On-Farm Composting:
Overview and Short Bibliography

Introduction

Composting is the management of aerobically decomposing organic materials into a stable humus-like substance that resembles soil and provides a great diet and environment for beneficial microbes. There are several effective ways to successfully compost a variety of farm waste and other appropriate waste streams. This guide is intended to give an overview of on-farm composting techniques and provide a short bibliography of online resources. This short paper is intended as a companion to four on-farm composting videos that look at successful examples in Pennsylvania, these can be found on the Capital RC&D website, https://www.capitalrcd.org/local-food-initiative.html . Each video contains case-study information from farms in Pennsylvania that are successfully composting and using the resulting compost to improve their soil and/or sell the compost to other farms. Featured farms are examples of successful composting of a variety of inputs including manure, food waste, crop wastes, municipal leaf collection and mortality.

Common On-Farm Techniques

Common composting techniques discussed below include:

- Windrows (Both covered and uncovered),
- static aerated piles,
- In-vessel
- Vermicomposting
- Dairy pack composting

Most of these techniques of composting can be produced at a wide range of scales by both small and large operations and can require varying amounts of capital.

Windrow Composting

Windrow composting is the simplest of the four composting methods featured in this guide. It can be the lowest cost as well, it is possible to make a successful windrow by renting a skid loader only two days each year, however, additional equipment will reduce composting time and enable the farm to handle more volume. A windrow is an elongated pile of compostable materials that is normally between four and eight feet tall by eight to 16 feet wide and as long as the farmer wants to make it. As with all compost methods, turning the composting material to expose it to oxygen will speed up decomposition by allowing the core of the windrow to heat because of the addition of oxygen to the process. Windrows don't need to be turned very often, however, the more frequently it is turned the faster the final product will be complete. With the windrow method aeration is done by turning and is passively impacted by how porous the compost material is for oxygen infiltration.

The size of the windrow also impacts the speed of decomposition, very large windrows compost more slowly. Alternately, if the windrow is too small it will not retain the heat it needs to kill pathogens and weed seeds. Not only is heat important for killing pathogens and weed seeds, a hot windrow can evaporate excess moisture. As the temperatures fall during the late fall, it's a good practice to combine two windrows together to better retain heat and save. It is important to keep in mind that too large windrows can develop a zone of anaerobic activity near the center. Anaerobic activity causes a bad odor and can be an indicator of an anaerobic zone occurring. When using windrows, the active composting stage ranges from 3 to 9 weeks with 8 weeks being typical.

Static aerated piles

Static aerated piles are a second method featured in the Capital RC&D videos, they require a higher initial cost but pile management takes less time. The system consists of a triangular pile that is twice as wide as it is high with a French drain-type pipe embedded in the pile. This pipe allows for both positive and negative pressure to help with the aeration process. Pile size is normally dictated by how often new raw materials are added. The aeration process leads to quicker composting than in a windrow system because the operator has greater control over the amount of oxygen that goes into the pile. A static aerated pile requires less area and work then windrows and the active composting period normally takes from 3 to 5 weeks to complete. Just like windrows, extra height is advantageous during the winter to retain heat. A filtration system may be necessary to filter the air when the aeration system is using negative pressure to pull air through the pile.

In-Vessel

The in-vessel method uses several different turning techniques. In-vessel takes the forced aeration of the static pile method and the turning component of windrows and combines them resulting in increased speed of the decomposition process. The simplest of the in-vessel methods is bin composting. These bins eliminate problems from wet weather because they are covered with a roof and also help contain odors that may come from the pile. In addition, bins provide better temperature control. Like the static aeration piles, forced aeration is implemented in a closed space. When using this system, high-walled bins have higher compaction rates and a greater amount of material for the air to pass through which is why forced aeration is used.

Another method of in-vessel composting is rectangular agitated beds. These beds have controlled aeration with periodic turning which is controlled remotely by switches. Raw materials are normally loaded into the front of the bed and the turning devices incorporate the new material with the old material. The beds have zones that have a blower in each zone and are controlled by a temperature

sensor or timer. Silos may also be used in the in-vessel method of composting. An auger removes finished compost materials from the bottom of the silo and new raw materials are added from the top of the silo. Air is forced through the silo and caught in an air treatment system located in the top of the silo. Composting time normally takes 14 days however, 1/14th of the compost is finished every day if the same amount is added daily. Using a silo minimizes the amount of space needed even more. A rotating drum is the most expensive method of in-vessel composting and this involves a horizontal rotary drum which is used to mix raw materials. However additional decomposition is necessary, this is normally done in windrows or aerated static piles.

Vermicomposting

Vermicompost uses worms to mix raw materials the excreta that the worms produce, the finished product is high in nitrates and has available forms of phosphorus, potassium, calcium, and magnesium. Earthworms are able to add a significant amount of Actinomycetes to the soil. Worms can also be introduced into windrows. Worms prefer a moist location, windrows may be covered to reduce drying out or moisture may be added to maintain a moist environment. When vermicomposting the temperatures don't get high enough to kill pathogens. In addition to adding worms to windrows, worms can be raise in a two-part system - one part above the other and separated with wire. Worms are raised in the top and fresh material such as food scraps and/or finished, screened compost can be used to feed the worms. The worm casts are harvested from the bottom of the bin and the finished vermicompost is typically used for special needs such as in potting mix.

Dairy Pack Composting

Compost bedded pack barns (compost dairy barns) are an alternative loose housing system for dairy cows. They appear to offer good comfort for lactating, dry and special needs cows. Successful composting systems have a bedding pack resting area, A compost barn gives cows more room to move than tie stalls or free stalls. These barns may also reduce manure storage costs and space, and save in labor and manure handling.

The compost bedded pack barn consists of a large, open resting area, usually bedded with sawdust or dry, fine wood shavings that are composted in place, along with manure. The system requires regular deep mechanical stirring and a facility designed for ventilation and frequent addition of fresh dry bedding.

Inputs and Equipment

Compost Inputs

High Carbon Materials

High carbon materials are necessary when creating high quality compost, examples include bark mulch, wood chips, straw, wood shavings, small grain hulls, and corn stover and a larger amount of high carbon materials (versus high nitrogen materials) is needed to produce compost that will support the functions described above. Some farms interviewed to produce the Capital RC&D video described above, acquire most of their carbon materials from on-farm sources while others acquire much of the carbon materials from outside sources. High carbon materials allow for the heating of the compost pile and also can be used to cap the compost to trap the heat and smell.

High Nitrogen Materials

Mortality

Dead livestock and most things that livestock use/produce can be composted such as feed and bedding along with the actual carcass. For additional guidance in proper handling and safety please see the references below.

Animal Manures

The animal manure can be used in windrows or using other methods. Barn floor composting is another option that has been used very successfully by adding a carbon layer over manure/urine and turning the material on a barn floor to allow for composting in place with cows using the warm and relatively clean surface. Additional guidance for manure composting can be found below.

Waste Streams

Waste streams can come from a variety of sources such as grocery stores or school cafeteria. 7 out of 10 of the top materials disposed of in California landfills were organic matter that could have been composted. Having mostly fruits and vegetables will cause the compostable material to be water logged and quickly will become anaerobic. Various carbon materials are used to soak up the moisture.

Compost uses

Soil Amendment

The benefits of adding compost directly to soil for plant health are significant and are discussed by multiple farmers in the companion on-farm composting video series. Some of the improvements that are seen when adding compost to farm soil include nutrient impacts - slow release of nitrogen and added phosphorus, potassium, calcium, and magnesium. Compost also improves soil structure by reducing bulk density and improving friability and porosity. It also helps to increase the gas and water permeability of the soil and stabilizes soil pH and the increasing the cation exchange capacity. Finally, soil that has been treated with compost provides greater drought resistance and more efficient water utilization.

Compost Tea

Compost tea is liquid steeped in compost and contains nutrients released from the compost. Teas can be strained and used as a foliar spry to add nutrients. Some compost teas are made with additives such as molasses, yeast extract, algal powder, and kelp to increase microbial biomass. Once compost tea is

sprayed onto plants including weeds it reduces the weed biomass significantly and will increase the yield of crops. Compost tea also has disease suppression qualities that allow the microbial biomass to outcompete the disease organisms. When the tea is applied to the plants it gives a quick shot of micronutrients that can replace deficiencies in the plants and provides short term solution further soil amendment will need to take place to increase soil health. Compost tea is also shown to help with residue decomposition and pest suppression.

Compost blankets for runoff prevention

If a farm is having problems with runoff a one to two-inch thick layer of compost can be applied directly to a slope to protects the soil from splash erosion and absorb large amounts of rain water. When a slope is plagued with bad run off and doesn't have any vegetation, compost is a great amendment to help soil quality and to help restore natural landscapes. Compost can also enhance above and below ground ecosystems.

Marketable products and cost savings

As discussed above, compost can be used on farm to improve soil fertility and reduce the requirements for purchased fertilizer and lime. Compost has also been shown to improve crop vigor, increase the number of flowers per plant, reduce the need for fungicidal drenches, and improve root growth. Excess compost can be sold to other farms or home gardeners as many of the featured farms interview for the companion video.

Soil and plant health impacts

Soil Health

Compost improves soil health in several ways impacting soil nutrients, microbiota and structure. The amount of water the soil can hold is increased and soil respiration will also increase. In addition to positive improved agricultural soil compost has been shown to help aid in reforestation, wetlands restoration, and habitat revitalization efforts by improving contaminated, compacted, and marginal soils.

Plant Health

As mentioned above, compost tea helps with disease and pest suppression. Compost in general will reduce the fertilizer and liming requirements of the soil; it will improve crop vigor, increase the number of flowers per plant, reduce the need for fungicidal drenches, and will improve root growth. Some results from studies of compost use show that it can completely inhibit growth of funguses that give way to root-rot pathogens in cucumbers and it also improved all of the plant growth parameters.

Regulations

Please check with Pennsylvania Department of Environmental Protection (DEP) **https://www.dep.pa.gov/Business/Land/Waste/Recycling/Composting/Pages/On-Farm-Composting.aspx** for state permitting requirements**.** Regulations are intended to protect your farm and surrounding area from potential issues associated with transportation and storage of waste products. Local, state and federal regulation can impact elements of your specific composting process, remember to always check with your conservation district and DEP to identify any regulations associated with a

proposed composting plan. Regulations can impact compost pile site preparation and placement, type of compost material to be used and the volume of compost to be made. Updates to the farm's conservation plan may also be needed to address runoff from covered piles and waste water draining from fresh piles. Safety and personnel protection features should also be incorporated to ensure no injuries occur on site.

Conclusion

Pennsylvania farmers have a whole array of options when it comes to composting. The process can be started with just a skid loader that is rented for two days a year to an enormous in-vessel operation that requires a ton of capital. This guide is a companion to the video series that is made by Capital RC&D. For a further look into the regulations please call your conservation district office to make sure your operation is up to regulation!

Online Resources

Augustin, Chris and Rahman, Shafiqur. "Composting Animal Manures." Extension Service North Dakota State University. May 2010
https://www.ag.ndsu.edu/manure/documents/nm1478.pdf
Eight-page guide to the composting of animal manures.

Bomford, Michael. "Compost Tea Slideshow." Kentucky State University.
http://organic.kysu.edu/CompostTea.pdf
Twenty-seven slide presentation provides a good overview of the uses and benefits of compost tea including food safety considerations.

Cornell Waste Management Institute.
http://cwmi.css.cornell.edu/composting.htm
Cornell University has a large number of links for their resources on specific topics under the topic on-farm composting.

Hursh, Carl and Olenick, Patti. "On-Farm Composting." Pennsylvania Department of Environmental Protection website. February 2009.
http://files.dep.state.pa.us/Waste/Recycling/lib/landrecwaste/composting/on-farm_composting.pdf
This excellent 2009 slide show was produced by Pennsylvania Department of Environmental Protection (PA DEP) to provide an overview to farmers interested in on-farm composting.

Pennsylvania Department of Environmental Protection. "On-Farm Composting." Webpage.
https://www.dep.pa.gov/Business/Land/Waste/Recycling/Composting/Pages/On-Farm-Composting.aspx
PA DEP webpage for on-farm composting with multiple permit links and information about regulations.

Rodale Institute Website.
https://rodaleinstitute.org/category/topics/compost/
The Rodale Institute website has many articles on the topic of compost, search their online resources using the search term compost.

Taylor and Francis Online. *Compost Science and Utilization*. Online journal, abstracts available for free, $179/yr. subscription. For list of current articles.
https://www.tandfonline.com/toc/ucsu20/current?nav=tocList

USDA Natural Resources Conservation Service. "Composting Facility NRCS Practice Standard." 9/16
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1254949.pdf

Jeffrey Bewley and Joseph Taraba. "Guidelines for Managing Compost Bedded-Pack Barns." University of Missouri Extension. July 2013.
http://extension.missouri.edu/webster/documents/resources/agriculture/compostbarns/Guidelines_for_Managing_Compost_Bedded-Pack_Barns--DairyPracticesCouncil110.pdf
Overview of guidelines for design and management of compost bedded-pack barns. Published 7/2013