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FROM:	**NICOLE CHARDOUL, HOLLY HALLIWILL, JD LINDEBERG**
DATE:	**9/27/2021, REVISED 12/27/21**
RE:	**SOLUTIONS RECOMMENDATIONS AND PROCESSING TECHNOLOGY OPTIONS**

Food waste is a subset of organic waste, which includes anything biodegradable that comes from plants or animals, such as yard trimmings and manure. Food waste includes unavoidable scraps, such as bones and rinds that retain beneficial value for reuse. It does not include waste from crop varieties specifically grown for fuel, animal feed, or other commercial uses. Further, recovery of residentially and commercially generated yard and woody waste materials are closely tied to food waste recovery efforts through both common infrastructure (curbside collection, yard waste composting facilities) and as needed constituents (e.g. bulking agents, carbon sources) to some recycling activities.

Consumer-facing businesses and homes represent over 80% of all food waste. Furthermore, home waste represents roughly two-thirds of total lost Economic Value, due to high volumes of waste, the higher cost of food sold at retail, and the high value of meat — a popular consumer purchase item.

Existing efforts already recover and recycle significant quantities of food in the region. These efforts, while not sufficient, represent commendable progress made by stakeholders to date and an opportunity to increase value further through more focus and attention on the issue.

In conjunction with the Solutions Matrix, the following recommendations are organized by Category (e.g. prevention, rescue/recovery, recycling/technology, recycling collection/policy). Areas of suggested focus are informed by the proposed feasibility levels indicated in the Solutions Matrix.

PREVENTION

On one hand, excellent prevention strategies will provide SEEDS with the biggest bang for its buck. Food not produced, not transported, not warehoused, and not kept cold brings with it tremendous economic and environmental benefits. But these gains and benefits have traditionally not been easy to quantify and evaluate over time. Successful outcomes for food waste prevention will incorporate both real quantitative reduction in food wasted as well as a means to create a robust measurement environment that is sufficient to measure and communicate success.

FOCUS SOLUTIONS

- *Educational Campaign/Enhancement of Existing Efforts* – Educational efforts targeting consumers help them make better use of leftovers and minimize spoilage by properly storing perishable foods. At the same time these consumers have a direct hand in reducing waste in and outside the home by creating the awareness necessary to demand that businesses operate more responsibly. These campaigns help to overcome apathy, emphasize importance, and create a long-term commitment to food waste prevention.

- *Waste Reduction Goals* – We can't manage something we don't measure. Creation of numerical goals, and the means/metrics to track, enables effective measurement and tracking of progress. Although a small step, creation of goals is simple, inexpensive, and ultimately a very powerful tool in creating a circumstance of success.

CHALLENGE SOLUTIONS

- *Waste Tracking & Analytics* – Once waste reduction goals have been created, rigorous measurement creates the opportunity for regular management and improvement. Where it is collected, rigorous data collection enables businesses to identify the volumes and types of food that are wasted during food preparation. This knowledge in turn builds the business case for investment in other recovery and prevention solutions. This can accomplish two corporate priorities: increased profit margins and data reporting to show external stakeholders a path to lower overall waste levels. Implementation and collaboration such that individual business decisions can be aggregated into a community profile requires cooperation and a willingness to engage in pre-competitive collaboration.

STAKEHOLDER ROLES

- *Non-Governmental Organizations* – NGO's like SEEDS play an important catalytic role in creating the momentum for social initiatives. Their role in food waste prevention and recovery fits nicely in this model as well as working collaboratively with other NGOs at the local, regional, state and national level that are also engaged in these issues.
- *Local Units of Government* – Similarly relevant units of government can amplify the messages created for these social initiatives and coordinate with message developers to insure consistency and "sign-off". Public funding could also be available to match efforts of the NGO and business sector as the parties move forward with a concerted food waste education initiative.
- *State Agencies* – State agencies are potential sources of funding for one-time support through grants in aid and in-kind support for food waste prevention efforts. In Michigan cooperation with the Recycle Racoons, Know it Before You Throw It Campaign, and other education initiatives could yield a message across the state that is consistent with regional efforts promoted by SEEDS.
- *Institutions (schools, hospitals, universities)* – With their captured clientele, customers, and staff, institutions are closed systems where engaging food organics diversion behavior can be simpler than in the broader public. Institutions are often excellent places to pilot approaches to recovery, institute best practices, and concentrate food waste sufficiently to enable cost effective collection and hauling.
- *Consumer-Facing Businesses* – Businesses, especially those with an established customer basis, can influence the behavior of these individuals through various education and promotion activities. Some, like food service establishments, are uniquely able to engage as influencers through their own participation in prevention, recovery and recycling activities.
- *Residents* – Residents play a key role in all of these initiatives, both as consumers of information and voters who seek social change that reflects their desires for the kind of community in which they wish to live.

VISION FOR SUCCESS – The Region seeks to accomplish the implementation of a world-class set of prevention approaches that create the opportunity for reduction of food waste by ~1.6% of total organics waste generation. With this reduction, comes additional profits for participating businesses (e.g. restaurants, caterers, grocery stores) and reduced costs of food for regional families.

RESCUE/RECOVERY

Although food recovery initiatives already exist throughout the region, opportunity remains to increase donations. Food recovery networks — including food banks, pantries, soup kitchens, shelters, and other agencies — already receive and distribute many pounds of rescued food each year. While prevention strategies can be implemented independently, recovery requires a systems approach with key success features: first, businesses need to be protected from liability related threats and understand how to safely handle recovered food, second, policy that assess financial incentives for individual and corporate donations need thorough understanding, and finally, appropriate infrastructure for transportation, processing, storage and distribution are also needed.

FOCUS SOLUTIONS

- *Food Donation Guide* – This resource will help businesses understand why and how to donate food easily. Smaller donations (under 50 pounds) are expensive.
- *Business Food Donation Awareness and Training* - tracking food waste and training kitchen staff on best food prep or organics recycling practices to reach goals of reducing waste and increasing donations.
- *Donation Liability Education* - educating potential food donors on donation liability laws, the Emerson Act, etc. Donors, gleaners, and nonprofit organizations must still comply with state and local health regulations.

CHALLENGE SOLUTIONS

- *Donation Transportation, Storage & Handling* - providing small-scale transportation infrastructure for local recovery, expanding temperature-controlled food distribution infrastructure/labor
- *Donation Matching Software/App* - Using technology platforms to connect individual food donors with recipient organizations to reach smaller-scale food donations. App providing dynamic, real-time information about food available for donation to enhance the operational efficiency of food recovery partnerships between nonprofits and businesses with smaller-volume batches of edible food, such as cafes, restaurants, hotels, and other foodservice settings.

STAKEHOLDER ROLES

- *Non-Governmental Organizations* – NGO's like SEEDS play important coordinating and motivating roles for catalyzing community focus on many aspects of food recovery. Donation is one area where an organizing entity like SEEDS can provide significant impetus to gain traction with all aspects of donation and reuse, including working with local food rescue organizations, coordinating and promoting their programs.
- *Local Units of Government* – Because donation is primarily an activity occurring within the business community, the role of local governments is primarily supportive. Support can come in many ways including funding for program education and promotion, zoning and planning support, and frequent vocal public support by elected leaders and senior staff.
- *State Agencies* – State agencies are potential sources of funding for program education and promotion. Supportive policy in the form of recovery goals and technical outreach that understands local and regional centers of expertise and information are areas where state agencies can provide important support and funding.
- *Institutions (schools, hospitals, universities)* – Institutional entities often prepare and serve large quantities of good in a variety of settings. As such they are prime targets for joining the network of donors of unused but still edible food. Similarly, they are also prime targets for both recycling and prevention.
- *Consumer-Facing Businesses* – Commercial establishments (groceries, restaurants, food processors) make up the bulk of the potential active participants in donation eco-system. To make their participation in regular donation "sticky" they need assurance that their efforts will be safely implemented (liability for spoilage is limited by the recipients of their donations) and reasonably efficient and low cost. Most of these

commercial establishments are low-margin businesses, which make them exceedingly sensitive to higher costs food waste management options.

- *Residents/Consumers* – Residents play a key role in all of these initiatives, both as consumers of information and voters who seek social change that reflects their desires for the kind of community in which they wish to live. For instance, publicly identifying commercial establishments that play a role in donation of excess food provides residents/customers with the ability to patronize those establishments.

VISION FOR SUCCESS – The Region seeks to establish, fund, publicize and implement an efficient food donation system that both diverts organic waste from landfills as well as provide food for community families facing hunger. Divert ~1.0% of regional food waste through Rescue/Recovery solutions.

RECYCLING/PROCESSING TECHNOLOGY

Once the opportunities for food waste -diversion through prevention and recovery have been maximized some scraps remain and today a majority of these materials end up in landfills where they incur disposal fees costing millions of dollars and rapidly create and release methane, one of the most potent greenhouse gasses.

Recycling technologies for organic, biodegradable materials have existed for decades. Historically, this organics recycling sector has focused on the composting of lawn clippings and manure, driven by bans or mandates to collect yard debris and lawn clippings in half of U.S. states. In many cases efforts to recycle food waste can be effectively combined with other, more established, organics recycling efforts.

FOCUS SOLUTIONS

- *Centralized Windrow Composting* – There are thousands of composting facilities nationwide that employ a combination of windrows predominantly for yard debris. Some food waste can be accommodated in these facilities as long as it remains less than 10 – 15% of the total material by volume as a best practice for odor and vermin management. Foundational infrastructure in the form of centralized composting facilities located near the region's major larger communities of Traverse City, Petoskey/Harbor Springs, and Cadillac create a good starting point for greater recycling of organic materials. But initial reviews suggest that expansion and capital improvements to these facilities will likely be required.
- *Backyard Composting* – Many communities have successfully established home composting programs that can cost effectively manage residential food scraps for homes with sufficient outdoor space to allow management of 1-2 CY piles of food and yard debris scraps. Although substantial education and promotion investment is required to successfully implement a community-based backyard composting program, the operational and capital costs are tiny in comparison to the investments necessary for more centralized systems. In circumstances where curbside collection is not available, backyard composting is often one of the only feasible solutions for residential food scrap composting.
- *Community Compost Drop-Off/Community Composting* – This approach contemplates transporting food from homes by truck, car, bicycle or foot to small, community, or neighborhood-level compost facilities that manage small (less than 2 tons per year) quantities at locally established community facilities. This kind of operation is often co-located with community gardens.
- *Animal Feed* - Feeding food waste to animals after it is heat-treated and dehydrated and either mixed with dry feed or directly fed provides an important mechanism for beneficial reuse of a waste product. In some instances, unless farmers are close to the generation source, food waste might require dehydration. Successful programs match large producers with large farmers who have sophisticated means of matching nutritional qualities of the food waste with the balanced diet needs of individual animal species. It is important to follow Federal and Michigan state laws that regulate the use of food scraps in animal feed when exploring solutions.

CHALLENGE SOLUTIONS

- *ASP (Aerated Static Pile)* – ASP composting, is a higher tech, controlled approach to efficiently composting organic materials. Critically, one of the most important consequences of carefully managed airflow in the composting material is better control of odors. For this reason, once open windrow facilities exceed 10 – 15% by volume of food waste a technological upgrade to ASP is often required. It is likely that some regional investment in this approach to organic recycling will be required if the region is to successfully accomplish its overall food waste reduction goals. Finally, a major lever of success is ensuring final product quality by limiting incoming contamination in the recovery food waste streams.
- *Containerized Composting* - Parks and resorts, institutional or corporate campuses, restaurants/ breweries each of which for their own reasons seek small scale in-vessel composting with minimal labor and expedited processing time participate in recycling organics through containerized composting systems. Several vendors sell "turn-key" applications for this approach. Although not the least expensive capital and operating cost solution, this approach is often successfully implemented by organizations whose primary goal is control and assurance that its waste organic material will be successfully recycled.
- *Vermicomposting* – Like containerized composting, the use of worms to consume food waste residuals has gained popularity with parks and resorts, institutional and corporate campuses and universities. They are best deployed where the "worm castings" can be used onsite as a high quality soil amendment to fully "close the loop". As a system that is most often deployed using bins, this approach can often be volume limited, making it less useful for organizations with unpredictable or cyclic waste generation profiles.

STAKEHOLDER ROLES

- *Non-Governmental Organizations* – NGO's like SEEDS play important coordinating and motivating roles for catalyzing community focus on the development of recycling solutions. Other regional NGO's such as conservation districts and MSU Extension could partner with SEEDS for further support and regional involvement. They are ideally suited to playing an "extension" role in the popularizing and implementation of onsite technologies like containerized composting, vermicomposting, and backyard composting. Their role in developing more capital-intensive centralized approaches can vary from site identification to the coalition-building necessary to achieve the economies of scale essential to the justification for capital expenditure.
- *Local Units of Government* – Local governments can play supportive roles for onsite technologies by ensuring its health, building, and planning enforcement bodies understand the benefits and best practices with organics recycling. Contributions like contractual requirements for delivery of organics collected within their boundaries stimulate the development of infrastructure quite effectively. Others like site identification also play disproportionate roles in allowing recycling infrastructure to develop.
- *State Agencies* – State agencies are potential sources of funding for capital and marketplace development of new and existing facilities. Supportive policy in the form of recovery goals, technical outreach, education about uses of food waste as animal feed and recovery-oriented planning provide key environmental supports. Finally, an established permitting environment based on industry best practices creates a balance between private and public and environmental interests.
- *Institutions (schools, hospitals, universities)* – As organizations where food waste is concentrated, commitment to the delivery of aggregated streams of food waste at a tipfee, to centralized facilities, institutions can provide a "bankable" stream of income against which facility developers can borrow for capital investment in the underlying business.
- *Consumer-Facing Businesses* – Commercial establishments (groceries, restaurants, food processors) make up as similarly large portion of available food waste, creating important synergies for possible facility developers and operators. They will play a key role in helping to maintain high quality flows of organics by investing in education and enforcement to prevent contamination.

- *Residents/Consumers* – Residents play a key role developing the necessary momentum for a robust recycling program. They can also play a key role in helping to reduce the contamination that is often part of an aggressive food waste recycling program.

VISION FOR SUCCESS – The Region seeks to develop and fund a geographically disbursed, well operated centralized composting infrastructure that can effectively accommodate a growing flow of organic material while continuing to recover currently delivered materials. Due to the higher volume of food waste recovery that is planned and need for smaller processing footprints, an ASP composting solution will be evaluated. Where possible, onsite solutions will be aggressively supported to enable self-management of organics by individual residents, institutions, and select commercial/agricultural options. Charismatic stories can illustrate closed loop strategies that show how food waste contributes to the production of more food (whether vegetables powered by compost or animals raises for meat that are fed food waste).

SEEDS, in collaboration with other regional agencies and NGOs, needs to develop an "extension" expertise in the operation of onsite solutions. Overall, these activities can divert ~31.7% of the total organic available in the region.

RECYCLING/COLLECTION AND POLICY

Centralized composting solutions require collection options. Even in the densest of urban settings, residential collection is sufficiently expensive that most communities seek to co-mingle residential food waste with existing (and higher volume) yard debris collections. However, collection of commercial, institutional and industrial volumes with higher quantities can be cost-effective in urban communities. Finally, an established drop-off system can also enable organics collections for people wishing to self-transport materials. State and local policy plays a critical role to enable food residual diversion.

FOCUS SOLUTIONS

- *Community Compost Drop-Off/Community Composting (ALSO A PROCESSING SOLUTION)* – This approach contemplates transporting food from homes by truck, car, bicycle or foot to small, community, or neighborhood-level compost facilities that manage small (less than 2 tons per year) quantities at locally established community facilities. This kind of operation is often co-located with community gardens.
- *Curbside Collection* – As described collection of single-family residential recycling is limited by the small individual quantities of material generated by each household and the countervailing need to make collection frequency sufficiently often to prevent generation of odors. Unless residential food waste can be co-collected with yard waste, there are few cost-effective solutions. With larger commercial, institutional, multi-family residential or industrial generators, a commercial collection using larger volume containers is more likely to be both technically and economically effective.

CHALLENGE SOLUTIONS

- *Local Policy* – Policies like mandatory organics diversion, compostability standards, and landfill bans are proven approaches to encourage organic diversion. Although not sufficient on their own, these policies create a policy eco-system that makes the development of an organic diversion system much more effective.
- *Green Restaurant Program* – Restaurant owners interface with food diversion programs at many different levels ranging from prevention (waste tracking & analytics), donations and recycling. But because the vast majority of restaurants are not part of large chains with corporate support functions available for food waste diversion, support needs to be developed elsewhere. In this case, local groups of restaurant

managers and owners can gain support, knowledge of best practices, and community resources through development of green restaurant associations.

- *PAYT Waste Collection Structure* – One specific policy that has received significant attention over the years are Pay As You Throw waste collection arrangements. The PAYT economic concept hypothesizes that one means of incentivizing recovery options is to make waste disposal more expensive. Although, PAYT has been "proven" to be effective its ability to drive substantial additional diversion has been questionable. To best implement PAYT, it is clear that it needs to be accompanied by excellent and cost-effective diversion programs and consistent and effective messaging. In other words, like many solutions, by itself it won't move the needle.

STAKEHOLDER ROLES

- *Non-Governmental Organizations* – In perhaps their most significant contribution, NGO's like SEEDS are well positioned to articulate and advocate the benefits of supportive food waste diversion policies. They can also play catalytic roles in crystalizing community activity in support of collection programs as well.
- *Local Units of Government* – Governments play roles in passing legislation and making regulations that result from food diversion policy actions. These require both an understanding of community activity and best practices for food waste diversion. Individual policymaker and senior staff support can also be critical to the success of diversion goals.
- *State Agencies* – State agencies are potential sources of funding for collection programs. Supportive and consistent policy into which local regulations can fit also support recovery goals. And finally state funded technical outreach with supportive expertise is also a likely factor for eventual success.
- *Institutions (schools, hospitals, universities)* – Institutions provide the opportunity for R&D support (universities), demonstration projects (all), and eager participation that contributes to both overall recovery and creating momentum for the rest of the community.
- *Consumer-Facing Businesses* – Commercial establishments (groceries, restaurants, food processors) often participate in local chambers of commerce, some of which have been traditionally opposed to governmental mandates. Support for these policies within chamber discussions can be especially useful in gaining support or at least neutrality on these steps at the local chamber level.
- *Residents/Consumers* – As always, voter support from residents and consumers form the basis for proactive progressive policy and system development.

VISION FOR SUCCESS – The Region seeks to create supportive and enabling policies for accomplishing best in class food waste diversion. As part of this, support and funding for the development of an appropriately scaled collection infrastructure that provides access for the largest portion of the population will be essential.

Together, these prevention, rescue/recovery, recycling efforts will assist the region in a total recovery of ~34% of the regionally generated organic materials.

Types of Processing Systems

Composting technologies can be classified as in-vessel or outdoor based systems. An in-vessel based system degrades material biologically in an enclosed vessel. An outside based system allows the material to be exposed to the ambient environment where it is also biologically degraded. Both systems provide oxygen, generate sufficient temperatures and allow water and carbon dioxide to escape from the composting material. All technologies for composting of recovered food waste must meet the Process to Further Reduce Pathogens (PFRP) to reduce issues with bacteria and pathogens in parent materials. Some composting systems use a combination of in-vessel and outdoor approaches to create a marketable end product. Following PFRP allows the end product to be free of diseases, insects and weed seeds. Enclosed static piles and the Ag-bag system are two examples of this kind of combination. The following technologies represent commercially available methods for digesting/composting organic wastes.

Centralized Composting

WINDROW COMPOSTING

Windrowing is the simplest form of compost technology. It is used throughout the U.S. for composting organics such as yard debris and limited amounts of food waste. Windrows are simply triangular or trapezoidal shaped piles spaced far enough apart to navigate equipment between them. Windrowing is an effective and reliable compost technology for yard wastes and is the least expensive method to biologically treat organic wastes. However, windrow composting of large quantities of food waste has the potential to generate odors if "best practices" aren't employed.

Organic wastes are composted by arranging layers of size reduced organic wastes and brush chips/wood chips in a pile. The pile is called a windrow and is constructed in order to facilitate aerobic microbial activity by creating sufficient mass to both generate and maintain the heat necessary to promote microbial growth and material breakdown. Windrows are typically six to eight feet wide, and as long as possible within space constraints.

Once the windrow is established, machines turn and mix the windrow on a regular basis. Windrows can be turned by a front-end loader, but this turning approach is less efficient then using a windrow turning machine. Many windrow-turning machines are available to windrow compost and they vary considerably in size, capacity, style and price. Windrow turning machines typically vary in price between $100,000 and $750,000. Windrow composting can take as long as 6-12 months for finished product and the resulting product is typically sufficient for high value soil product use as long as incoming contamination is kept to a minimum.

STATIC PILE COMPOSTING

Static pile composting is similar to windrowing. Rather than aerating the feedstock mixture with a mechanical turning machine, the mixture is actively aerated by means of forcing or drawing air through the composting mass. Although most static piles are aerated with fans and blowers, simple passively aerated static piles can also be used efficiently to compost organic wastes. Oxygenation is accomplished in passively aerated static piles by increasing the amount of bulking agent in the compost mixture and by keeping compost piles smaller. This allows for the free flow of oxygen throughout the compost pile without fans or blowers. Passively aerated static piles are less expensive to maintain but take longer to complete the composting process; thus, a larger area (pad) for the storage of composting material is needed which in turn contributes to higher facility capital costs.

AERATED STATIC PILE (ASP) COMPOSTING

Aerated static pile (ASP) composting is the most cost efficient and simplest composting method for large volumes of food-based organic waste. It is especially suited for yard debris, food waste and livestock manure. ASP can be done indoors, outdoors in a windrow composting operation or totally enclosed in-vessel composting. It uses an aeration system to push and/or pull air through the composting mass. Inducing airflow into the organics pile helps to maintain aerobic conditions such as moisture level and temperature that are ideal for the microbial populations, allowing for maximized degradation efficiency and minimization of pathogens. Unlike windrow facilities that require turning of the pile, ASP does not because of the automated air flow produced through the pile, which reduces the operational costs of the facility. In addition, instrumented and process controlled airflow through the compost for aeration provides an added benefit of odor reduction, lowering the impact of the facility on surrounding neighbors. ASP composting takes between 4-6 months for finished product.

IN-VESSEL COMPOSTING

In-vessel composting uses equipment that encloses feedstock, thereby controlling conditions such as temperature, moisture content, and aeration. It is more compact than other forms of composting and expedites the composting process in as little as 10-21 days, plus 30 to 60 days for curing the product. In-vessel units vary in size, from being able to process 50 or more tons per day, allowing them to work well for kitchens and schools or larger campuses and farms. This approach to composting is capital intensive and less operationally complex than other approaches. This composting technology is often used in institutional settings (e.g. universities, schools, corporate campuses) where space is at a premium and capital is available.

Small Scale On-Site Systems

CONTAINERIZED COMPOSTING

Containerized composting has emerged as foodwaste diversion grew in popularity and need. Containerization enables operators to effectively manage process control, odor, moisture, vermin and final product quality. It creates an increase in logistical flexibility. Containerized systems can be operated as standalone operations or scale with multiple installations to track effectively track collection growth. As onsite solutions, these systems often range in capacity from less than 0.5 tons per day to as much as 3.0 tons per day.

Although more costly than open air composting, the benefits of containerized systems appear to be gaining ground as more food waste projects are implemented. Many operations find permitting easier where state and provincial regulatory agencies call for control of these environmental factor control. The other trend that makes containerization more popular and useful is its ability to be deployed in a modular fashion. Containerized technology employs a variety of approaches including tunnel systems, positive aeration, and mechanical agitation many of which are reapplications of mechanical systems developed from farm silage management, mushroom growers, and other batch process industries.

VERMICOMPOSTING

Vermicomposting is the process by which Eisenia fetida and Eisenia andrei, different species of earth worms, decompose food waste to produce vermicast, a nutrient-rich substance that can be used as a fertilizer. Vermicomposting can be undertaken on a small-scale, using a wooden or plastic bin, or it can be done using windrows in a hoop house. In small-scale vermicomposting, the bin should have holes for ventilation and be kept in a cool, dark space, like in a basement or under a kitchen sink. Approximately 1 pound of worms per square foot of bin surface area are needed. Worms should be fed produce scraps, with the exception of citrus and never be fed meat, dairy, or other fatty foods, and bioplastics are generally not accepted as the worms cannot digest these items. Worms can consume one-half to their full body weight in food per day. One method of harvesting the finished compost is to shine light on the surface of the bin for several hours, causing the worms to migrate to a bottom layer while the product on top is removed.

BACKYARD COMPOSTING OR COMMUNITY COMPOSTING

Backyard composting and community composting can be an easy and inexpensive means for municipalities to generate enthusiasm toward composting and to accomplish significant recovery of household organics without incurring significant operating and capital cost. One of the most challenging aspects of starting a composting program and an essential component for success is creating an environment where residents can understand the value they receive from composting. An ideal means of demonstrating value is by providing incentives for residents to compost in their backyard or nearby community garden. Many cities in the U.S. promote composting by offering discounts or vouchers to purchase the equipment necessary to start. For example, the City of San Diego, CA offers a year-round voucher program where residents can get one of three styles of bins at a discount. A significant differentiator for success is the support of residents as they employ this approach for managing their organic material streams.

Other

ANAEROBIC DIGESTION

Anaerobic digestion (AD) is a natural process in which organic materials are broken down by microorganisms in the absence of oxygen. AD treatment systems have been used for decades as a way to stabilize municipal solids and as a form of treatment for high-strength organic waste. A benefit of AD processes, as compared with aerobic processes, is the production of methane-rich biogas which is readily captured. The biogas can be utilized to offset heat or electricity demands and can result in an additional revenue source. In addition to biogas, the end-product of the AD process is a digested, stabilized material called digestate, which has nutrient value and can be applied as a low analysis fertilizer after stabilization or composted in a windrow or aerated static pile. When evaluating AD systems for feasibility it is critical to consider the end uses and/or management of the biogas and digestate end products.

AD requires a few key conditions, including an environment without oxygen, optimum temperatures (which vary depending on the specific process), and the proper nutrients. Based on samples collected by Eureka Recycling, residential source-separated organics (SSO) has a carbon to nitrogen (C:N) ratio ranging between 24.6 and 32.7, which is consistent with the optimum range for digestion between 20 and 30[21]. The commercial SSO characterization showed more variable and lower C:N ratios ranging from 9.2 to 22.9. Given the long detention times in anaerobic systems (on the order of 15 days), the fluctuations in the C:N ratios is expected to equilibrate in the AD reactor. AD systems are not well equipped to digest or accept yard waste, especially brush and woody material. Woody waste contains high amounts of lignin, a compound anaerobes are unable to efficiently degrade.

AD processes are typically classified as wet digestion (or low solids) and dry digestion (high solids). While the solids concentration threshold between the wet digestion and dry digestion varies from reference to reference, generally wet digestion systems have solids concentrations of 10-15 percent or less. The wet and dry AD systems involve different treatment components, but generally, the biogas quality and quantity produced is similar. However, material management within the systems differ greatly because wet systems allow the digesting mass to be pumped, while the dry substrate needs to be handled using bucket loaders and the like. The description of the AD alternatives includes more information about wet and dry AD systems; however, primary differences between the two systems are summarized below.

- The two systems require different energy inputs. Wet digestion processes require more energy input, using up to 50 percent of the energy generated, whereas dry digestion processes use only 20 to 30 percent of the energy generated.
- Wet systems have been in use for decades for treatment of municipal biosolids. Dry systems are newer and there are limited U.S. installations.
- Wet systems require the input of water or another wet waste stream. Dry systems, depending on the waste characteristics, may require the input of a bulking material (grass, brush, or woody) to increase the solids concentration and allow percolation of liquid.
- Dry systems require more costly conveyance equipment because standard pumps cannot be used.
- Wet systems require larger storage and heating equipment.

Although popular in Europe and initially frequently utilized for North American on-farm installations, high solid digesters have had difficulty achieving their predicted gas yields using SSO. A number of operators and observers who have focused on SSO digestion in the field at larger volumes find that the combination of operational cost, input requirements, and energy production are not consistent with low solid digestion. Organics can be digested in 4-6 weeks, with digestate management requiring at least another 8 – 10 weeks for complete stabilization.

CO-DIGESTION

Solids from sewage sludge are already anaerobically digested at publicly owned treatment works (POTW) facilities. There, they generate methane and a solid residual as part of the standard secondary treatment process. The methane gas is used as a source of energy (often for plant operations) and the solid residual (biosolids) can be composted to produce a soil amendment or in many cases directly land applied at appropriate agronomic rates on nearby farmland. Where there is excess capacity in the digester system, food waste can be added to generate more energy. In California alone there are almost 140 POTW facilities that utilize anaerobic digesters, with an estimated excess capacity of 15-30%. An excess capacity at a POTW facility can occur when utility districts overestimate development or when large industries leave the area. For example, East Bay Municipal Utility District's (EBMUD) main treatment plant has an excess capacity because canneries that previously resided in the Bay Area relocated resulting in the facility receiving less wastewater than estimated when it was constructed.

Overall, co-digestion at POTW facilities works well because in many cases the anaerobic digesters already exist and are under-utilized and operational expertise is already in place. In addition, facilities are located in urban areas thus facilitating lower transportation costs and the pre-digestion of food waste can reduce the overall odor production during the composting phase. However, POTW managers and engineers can be reluctant to accept food waste because its characteristics can differ from their usual wastewater inputs.

BIOCHAR

Biochar is a material produced from burning biomass, typically woody material, in an oxygen-limited environment such as in small or larger-scape pyrolysis ovens that can also generate heat and power. Smaller units can be used in a residential setting and larger units are more practical for large farms or district heating needs. Smaller stoves can be converted to mobile units and taken to the biomass source saving on transportation costs when large amounts of bio-mass are available periodically but not regularly in a specific location. Larger industrial-sized units can handle tons of biomass on a daily basis. They can produce electricity as well as biochar, bio-oils and syngas in large quantities. These stationary units depend on a steady, sustainable supply of biomass, so need to be located where they can take advantage of reasonable haul distances for feedstocks.

Biochar is beneficial as a soil amendment, in some cases it has been shown to retain nutrients in soils, control odor, inhibit growth of molds, and soil increase aeration. It can be added at the beginning of the compost process to reduce GHG emissions, odor, and ammonia loss, or it can be incorporated with the finished product. The amount of biochar added at the beginning of the compost process depends on bulk density and carbon to nitrogen ratio of compost feedstocks. Properly using biochar requires several considerations, from understanding general characteristics of the biochar, BMPs for storage, and what crops for which it will be used. It's production and use has not grown appreciably in the time since it gained more notoriety in the 1990's as an enhancement in the organics recovery and soil marketplace. It's benefits to soil remain significant and uncontroversial, however its production, using pyrolysis is difficult to replicate and to reconcile with high costs and production requirements.