Latest Developments in Mid-to-Large-Scale Vermicomposting

By Rhonda Sherman-Huntoon;
Courtesy of Biocycle - Advancing Composting, Organics Recycling & Renewable Energy

Nov. 1, 2000

Latest Developments in Mid-to-Large-Scale Vermicomposting

This overview of systems and operational projects describes factors which contribute to their success as well as the challenges that have forced sites to close.

Many different approaches are being used to process large volumes of organic residuals with earthworms, ranging from relatively simple land and labor-intensive techniques to fully automated high-tech systems. Types of systems include windrows, beds, bins, and reactors. The largest vermicomposting facilities rely on tipping fees for feedstocks and accept a wide variety of organic materials. Smaller facilities usually have to purchase feedstocks or pay for transportation of materials.

Commercial in-vessel vermicomposting systems first appeared on the market in the United States in the early 1990s. The first mid-scale vermicomposting system was the Worm Wigwam, which was introduced in the Pacific Northwest by John Gorman-Sauvage. About the same time, Al Eggen — owner of Original Vermitechnology in Toronto, Canada — developed an automated, larger-scale vermicomposting system.

Operating mid-to-large-scale systems poses temperature control challenges that are seldom experienced with smaller operations. Larger systems generate more heat from decomposing organic materials and hold heat longer than smaller units. Operators also have to be concerned with solar gain in or around the system. Methods of lowering system temperatures include adding water, activating fans in or near the unit, and reducing the amount of feedstock applied.

Factors that may be considered for selecting the appropriate vermicomposting technology for a project include: Amount of feedstock to be processed; Funding available; Site and space restrictions; Climate and weather; State and local regulatory restrictions; Facilities and equipment on hand; and Availability of low-cost labor.

WINDROWS

Windrows are extensively being used both in the open and under cover, but require either a lot of land or large buildings. It is difficult to harvest the vermicompost without earthworms being included, so a mechanical harvester is commonly used with these operations.

The largest vermicomposting facility in the United States is operated by American Resource Recovery (ARR) in Westley, California. Managed by Mario Travellini and owned by Jim Davis, the vermiculture operation was begun in 1993 to build an earthworm inventory; four years later, ARR began processing and selling vermicompost. Currently, an estimated 500,000 pounds of earthworms process 75,000 tons of materials annually on 70 of ARR's 320 acres. The worms are fed paper pulp generated from recycled cardboard, tomato residuals, manure, and green waste in three-foot wide windrows, some of which are a quarter mile long. During its busiest season, ARR ships up to 100 tons of vermicompost per week. In 1998, they began selling earthworms throughout the United States, and expanded to foreign markets in 1999.

From 1994 until 1999, at the Crow Worm Farms in Cleburne, Texas, vermicomposting windrows occupied ten of the 200 acres. About 20,000 pounds of dairy manure were applied to windrows each week using a side discharge feed wagon pulled by a tractor. The hot, humid summers and cool winters posed challenges for Bobby and Betty Crow to keep their temperature-sensitive redworms happy. Misting hoses on top of the windrows were used in summer and winter to protect worms from temperature fluctuations. In summer, windrows were kept moist by running the hoses twice daily for 15 minutes, or a third time if the temperatures soared above 100° Fahrenheit. Water was also used to protect the worms when freezing temperatures were expected. "I wetted the top of each windrow so it would freeze on top and act as an insulator to keep worms warmer in the middle of the bed," says Bobby Crow. In addition to being susceptible to

the middle of the bed," says Bobby Crow. In addition to being susceptible to overheating, worms are sensitive to vibrations, and thunderstorms can cause them to leave their beds. The Crows spaced their windrows 20 feet apart to allow worms that left their beds to reach another bed safely. About ten tons of vermicompost were harvested from the windrows each week at roughly a 40 percent moisture level. The Crows priced their vermicompost at $55/yard in bulk (about 1,000 pounds), but the facility ended its operations in 1999 due to unsuccessful marketing.

WEDGE SYSTEM

This modified windrow system maximizes space and simplifies harvesting because there is no need to separate worms from vermicompost. Organic materials are applied in layers against a finished windrow at a 45-degree angle. The piles can be inside a structure or outdoors if they are covered with a tarp or compost cover to prevent leaching of nutrients. A front-end loader is used to establish a windrow four to ten feet wide by whatever length is appropriate. The windrow is started by spreading a 12 to 18-inch layer of organic materials the length of one end of available space.

Up to one pound of redworms is added per square foot of windrow surface area. Subsequent layers of two to three inches of organics are added weekly, although three to six inch layers can be added in colder weather. After the windrow reaches two to three feet deep, it can be extended sideways by adding the next layers at an angle against the first windrow. Worms in the first windrow will eventually migrate toward the fresh feed. Fresh manure is added to the second pile until it reaches the depth of the first one, and then a new windrow is started. Worms will continue to move laterally through the windrows. After two to six months, the first windrow and each subsequent pile can be harvested.

The wedge system is one of the processes used on the Yelm Earthworm and Castings Farm, located near Yelm, Washington. The 10-year old worm farm is among the largest in North America, with 30,000 square feet of enclosed space in addition to production areas outdoors. About 15 tons of redworms are used to process a variety of feedstocks, including animal manures, wood chips, leaves, spoiled hay/straw, grass clippings, yard debris, produce, food scraps, waxed cardboard, soiled paper, and corrugated cardboard. Jim Jensen, operations and development manager since 1997, describes how the wedge system can be used for vermicomposting on dairy or horse farms in his KISS (Keep It Simple & Save) plan, which can be found on Yelm's website at www.yelmworms.com.

BEDS AND BIN SYSTEMS

Beds and bins have been used extensively throughout the industry to varying degrees, from home enthusiasts to part-time worm growers to large operations. Outdoor large-scale systems usually require some type of cover to keep out direct sunlight or rain. It's a labor-intensive process to harvest worms and vermicompost by hand.

For over 20 years, Tom Christenberry has operated large-scale facilities that vermicompost animal manure in eastern North Carolina. Today, Christenberry is one of the few worm farmers using hog manure as a feedstock. His work is especially important in North Carolina as researchers are currently scrambling to create alternatives to hog waste lagoons that have overflowed into the state's waterways in recent years. Tom constructed a 200-foot long by 36-foot wide greenhouse that shelters five worm beds. The four-foot wide beds that run the length of the greenhouse extend nine-inches into the ground and eight-inches above ground. The sides of each bed are lined with high-density polyethylene reinforced with boards and steel pipes. A rubber hose that runs along one side of each bed has nozzles that spray automatically for 15 minutes daily. There is enough space between each bed to accommodate the wheels of a tractor with a manure spreader driven over each bed to distribute the hog manure solids. Worms are fed daily, averaging about 1,000 pounds of manure per bed each week. Hog waste has passed through a solids separator on-site at the hog farm. One advantage of this system is that if the worm beds get too hot, worms can burrow deeper into the bed where the temperature remains below 75° Fahrenheit. Another advantage is the system can be left alone for up to three days, as compared to automated reactors that need to be checked daily for moisture and temperature levels. A disadvantage is that the worms and castings must be separated manually. Migrant workers use pitchforks to

worms and castings must be separated manually. Migrant workers use pitchforks to remove the top 4-inches of the beds for use in starting new beds. Pitchforks and flat shovels are used to harvest the finished castings, which are then run through a trommel screen to separate the worms. Castings are sold to several markets, either in bulk or in 50-pound bags.

The bin system was chosen for use at the Broad River Correctional Institution in Columbia, South Carolina. In May 1998, a Vermitechnology Unlimited unit was installed by its designer, Larry Martin of Orange Lake, Florida. Measuring 34-feet long by seven-feet wide by 20-inches high, the wooden bin with insulated panels has a center divider for ease of feeding and harvesting. A screen was laid down first to keep out moles, and greenhouse mesh suspended by metal poles was added overhead for shading.

Kitchen scraps are placed in a pile for composting, then every two to three weeks about 800 to 1,000 pounds of shredded food scraps are added in four- to six-inch layers in the worm bin. About thirteen 55-gallon barrels of castings are harvested from the bin two or three times a year. They tried selling five-pound bags of castings for $7.50 each at three retail outlets, but they didn't sell well, so now there are 15-pound bags for $9.95. Most of the castings are used on the prison grounds.

(There is often considerable debate about defining the differences between castings and vermicompost. Some producers use the terms interchangeably, while others prefer to differentiate between materials that pass through the worms (castings) and that which includes all composted feedstocks (vermicompost.)

For over 20 years, Tom Christenberry has operated large-scale facilities that vermicompost animal manure in eastern North Carolina. Today, Christenberry is one of the few worm farmers using hog manure as a feedstock. His work is especially important in North Carolina as researchers are currently scrambling to create alternatives to hog waste lagoons that have overflowed into the state's waterways in recent years. Tom constructed a 200-foot long by 36-foot wide greenhouse that shelters five worm beds. The four-foot wide beds that run the length of the greenhouse extend nine-inches into the ground and eight-inches above ground. The sides of each bed are lined with high-density polyethylene reinforced with boards and steel pipes. A rubber hose that runs along one side of each bed has nozzles that spray automatically for 15 minutes daily. There is enough space between each bed to accommodate the wheels of a tractor with a manure spreader driven over each bed to distribute the hog manure solids. Worms are fed daily, averaging about 1,000 pounds of manure per bed each week. Hog waste has passed through a solids separator on-site at the hog farm. One advantage of this system is that if the worm beds get too hot, worms can burrow deeper into the bed where the temperature remains below 75° Fahrenheit. Another advantage is the system can be left alone for up to three days, as compared to automated reactors that need to be checked daily for moisture and temperature levels. A disadvantage is that the worms and castings must be separated manually. Migrant workers use pitchforks to remove the top 4-inches of the beds for use in starting new beds. Pitchforks and flat shovels are used to harvest the finished castings, which are then run through a trommel screen to separate the worms. Castings are sold to several markets, either in bulk or in 50-pound bags.

The bin system was chosen for use at the Broad River Correctional Institution in Columbia, South Carolina. In May 1998, a Vermitechnology Unlimited unit was installed by its designer, Larry Martin of Orange Lake, Florida. Measuring 34-feet long by seven-feet wide by 20-inches high, the wooden bin with insulated panels has a center divider for ease of feeding and harvesting. A screen was laid down first to keep out moles, and greenhouse mesh suspended by metal poles was added overhead for shading. Kitchen scraps are placed in a pile for composting, then every two to three weeks about 800 to 1,000 pounds of shredded food scraps are added in four- to six-inch layers in the worm bin. About thirteen 55-gallon barrels of castings are harvested from the bin two or three times a year. They tried selling five-pound bags of castings for $7.50 each at three retail outlets, but they didn't sell well, so now there are 15-pound bags for $9.95. Most of the castings are used on the prison grounds.

(There is often considerable debate about defining the differences between castings and vermicompost. Some producers use the terms interchangeably, while others prefer to differentiate between materials that pass through the worms (castings) and

prefer to differentiate between materials that pass through the worms (castings) and that which includes all composted feedstocks (vermicompost.)

REACTOR SYSTEMS

Reactor systems have raised beds with mesh bottoms. Feedstocks are added daily in layers on top of the mesh or grate. Finished vermicompost is harvested by scraping a thin layer from just above the grate, then it falls into a chamber below. These systems can be relatively simple and manually-operated — or fully-automated with temperature and moisture controls. For maximum efficiency, they should be under cover.

According to Ohio State University professor Clive Edwards, construction and operation costs of flow-through reactor facilities compare favorably with similar sized conventional thermophilic composting operations. Edwards estimates that a 1,000 ton/year vermicomposting facility would cost approximately $100,000.

The smallest flow-through reactor on the market is the Worm Wigwam, which is now manufactured by EPM, Inc. of Cottage Grove, Oregon. This system has a proven record of efficiency with few problems and is being used at correctional facilities, schools, universities and colleges, office buildings, military bases, and hospitals throughout North America. The Wigwam consists of a recycled plastic shell and lid that stands three-feet high and is three-feet in diameter. Inside is a galvanized steel grate about 16 inches off the ground, leaving an 18-inch vermicomposting chamber above and a storage area below for the finished product. A hand-operated crank pulls a bar across and just above the grill, scraping off a thin layer of finished vermicompost that falls through the widely-spaced bars to the chamber below. The bin is heated and insulated for optimum year round use. The Worm Wigwam uses up to 35-40 pounds (35,000 to 40,000) of worms, and can process up to 8,000 pounds of organics per year, depending on the material. Reactors are often used in "groups" to increase capacity to handle feedstocks.

Original Vermitech systems have also been installed at similar facilities as the Worm Wigwams. For example, since July 1999, the Medical University of South Carolina has used a Vermitech system to process 100 pounds of cafeteria food residuals daily. The 18-feet long by seven-feet wide by five-feet high/Vermi-Organic Digester can actually handle up to 250 pounds of organic material daily, so the university plans to expand to that amount this year. The vermicomposting unit consists of two, eight-foot modular beds with a two-foot section containing hydraulic equipment and an air conditioner. Feedstock is delivered to the bin via a conveyor belt connected to a Vermitech shredder/mixer. Every two to four weeks, the hydraulic system is activated to scrape off the bottom layer of vermicompost. About 500 pounds are collected each month and used by the campus grounds department.

Pacific Garden Company in Ferndale, Washington, uses a continuous-flow reactor to process separated solids from a dairy farm. The 120-foot by eight-foot bed, constructed from existing equipment used in the dairy industry, was designed to handle 6,000 pounds of organic materials per day. Layers of waste are applied by a moving gantry feeder on rails above the earthworm bed. A moving breaker bar expels the finished vermicompost through the suspended mesh floor and a hydraulically-driven series of scraper bars remove the vermicompost from beneath the bed to a collection point. Pacific Garden president Scott Subler plans to expand to other dairy farms, installing a minimum of two lanes, 200 to 250-feet long, to try to keep up with the amount of manure generated.

TRENDS AND FUTURE DEVELOPMENTS

For the past decade, several large-scale vermicomposting systems have been used with varying success. Given the time frame and the number of failed attempts, perhaps we are still in a developmental phase of large-scale vermicomposting. This indicates the need for ongoing assessment of factors that contribute to the success of large-scale systems. Problems that plague the industry include poor management, undercapitalization, misrepresentations of facts, difficulties with regulatory agencies, unstable markets, and emerging technology that still needs to be perfected. Some system designers who were eager to introduce their units on the market didn't have all of the bugs worked out in some cases and in others they failed to provide thorough training, resulting in poor management. Many regulatory

agencies don't know whether to classify vermicomposting as composting or create a new category with different rules.

Yet, most of these challenges can be overcome through dissemination of information and training. Workshops offered by Peter Bogdanov, of Vermico in Oregon, and Jim Jensen over the past couple of years have benefited hundreds by portraying the realities of establishing successful worm businesses. The recent Vermillennium (see sidebar) organized by Mary Appelhof of Flowerfield Enterprises, Kalamazoo, Michigan, also provided excellent information.

Marketing vermicompost continues to pose a challenge due to potential users' unfamiliarity with the product. However, this can be overcome by making research data available in an accessible form and educating retailers, nursery workers and the public. Tremendous opportunities lie in two trends: Blending vermicompost with compost to give it a competitive edge; and vermicompost tea which is drawing interest from farmers as well as gardeners.

MARKET NICHES

Composting & Organics Recycling, Shredders

RELATED KEYWORDS

cardboard, conveyor belt, digester, recycled plastic, research data, resource recovery, scraper, shredder, trommel screen, vermicompost, vermiculture, waterway