Trading House

composting material already inside. In the first one-third of the cylinder, the material goes through the thermophilic phase of decomposition. In the following phase, most of the initial decomposition is complete. The material has a retention time of 6-10 weeks in the reactor. There are temperature probes situated in the front, middle and back of cylinder. The current temperature is displayed at all times and logged in the operator panel. Figure B-4 illustrates this bioreactor.

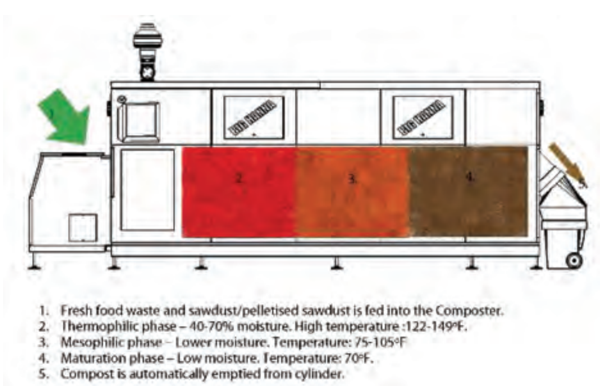

Figure B-4: Big Hanna Horizontal Bioreactor.

Illustration credit: Susteco AB

Spotlight

The Noble Correctional Institution (NCI) in Caldwell, Ohio, uses a Big Hanna Model T240 composter to process the food scraps of its incarcerated population. The Big Hanna system is coupled with a Somat Model 75S Pulper and Hydra-Extractor, which is a macerator designed to process food scraps and reduce their moisture content and volume. The system handles about 675 tons/year, which previously had been landfilled at an annual cost of $54,535. The NCI staff calculated a 3-year return on investment for the system, and also calculated a CO_2 emissions savings of 1,014 tons per year.

Figure B-5: Big Hanna Composter at Noble Correctional Institution

Photo credit: Susteco AB

Tunnel Bioreactors

Tunnel bioreactors are another form of actively aerated composting systems, more suited to larger-scale applications like municipal, commercial and industrial sectors, with capacities up to 100,000 tons/year. These systems consist of long narrow cast-in-place concrete walls and floors, typically 12-

Figure B-6: Tunnel Bioreactors

Photo credit: Engineered Compost Systems

Spotlight

The Region of Peel government in Mississauga, Ontario, Canada, uses a tunnel bioreactor for composting organics such as yard trimmings and food scraps (http://www.peelregion.ca/pw/waste/facilities/piwmf.htm). The technology provider was The Christiaens Group in the Netherlands. The system consists of six concrete tunnel reactors and has a capacity of 60,000 tons/year. Food scraps are mixed equally with leaves and yard trimmings, then shredded and placed into reinforced concrete tunnels measuring 15 feet wide by 18 feet high by 90 feet long. Air is circulated through the tunnels using a series of holes within the floor. After approximately seven to ten days, the material is removed from the tunnels and brought to the Peel Curing Facility in Caledon. The material is cured outside in 24 windrows for 45 days using the fabric Gore Cover System and then screened to produce the finished compost.

18 feet wide, 18-24 feet tall and 80-150 feet long. An 18 feet wide by 90 feet long tunnel bioreactor will hold about 560 CY of mixed feedstocks.

The positive aeration system is in the floor. The tunnels are designed to be filled and emptied with large rubber-tired front-end loaders. The airtight door systems that close each tunnel after filling are either hinged at the top and open with hydraulic lifters or hung on tracks and slide to one side (like a barn door). Composting times are 2-4 weeks, and some are configured to allow material to be removed and remixed during the process. During operation, process air is exhausted from the headspace above the composting mass and routed to a biofilter for treatment. Figure B-6 illustrates this technology. The only US technology provider of tunnel bioreactors is Engineered Compost Systems; this technology is also available from Canadian and European companies.

Agitated-Channel Bioreactors

Agitated-channel bioreactors are similar to turned windrow systems, except the windrows are contained within two long parallel concrete walls that are 6-8 feet high and spaced 9-18 feet apart. The mixed feedstocks are loaded into one end of the channel and are moved down its length over a 2-4 week period by an agitator that rides on rails bolted into the top of the concrete walls. As the turning machine moves forward on the rails, it mixes the compost and discharges the compost behind itself. With each turning, the machine moves the compost a set distance toward the end of the bed. The turning machines work in a similar way to windrow turners, using rotating paddles or flails to agitate the materials, break up clumps of particles, and maintain porosity. Some machines include a conveyor to move the compost. The machines work automatically without an operator and are controlled with limit switches.

Most commercial systems include a set of aeration pipes or an aeration plenum recessed in the floor of the bed and covered with a screen and/or gravel. Between turnings, blowers aerate and cool the composting materials. As the materials

Spotlight

The Lewiston-Auburn Water Pollution Control Authority in Lewiston, Maine, has relied on biosolids composting at their wastewater treatment plant since the 1990s. They handle 30,000 wet tons/year at the facility. They use a Longwood agitated-channel bioreactor system with sawdust and shavings as the bulking agent. The facility is enclosed in a building and air emissions are treated with a biofilter. Compost is sold under the brand name "MaineGro" and sells for $7 per CY (~$15 per ton).

Figure B-7: Lewiston-Auburn Water Pollution Control Authority Agitated-Channel Bioreactor

Photo credit: Coker Composting & Consulting

along the length of the bed are at different stages of composting, the bed is divided into different aeration zones along its length. Several blowers are used per bed. Each blower supplies air to one zone of a bed and is controlled individually by a temperature sensor or time clock. The capacity of the system is dependent on the number and size of the beds. The width of the beds in commercially available systems, ranges from about 6 to 20 feet, and bed depths are between about 3 and 10 feet. The beds must conform to the size of the turning machine, and the walls must be especially straight. To protect equipment and control composting conditions, the beds are housed in a building.

Rotary Drum Bioreactors

Rotary drum composting systems are used for municipal, commercial and industrial composting of municipal solid waste (MSW), animal mortalities, meatpacking and rendering wastes, and small-scale institutional (such as prison or university dining hall) food wastes. This approach uses a horizontal rotary drum to mix, aerate and move the material through the system. Rotary drum composting for MSW has been practiced since the early 1970s and Bedminister Bioconversion and Conporec are two manufacturers of large MSW composting systems. Other manufacturers make smaller systems, such as BW Organics, DTE Environmental, XACT Systems (Figure B-8), and Rotocom.

The drum is mounted on large bearings and turned through a bull gear. A drum about 6 feet in diameter and 16 feet long

Figure B-8: XACT Systems Rotary Drum

Photo credit: XACT Systems, Tenton, Ontario, Canada

has a daily capacity of approximately 4 CY with a residence time of three days. In the drum, the composting process starts quickly; and the highly degradable, oxygen-demanding materials are decomposed. Further decomposition of the material is necessary and is accomplished through a second stage of composting, usually in windrows or aerated static piles. The primary advantage of rotary drum composting is it usually achieves the requisite pathogen kill time-temperature relationship (>55˚C for three days), and it can reduce potential odor problems due to rapid decomposition of highly degradable organics, which are often the source of odor problems. Air is supplied through the discharge end and is incorporated into the material as it tumbles. The air moves in the opposite direction to the material. The compost near the discharge is cooled by the fresh air. In the middle, it receives the warmed air, which encourages the process; and the newly loaded material receives the warmest air to initiate the process. These types of units can also be used as mixers to combine feedstocks prior to the composting process.

Hybrid Systems

Hybrid systems combine the forced aeration of ASP composting with the agitation of the turned windrow. A hybrid system using both forced aeration and windrow turning has been developed by Green Mountain Technologies. See Figure B-9. Marketed as the "Earth Pad," there are three installations in the US (Annen Farms in Mount Angel, Oregon; LRI Compost Factory in Puyallup, Washington; and Little Hannaford Farms in Centralia, Washington). The system is located under an open-walled roofed structure, and has an aeration system buried inside a concrete slab. The system is divided into modules, with each module supplied by one blower and with separate zones within each module that can be independently controlled for temperature targets. Each module holds 5,400 cubic yards over 16 days, which allows for 300 cubic yards of incoming feedstocks to be placed daily in a module. Usually 2 modules are placed side by side for a total of 36 days of active aerated composting. Additional sets of modules can be laid end to end for unlimited expansion capability. During processing, the compost is periodically turned with an elevated face compost turner.

Spotlight

Alaska Green Waste Solutions in Anchorage opted for an in-vessel composting system and chose a rotating bioreactor drum by XACT systems because of its small footprint and large capacity. It purchased a 10-foot diameter by 30-foot long vessel and installed it in 2009. Alaska Green Waste Solutions collects vegetable and fruit waste from grocery stores such as Costco, Fred Meyer, and Carrs/Safeway. Horse stables also contribute their manure to the composting system, which is comprised of the bioreactor, 4 conveyors, and a mixer. The heat from the bioreactor helps heat the building in which it is housed. The produce scraps are loaded into the mixer and allowed to sit over night to allow excess liquid to drain off. The following morning the mixer is started and 2 parts wood chips are added to 2 parts produce material and 1 part manure. An additive, EM-1, is also added to the mix as a microorganism accelerant. After being mixed for 20 minutes, the contents are discharged onto a conveyor that feeds into the bioreactor. The materials take about 7 days to cycle through the bioreactor drum, and about 3 batches of compost are produced each week. It rotates only a few hours each day. According to the operator, with the help of the EM-1, the temperature of the composting material is kept in the range of 115°F and 145°F. The material exiting the bioreactor, which is reduced in volume by about 20%, is then moved offsite for curing in windrows or static piles. It is then mixed for different applications such as landscaping and erosion control and sold for between $65/ and $95/cubic yard. Their main compost purchaser is the Alaska Department of Transportation.

Figure B-9: Green Mountain Technologies Earth Pad

Photo credit: Green Mountain Technologies

End Notes

[1] Jean Bonhotal, Mary Schwarz, and Gary Feinland, "In-Vessel Composting Options for Medium-Scale Food Waste Generators," *BioCycle,* March 2011, p. 49

[2] Environment Canada, "Technical Document on Municipal Solid Waste Organics Processing," 2012, p. 5-22.

Anaerobic Digestion Systems

Liquid Digesters

There are many styles of liquid AD systems including single stage, two stage, and batch with a variety of control and mixing methods. The most common digester process configuration is a completely mixed, single stage reactor in which the various biochemical conversions are occurring simultaneously in a mixed culture. A single stage reactor is simple to build and operate and effectively promotes conversion to methane. Conversely, AD can be broken down to the multi-

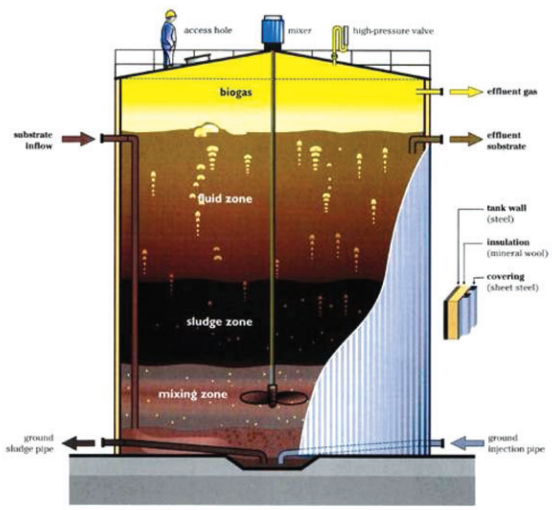

Figure C-1: Typical Low-Solids Liquid Digester

Illustration credit: David Darling, Encyclopedia of Alternative Energy

Figure C-2: Typical Slurry Digester

Illustration credit: Organic Waste Systems, OWS, Brecht, Belgium

Spotlight

Exeter Agri-Energy (EAE) owns a liquid AD system at Stonyvale Dairy in Exeter, Maine, which consists of two 400,000-gallon liquid AD reactors handling manure from the dairy (Figure C-3). EAE also takes in source-separated food scraps, primarily from preconsumer sources such as Hannaford Grocery Stores. The system came on-line in December 2011 and is currently handling about 20,000 gallons/day of manure plus 8,000 to 10,000 gallons/day of off-farm organics. The off-farm organics are 4-8 tons/day of food scraps with liquid waste (such as grease trap waste) making up the remainder. The food scraps are delivered into a concrete block and floored bunker (500 ton capacity) where a REMU loader attachment shreds the food scraps to a 1-inch minus particle size. A loader moves the shredded scraps to one of two 1,000-gallon in-ground, heated receiving tanks. A 40-hp Baldor chopper pump is used to pump the scraps into the AD reactors. CHFour Biogas, a Canadian company, provided the AD system. The continuously-stirred tank reactors are 65-feet in diameter, 20-feet tall, made of 12-inch cast-in-place concrete with heat tubing cast into the walls and a 4-inch insulation layer on the outside. Biogas is stored in a 60-mil flexible membrane storage system above the reactors. Temperatures in the digesters are typically close to 100°F.

Figure C-3: Liquid AD System at dairy farm, Exeter, ME

Photo credit: Coker Composting & Consulting

Spotlight

Toronto, Ontario, Canada is home to the Dufferin Organics Processing Facility, an anaerobic digestion system owned by the City that takes in about 60,000 tons/year of source-separated organics, mostly food scraps from Toronto's residential Green Bin program and its commercial Yellow Bin program.[1] The main challenge in digesting a solid material like food scraps is to liquefy the scraps to make them pumpable into a liquid digester. The Dufferin plant uses a wet pretreatment system consisting of pulper, float tanks, and sedimentation tanks to remove contaminants (such as film plastic, plastic bottles, and cans) from the organics, which are then pumped into the digester. Following a solids retention time of 27 days, the digested organics are dewatered with screw presses, and the press cake sent off-site for composting. The biogas produced by the AD system is currently flared, but plans are in place to convert it to biomethane for vehicle fuel usage.[2]

stage processes of hydrolysis, fermentation, and methanogenesis. Process design can consist of reactors in series to create optimal conditions for the bacteria involved in each of these conversion steps. Such a reactor arrangement may require less total reactor volume than a single stage reactor and may result in more complete conversion of the organic wastes to methane. However, systems with multiple reactors are typically more expensive to build and operate.

Anaerobic digesters are operated at two temperature ranges, mesophilic and thermophilic. Most digesters currently operating in the US are mesophilic and run at temperature ranges from 90˚F to 110˚F. Thermophilic digestion refers to operational temperature conditions above 125˚F. Thermophilic digestion can produce 30-50% more methane than mesophilic digestion processes operating at the same residence time. Thermophilic digesters typically generate fewer odors and have greater pathogen destruction than mesophilic systems.

Illustrations of typical liquid digesters are shown in Figures C-1 and C-2. Figure C-2 illustrates a higher-solids liquid "slurry" digester, which can handle feedstocks up to 50% total solids.

Dry Fermentation Reactors

Dry fermentation systems are a newer entry into the waste processing market in the US, but have been in use in Europe, due to the large number of source-separated organics collection programs there (see Figure C-4). Dry AD systems are better suited to solid waste processing than wet systems, due to pumping, clogging and toxicity issues with wet systems. The first dry AD system in the US managing solid municipal feedstocks, came on-line November 2011 at a university installation in Oshkosh, Wisconsin (8,500 tons/year capacity); the first municipal/commercial dry AD system came online in Marina, California, in March 2013 (5,000 tons/year).

In a batch process, the digester is completely filled with a mix of fresh organic matter and digestate, then closed with a gas- and liquid-tight seal (see Figures C-5 and C-6). The digester remains closed until the end of the desired retention time (around 28 days). It is then emptied and filled with new material, often a mixture of partially digested material that was just removed and fresh, undigested material. The partially digested material acts as seed material to restart the digestion process. Digestate recycle rates vary with each vendor's system, varying from 20% to 50% for dry batch systems and up to 85% for plug-flow (i.e. unmixed) systems.

Anaerobic microorganisms require a moist environment in which to thrive. A dry system is not moist enough to foster this. To overcome this, a liquid "percolate" is sprayed into the fermenter over the digesting feedstocks. The percolate has already been through an active digester; therefore, it contains anaerobic microorganisms. Once a fermenter has been reseed-

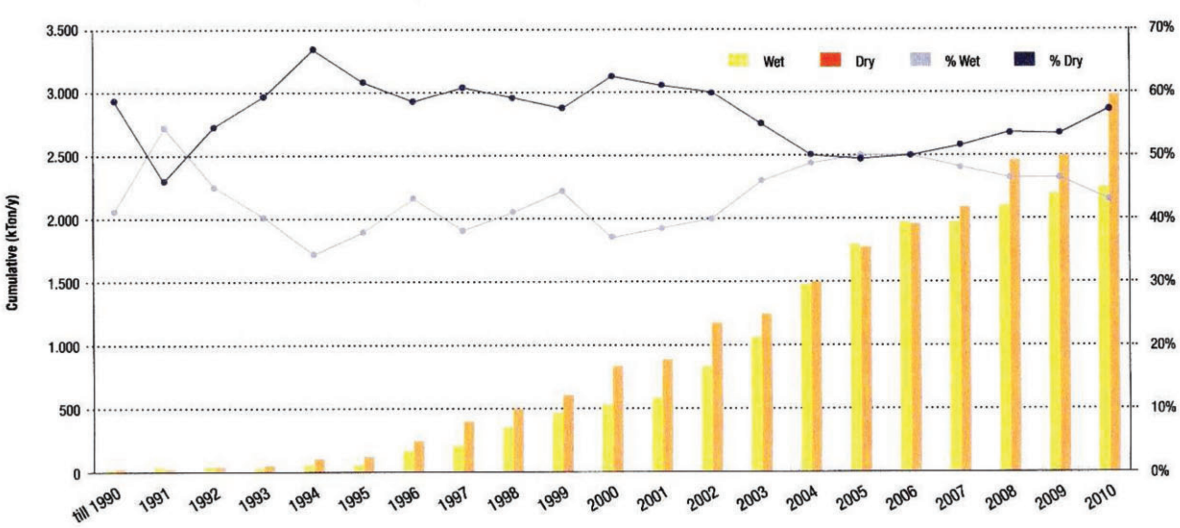

Figure C-4: Evolution and Ratio of Wet vs. Dry AD Capacity in Europe

Source: "Fact Sheet: Anaerobic Digestion, European Bioplastics, February 2011

Figure C-5: A Loaded Dry Batch AD Fermenter

Photo credit: Coker Composting & Consulting

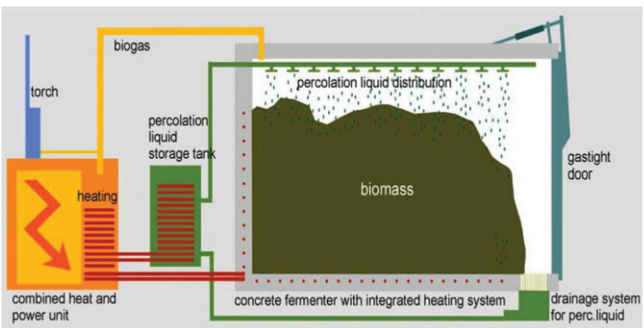

Figure C-6: A Cross Section through Dry Fermenter

Illustration credit: P. Lutz, BEKON Technologies, "New BEKON Biogas Technology for Dry Fermentation in Batch Process, Nov. 2005

ed, and percolate has been pumped into it, gas production begins almost immediately. Over the retention time of the digester, the percolate is repeatedly drained and resprayed onto the fermenting mass.

Dry-batch anaerobic digesters have several advantages over liquid and high solids digesters for processing organic solid wastes like food scraps and yard trimmings:

- The units can be loaded and unloaded with front-end loaders because the dry material is stackable;
- The digestate has a relatively high solids content and can be composted without having to remove excess liquid (although fresh dry compostable feedstock may be needed to elevate volatile solids content);
- Pumping liquid percolate is easier than pumping a slurry, with less potential for clogging and equipment wear;
- The fermenter "cells" are modular, so that multiple cells can be loaded and used at different times, ensuring a more even gas production rate; and
- A toxicity event, or an upset condition, does not take an entire digester out-of-service, just an individual cell.

Biogas generation rates are a function of the "richness" of the feedstocks; most European plants are handling residential source-separated organic materials (kitchen and garden scraps) – which they refer to as "biowaste" – and are getting gas generation rates on the order of 3,000 cubic feet/ton of feedstock. A feedstock stream of more digestible materials (such as food processing residuals, bakery wastes, and brewery wastes) might produce gas at a rate of 4,500 cubic feet/ton. A January 2013 test of the output of a mixed-waste materials recovery facility (i.e. a "dirty" MRF) in Minnesota showed a methane generation potential of 5,700 cubic feet/ton.

Most of the dry fermentation systems use the biogas (55-60% methane, 30-35% CO_2) as fuel for a combined heat-and-power (CHP) engine, which requires the gas be condensed to remove moisture and filtered through a charcoal filter to remove hydrogen sulfide. As an example of conversion of biogas to electricity, General Electric's Jenbacher JS3 316 engines (a common type found in AD systems) have a heat rate of approximately 9,400 Btu/kWh, which translates to an electrical efficiency of 36.3%. A dry AD system will use about 7-8% of the power produced internally (parasitic power). There is not a lot of available data on actual power produced by these generators in Europe. One American feasibility study *esti-*

Spotlight

The organics recycling facility at the Oshkosh, Wisconsin campus of the University of Wisconsin uses the BIOFerm™ biodigester technology, which is a dry fermentation anaerobic digestion system. The 19,000 square foot facility consists of four separate reactors and handles 8,000 tons/year of campus food scraps and landscaping debris, animal bedding wastes, and recycled digestate (Figure C-7). The mix ratio is one-third food scraps, one-third animal bedding and one-third yard trimmings. Each fermentation vessel is 70 feet long by 23 feet wide by 16.7 feet high. The source-separated organic (SSO) materials and about half of the digestate (the solid residual left over after fermentation) are loaded into one of the four reactors with a front-end loader. Once full, the reactor is closed and a 28-day fermentation process begins with spraying percolate onto the organic biomass, filling the biomass pore spaces with liquid, and shifting the bacterial activity to anaerobic digestion, producing biogas. Biogas is collected from all four reactors and is stored in a flexible membrane storage bag above the reactors. The facility produces 23.8 million cubic feet/year of biogas (with a 54% methane content), which is combusted on-site in a 370 kW Combined Heat and Power (CHP) generator, producing 2,320,000 kWh/year of electrical power and recovering 7,918 million BTUs/year of heat. The electricity produced is sold to Wisconsin Public Service (WPS) under a Power Purchase Agreement (PPA) and the recovered heat is used for maintaining the digester at mesophilic temperature and heating the facilities throughout the winter months. The digestate is composted in turned windrows at an off-site facility for market maturation for a period of several weeks. The Oshkosh facility was constructed in 2011 for a capital cost of $3.5 million. Other dry fermentation facilities using this technology are in planning, design or construction. The BIOFerm™ technology is available from BIOFerm™ Energy Systems in Madison, WI (www.BIOFermEnergy.com).

Figure C-7: University of Wisconsin – Oshkosh Dry Fermentation AD System

Photo credit: BioFERM Energy Systems

mated electrical production of 61 MWh/yr;[3] however, that was based on a 20,000-tons/year waste stream with very high gas generation potential. Many of the European plants had gensets with 300-400 KW capacities.

Waste heat from the CHPs is used in European systems for hot water heating (much space heating in Europe is achieved via hot water radiators), for drying of composts and sludges, and for similar uses. The American study referenced above estimated that about 4 MMBTU/hour of heat could be captured for reuse from the engine jacket and from the exhaust stack.

If the biogas is to be reused as "renewable natural gas" (RNG), then other impurities must be removed (such as CO_2) and the methane content elevated to 97-98%. Typical specifications for RNG include maximum concentrations for oxygen, hydrogen sulfide, sulfur and moisture content, requiring considerable cleanup of biogas. □

End Notes

[1] [31] Van Opstal, B. "Evaluating AD System Performance for MSW Organics," *BioCycle*, Vol. 45, No. 11, November 2006, p. 35-39, and "Managing AD System Logistics for MSW Organics," *BioCycle*, Vol. 45, No. 12, December 2006, p. 39-43.

[2] CCI BioEnergy, at http://www.ccibioenergy.com/projects/toronto-success/toronto-dufferin, accessed Jan. 31, 2014

[3] Mass Natural Fertilizer Co. "Feasibility Study of Anaerobic Digestion of Industrial Organic Waste Using Dry Fermentation Technology," Massachusetts Technology Collaborative Task Order 09-1, January 2010.

Appendix D

Managing Odors at a Compost Site

Odor Generation and Compounds

Aerobic decomposition is the cornerstone of composting. Aerobic composting is an *oxidation* process, whereby decomposition raises the oxidation state of the building blocks. This is the same process that turns an apple skin brown, a bicycle fender rusty or a copper penny green. Oxidation is defined as the interaction between oxygen molecules and all the different substances they may contact, from metal to living tissue. This occurs on a molecular level, but we see it when the free radicals formed by oxidation break away (rust flakes, copper oxide particles, brown spots on fruit). The main ingredients of food scraps to be composted are proteins, carbohydrates, and fats. These three components are made of various combinations of carbon, hydrogen, oxygen, nitrogen and sulfur.

Decomposition of these compounds follows a well-evolved sequence of events, each event producing both products and by-products. Each of these categories of decomposition products has several subcategories, many of which are intermediate byproducts of the decomposition process. For example, proteins decompose into their component polypeptides, which in turn, decompose into their component amino acids. At each stage of the decomposition process, there are a variety of different organic compounds, each with its own volatility characteristic. Think of a compound's volatility characteristic as its potential to generate odor.

An odor is a volatile chemical gas. Volatility is the tendency of a substance to vaporize, which is proportional to a substance's vapor pressure. At a given temperature, a substance with higher vapor pressure vaporizes more readily than a substance with a lower vapor pressure. As an organic material decomposes, the mix of volatile compounds change, so the mix of vapor pressures changes, which can change the characteristic odor. Some odors are produced by the biological changes in compounds by microorganisms; others are due to chemical changes in the compost pile.

The major odor-causing compounds in composting are sulfur-, nitrogen-, and carbon-based. Table D-1 lists some compounds that cause odors, and the nature of those odors.

Factors that can influence odor generation include: feedstock composition, the metabolic activity rates of the decomposers doing the work, the availability of the nutrients in the feedstocks to the microbes, how well mixed the feedstocks are, and several physical factors, such as moisture content, particle size, oxygen content and diffusion, and temperature.

Composting is *never* odor-free. Even under optimum conditions for aerobic decomposition of organic matter, odors are going to form. However, failure to develop those optimum conditions is guaranteed to make odors worse, particularly those odorants that people find annoying or unpleasant. The more odors that are formed due to poor composting conditions, the more quantities of that odorant escape into the atmosphere, and it becomes much harder to disperse those quantities below the recognition thresholds. The recognition threshold of an odor is much higher than the detection threshold; for example, ammonia has a detection threshold of 0.037 part per million (ppm), but a recognition threshold of 47 ppm (one part per million is equal to one inch in 16 miles). The detection threshold of an odor is the minimum concentration that the human nose can perceive something in the air but not identify it; the recognition threshold is the minimum concentration that a human receptor can identify the odorant.

Table D-1: Odor causing compounds at compost sites

Compound	Nature of Odor
Sulfur Compounds	
Hydrogen sulfide	Rotten egg
Methyl mercaptan	Pungent, rotten cabbage, garlic
Carbon disulfide	Rotten pumpkins
Dimethyl disulfide	Putrid, sulfurous
Nitrogen compounds	
Ammonia	Pungent, sharp, eye-watering
Methylamine	Putrid, Rotten fish
Cadaverine	Putrid, decaying animal tissue
Indole/Skatole	Fecal
Carbon compounds	
Acetic acid	Vinegar, pungent
Butyric acid	Rancid butter, garbage
Iso-valeric acid	Rancid cheeses, sweaty
Acetaldehyde	Green, sweet, fruity
Formaldehyde	Acid, medicinal
Limonene	Sharp, lemony
α-Pinene	Sharp, turpentine

Odor Management

Optimizing the conditions of a good compost pile or windrow is vital to managing odors. See Figure D-1. The microbes live in that thin biofilm around each particle in the pile and draw their life-sustaining oxygen from the air flowing through the pore space in the pile. So the first step in controlling the microbial activity is a mix that adheres to good best management practices (BMPs): the right nutrient balance between carbon and nitrogen (at least 25 parts of carbon for each part of nitrogen), adequate moisture to form and maintain the biofilm (around

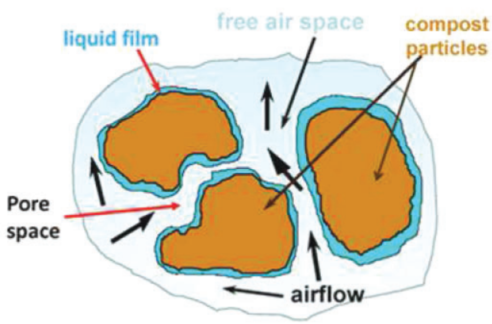

Figure D-1: Optimum Composting Conditions
Photo credit: US Composting Council

50-55%) and enough structural porosity to ensure a free air space of at least 40% to keep oxygen levels above a 8 to 10% minimum.

There is no one practice that influences odor generation potential more than the others. Successful odors management is a combination of smaller steps. Particle size is one of several steps to be managed. As illustrated in Figure D-1, the effectiveness of microbial metabolism on the compost particle is defined, in part, by the surface area-to-volume (SAV) relationship of the particle. The SAV explains why finely-ground salt dissolves in water faster than coarsely-ground salt. If SAV is too high, the interior of that particle will take a very long time to compost. If it is too low, then the particles in the pile can't support themselves and they collapse the free air space between them, reducing the ability of the pile to stay aerobic. Particle sizes should be in the 2- to 3-inch range.

Achieving the right moisture level is also important. If the biofilm around the particles dries out, microbial activity will go dormant and composting will stop. As piles dry out, the concentration of potential odorants in the biofilm increases. This can cause a chemical equilibrium shift between soluble and volatile forms for odorants such as ammonia or the terpenes found in green wastes. When a chemical volatilizes, it becomes a gas and migrates out of a compost pile by either passive or forced aeration. Conversely, if moisture is allowed to climb above 60% or so, the free air space channels between the particles clog with water. This thicker biofilm reduces the amount of oxygen available to the microorganisms on the surface of the particle as the rate of oxygen transfer in water is much slower than the rate of transfer in air. Material with an optimum moisture content of around 50 to 55% has the consistency of a wrung-out sponge that is wet but not freely dripping water. One of the challenges in composting food scraps with large amounts of vegetable and fruit material is that the plant cell walls break open readily under the heat of initial decomposition, flooding the pile with water. Without adequate structural porosity to allow that flush to drain out, the pore spaces in the pile will fill with water and risk formation of anaerobic conditions.

The transfer of oxygen across the biofilm requires a steady flow of air through the pile. Whether by natural or passive means, or forced through a pile by a blower, aeration serves several critical functions in process management, including replenishment of oxygen, removal of carbon dioxide (and volatile odorants), and removal of heat. Compost piles and windrows have both macro-aeration and micro-aeration characteristics. Macro-aeration refers to the overall uniformity of the structural porosity of a pile. A compost pile of wet dairy manure mixed with sawdust has low macro-aeration characteristics. A compost pile of chipped tree waste has good macro-aeration characteristics. Good macro-aeration characteristics are necessary where passive aeration is the primary means of oxygen transfer, like in windrows. Micro-aeration characteristics refer to how well air moves inside the pile. Fine particles, such as those produced by processing woody wastes with a hammermill, can impede aeration rates in various areas in a pile, creating air-starved sections in a pile.

Odorants are produced at various stages in the decomposition process and there is a sequence of events in which initial-stage decomposition odorants are degraded by microorganisms in the pile during composting. Forced aeration systems, particularly those with deliberately elevated aeration rates, can strip odorants out of a pile, before the odorant has had time to decompose in the pile. This can be a problem if the fans strip odorants out of air-starved portions of the pile. This puts pressure on the pile-external odor control system (e.g., biofilter) to handle this load and should be factored into the system design. In windrow systems that rely on the "chimney effect" of passive aeration, the high temperatures of early composting enhance the air flow through the windrow, potentially carrying off odorous compounds. That can be minimized by covering windrows with a 4-inch layer of unscreened compost to act as an *in-situ* biofilter. However, it is easy to overload a compost cap and suffocate the windrow.

As feedstocks decompose, they provide nutrients to the microbes, which use them to sustain their metabolism. Excess nutrients are not processed and can accumulate. As the biological and chemical changes in a pile shift the equilibrium between soluble and volatile forms of a chemical, these nutrients can be volatilized and become an odorant. The most notable example of this is ammonia emissions from a pile with a C:N ratio below 20:1.

Following best management practices in site layout and design and in compost pile recipe development and construction will not eliminate odors, but will greatly reduce the potential for odor episodes that will cause problems. □

State-by-State Snapshot: Survey of State Composting Activity (Sample Response)

BIOCYCLE
COMPOSTING | RENEWABLE ENERGY | SUSTAINABILITY

Survey of State Composting Activity

Thank you for completing this brief survey summarizing composting activity within your State.
If possible, when saving the completed survey please include your State in the file name (ex. NY_Composting_Survey.xlsx)
Please direct any questions to Nora Goldstein, Editor. Phone 610.967.4135 ext 26; noragold@jgpress.com. ***Please complete and email the survey at your earliest convenience. but no later than Mondav. November 19. 2013.*** *Thank vou.*

For which State are you completing the survey?

State
Florida

Who is completing the survey?

Name(s)	Title / Position
Shannan Reynolds	Environmental Specialist III
Michell Mason Smith	Engineering Specialist IV
Lauren O'Connor- lauren.oconnor@dep.state.fl.us	

Please provide the number of permitted and/or exempt composting facilities by feedstock type.

Feedstock Type	# of Facilities in your State
Yard trimmings only	257
Source separated food waste[1]	2
Mixed waste composting	8
Biosolids composting	29
On-site at institutiuons (e.g., schools, univ., prisons)	N/A
On-farm composting (e.g., manure, crop residuals)	N/A
Other *Specify feedstock:* Manure Composting and Blending	1

[1] *Processes residential, commercial, institutional and/or industrial food waste streams; may also include soiled paper and OCC, compostable products.*

Please estimate the total volume diverted annually by feedstock type. (tons or cubic yards)
(2010 data or later, if available. Please specify year.)

Feedstock Type	Annual Volume	T (tons) or Y (cubic yards)	Data Year
Yard trimmings	1,142,648	T	2012
Food waste[1]	29,884	T	
Biosolids	239,500	T	

[1] *Processes residential, commercial, institutional and/or industrial food waste streams; may also include soiled paper and OCC, compostable products.*

Please estimate the percent of the total MSW stream that is diverted to composting.
(2010 data or later, if available. Please specify year.)

			Data Year
Total MSW generated	27,800,000	tons / year	2102
Total organics diverted to composting	1,450,757	tons / year	
Estimated percent MSW diverted to composting	5	%	

Does your state administer the following in support of composting? (Yes/No)

Program	Yes or No
Competitive grants	No
Loans	No
Techncial assistance	Yes
Diversion mandates	No
Disposal bans (e.g., yard waste)	Yes
Outreach & education	Yes
Operator training course	No
Other *Please specify:* Recycling Credits	Yes

Please estimate the number of composting facilities in your State by size.

Size	Volume (tons/year)	Number of Facilities
Small	Less than 5,000	131
Medium	5,000 to < 20,000	58
Large	20,000 or more	40

Has your state conducted a waste characterization study in the past few years (2010 or later)?

Yes or No	Year of Study	URL for waste characterization study
No		

If available, please provide a link to the most recent annual solid waste report.

URL for Solid Waste Report
http://www.dep.state.fl.us/waste/categories/recycling/SWreportdata/12_data.htm

- End of Survey -

Please save and email completed survey no later than November 19 to Nora Goldstein: ***noragold@jgpress.com***

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Community-Based Composters Survey Results

Appendix F

ILSR October 2013 Survey Results: Community-Based Composters

- 43 sites identified to survey in US
- 24 sites responded
- Another 2 sites participated in shorter survey via BioCycle Community Composting Forum registration, plus input from other registrants

12 different states:

NY (9) MA (2) PA (2) AZ (2) OH (2) WI (2) MN IL OK UT VT CA KY

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NAME	City	BEGAN
Northern Arizona University	Flagstaff, AZ	2011
Roots Composting LLC	Flagstaff, AZ	2013
The Compost Club	Healdsburg, CA	2003
Resource Center	Chicago, IL	1983
Eco-Reps at University of Louisville	Louisville, KY	2010
City Soil (proposed)	Boston, MA	
Pedal People Cooperative	Florence, MA	2007
Eastside Food Co-op	Minneapolis, MN	2010
BIG!Compost,	Queens, NY	2010
Empire Zero	Castleton, NY	
Farmer Pirates Cooperative	Buffalo, NY	2012
GrowNYC, Office of Recycling Outreach & Education	New York, NY	2011
Myrtle Village Green	Brooklyn, NY	2012
NYC Compost Project in Queens	Flushing, NY	1993
NYC Compost Project, Lower East Side Ecology Center	New York, NY	
NYC Compost Project/Brooklyn Botanic Garden	Brooklyn, NY	1993
Red Hook Community Farm	Brooklyn, NY	2003
Green Scoop 'Pet Waste Recycling & Removal'	Columbus, OH	
We Compost	Akron, OH	
Commonwealth Urban Farms	Oklahoma City, OK	2010
Philly Compost	Philadelphia, PA	2011
The Dirt Factory	Philadelphia, PA	2012
Wasatch Community Gardens	Salt Lake City, UT	1989
Grow Compost of Vermont LLC	Waterbury, VT	2008
Community Action Coalition for South Central WI, Inc.	Madison, WI	2004
Growing Power, Inc./The Farms Composting	Caledonia, WI	1993

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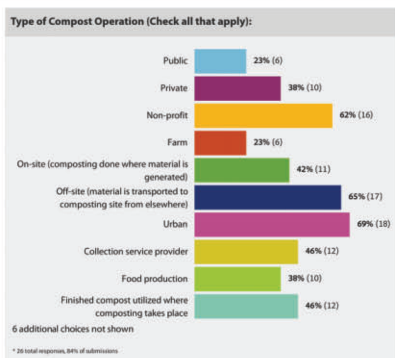

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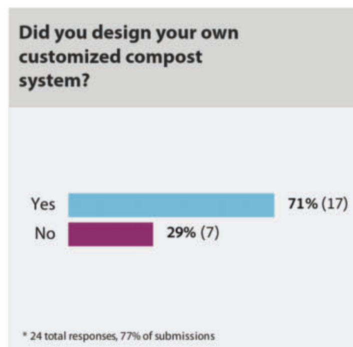

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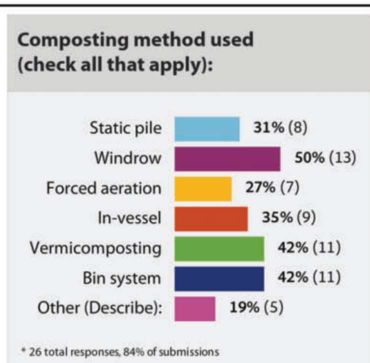

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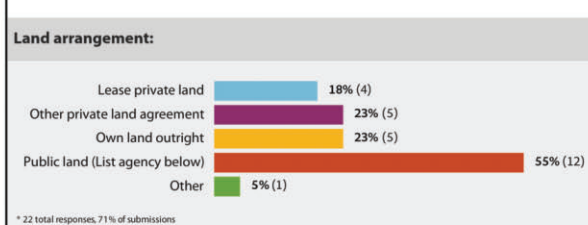

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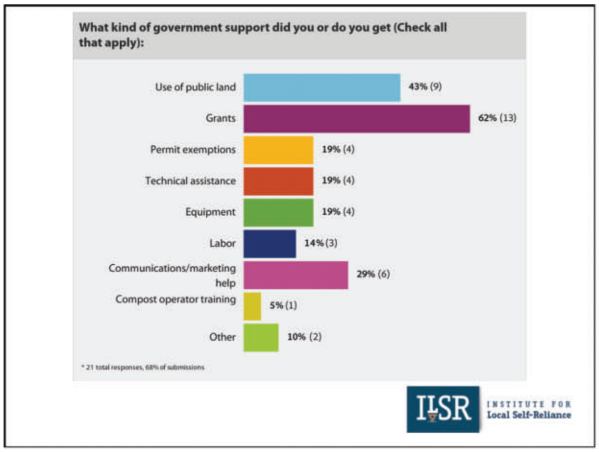
What kind of government support did you or do you get (Check all that apply):
Use of public land
43% (9)
Grants
62% (13)
Permit exemptions
19% (4)
Technical assistance
19% (4)
Equipment
19% (4)
Labor
14% (3)
Communications/marketing help
29% (6)
Compost operator training
5% (1)
Other
10% (2)
* 21 total responses, 68% of submissions
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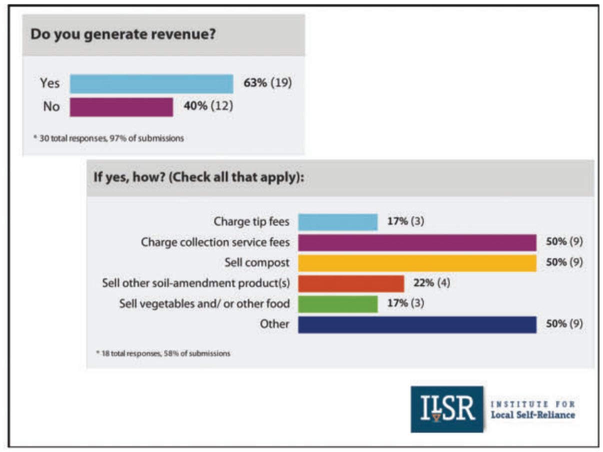
Do you generate revenue?
Yes
63% (19)
No
40% (12)
* 30 total responses, 97% of submissions
If yes, how? (Check all that apply):
Charge tip fees
17% (3)
Charge collection service fees
50% (9)
Sell compost
50% (9)
Sell other soil-amendment product(s)
22% (4)
Sell vegetables and/ or other food
17% (3)
Other
50% (9)
* 18 total responses, 58% of submissions
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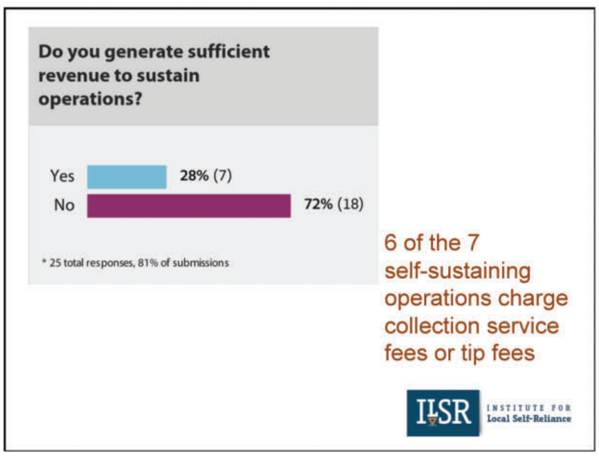
Do you generate sufficient revenue to sustain operations?
Yes
28% (7)
No
72% (18)
* 25 total responses, 81% of submissions
6 of the 7 self-sustaining operations charge collection service fees or tip fees
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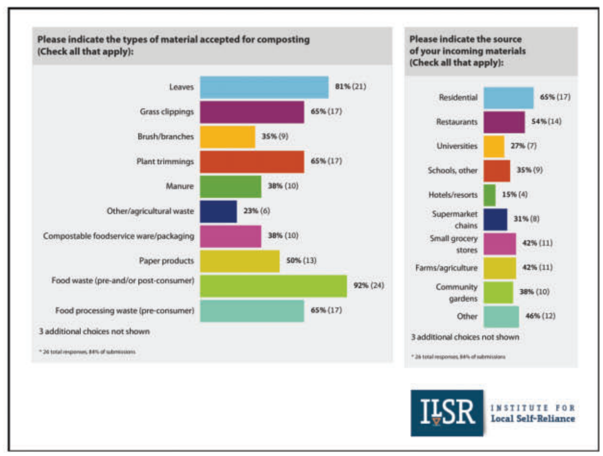
Please indicate the types of material accepted for composting (Check all that apply):
Leaves
81% (21)
Grass clippings
65% (17)
Brush/branches
35% (9)
Plant trimmings
65% (17)
Manure
38% (10)
Other/agricultural waste
23% (6)
Compostable foodservice ware/packaging
38% (10)
Paper products
50% (13)
Food waste (pre-and/or post-consumer)
92% (24)
Food processing waste (pre-consumer)
65% (17)
3 additional choices not shown
Please indicate the source of your incoming materials (Check all that apply):
Residential
65% (17)
Restaurants
54% (14)
Universities
27% (7)
Schools, other
35% (9)
Hotels/resorts
15% (4)
Supermarket chains
31% (8)
Small grocery stores
42% (11)
Farms/agriculture
42% (11)
Community gardens
38% (10)
Other
46% (12)
3 additional choices not shown
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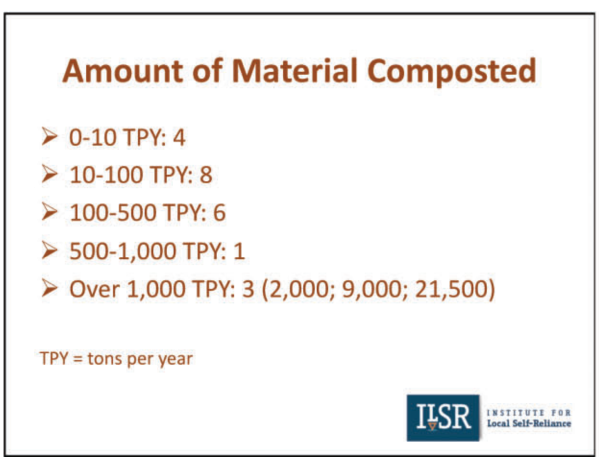
Amount of Material Composted
0-10 TPY: 4
10-100 TPY: 8
100-500 TPY: 6
500-1,000 TPY: 1
Over 1,000 TPY: 3 (2,000; 9,000; 21,500)
TPY = tons per year
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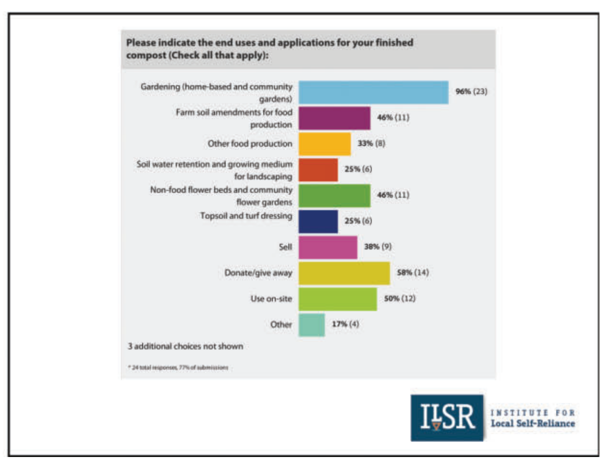
Please indicate the end uses and applications for your finished compost (Check all that apply):
Gardening (home-based and community gardens)
96% (23)
Farm soil amendments for food production
46% (11)
Other food production
33% (8)
Soil water retention and growing medium for landscaping
25% (6)
Non-food flower beds and community flower gardens
46% (11)
Topsoil and turf dressing
25% (6)
Sell
38% (9)
Donate/give away
58% (14)
Use on-site
50% (12)
Other
17% (4)
3 additional choices not shown
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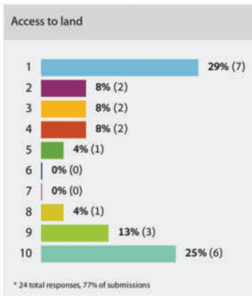
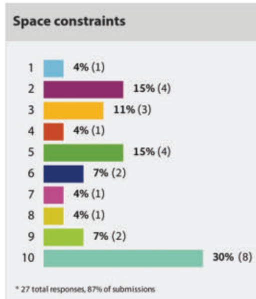
Challenges: Rate 1 to 10 10 = worst challenge





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Government assistance needed to help with SPACE and LAND

- "Partnerships with municipality for access to equipment and land."
- "Making empty and un-used public space available to composting operations."
- "Public land donation/lease nearby."
- "Land - access to public land"
- "Locating vacant land, even if for temporary use is needed."
- "...we have been unable to find anyone, public or private, to lease us one parking space worth of land."
- "Incentivize the conversion of empty and un-used real-estate for composting operations."
- "More access to land"
- "Free land to do this would be very helpful."
- "Designate public areas for compostable drop-offs."
- "Locate land and allocate land for these operations. "

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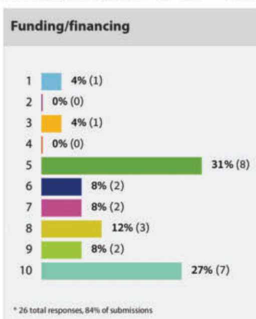
Challenges: Rate 1 to 10 10 = worst challenge



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Government assistance needed to help with FINANCING

- "working capital and political buy in"
- "funded staff"
- "Investment in order to get up to a medium size hauling/ education company."
- "Having time/money/staff to run composting is a challenge. need funding for staff or lots of great volunteers."
- "Financing for more machinery and labor."
- "Need funding to acquire larger facility to accommodate demand."
- "Grant programs designed to encourage onsite site-wide composting for schools and institutions"

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Government assistance needed to help with FINANCING, cont.

- "Increased access to public funding to start pilot programs. This program began as a grant-funded student-led pilot project, with the University adopting it once the techniques were proven successful."
- "More funding"
- "Grants to build more bins. grants to pay people to turn piles and do collection work. grants for slightly larger sites to have machinery to turn. grants for anaerobic digestors."
- "Training, and funding assistance for improved equipment that mitigates odor and vectors is a #1 priority."
- "Define an appropriate scale and a financial structure that allows community-based composting to exist with paid staff."

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Government assistance needed to help with FINANCING, cont.

- "Grants to: build more bins, pay people to turn piles and do collection work, for slightly larger sites to have machinery to turn, for anaerobic digesters."
- "SITE PURCHASE and PREPARATION!"
- "Equipment to repurpose solidly built existing buildings for compost production. The facility being totally enclosed allows complete odor and vector control, enabling it to be in urban areas close to where compostables are generated and where compost is needed."
- "Raise funds and build system"
- "Money to pay staff should be made available."
- "testing of product (e.g., a fund to pay for expensive testing that small sites cannot afford, discounts from labs)."

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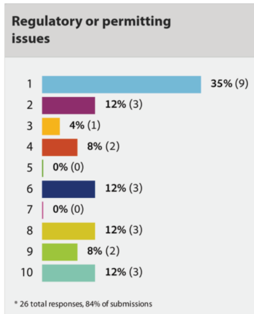
Challenges: Rate 1 to 10 10 = worst challenge



Government assistance needed to help with REGULATIONS & POLICY

- "With public regulators, develop voluntary standards for operating a community compost site… avoid passage of unnecessary and potentially hindering new regulation… create a mechanism for distributing and monitoring compliance with standards while at the same time providing needed support and expertise for sites willing to honor the standards"
- "Local and state officials, such as those who regulate hauling of waste and environmental protection, need to interpret their mandates, or have their mandates changed, to actively support rather than impede community composters. Not only are exemptions needed, but active assistance is needed."

Government assistance needed to help with REGS & POLICY, cont.

- "If farmers could get more subsidies for [them] to benefit from land application compost"
- "change legislation so that we could accept more off-site materials."
- "Regulatory lenience from hauling agency (BIC) is needed." [BIC is in NYC]
- "DEC regulations are nearly impossible to navigate in dense urban settings." [NY]
- "Allowing composting in more places"
- "either mandatory %composting of organic wastes in grocery/restaurants, or a tax benefit for those that do compost."
- "Creating more demand for finished product."

Government assistance needed to help with REGS & POLICY, cont.

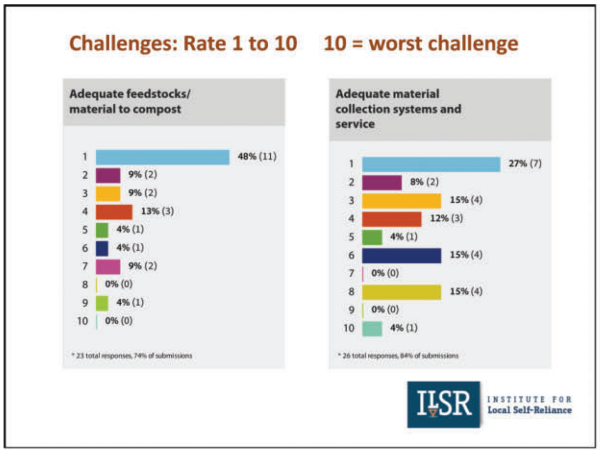
- "Perhaps property tax abatements for undeveloped real estate converted to community compost operations."
- "Some kind of small-medium community composting ordinance. We would likely be shut down if we were called in for a code violation due to undefined language in municipal code."
- "Laws requiring the composting of all organic waste in cities and towns. Laws that paid composters."
- "Make it easier to have compost transfer centers without having to be 'site-assigned.' It seems like the laws and public health safeguards are set up with big trucking operations in mind, so it can be hard for low-volume, very localized, bike-based businesses to have to go through the same regulatory process."

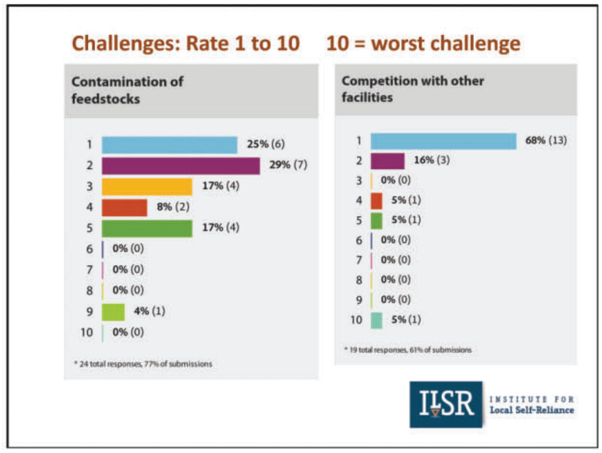
Government assistance needed to help with REGS & POLICY, cont.

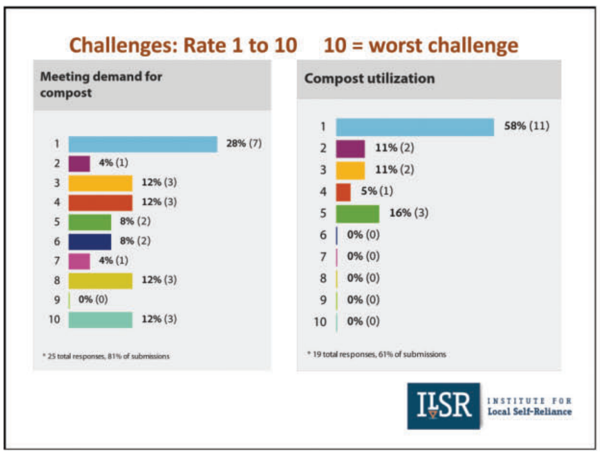
- "A permitting option for this type of operation."
- "There should be a designation and specific regulations for composting operations that fall between 'farm' and 'backyard'. Funding systems for this size and style of operation would also be helpful."
- "…requirements for recycle bins and commercial food waste pickup in areas not yet seen (ex: gas stations); incentives and tax breaks to promote anaerobic digestion of organic waste"
- "appropriate permits for med scale operations"
- "Policy to implement tax benefits for businesses to compost."
- "great to see categories for smaller-scale operations. … City-owned land more open to being transfer centers for small volumes of compost."

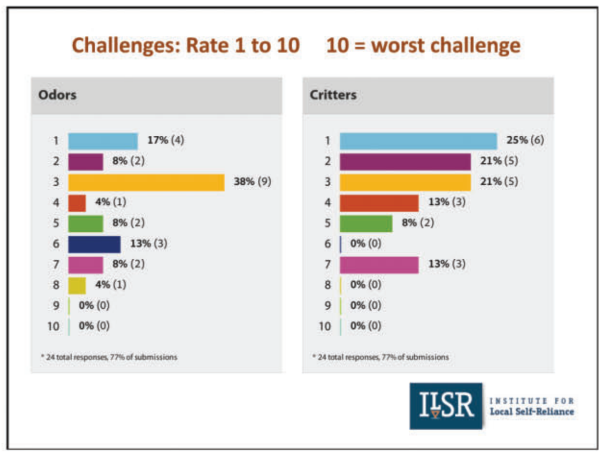
Government assistance needed to help with REGS & POLICY, cont.

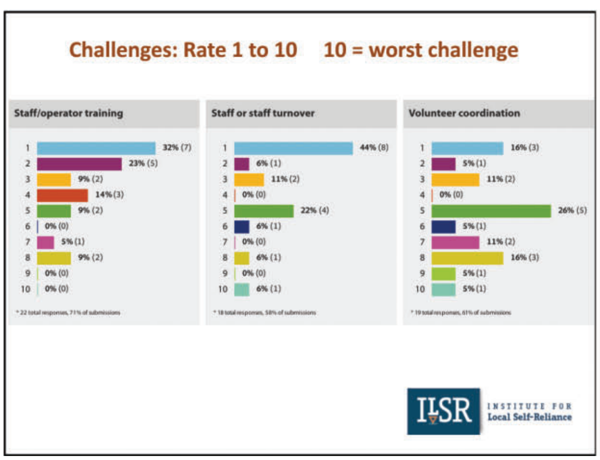
- "pass laws to make composting mandatory, policies"
- "Composting needs to be a 100% agricultural enterprise. Require composting of organic material; support composters by allowing 'right to farm' at compost facilities. Farm smells cannot be illegal if community compost is going to happen on any scale."
- "Require standards to insure quality operation and product."
- "carbon credit incentives to pay schools for composting"











Assistance needed to help with TRAINING & STAFF

- "Training, and funding assistance for improved equipment that mitigates odor and vectors is a #1 priority. A trained composter knows the need for proper equipment and systems to ensure and odor free, vermin free operation."
- "Compost operator training or other compost educational programs."
- "trainings for community members to ensure they're making quality compost."
- "Technical assistance/community educators"
- "For urban contexts the compost operator trainings have got to be turned inside out and upside down to recognize some realities about how different success looks in an urban context."
- "Statewide Master Composters classes and certification for small scale thermophilic composting assistance and oversight."

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Help Needed with Volunteers

- "Hiring staff to coordinate volunteers"
- "Community garden compost is difficult to manage, with so many people with varying knowledge on compost management - lots of confusion about the composting process"
- "Better volunteer coordination"
- "need funding for staff or lots of great volunteers."
- "Gaining the notice of volunteerism organizations would also help."

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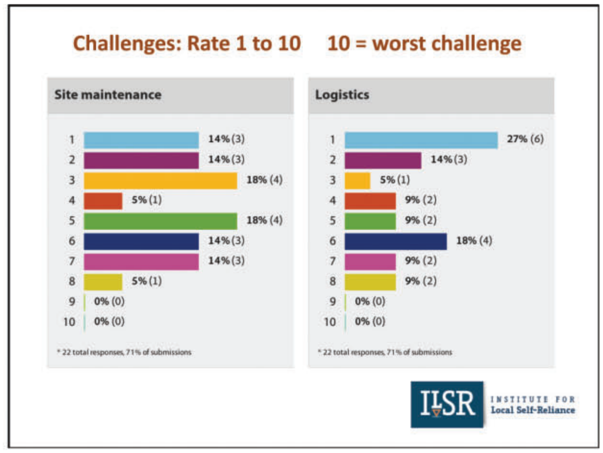

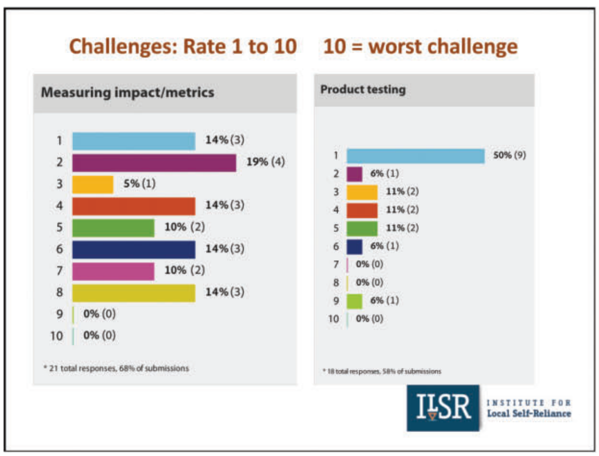

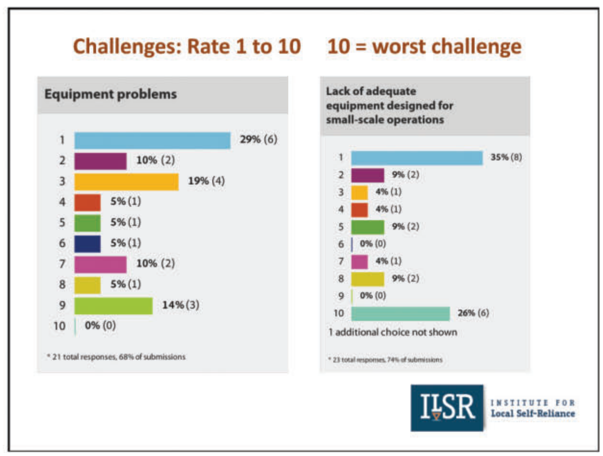

LACK OF SMALL-SCALE EQUIPMENT

- "Design appropriate technologies for medium scale composting, cost effective, low cost, durable, has capacity"
- "Set up an engineering 'challenge' for new technology (using materials readily available from Home Depot), 60 days or less, no electricity, no moving parts, use in vacant lot until developed, flexible, transportable, 12 months a year, insulated"
- "With the private sector, work with industry partners, to address needs for: more aptly sized and powered equipment (e.g., effective human-powered equipment, smaller and affordable/donated industrial equipment, shared-equipment cooperatives)"
- "We need development of equipment appropriate to our scale, e.g., bicycle-powered sifters and shredders."

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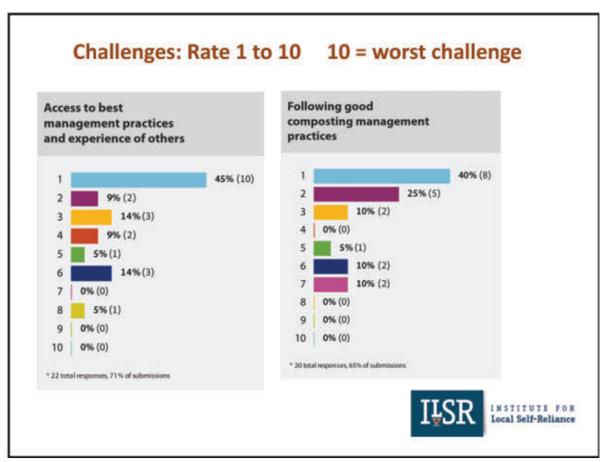
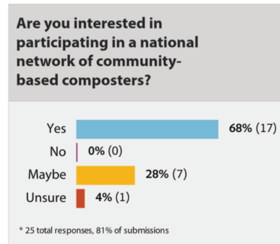
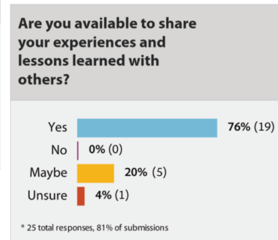


Networking & Learning Best Practices

- "Salaried stewardship teams to help set goals, assess operations, and facilitate local networking and cooperation between composters, gardens, waste producers, public infrastructures, etc."
- "Networking/information sharing to connect composters with suppliers of compostable materials."
- "Offering technical assistance for governments and groups seeking to start such operations, share best practices"





Other ideas to advance community-based composting

- "getting people to DO it! Education, Research & Development"
- "Public education"
- "First the policy argument in favor of community composting should be thoroughly developed for multiple audiences, including the general public, national/state/local electeds, and private funders. That will also require some marketing methods, especially videos appropriate for short presentations in public settings or private Board meetings."
- "Education about importance of composting and using locally made finished product."
- "Grants; Technical assistance; Equipment; Labor; Communications/marketing help"
- "Technical assistance; Communications/marketing help"

Other ideas to advance community-based composting

- "Decentralized composting onsite with regional information or resource centers to assist with practical needs… Steps: Outreach and educate site; provide technical expertise and track record of results; assemble team of key personnel; design system to handle specific quantity and type of feedstocks; raise funds and build system; implement educational outreach and technical maintenance training; develop farm production calendar and harvest and process on schedule; develop sales and marketing outlets to sell products or develop plan to use it onsite as a nutrient management plane or soil building plan; advertise and communicate about the program to the general public"
- "model systems for urban environment"
- "Quantify benefits"

Other ideas to advance community-based composting

- "Quantify benefits"
- "Government must establish an empowered local "expeditor" for every municipality, namely a 'go to' person who is familiar with all of the issues confronting community composters and can help get to solutions rather than say it's hopeless. So empowered means someone with some clout, so at least phone calls to regulators or local electeds get answered, and over time ways can be found to grow the community composting movement."
- "Create ad campaigns and tax credits that support community composting. Make community composting the norm at a local government level, rather than commercial, technologically- and resource-intensive systems. Provide outlets for community composting donors to direct the produce of their compostables (soil or food) or to buy them back at a discount."

Tips for Replication

- "Start slow, figure it out as you go. Start with at least one other person, work cooperatively and be sure responsibilities and visions are shared and everyone is invested in the success of the project. Try to keep overhead down. It's easier to keep rodents out from the beginning than to get rid of them later."
- "Be very sensitive of where you do your operation. Static pile. Always have carbon on hand."
- "Small scale operation is unsustainable w/o best equipment or with high debt load. Few survive. Our solution: buy equipment after it has served It's useful life for others, nurse it back to life, and After 5 or more years of using and rebuilding, it Will operate nearly like new."

Tips for Replication

- "Have constant oversight of equipment, need onsite help every day, a lot of aspects can go wrong, material coming in (not too wet or dry). People are eager to be a part, people want to drop off and pick up, find a big in-vessel composter, make sure adjacent property owners are ameniable, find appropriate location"
- "Set realistic goals"
- "Apprentice at a successful site first to make sure you are not just talk and no action … it is hard work when it is done right. … And for urban contexts, be certain you will be able to schedule operational tasks sufficient to control odors and rodents and observe an aesthetic standard far higher than for a rural context – otherwise your impact will be to generate opposition to composting rather than love for it."

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Tips for Replication

- "We only let trained volunteers work the compost, but anyone can bring compost donations to the site. We also employ attractive multi-lingual signs for on-site communication about our compost practices and evolving needs/concerns."
- "As a collection company we found it best practice to work with local governments on the town or village level as well as prominent people. For example, we worked with the town recycling coordinator and the director of a few local farmers markets in order to have our booth at the farmers markets while marketing our programs."

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Tips for Replication

- "integrate composting into community gardens! consider energy costs/benefits of small scale versus large scale composting programs"
- "Start small and work your way up – we began with just a few student volunteers carrying buckets on foot, then a few bike trailers to expand range of collection, and then the full-scale implementation."
- "Start small to gain experience working with the composting process. It's such a context specific, place-based and dynamic process that even beginning with best practices from other sites you will inevitably have to figure out a lot on your own."

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Tips for Replication

- "Know your neighbors but don't make too much noise. Try to keep composting areas hidden or shaded. Seek out partnerships with organic grocery chains and tree trimming company. Wood chip compost can be sorted and reused multiple times. Build a coalition of folks who can spread the labor of grocery store pickup, such as other community gardens, farms, schools, and individuals. Don't wait for the perfect arrangement before starting, just start with what you've got."
- "Just start based on common principles of composting and troubleshoot problems as they develop. There is no magic or secret to composting, it just takes practice, trial and error, like anything else. Also, people are willing to pay to have you pick up their compost, even if it does not save them money. Take advantage of this fact and do not pick up compost for free."

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Tips for Replication

- "Do your homework, talk to the experts, visit other projects to see what works and what doesn't."
- "Plugging in to existing organizations is critical. Ex. BIG! Compost plugged in to existing farmer's markets to provide collection of food waste. Grant money or city funding is a must to secure equipment to transport and process."
- "We support over 65 community compost sites in Brooklyn, NY with education, technical assistance, and small scale funding for bin builds. We recommend that sites reach out to us for assistance in starting small scale or on-site composting operations."

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Tips for Replication

- "Make sure you realize how much time all aspects of processing will take. …. we have volunteer days once per month to help with some labor intensive processing items (sifting, emptying Earth Tubs, bagging finished material)."
- "For schools, start small with a motivated group or section of the campus; don't limit it, however, to a one classroom example of a worm bin; seek to fundamentally change how waste is handled at the institution – our program starts a new school each year"
- "Be sure you have experienced composters as part of the operation. Be sure you understand the systems. Be sure you consider what is already available before you begin purchasing. Resist the temptation to privilege aesthetics. Know all of the rules before you begin. Have resources to connect with the community."

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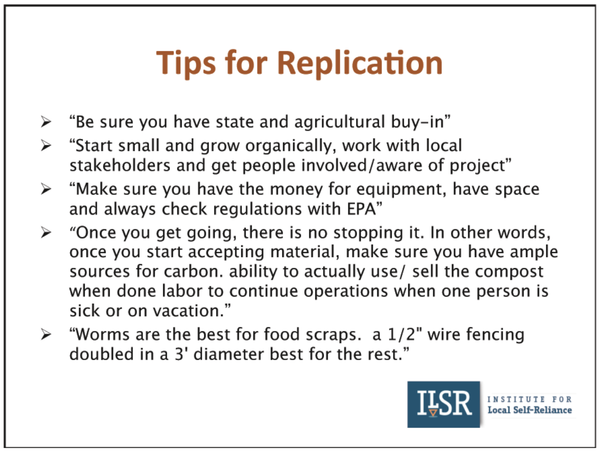
Tips for Replication
➢ “Be sure you have state and agricultural buy-in”
➢ “Start small and grow organically, work with local stakeholders and get people involved/aware of project”
➢ “Make sure you have the money for equipment, have space and always check regulations with EPA”
➢ “Once you get going, there is no stopping it. In other words, once you start accepting material, make sure you have ample sources for carbon. ability to actually use/ sell the compost when done labor to continue operations when one person is sick or on vacation.”
➢ “Worms are the best for food scraps. a 1/2" wire fencing doubled in a 3' diameter best for the rest.”
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