Composting on Michigan Farms
Michigan State University
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# COMPOSTING on Michigan Farms


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## *Table of Contents*




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# Composting on Michigan Farms

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## A Necessary Warning

Anyone contemplating composting – whether it's a large volume of manure or leaves and wastes in the back yard – should be aware that "bio-aerosols" in compost can affect the health of some people. The chief – but not only – organism is *Aspergillus fumigatus. A. fumigatus* grows on many materials, is present in compost, mulch and potting soil, and can cause health problems such as bronchitis and inflamation of the respiratory tract as it releases its spores into the air. Airborne concentrations are highest when composting is done in an enclosed space. Infection is rare. Most *A. fumigatus* cases involve people with depressed immune systems resulting from the use of immunosuppressant drugs in hospitals or AIDS.

# Facing Challenges by Composting

Michigan livestock producers are facing new challenges that may be more easily handled by on-farm composting of their animal manure.

In the last decade, non-farm people have moved away from urban centers and into the countryside. That has brought them into closer contact with farming operations. They are sometimes shocked at the scale and sometimes the odors associated with some modern livestock operations. This has led to lawsuits and protests taken to local governments seeking redress or restriction of farmer activities.

While Michigan does have a Right To Farm Law that protects farmers from "nuisance" lawsuits if they are following good management practices, most farmers would undoubtedly prefer a less confrontational relationship with their new neighbors. While not completely odor-free, composting does not generate the same kind of manure odors, preventing or eliminating the noxious ones associated with manure collected and stored in pits or lagoons under anaerobic conditions.

Under Michigan law, livestock farms have to operate with no runoff of manure-contaminated water from their premises. While liquid manure handling systems can be managed in ways that satisfy the rules, they are inherently riskier systems, and many farmers will undoubtedly want to avoid those risks. Composting fits easily into manure handling systems that generate manure with low levels of added water.

Many farms, especially the larger ones, may be required to have comprehensive nutrient management plans. These plans must address how farmers intend to apply manure at rates that do not exceed the soil's capacity to absorb manure nutrients, especially phosphorus, or the capacity of crops to remove them. This means hauling manure further, and that is more easily done with compost.

On some larger farms that buy significant amounts of feed, the land base may not be large enough to properly use all the manure the farm's animals generate. These farms may need to change manure into a form that can be sold or brokered to crop farmers or conveniently hauled greater distances. Composting addresses these problems.

Composting reduces the volume of manure. It creates a product that can be more easily hauled and thus more easily applied to distant fields. It is drier than manure and doesn't slop on roadways or require the large equipment it takes to haul heavy, wet material.

Compost is stable and stores well. It can be applied at the best time of the year for crop production. It can eliminate the problem of having to dispose of manure during periods of heavy rain or snow that could produce manure runoff or nutrient leaching. Because it is non-burning to crops and its texture does not interfere with plant growth, compost can be topdressed on alfalfa fields between cuttings without stressing the plants or contaminating the next hay cutting. Compost fits like a glove on dairy farms where land is rolling and alfalfa is the preferred forage.

One of the most exciting aspects of composted manure is the growing realization that compost can play a larger role in crop production. Many farmers appreciate the benefits of organic matter on soil quality and value manure for that reason.

Compost provides a biologically degraded form of organic matter high in humus. Compost acts as a slow-release, non-burning fertilizer. It is biologically active and stimulates plant growth to a greater degree than its nutrient and organic matter content alone would explain.

Research at Michigan State University has demonstrated that use of compost can alter the balance of soil nematode populations, suppressing plant parasitic species like root lesion nematodes and enhancing predator species. Instead of feeding on plant roots and adversely affecting crops, predator nematodes feed on other nematodes and their eggs and on disease-causing bacteria and fungi. MSU scientists Richard Harwood and George Bird say that compost will play a leading role in the next step of crop yield enhancement, reducing the need for synthetic pesticides and increasing yields at the same time.

***Some of the other benefits of composting include:***

*** Pathogen and weed seed destruction**

The heat generated by composting kills weed seeds and disease-causing organisms. It may help break disease cycles on farms where livestock become infected with diseases that pass through manure.

*** Tipping fees**

Since manure composting requires addition of materials with higher levels of carbon, some farmers allow municipalities, landscapers, food processors and homeowners to bring leaves, yard wastes and food processing byproducts to their farms, and sometimes earn a tipping fee. (Farmers should first make sure such activity is within the confines of farm practice in their area. Activity defined as "commercial" could endanger a farm's classification as a farm and its protection under Right To Farm and zoning laws.)

There are some drawbacks to on-farm composting. It is a manure management system, and it requires time and investment. It takes space within the farmstead. It must be properly sited for material flow and water flow and also to keep peace with neighbors. While overall it produces fewer and less offensive odors than daily haul or pit storage, it is not odor-free. Snow and rain can also interfere with composting and building compost piles or windrows.

Composted manure contains less nitrogen than fresh manure. Nitrogen is lost in the composting process. (But remember that nitrogen is quickly lost to the atmosphere in most manure handling systems unless manure is hauled daily and immediately incorporated into the soil.)

Composting changes the availability of the nutrients in manure. Nitrogen is converted to complex organic forms that must be broken down (mineralized) in the soil to become available to plants.

Typically, only about 5-15 percent of the nitrogen in compost is available to plants in the first year after application, less than manure that has not been composted. This stability has benefits, for it meters nitrogen out to plants during the growing season and reduces the risk of nitrate loss into groundwater.

Summed up, composting is a different management system that can tame manure – subdue its odors, reduce its bulk, enhance its storability, make its application conform to crop production systems, provide bonus benefits in weed and disease control and enhance yield. But these benefits are not free. It takes time, labor, knowledge and some investment to release benefits on Michigan farms.

# Getting Started in Composting

*Old hay or straw can make a good foundation for a windrow when wet manure is to be composted*

### *The Composting Process*

Composting is defined in the On-Farm Composting Handbook (see Sources of Information listing) as "the aerobic decomposition of organic materials by microorganisms under controlled conditions." During composting, microorganisms consume oxygen as they feed on the carbon and nitrogen contained in organic matter. As they turn organic matter's simple and complex sugars into their own bodies, they incorporate nitrogen and carbon into proteins and produce heat, carbon dioxide and water vapor as byproducts. When the food supply—the carbon and nitrogen—runs out, the microorganisms become dormant, temperature falls and composting is complete. What's left is a fine-textured, dark, crumbly, odorless, rich material not unlike potting soil.

Composting manure is not difficult.

While there are situations in which the process can "go wrong," remember that farmers have used an uncomplicated form of composting from ancient times well into the twentieth century. Just placing a mixture of animal manure and bedding in a stack will typically result in a low grade of compost in a year. A pile of tree leaves, unturned and ignored, will be reduced to compost in two to three years. When farms were smaller, it was fairly typical for farmers to use this passive form of composting. Today, with larger farms, it's probably not feasible to have a year's worth of manure stored in stacks, although we can imagine that such a system would work.

Most composters use more sophisticated composting methods to achieve several objectives:

**Better composting conditions**. Raw manure by itself will not compost properly. It is usually too wet and too compact to allow air movement through the pile and digest aerobically. When oxygen is limiting, anaerobic bacteria go to work. They produce gases with noxious odors. Manure stacks turn anaerobic under most conditions.

**Faster composting**. Compostable materials—manure with carbon source added—piled in windrows and turned frequently will produce finished compost in three to four months. After proper curing (storage for one to two months), the finished compost is ready for sale or spreading. This faster throughput cuts the amount of space a farm must devote to composting activities.

**Desire for quality.** Not all compost is equal in quality. Uniform texture, for example, may not be important where compost is applied on the home farm, but other traits may be. Organic farmers, for example, seek to avoid sulfites in their soil amendments. Sulfites are created when anaerobic conditions occur. They are abundant in manure stored in lagoons and pits, and they can occur in composted manure that was not properly aerated. If these compounds are undesirable on your farm, you want higher quality compost and you manage to obtain it. Compost quality is also increased by a storage and curing period after composting is complete and before use. During that period, there is a reactivation of desirable bacteria that were inactivated by high heat during composting.

**The benefits of heat**. Good aeration, accomplished mostly by proper material mix and pile size, provides ideal conditions for thermophilic (heat loving) bacteria to work. Not only does this increase the speed of composting, it generates temperatures high enough (in excess of 140 degrees Fahrenheit) to kill weed seeds and pathogens.

**More uniformity**. Frequent turning results in an end product that is granular and uniform, easy to spread with lime or fertilizer spreaders. Application is faster and doesn't require large, powerful tractors. There is less moisture to transport and less power is needed than it takes to beat, propel or inject manure.

**Simplicity and ease of operation**. Investments in concrete or asphalt pads eliminate the mud and ruts that can result when weather turns ugly at the composting site. Some farmers go so far as to build roof-covered pads. One recommended management practice is the use of geo-synthetic fiber "fleece blankets" to prevent rain or snow from saturating composting windrows. Minimal land-forming may be needed to safely divert clean water away from the compost area, but most farmers are able to find sites where water will drain away. Commercial turners take less time and do a better mixing job than front-end loaders.

**Ingredient flexibility**. While some compost makers are able to control manure composition by bedding barns with straw, leaves, sawdust, wood chips or even shredded newspapers, most manure comes from the barn needing ingredient manipulation at the composting site. There, composters can be flexible and add whatever is readily available—leaves from urban yards, waste hay from barn lots, spoiled hay or silage, sawdust or wood chips, crop residues, food processing wastes and others.

### *Management*

Most farmers manage composting as a continuous flow process. Manure is removed from the barns — sometimes to temporary storage — and then to windrows that are built of manure combined with carbon-source materials. The space required depends upon how many windrows will accumulate. Some will be in the process of being built, others in various stages of completion, and some will be waiting to be spread on fields. Generally, the space required is dictated by the amount of manure produced in two to four months — the length of the composting process — plus space for storage until the compost is cured and then spread or moved off the farm. Windrows are usually 10 to 15 feet wide and five feet high.

Composting, however, is not "all or nothing." Some livestock farmers continue to use daily haul and spread, building compost windrows only during times when they cannot spread manure because of weather or crop conditions.

Because the release of heat is directly related to microbial activity, temperature is a good indicator of how the composting process is going. A good thermometer is a good investment. In a windrow containing the right ingredients, temperature should rise quickly to 120 to 140 degrees Fahrenheit as readily degradable compounds are consumed. As composting slows, temperature will fall to around 100 degrees and then, gradually, to ambient air temperature.

The heating process is self-limiting. When temperatures reach approximately 160 degrees, even thermophilic bacteria are killed, so turn the material and release heat before it gets that hot. As composting progresses, the heat generated will rise and oxygen will be drawn into the windrow. Temperature will fall if oxygen levels are depleted by the microbes. To keep the process going, air can be incorporated in the pile by turning. Turning helps regulate the composting process and helps create the final homogenized texture of the finished compost.

In a sense, the composting process does not really end until all the digestible carbon is converted to carbon dioxide gas or humus by the microbes. But before that happens, microbe activity slows and the compost becomes relatively stable.

According to the On-Farm Composting Handbook, "Microorganisms decompose organic materials progressively, breaking them down from complex to intermediate to simple compounds. The nutrients that become available during decomposition remain in the compost within the bodies of new microorganisms and as humus. The final product has a low rate of microbial activity but it is rich in microorganisms and the remains of microorganisms."

Composting proceeds best when the carbon to nitrogen ratio of the material is 25 or 30 to 1, but 20 to 40 to 1 is a workable range. The best moisture content is 50 to 60 percent, but 40 to 65 will work. The best pH is near neutral, but 5.5 to 9 will work. Bulk density (weight per unit volume of mixed material) should be less than 40 pounds per cubic foot.

Because composting is a flexible process, as the ranges above indicate, the recipe is flexible, too. When manure is too wet or too large a part of the mixture, nitrogen losses as ammonia or other odorous gasses will be larger. High-carbon sources like straw or sawdust capture nitrogen as it is released and slow down the decomposition process.

Farmers who want complete control over the process and want to produce a consistent product, perhaps for sale, will use more sophisticated methods than farmers whose needs are less demanding. Control means testing or checking book values for the manure and the amendments for moisture, carbon and nitrogen levels and then calculating the amounts of each that are needed. The process is much the same as creating a total mixed feed ration for livestock.

In general, raw manure mixed about two to one by volume with relatively dry straw, waste hay or sawdust will produce a compostable mixture of about the right carbon to nitrogen ratio and moisture level. To keep the moisture level right, windrows are usually covered with special spun polyester fleece blankets that shed water but allow gas and heat to flow in and out.

### *The Compost Site*

An important part of any composting operation is the location of the site and the construction of the pad. The site should allow for year-round access if it will be used all months of the year. The pad can either have a fixed location or move from site to site. If fixed, it will probably need to have a hard surface. Whether fixed or moving, there are several guidelines that should be followed to provide environmental protections:

*A firm pad base makes a weatherproof composting area*

1. The compost site should have a 1 to 3 percent down slope and no cross slope.
2. Size the pad according to the volume of manure to be handled.
3. Locate it 500 feet from surface water and away from wells that might lead to groundwater contamination.
4. Place the site close to manure production and the carbon source.
5. Set back the site from residential dwellings and preferably downwind.
6. Develop a filter strip or retention pond to handle the water runoff from the site.
7. Be aware of and satisfy local zoning issues.

The Natural Resources Conservation Service, Michigan State University Extension specialists and private consultants can help in planning the composting site.

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## Compost as a Crop Production Tool

Composting is more than just another way to dispose of animal manure. The final product, the compost itself, has unusual properties. Research is still discovering its value and how compost can best be managed within a crop production program to capitalize on this value.

Michigan State University research is on-going at the Long Term Ecological Research site and the Living Field Laboratory at the Kellogg Biological Station (KBS) north of Battle Creek, at the Montcalm Research Farm and at the Northwest Michigan Horticultural Research Station near Traverse City.

At KBS, research has focused on a cropping system in which most nitrogen is supplied by composted dairy manure and red clover from a cover crop in a corn-corn-soybean-wheat/clover rotation.

Researchers Ann-Marie Fortuna, Richard Harwood and Eldor Paul write in *Extension Summary of Long-Term Ecological Research Abstracts, 1999* that "replacement of nitrogen fertilizer with compost was shown to affect the amount of plant-available nitrogen during the current and future field seasons."

Because the nitrogen in compost is tied up in complex organic forms, it makes nitrogen available in complex ways. Only about 5-15 percent of the total N in compost is plant-available in the first season with much of the rest becoming available over the next six years. A fertility program based on compost has to account for this slow release.

*Finished compost is fine-textured and non-burning, so it can be topdressed on hay fields between cuttings*

"Nitrogen in chemical fertilizers is immediately available for plant uptake," they write. "Fertilizer nitrogen that is not applied as nitrate is rapidly converted to nitrate through a process known as nitrification."

The conversion of organic nitrogen, the kind found in compost, into nitrate is slower than the conversion of an inorganic form. "Substitution of compost for nitrogen fertilizer decreased nitrification rates by 25 percent without decreasing yield," they said.

The slow release of nitrogen from compost greatly reduced leaching losses compared to the use of commercial fertilizer. That is partly because the nitrogen tends to become available in a way that parallels crop use, according to Dr. Harwood. This is especially true with corn. Because nitrogen release from compost is a biological process, release of nitrogen increases as soil becomes warmer and soil microorganisms become more active. Moreover, corn roots themselves have been shown to influence the release of nitrogen. Corn accumulates biomass more rapidly as the season progresses, so nitrogen release from compost parallels nitrogen demand by the growing corn crop.

In the KBS studies, leaching losses were never as great in compost systems as in commercial fertilizer systems, but the compost fit was better with corn than with soybeans or wheat. Soybeans produce much of their own nitrogen so nitrogen release from compost is not as important as it is with corn.

Wheat also did not respond as well to the compost as did corn. With wheat, the peak nitrogen demand is two to three months earlier than for corn. The soil is colder so microbial activity is less in early spring, when wheat makes its demands for nitrogen. As wheat grows, it also takes away soil moisture, which also reduces soil microbe activity just as heat is becoming available.

While leaching losses of nitrogen from wheat were nearly as high in compost systems as in fertilizer systems, still the pattern of wheat growth—taking place during high rainfall periods in late fall and early spring—resulted in the lowest leaching losses of any of the crops in the rotation.

Managing compost as a fertilizer source within a cropping system takes a higher level of management than using commercial fertilizer. In the KBS studies, compost was initially applied at the rate of 10 tons per acre and applied every year thereafter at rates needed to provide plant nutrients. The first application went on after wheat harvest and during the growth of clover, which was frost-seeded into the wheat.

The compost supplied ample nitrogen. In the corn years, the corn crop received both the residual nitrogen from the clover and from the compost. Soybeans the third year did not require added nitrogen and generated some for the wheat that followed.

In 1998, four years after compost was first applied, corn yielded 113 bushels per acre on the compost system and 108.5 under the fertilizer management. "Substitution of compost for nitrogen fertilizer resulted in equivalent yields in the first year of the corn rotation and decreased volatile forms of nitrogen in the season compost was applied," Fortuna and her colleagues write. "Compost appeared to provide additional plant available nitrogen that would become available several seasons later at the time of maximum crop nitrogen uptake in corn."

The story of nitrogen, the nitrogen cycle and how crop biodiversity and crop rotation benefit nitrogen management are presented in some detail in *Michigan Field Crop Ecology* (Michigan State University Extension Bulletin E-2646) published in 1998.

Addition of compost can be an important step toward a cure for soil quality problems that develop over years of intensive crop production. Research by MSU nematologist George Bird has shown that crop yields increase with the addition of compost—for reasons unrelated to nutrients.

"Keeping a field in crop production for many years can decrease soil organic matter levels and quality, resulting in fewer bacterial- and fungal-feeding nematodes and more plant-feeding nematodes," he writes in *Michigan Field Crop Pest Ecology and Management,* an MSU bulletin (E-2704) published in 2000.

"In contrast, farming systems designed to maintain or increase soil organic matter and improve soil organic matter quality can decrease the risk of root damage caused by (plant-feeding) nematodes and increase crop health, growth and development.

"Higher soil organic matter levels can result in higher water-holding capacity, water infiltration rate and microbial biomass; better soil structure; lower bulk density; near optimal pH and biotic diversity. Each of these factors affects nematode communities."

It has long been known that nematode damage to crops is more severe where soil is compacted, where crops are under moisture stress and where soil is coarse-textured. There are several dozen plant-parasitic nematode species that attack crops, including cyst nematode species that attack sugar beets and soybeans, corn needle nematode and the root lesion nematode that, in concert with Verticillium wilt, causes potato early die.

Combinations of cover crops like buckwheat and composted cow manure have improved yield and decreased harmful nematode population densities according to Dr. Bird.

In his studies, he has found dramatic shifts in the ratio of predator nematode species to plant-eating species, with an increase in predators and a decrease in plant eaters.

In sum, livestock farmers who choose to compost the manure their animals produce or those who buy compost to use with their cropping operations have taken a larger step than merely changing a nutrient source away from purchased commercial fertilizer. They are adding a biologically active material to their soil, with potential positive effects they may never have imagined.

## Farmer Profile # 1

### The Tuthills Make Composting a Community Service

*"We recycle leaves, grass, brush, logs, stumps, soil and manure," says the brochure from Tuthill Farms and Composting, Inc. "We are glad to have the opportunity to partner with our customers to turn waste materials into valuable products."*

For Jim and Sandra Tuthill, the services they provide on their 180-acre farm near South Lyon are an opportunity, one that's critically important to their farm's survival. The farm is too small, and land they rent to expand their base keeps disappearing to suburban development. They needed more income from fewer acres.

In 1995, to save the farm that had been their family's since 1863, they seized an opportunity provided by legislation that banned yard wastes and other organic materials from landfills. That created a niche for a service somebody needed to provide, and the Tuthills decided they would fill it.

*Sandra Tuthill is convinced composting is a win-win situation for farmers and communities*

"The yard waste ban posed a problem for some but an answer for us," said Sandra, speaking for the four people who all work at running the composting operation. "We saw an opportunity to make a business of turning these organics into compost that could be used as a soil amendment for our crops."

They charge disposal fees of $5 a cubic yard or $1 a bag. They take leaves and grass from household yards and logs, brush and stumps from landscaping and tree removal operations. Brush and larger materials are ground to produce wood chips. This is all mixed with manure from the 150 head of beef and the smaller livestock animals they keep. The mixture is put into windrows.

For composting, they use a 16-acre field covered with 20 or more windrows, each 10 feet and more high. The windrows are well structured and turned for aeration.

It is a major operation. In their peak year, they took in some 30,000 cubic yards of material. They have since cut back to taking about 12,000 yards a year.

"Composting yard wastes is a good fit for our natural farming methods," Sandra said. "Compost produced here is used as a nutrient source for the crops we raise to feed our animals and to maintain healthy soils for the produce we raise."

Although 12,000 yards sounds like a lot, composting reduces that volume by more than half. Their yearly capacity for compost use totals more than 20,000 yards, figuring 135 yards per acre on 150 tillable acres. The Tuthills haven't purchased commercial fertilizer in more than 20 years.

Their farm isn't certified as organic, but has a wholesome image in the community. They raise a large garden and sell vegetables in season. They also sell beef, chickens, eggs and goat milk, both at the farm and to a local food cooperative they supply with naturally grown products.

Making compost is fairly easy, Sandra says, but it takes organization. When they first started, Sandra did much of the work with the help of her father-in-law, Lloyd. As it grew, Jim quit his construction job to farm full-time and work with the composting operation, and later they added a full-time employee.

There are several steps in the process. As materials come in, they need to be sorted, Sandra said. Brush and large wood is piled for grinding later. As dry leaves arrive in the fall, they are piled separately. They will be loaded onto a manure spreader and, as needed, used as livestock bedding in the barns and to soak up manure and water in the feeding area. Grass is a third category and is piled separately.

When materials are combined for composting, wood chips or leaves can serve as the base of the windrows. This dry, high-carbon source needs to be mixed with manure or grass clippings, both of which contribute nitrogen. The leaf-manure mixture will compost well on its own.

"Piles of things are going to compost whether you watch them or not," Sandra said. But they monitor their windrows, especially for temperature. Thermometers protrude from windrows. "We want it to get to 150 degrees or so, hot enough to kill weed seeds," she said. "If we didn't, we'd be in trouble because we don't use any herbicides on our crops." The thermometers also tell when the windrows have reached a stable temperature and can be stockpiled for spreading.

They have invested money in the project. Not only does it take acreage, it takes machines. They have a tractor with front-end loader, a compost turner, a grinder for wood and a screener to remove undesirable materials from the finished material. Their biggest headache was plastic bags. Now they won't accept yard wastes in anything but paper bags.

The Tuthills are pleased by their interaction with neighbors and their ability to provide a community service. But they have to work at it, educating their neighbors, offering tours, fact sheets and open houses. They worried that some of the new neighbors might think their operation was merely a nuisance and attempt to stop their operations or have property zoned against their activities.

While composting is protected under Michigan's Right To Farm law as a Generally Accepted Agricultural and Management Practice (GAAMP), they feared they might lose farm status if they made composting a commercial operation. So instead of selling compost, they use almost all of it on their farm. Some neighbors take small amounts for their yards and gardens.

In 1999, the Right To Farm Law was amended, by Act 261, restricting the power of local units of government to regulate farming. "This is a whole different ball game," Sandra said. "I feel more confident now that, if I follow the GAAMP guidelines, our right to farm will be protected."

Before they started composting, the Tuthills attended educational seminars to learn how to do it right. There is an annual two-day Compost Operator Certificate Course put on by the Michigan Composting Council, Michigan Department of Agriculture, Michigan Recycling Coalition and MSU. It is geared for operations like theirs that use diverse materials for compost-making. They use that as an annual refresher course.

For two years, the Tuthills were cooperators in on-farm research trials organized by the Michigan Agricultural Stewardship Association. They had their compost tested for residues of herbicides and insecticides that might come on their farm with grass or brush, and none were found. They also compared the performance of asparagus grown with composts made of animal manure only, yard waste compost and no compost at all.

They are currently comparing the effects of compost applied after plowing. "We used to spread it, then plow," Sandra said. "This year we plan to spread after plowing to keep it in the top six inches of the soil." That is where biological activity is the greatest.

In the final analysis, the Tuthills want to be good farmers. Composting is a step toward that end, not an end in itself.

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## Farmer Profile # 2

### Composting Tames the Manure

When John Newland added composting to his dairy operation in 1991, it was primarily to give him an alternative to the daily-haul-and-spread program he still uses as his basic plan for manure management on his 220-cow dairy near Belding.

Weather and growing crops have always interfered with daily spreading. Like many dairymen have done over the years, he "solved" that problem by dedicating some fields near the barn to a "relief valve" solution. But, as early as 15 years ago, tests showed phosphorus levels in his nearby fields were high, going higher, and would someday be too high to meet the emerging environmental rules governing phosphorus levels in soil.

Then, too, Newland's 800 acres of farmland were scattered up to eight miles from the farmstead, which is located on a heavily traveled state road that is a racetrack for commuters trekking between their rural countryside homes and their jobs in Grand Rapids. Only once did that result in an altercation between a car and his farm machinery, but the experience reinforced his desire to spend less time on the highway.

"We started to give manure away to neighbors . . . and we'd spread it for them," John said. "It was a good deal for them, but for us we were merely disposing of manure and buying fertilizer to replace it."

He made his first attempt at composting in 1991. Instead of spreading in that nearby field, "We just piled the manure up and turned it a few times with a front-end loader."

Since then, he has made the process more sophisticated. But, he adds, "composting is being made to look too complicated. It doesn't have to be an exact science."

By composting, John wanted to reach several goals.

* By reducing the volume of manure, he could afford to haul it further and gain the nutrient, organic matter and biological activity benefits on his fields farthest away.

* By changing the consistency and chemistry of the manure, he could topdress it on growing crops. "We had no place to spread manure during the growing season," he said. "The big plus for composting is that we can topdress it onto alfalfa fields between cuttings." Unlike raw manure, compost neither smothers nor burns. And because the finished product has the consistency of rich black soil, their side slinger manure spreader lays down a uniform layer.

* By changing the character of the manure, he could make it less offensive. Odor was not a big concern. The problem was the manure that lined the roadway when the tractor and spreader made repeated trips. "It's a lot less of a problem if compost slops onto the road," he said.

* By capturing more of the nutrient value, he could cut his fertilizer bill. "Composting gives us a nutrient recovery system that is better than what we had when we were basically disposing of a waste," he said.

* By composting properly (as opposed to mere manure stacking), he could generate heat that destroys weed seeds, a very important feature when the compost is spread onto alfalfa fields.

The composting procedure starts with hauling box stall manure and manure-contaminated waste hay from around hay feeders. This is relatively dry and has a high carbon to nitrogen ratio. This is spread in windrows about 30 feet wide.

Then, each day, using the side slinger spreader, manure scraped from the barns is spread on top of the layer. When the manure is two feet or so deep, a tractor with front-end loader pushes the wide windrow together to about 10 feet wide.

The compost turner initially mixes the windrow ingredients and then is used weekly to speed the composting process. The process takes six to eight weeks to complete a windrow. Other windrows are in various stages of completion.

John was a cooperator in the Manure Management Demonstration Project for Michigan Agriculture. That was how he first gained access to a commercial compost turner. When that project ended, he and a neighbor went together to buy that turner, which he still uses.

What makes the turner special is a drive system on the turner designed to move the turner and tractor at the appropriate slow speed. A tractor, unless it has an ultra-slow creeper gear, moves too fast to pull a compost turner without repeatedly using the tractor clutch. The tractor is put into neutral, and PTO power propels the tractor and turner slowly down each windrow.

As a cooperator in the Manure Management Demonstration Project in the early 1990's, John learned about composting. He found that covering windrows with fleece blankets made of synthetic fiber discouraged flies early in the windrow formation stage and later kept excess moisture out of the composting windrows. "Composting really slows down when it's too wet or too dry," he said.

He was also intrigued by the idea that farmers and urban people might come together to solve mutual problems. The project envisioned homeowners bringing leaves and grass from their yards to a common site where they could be mixed with farm livestock manure. Farmers and homeowners could both capture nutrients for use on lawns, gardens and fields.

The project started at a landfill where a mountain of leaves and yard wastes had been gathered for composting. But, on a tonnage basis, there is a lot less of this material compared to the volume of manure a large farm produces. "There's a lot less of leaves and yard trimmings available then we thought," John said.

*A compost turner keeps windrows aerated and produces the potting-soil-like texture*

In general, he's sold on composting, although the time commitment is sometimes difficult. It has a future. "If I were a big farmer, buying a lot of feed and having a limited acreage to spread manure, I'd go after composting as a value-adding project. There's a market for compost," he said.

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## Farmer Profile # 3

### Composting the Manure from 2.2 Million Chickens

To grow enough corn to feed the laying chickens at Herbruck Poultry Ranch would require about 20,000 acres of land. "It takes about a bushel of corn to feed a chicken for a year, and we have 2.2 million chickens," said Brian Geerlings. The arithmetic is easy: 20,000 acres of 110-bushel corn provides 2.2 million bushels.

And to spread this manure, without exceeding the phosphorus requirements for corn, would require about 50,000 acres.

Brian was hired eight years ago to sell composted chicken manure – since with only 500 acres farmed by Herbrucks, most of the manure had to leave the farm. The Herbrucks, located in Saranac, had already made the decision to compost the manure and were doing it for about six years before Brian arrived.

Now all the compost gets sold, about $250,000 worth a year. "Ninety percent of it goes to farmers and it's used on crops of all kinds – fruits, vegetables, corn, soybeans, hay and others," Brian said. "We sell it by the semi-load for $40 a ton plus trucking. We also bag some, which is sold in 50-pound sacks in lawn and garden stores. Some gets used on athletic fields and golf courses," he said.

Even with the revenue, costs of operation are high. "We barely break even, but remember: On most poultry farms, getting rid of manure is an expense. We're trying to minimize that cost, and it's working."

Today, Brian not only handles sales. He oversees the composting operation.

Herbruck laying operations take place on two farms; each farm has a compost building. All the composting is done under roof. The laying houses contain stacks of cages in long rows, and under each level of chickens is a conveyor belt, which catches manure. Three times a week, the conveyor belts are started and they take manure from the houses.

Each of the two layer farms has its own compost building. On one farm, conveyors move the manure directly to the composting building. On the other, it goes into dump trucks and is hauled to the building.

The main farm composting building is 180 feet wide and 350 feet long – a large pole building with three bays. Manure is mixed with previously finished compost – both to dry the manure and to inoculate the fresh manure with composting microbes. The mixture is piled onto 300 feet long windrows, four feet high and 10 feet wide, for turning.

Special air ducts in the concrete floor of the composting barn carry air under and up into the windrows. That air comes from the attic of the barn, where the benefits of solar heating assure the air coming to the windrows won't chill the composting manure and the bacteria that do the work. In addition, the incoming air helps dry the finished compost to about 20% moisture before shipping.

The chicken manure is composted as is, without addition of litter or other high-carbon additives. "It composts well, but we have to take special precautions to keep it aerobic," Brian said. They turn windrows two or three times a week, in addition to the other aeration, to assure there is enough oxygen in the mixture.

In the laying houses, high airflow is used to clear the air of gases, such as ammonia. Five buildings have a special drying system incorporated with the ventilation system to produce dried chicken manure, which is sold without composting.

One of these five buildings also has a pellet mill at the end of it to pelletize the dried manure. That makes the manure easy to handle and spread with any fertilizer spreader.

With 2.2 million chickens, Herbruck is the largest poultry laying operation in Michigan, but not as large as some operations elsewhere. The farm has its own feed mill and markets the eggs, delivering them in their own trucks. Herbruck sells about 60% of its eggs in liquid form. It also raises some free roaming, certified organic chickens to satisfy consumers who value that.

Because there is nothing added to the manure, it has a comparatively high fertilizer nutrient analysis of 2% N, 5% $P_2O_5$ and 3% $K_2O$. It is also about 10 percent calcium, making it a good liming material. The calcium comes from the limestone addition to the feed, which helps chickens make strong egg shells.

Herbruck does not routinely use antibiotics in feed, reserving their use for known disease problems when they appear. That may have some effect on how well the manure composts.

# Farmer Profile # 4

### Composting's a Perfect Fit for Turkey Producer

"Manure might be worth a nickel, but you can't get two cents for it. If you add a nickel to it by composting, it's worth ten cents." That's how Joel Bussis looks at composting. Manure is valuable, but people are not willing to pay for it. Composting converts manure to a salable product.

He learned that from experience. The Hamilton turkey grower has but 25 tillable acres of land, so he was giving away the manure produced by 103,000 turkeys a year. It was a waste to be disposed of. In fact, it was worse than that. "When I had manure that needed to be spread, landowners often weren't ready to take it. I had to meet their work schedule or fit the schedule set by their crops," he said.

Four years ago, the Bussises — Joel and his father, John — made the decision to go into composting. Joel gives his father, who died in 1999, a lot of credit for his enthusiastic reception of the new practice for their farm.

Composting is ideally suited to turkey production, Joel says. The birds are raised with 17,000 turkeys in a batch, so manure can be taken out of buildings when they are empty.

Moreover, the two different kinds of manure the operation produces, when combined, have the proper carbon to nitrogen ratio for composting.

One kind of manure is the high-carbon type — high in wood shavings — that comes from the brooder barns. Day-old turkeys, 17,000 at a time, are placed in a barn bedded with 100 cubic yards of wood shavings. At five weeks of age, the growing birds are split into two groups and placed in grow-out barns.

At the end of the 18-week finishing period, birds have reached about 36 pounds and go to market. The barns are "de-caked" — accumulated manure is taken off the top. Some wood shavings are added for the next group.

*Poultry manure often needs added water to compost properly*

This concentrated manure, low in wood shavings content, from the grow-out barns is unloaded onto windrows. Manure and shavings from the brooder barn goes on top and the windrow is about ready for turning. Joel uses a manure spreader or a mixer wagon to distribute the manure.

The one thing his system is short on is water. "The manure cake is quite dry, 17 to 22 percent moisture, and the brooder manure is drier still," Joel said. "You need 40 to 50 percent moisture to get a good heat going."

What he does is pile the manure on windows and wait for rainfall to raise the moisture level. They have a 1,500-gallon water wagon to add more water if needed. Composting starts quickly once the windrows reach the right moisture level.

The turkey manure composts vigorously. The temperature rises quickly, so turning is done every week. It takes about three months before the windrows cool to a stable temperature.

When Joel decided to start composting manure, he got quite involved. He toured other farms and the Manure Management Demonstration Project underway in Ionia County. He volunteered to work with Michigan State University on turkey mortality composting, which has since become a legal method for poultry farmers to dispose of dead birds. He bought all the equipment—a turner, thermometers, polyester fleece blankets.

At first, he used the thermometers to monitor windrow temperatures, but quickly learned to gauge a pile by eye and feel. "The first year or two we took daily temperature readings. Turkey manure heats up so fast, and we needed to know when to turn it."

The fleece blankets are used to protect piles of finished compost from excessive rainfall, but during the composting process they are not used; the system needs all the water nature can provide.

The Bussis farm is located a mile upwind of the town of Hamilton, and there's a mobile home park a quarter mile away from the farm. The Michigan Department of Agriculture was called twice to investigate complaints. "We got a clean bill of health," Joel said. "We try hard to be good neighbors."

To make sure his farm is protected under the state's Right To Farm law, he does not take in leaves or any other material from off the farm. Everything in the compost pile is part of the farming operation. Selling the compost is also part of the farming operation, since he doesn't have enough land to spread it on.

Marketing is still not easy. "Farmers buy most of it," Joel said. "We have developed our own label and last year sold about 320 bags of compost to garden centers. We advertised and sold some by pickup loads to homeowners for lawn and garden use. One organic farmer really likes our product and takes enough for his farm. But we produce about 1,500 yards of compost a year we need to sell."

He hopes more farmers learn just how valuable compost is. "It's not just for NPK," he said. "It's for the micronutrients and the bacteria that improve the soil. It's also high in calcium. I get all excited about composting. It's the best thing since sliced bread."

# Composting as a Community Project

It doesn't take a genius to imagine that composting can be a community project that serves the needs of farmers and non-farmers alike. But it seems to take genius to invent a system that will achieve this goal!

Between October, 1992 and 1995 Ionia County was selected as a local site for the Manure Management Demonstration Project for Michigan Agriculture (MMDPA). A committee including residents representing agriculture, agribusiness and local government and County-level staff from key agricultural and environmental agencies, came up with a plan to compost area farmers' manure with leaves from nearby cities. The innovative proposal promised to provide a number of environmentally friendly solutions for rural and urban waste disposal problems. If successful they might serve as models for other Michigan communities.

At the planning stage, committee members drew on their local experience in setting out key ideas for the project. They anticipated that participating farmers would be able to identify a common site for pooling manure from their livestock operations. A new state law had recently banned organic yard wastes from being dumped in landfills, so these materials would be available, looking for a new use instead of a final resting place. Thus it was expected that nearby municipalities would be willing to deliver leaves picked up at curbside to the central manure collection point. What could be a better fit? The high carbon yard wastes would complement the high nitrogen farm manure. The end product of this collaboration, compost, would be valuable as fertilizer for farms, and possibly salable for use in area parks and gardens. Finally, the project offered a chance to bring different groups in the County closer together in educational activities that would benefit the environment and the wider community.

*The Manure Management Demonstration Project in Ionia County showed farmers how to make compost*

As an old saying goes, however, the devil is often in the details. Looking back, the Ionia group's ideas still seem reasonable, but trying to put them into practice took more time and energy than planning committee members could possibly have imagined. Fortunately rather than giving in to their disappointment and frustration, demonstration project staff, veteran members of the planning committee and cooperating farmers drew on their ingenuity to find alternative means to keep the project going. An area landfill where leaves and yard wastes from the city of Ionia had been accumulating became one of the key sites for the compost demonstration project. In addition, cooperating livestock farmers from a number of County sites participated in on-farm composting trials. Through these efforts, the Ionia County project generated a wealth of information on composting technology. The experience also offers valuable lessons for other Michigan residents who remain interested in composting as a community-level project.

Marilyn Aronoff, a sociologist at Michigan State University, studied the Ionia Project. In a report, she wrote, "At the level of generating ideas and plans for compost integration, this group developed a promising and innovative manure composting strategy and created a positive atmosphere of cooperation. Over time, however, particularly in the absence of pre-existing collaborative ties, operationalizing these plans was problematic."

It was not clear who would assume the burden and the cost of transporting leaves and yard wastes to farm sites, and no mechanisms emerged to negotiate the responsibility.

The farmers had little composting experience or direct knowledge of the value of compost or composting, and most had used daily haul and spread. They had not invested in expensive manure handling and storage systems, and were reluctant to invest in composting.

So with non-farmers reluctant to gather and deliver urban area leaves and yard wastes, and with farmers unwilling to invest in compost turning service and equipment, the system did not develop and survive after initial public funding ran out.

In addition, Ionia County is still quite rural, so some of the pressures on both farmers and non-farmers were less. Farmers were not under pressure from non-farmers to handle manure differently, and there were other ways of handling leaves and yard wastes in a nonmetropolitan area.

In interviews, county residents typically expressed broad support for composting as a manure management technique. They were supportive of the beneficial social, environmental and economic benefits — in principle. But they did not have the infrastructure in place to make the project work.

"In a county not yet experiencing urban sprawl . . . traditional residents frequently are accommodating neighbors tolerating occasional farm nuisances and . . . appreciating producers' presence as a deterrent to inundation by newcomers who . . . would destabilize the county's non-metropolitan character," Dr. Aronoff wrote.

In principle, it should work. Entrepreneurs in other areas of Michigan—such as the Tuthills in southeast Michigan—have made it work, but of course the level of cooperation required is less because the Tuthills manage and operate their composting system as their own enterprise, not a community project.

The Ionia County experience can serve as a guide to other communities whose residents wonder if they have the right mix of local needs and resources to make a community-level composting project work. For example, communities which already have a local environmental group or civic organization in place may be able to move further ahead on the path carved out by Ionia County residents.

## The Sale of Compost

Anyone contemplating the sale of compost needs to consider the final use. While most compost is applied on the farm where it is produced, it may be sold off the farm.

The most logical customers are local crop farmers who do not have livestock operations. Sales, or trades of compost for grain or forage, or gifts of compost to non-farm neighbors with gardens, can enhance relationships within the community. Other outlets for compost include nurseries, landscapers, garden centers and soil blenders.

The key to all markets is compost quality and consistency as required to meet the customers' needs – the compost may need to be tested for nutrient content and labeled, or for maturity. If the compost is not well-finished (cured and stable), there is the possibility of product failure. Poor compost can release odor and even kill plants as it releases ammonia and heat.

## Is There a "Right" to Compost?

In Michigan, farmers have a right to farm, guaranteed to them by a law of the same name.

That law says, in effect: If you as a farmer are sued because your activities are alleged to be a "nuisance," the Michigan Department of Agriculture will help you to defend yourself in court. MDA personnel will visit your farm and evaluate your practices. If what you are doing conforms to Generally Accepted Agricultural and Management Practices (GAAMPs), then you are in compliance with the Right To Farm Law (Act 93 of 1981 as amended) and are not a nuisance.

There are several sets of GAAMPs, one of which addresses manure management. In that document, composting is specifically listed as a legitimate part of a manure management system.

But are there limits? If you're a farmer with two cows, can you bring in 100,000 cubic yards of leaves, grass and brush as the "carbon source" to compost the manure? And then can you sell 50,000 yards of finished compost because you have only two acres of land to spread it on?

Some court suits have been won by farmers whose farming operations seem small or incidental compared to their on-going commercial waste management operations, says Wayne Whitman, the Right To Farm program manager in the Michigan Department of Agriculture.

A "test" question might be: Is what I am doing part of my on-farm production of farm products?

It is generally recognized, Whitman said, that farmers will need a carbon source to compost animal manure. Whether it comes in indirectly, as feed or bedding for animals, or directly as an additive in the compost windrow makes no difference.

It is also recognized that some farms may have an inadequate land base upon which to spread all the manure generated by their own livestock. Farmers who buy feed – and most do buy some – are trending in that direction. Thus, shifting compost to other farmers for their crop production needs is part of the manure and nutrient management programs on both the sending and receiving farms.

Does that mean you won't run into laws or regulations that will constrain your farm operation?

You don't have the right to create truck traffic that violates local zoning or road restrictions. You don't have the right to sell compost without complying with regulations covered by the Natural Resources and Environmental Protection Act (Act 451 of 1994). That law says that if you make nutrient claims on the container, the compost must meet those claims. You may also need a license to manufacture or distribute fertilizer and soil conditioners and may have to pay the tax levied on commercial fertilizers.

So before you compost, think it through. Find out whether you could be in violation of local zoning ordinances or must comply with state laws.

For most on-farm compost makers, composting in a manner that conforms to the GAAMPS and using what they produce on their farm to meet crop fertility needs is acceptable.

For information on the GAAMPs for manure management or to get more information on the Right To Farm Law, contact Wayne Whitman in the Environmental Stewardship Division of the Michigan Department of Agriculture. The Right To Farm toll-free number is 1-877-MDA-1-RTF (1-877-632-1783).

# Composting Operations And Research at MSU

In the early 1990's researchers at Michigan State University began to direct their attention to making quality compost, using the resulting product and applying the composting process in a variety of ways. It was clear that the state's land-grant university should play an educational role in what was becoming an important process for waste management.

Composting provides a means of diverting organic materials from the waste stream and recycling them into a beneficial soil amendment. When yard wastes were banned from landfills in 1995, many municipal and private waste haulers adopted composting practices. No regulations were in place regarding the composting of large volumes of yard waste, so an ambitious educational program was developed to provide direction for the emerging yard waste composting industry.

### *Activities Overview*

Since 1995, Ted Loudon and Andrew Fogiel from MSU's Department of Agricultural Engineering have worked with the Michigan Composting Council (MCC) and the Michigan Department of Environmental Quality to develop and implement a statewide compost operator training and certification course. The program, sponsored by the MCC and the Michigan Department of Agriculture (MDA), and coordinated by MSU staff, has been credited with minimizing the occurrence of poorly managed yard waste composting facilities.

Several studies have been conducted at Michigan State University on compost production and utilization, and more projects are in process.

Ted Loudon studied on-farm dairy manure composting in the early 1990's as part of the Manure Management Demonstration Project in Ionia County and is currently conducting several dairy manure composting studies at the MSU dairy compost facility.

Crop scientist Richard Harwood continues to study field crop utilization of livestock manure and compost.

Agricultural engineer Robert von Bernuth studied the use of dairy manure compost as a biofilter for odors from swine facilities. The inexpensive filter system was shown to be effective and could be adopted by producers wanting to reduce odor from swine buildings from which air is exhausted through fans. Forcing that air through a 20-inch deep pile of composted dairy manure and wood chips reduced odors as much as 99 percent.

C.A. Reddy of the Center of Microbial Ecology has found that composting can play a role in bioremediation of contaminated soils.

Ramani Narayan of MSU's Department of Chemical Engineering has developed a variety of biodegradable plastic compounds and products that could potentially be recycled through composting. Dr. Narayan has established a compost research lab at the MSU Engineering Research Complex.

Horticulturist John Biernbaum is currently comparing different nursery potting soil mixes and has included compost in some of his treatments.

Researchers investigated composting as an alternative to earth burial of dead farm animals, providing the basic information needed to make that a legal method for farmers to use.

Interest in the use of compost as a soil amendment has increased in a variety of agricultural and horticultural industries. Researchers are documenting the disease suppressive qualities of manure-based composts in both horticultural and agricultural applications.

Compost has been shown to effectively control certain fungal diseases that have been traditionally controlled using methyl bromide, a soil fumigant currently being phased out.

Compost has been beneficially used in soil blends for athletic and residential turf establishment and management. Studies at Cornell University have shown that certain composts can help reduce the use of chemical fertilizers and herbicides in managing greens and fairways on golf courses as well as in residential and commercial lawns.

Darryl Warncke and his graduate students in the Department of Crop and Soil Sciences are producing a specifically blended compost at the MSU dairy compost facility and using the compost in vegetable production studies.

### *Composting at MSU's Farms*

Michigan State University has the facilities, the expertise and the backing of clientele to research and demonstrate the use of different types of compost in a variety of agricultural, horticultural, landscape and turf applications. The Michigan Turf Foundation, the Michigan Integrated Food and Farming Systems, the Michigan Nursery and Landscape Association and the Metro Detroit Landscape Association are among those supporting investigation of more sustainable and environmentally sound management practices such as composting. These industries are very active with Michigan State University and look to the university for guidance in innovative directions.

Considering the amount of compostable materials generated on campus and the growing demands for research in production and utilization of compost, MSU has the capacity to play a significant role in the future of composting in a variety of green industries in Michigan and throughout the Great Lakes region.

The livestock facility managers on campus at MSU and at the Kellogg Biological Station recognize composting as an effective manure management tool. Private farmers and state agency representatives visit the swine and dairy compost facilities to gain a better understanding of the practice.

MSU's farms are production farms as well as research farms. Animals must be fed, manure taken away and crops grown for feed. The facilities are being used to integrate these sustainable technologies, as they would be on other farms.

Nationally, an increasing number of livestock facilities are adopting composting as a means of managing manure. Many livestock farms in Michigan are faced with soil phosphorus levels that exceed the allowable threshold for continued manure application. As livestock facilities develop manure and nutrient management plans, composting provides a viable process for moving manure off farm so that producers do not violate recommended practices for land application.

Along with many producers, MSU farms face the challenge of overall manure management within the context of the state phosphorus management guidelines. As part of its land grant mission and philosophy, MSU is providing education on a broad-range of waste management methods including composting to assist Michigan's livestock industry as well as other industries that generate organic wastes.

Composting operations were initiated in the fall of 1999 on a newly constructed one-acre gravel surface pad at the MSU Dairy Teaching and Research Center. It is for both farm and research use. That composting facility can handle 5 to 10 percent of the manure generated from the MSU dairy farm. Bedding waste from the MSU Horse Teaching Center and the dairy farm are used as the carbon source in the compost mix. Manure is hauled to the pad when fields are inaccessible.

The MSU dairy manure composting system illustrates that composting need not be an all or nothing manure handing system. Composting is integrated into the daily haul system, providing a place to go with manure when fields are too wet or snow covered or when growing crops prevent summer application.

The dairy manure composting pad was constructed in part because of the need to divert some of the manure from land spreading, but also to provide a place to conduct composting research and demonstration projects. One quarter of the pad is used for research, and there were three composting research projects underway as the year 2000 began. The manure being composted is a mix of tie-stall, free-stall and bedded pack manure. Leftover feed is also being added to the compost mix.

The horse bedding waste (wood shavings) has proven to be a very good carbon source to mix with manure from the freestall barns. The packed bedding manure contains enough straw (carbon) that it can be composted in windrows without the addition of horse bedding, but the straw takes longer to decompose.

Compost generated at the pad is land spread on university agricultural fields and pastures. The integration of composting has already provided two significant advantages to the manure management at the dairy farm. In addition to providing an alternative to land spreading, composting reduces the volume of manure by approximately 50 percent. This reduces the number of often-lengthy trips required to spread the compost compared to spreading the manure and provides flexibility when fields are inaccessible.

### *Current Composting Projects*

Several composting projects are currently underway at the MSU dairy compost facility.

#### *Fleece Blankets*

Ted Loudon and Andrew Fogiel are comparing the quality of compost from windrows covered with fleece blankets with windrows left uncovered. Fleece blankets are designed to shed rain off the windrow to minimize the amount of water added to the compost while allowing the movement of air into the compost.

Moisture content during dairy manure composting should be maintained between 40 and 65 percent. If moisture exceeds 65 percent, water fills most air spaces in the mixture reducing air flow and causing the composting process to turn anaerobic, which can lead to the generation of foul and offensive odors. Preventing anaerobic activity is one of the primary challenges in managing the composting process. The finished compost in this study will be used in soil and plant disease suppression studies with assistance from Dr. Harry Hoitink at the Ohio State University.

Uncovered windrows typically have higher oxygen content than covered windrows during periods of high wind. During periods of low precipitation, covered windrows tend to dry quicker because uncovered windrows receive any rainfall that does occur. Fleece blankets also help keep the composting process going to maturity during colder periods, especially when snowfall occurs.

#### *Postage Stamps*

Ted Loudon, Andrew Fogiel and Lansing recycling coordinator Leanne Myers are investigating composting as a way to dispose of surplus postage stamps from the U.S. Postal Service. Shredded stamps are currently incinerated, and it is hoped composting will provide a more environmentally friendly disposal method.

### *Convection Aeration*

Another Loudon and Fogiel study is investigating the role of passive, or convective, aeration. In addition to aeration provided by turning, fresh air is supplied to piles or windrows by the process of convection.

Natural convection occurs in properly structured windrows and piles as heat generated from microbial activity rises and draws cooler air in from the bottom and sides of the windrow or pile. As hot air rises through the pile, fresh air is naturally pulled in. If this chimney effect can be made to operate more efficiently, turning frequency can be reduced.

It used to be thought that turning was the major source of aeration during composting. Studies have now shown that oxygen introduced into a compost pile during turning is depleted within a few hours by microbial respiration.

Dairy manure compost has been reported to become anaerobic in a matter of hours. It has commonly been recommended to turn compost piles and windrows as soon as the oxygen content falls below the critical level of 5 percent. However, turning the compost often comes down to availability of time rather than optimizing the composting process. There is a need to investigate methods that will improve aeration and at the same time reduce the machinery needs and overall amount of energy input to the composting process.

Objectives of the study are to develop compost mixes that will provide adequate porosity so natural convection is the primary mechanism for aeration.

### *Mortality Composting*

A dead animal composting study was conducted by MSU agricultural Extension Agent Charles Gould, agricultural engineer Howard Person and research assistant Andrew Fogiel with assistance from MDA.

Composting has gained acceptance as a disposal method for poultry and swine mortalities on U.S. farms. Composting of poultry mortalities began in the 1980's and was later adapted for swine.

The National Pork Producers Council's 1997 handbook details the advantages and disadvantages of the four primary facility types used in mortality composting: a bin, a static pile, a windrow and a mini-composter. Pile and windrow composting methods have become standard in composting poultry and swine, but these methods often take several weeks to process the carcasses.

A rotating drum in-vessel compost system was demonstrated to compost poultry mortalities in one to two weeks, reducing the carcasses to bones with very little or no tissue remaining. The MSU study was conducted in which swine manure and swine mortalities were composted in the vessel system at the Michigan State University Swine Research and Teaching farm.

The vessel system composted the materials through the first and most active phase in one to two weeks. The carcasses were successfully composted down to just bones.

Average compost temperatures reached 135-140 degrees Fahrenheit for three days. This does not meet the revised EPA criteria for pathogen kill. However, no pathogens were detected in a sample collected when the compost was unloaded. Further verification studies are being conducted, including composting diseased swine carcasses. If the vessel is capable of destroying disease pathogens, this method would be one of the quickest and most thorough ways of composting swine mortalities available.

# The Economics of Composting

An economic analysis of manure composting showed the costs of running a composting operation are about the same as using a daily haul system and less expensive than investing in long-term storage systems.

The following tables illustrate the relative costs of three management systems – composting, daily haul, and long-term liquid manure pit storage and injection when applied to a 120-cow dairy farm. These costs are illustrative only. Actual costs may be higher or lower.

| Annual Costs of Composting | Range | |
|---|---|---|
| | Low | High |
| Compost turner $15,000 to $20,000 (10-year life) | $2,235 | $2,980 |
| Bedding 4,000 to 6,000 bales @ $1/bale | $4,000 | $6,000 |
| Fleece blankets 5-10 @ $350 (5-year life) | $440 | $880 |
| Land for compost site 3 acres @ $35/acre | $105 | $105 |
| Tractor for manure delivery to compost site and windrow turning 208 hours/year @ $11/hour | $2,288 | $2,288 |
| Labor to operate compost turner and skid loader 208 hours/year @ $6.50 to $10/hour | $1,352 | $2,080 |
| Labor for spreading compost 1.1 hours/cow/year @ $6.50 to $10/hour | $858 | $1,320 |
| Manure spreader $10,000 to 13,300 (10-year life) | $1,490 | $3,000 |
| Maintenance for compost turner & manure spreader (3% of purchase price) | $750 | $1,000 |
| **Total** | **$13,518** | **$19,653** |
| Less value of nutrients saved | $(5,855) | $(6,000) |
| Annual net cost | $7,663 | $13,653 |

Source: Michigan Manure Management Demonstration Project

| Annual Costs of Daily Haul and Long-Term Storage Systems | Daily Haul | Long-Term Storage |
|---|---|---|
| Energy | $1,046 | $1,284 |
| Fuel, repairs, tractor expense | $2,827 | $3,792 |
| Bedding | $2,270 | $1,297 |
| Labor | $5,070 | $4,212 |
| Depreciation, interest, repairs, insurance | $1,657 | $10,472 |
| | | |
| **Total** | **$12,870** | **$21,057** |
| Less value of nutrients saved | $(4,963) | $(6,748) |
| Annual net cost | $7,907 | $14,309 |

Source: Agricultural Economics Report No. 561, Michigan State University

# Composting, Daily Haul and Long-Term Storage Comparison: Advantages and Drawbacks

Each manure handling system has certain advantages and drawbacks. Many of composting's advantages and drawbacks have already been described. Here, listed in summary statement form, are some of the advantages and drawbacks of composting, daily haul and long-term storage systems.

*Advantages of Composting and Compost*

- Reduced equipment wear and soil compaction vs. daily haul
- Decreased soil bulk density
- Increased soil organic matter and humus
- Increased soil water holding capacity
- Nutrient stabilization
- Flexibility in application timing
- Potential off-farm revenue
- Pathogen and weed seed destruction
- Potential decrease in herbicide costs
- Uniform application to land or for top dressing
- Fewer fly/odor problems

*Drawbacks of Composting and Compost*

- Specialized equipment/material requirements
- Inadequate carbon availability
- Potential for local/state regulation and zoning considerations
- Competition with other farming operations for labor
- Reallocation of land use to windrows

*Advantages of Daily Haul*

- Single handling of manure
- Decreased soil bulk density
- Increased soil organic matter and humus
- Less offensive odor

*Drawbacks of Daily Haul*

- Potential for local/state regulation and zoning considerations
- Competition with other farming operations for labor and machinery
- Nonuniform nutrient distribution
- Need to spread on frozen soil

*Advantages of Long-Term Storage*

- Scheduling flexibility for application
- Injectable liquid
- Disposal for all barnyard and/or milking center waste
- Complete containment and nutrient storage

*Drawbacks to Long-Term Storage*

- Potential for local/state regulation and zoning considerations
- Aesthetic/nuisance complaints
- Large capital investment

# Sources of Information and Equipment

Manure composting may be done successfully following the guidelines provided in **Composting on Michigan Farms** with equipment already available on the farm. However, many compost operators do purchase a few specialized tools, such as windrow covers and temperature probes, to ensure a high quality product. Some construct a composting pad and purchase a windrow turner.

Composters may also seek additional information on how to deal with specific situations. ***Equipment Suppliers*** and ***Information Sources*** are listed below as possibilities for addressing these anticipated needs.

There are many compost equipment suppliers; we have included just a few that have been used by Michigan composters and researchers. Endorsement is neither intended nor implied by their inclusion on this list.

Similarly, we have included a few of the hundreds of available information sources, again without the intent of endorsing any specific publication or service. With the information sources we have also included several public agencies and organizations that deal with composting.

*Compost temperature is the best indicator of process completion*

***Equipment Suppliers*** offer monitoring and testing equipment, windrow covers, turners and a range of testing and consulting services.

Autrusa Company
PO Box 1133
Blue Bell PA 19422
610/222-0937
610/222-0939 FAX
info@autrusa.com
http://www.autrusa.com

*Fleece blankets protect composting windrows from excess rain and seem to make composting go better*

Midwest Bio-Systems Inc.
28933-35E Street
Tampico IL 61283
800/689-0714
505/521-3699 FAX
treo@compuserve.com
http://www.galaxymall.com/commerce/bio-systems

Pike Agri-Lab Supplies
RR 2, Box 710
Strong ME 04983
207/684-5131
207/684-5133 FAX
info@pikeagri.com
http://www.pikeagri.com

***Information Sources*** listed include public agencies and composting organizations.

The JG Press, Inc.
BioCycle Journal of Composting & Recycling
Compost Science & Utilization
419 State Avenue
Emmaus PA 18049
800/661-4905
610/967-1345 FAX
biocycle@jgpress.com
http://www.biocycle.net

Michigan Compost Council
P.O. Box 10240
Lansing MI 48901-0240
517/371-7073
517/371-1509 FAX
MIRC@voyager.net
http://www.michiganrecycles.org

Michigan Department of Agriculture
Right To Farm Program
Wayne Whitman, Program Manager
P.O. Box 30017
Lansing MI 48909
877/MDA-1-RTF (or 877/632-1783)
whitmanw@state.mi.us
http://www.mda.state.mi.us/right2farm/farm.htm

Natural Resource, Agriculture and Eng Service
Publisher, On-Farm Composting Handbook, NRAES-54
Field Guide to On-Farm Composting, NRAES-114
NRAES Cooperative Extension
152 Riley-Robb Hall
Ithaca NY 14853-5701
607/255-7654
607/254-8770 FAX
NRAES@cornell.edu
http://www.nraes.org

U.S. Composting Council
P.O. Box 407
Amherst OH 44001-0407
440/989-2748
440/989-1553
info@compostingcouncil.org
http://CompostingCouncil.org

USDA Natural Resources Conservation Service
Conservation Practice Standard 317
Ionia Field Office
James G. Scott, District Conservationist
2568 Heartland Blvd.
Ionia MI 48846-2132
616/527-2620
616/527-9055 FAX
jscott@mi.nrcs.usda.gov

## Suggested for Further Reading:

"An Analysis of Composting as an Environmental Remediation Technology," from U.S. Environmental Protection Agency at 800/424-9346

"Composting for Manure Management," from The JG Press, Inc. at 800/661-4905

"Compost Science and Utilization," from The JG Press, Inc. at 800/661-4905

"On-Farm Composting Handbook," from Natural Resource, Agriculture and Engineering Service at 607/255-7654

"Science and Engineering of Composting: Design, Environmental, Microbiological and Utilization Aspects." Availability information from Dr. Harry Hoitink, The Ohio State University at 330/263-3848

"Using Compost to Improve Turf Performance," from Penn State Cooperative Extension at 814/865-6713

## Manure Area of Expertise Team

The Manure Area of Expertise Team at Michigan State University is comprised of a core group of campus staff and Extension personnel who have research and/or outreach interests involving animal manure. Team members as of Summer 2000 include:

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## Also From Michigan State University

- The Michigan Sustainable Agriculture Web Page
  http://www.msue.msu.edu/misanet/

- **Michigan Field Crop Pest Ecology and Management**, MSU Extension Bulletin E-2704, and **Michigan Field Crop Ecology**, MSU Extension Bulletin E-2646, are available from MSU Extension offices.

"**Michigan Field Crop Pest Ecology and Management**, and its companion volume, **Michigan Field Crop Ecology**, help us better understand the biology of our farming systems. These publications are excellent primers for farmers and agricultural specialists who will need a better understanding of production methods coming from the new "biological" revolution that is sweeping agriculture. **Composting on Michigan Farms** provides information for adopting methods presented in the **Field Crop Ecology** series. These methods will lead to more sustainable farming systems."

Richard R. Harwood, Ph.D.
C.S. Mott Foundation Chair of Sustainable Agriculture
Department of Crop & Soil Sciences



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