A University-Wide Compost Facility: Start-Up and Operation

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Summary and Implications

A university-wide compost facility adjacent to the new dairy farm on 260th Street, about 2 miles south of campus, was planned, built, and brought through start-up into full operation during 2008–2009. The facility is managed by the College of Agriculture and Life Sciences' Research Farms unit and has a separate revolving account that will receive all fees and sales and pay all expenses. The facility is designed to be self-supporting, i.e. not receive allocations for its operations.

Hoop barns cover the composting and receiving areas to control runoff and moisture content. A pull-type turner is used to maximize flexibility and minimize start-up costs. The hoop barns have paved floors to support the turner, and a scale is used to weigh all materials. The machinery includes: a turner, manure spreader, telehandler, and a tractor. The facility consists of seven, 80 x 140 ft hoop barns with paved floors. The central hoop barn is the receiving hoop and the other six are composting hoops. Using the current pull-type turner, there are three windrows per hoop.

The compost blend targets are a Carbon: Nitrogen ratio of 25-30:1 and a moisture of 45–50%. Other parameters to consider are porosity and structure. Porosity and structure both affect how well oxygen flows into the pile and its availability to the microbes.

In the first 11 months of operation, the facility has received approximately 8,056 tons of materials or about 732 tons/month. About 85% of the materials come from the dairy farm as various forms of manure—manure pack, solids from the separator, and general manure scrapings. The remaining 15% of incoming materials are as follows: 7% campus yard and greenhouse wastes, 6% manure from other ISU livestock farms, and 2% from a variety of sources, primarily ISU Dining food waste. The ISU Dining food waste stream started in August 2009 and is about 40 tons per month when classes are in session.

A projected annual incoming flow of material will be 10,000 tons. The breakdown is expected to be about 75% dairy manure, 5% other manure, 5% campus and greenhouse waste, 10% biomass research waste and 5% dining waste.

The compost is primarily used as a soil amendment or as a component of amended soil for university construction projects. The amended soil is made by mixing topsoil, compost, and sand. Most amended soil has been 3 parts topsoil, 2 parts compost, and 1 part sand; although a 1 part topsoil, 2 parts compost, and 1 part sand mix is also used. Construction projects at Jack Trice Stadium, BioCentury Research Farm, College of Veterinary Medicine, College of Design Pavilion, and BioRenewables Lab have used amended soil. The new "green" roof on the Design Pavilion is planted in amended soil from the University Compost Facility.

The average analysis of the compost produced in the fall was 26% moisture, 83% organic matter, and 9-7-9 lb/ton of total N-P_20_5 and K_20. Ammonia nitrogen was 6 to 13% of total nitrogen. The three samples were similar in fall 2008 and 2009.

A spring 2009 compost was much wetter–50% moisture, 71% organic matter, and 9-6-11 lb/ton of total N-P_20_5 and K_20. More mature compost was drier (22 vs. 30% moisture), had more organic matter (83 vs. 79%), and slightly lower nutrient contents (10-5-9 vs. 11-7-13). Because the facility is so new, sampling and compost analysis will continue.

Background

The new ISU Dairy Farm supports teaching, research, and outreach activities with a 450-cow milking herd and the required auxiliary cattle. The manure management plan for the farm includes solids separation, with the liquids stored in a covered tank and the solids composted in an adjacent compost facility.

The original plan called for the compost facility to handle the solid manure from the dairy, plus ISU campus yard waste. The campus yard waste had been composted in the past with dairy manure on a small compost pad located at the old Dairy Farm on Mortensen Road. Yard waste adds needed carbon to the compost mix. As the new dairy farm construction proceeded, there was department, college, and university discussion about adding materials from other university sources to the compost waste stream. The department and college decided to add solid manure from other animal science facilities, from the new proposed pavilion, and biomass from biomass research activities. University sources of greenhouse waste and dining hall waste were also included in the composting process. These sources not only supply carbon for a more balanced compost mix, but they also increase the amount of university materials that are being processed in a more sustainable manner, following Iowa State University's commitment to sustainable practices. The compost facility is a cooperative effort between ISU College of Agriculture and Life Sciences, ISU Research Farms, ISU Extension, ISU Design and Construction Services, Iowa Department of Natural Resources, and Leopold Center for Sustainable Agriculture.

The composted material is used as a soil amendment for campus landscaping and in ISU construction projects for soils around buildings. The compost material is also used in research activities, including being used as bedding for the dairy cows.

Results and Discussion

A university-wide compost facility adjacent to the new dairy farm on 260th Street, about 2 miles south of campus, was planned, built, and brought through start-up into full operation during 2008–2009.

Guiding Principles for ISU Composting Facility.

A set of principles guides the compost facility operation.

1. The facility serves the entire university.
2. The facility is managed by the College of Agriculture and Life Sciences' Research Farms unit.
3. The facility has a separate revolving account that will receive all fees and sales and pay all expenses.
4. The facility is designed to be self-supporting, i.e. not receive allocations for its operations.
5. All material coming into the facility is billed to the source.
6. All material exiting the facility is billed to the user.
7. Representatives of the users meet annually to review operations, review the fee structure, and review the account status.
8. Research, teaching, and extension activities are encouraged, but should not disrupt the material flow or generate additional costs to the facility/account.
9. The facility/account is expected to generate revenue and accumulate a balance to maintain and replace all machinery and buildings over time.
10. The facility does not routinely pick up or deliver material.

Design features.

Design features include:

- Hoop barns that cover the composting and receiving areas to control runoff and moisture content.
- Pull-type turner to maximize flexibility and minimize start-up costs.
- Paved hoop barn floors to support turner.
- Hoop barns with ridge vents to maximize ventilation. Note: Due to height of hoop barns, vents were probably not needed.
- Receiving area located centrally on the site.
- A scale as part of the facility to weigh all materials.

Facility. The facility consists of seven, 80 x 140 ft hoop barns with paved floors. The central hoop barn is the receiving hoop with six composting hoops. Using the current pull-type turner, there are three windrows per hoop. The facility also has a Mettler-Toledo electronic scale with a 10 ft x 70 ft platform to weigh all materials. The facility is adjacent to the ISU Dairy Farm.

Key machinery.

The machinery includes:

1. Turner – The compost turner is a used pull-type Aeromaster PT-170, 14 ft wide, made by Midwest BioSystems of Tampico, IL. The windrow, at the beginning of the composting process, can be 14 ft wide and 6.5 to 7 ft high. The turner has the capacity to turn 2,670 cubic yards/hr. Features include a water system to add water to compost, variable speed and hydraulically retractable drum, and naturally peaking windrows. This turner has proven to be simple and easy to repair and has performed well. The only drawback is that a drive alley is required for the tractor between each windrow.
2. Manure spreader – A Meyer 3750 tandem axle manure spreader is used to initially mix the materials and construct the windrow. The spreader has removable horizontal beaters and has a capacity of 750 bu or 482.5 cubic ft. The beaters are removed to construct the windrows
3. Telehandler – A Bobcat V-723FL telehandler with cab and 3.25 cubic yd bucket is used to move materials. The unit has a 100 hp diesel engine and lift capacity of 7000 lb. Maximum lift height is 283 in. and maximum lift reach is 156 in.
4. Tractor – A John Deere 7230 (110 hp) tractor with creeper gear is used to pull the turner and power the spreader.

Compost mix. In brief, feedstocks are analyzed for moisture and nutrient content. This analysis of the available feedstocks is recorded into a compost calculator computer program. The program helps to select the appropriate amount of each component to get a compostable blend. The compost blend targets are a Carbon: Nitrogen ratio of 25-30:1 and a moisture of 45–50%. Other parameters to consider are porosity and structure. Porosity and structure both affect how well oxygen flows into the pile and its availability to the microbes.

Composting process. After a windrow is made with the manure spreader (without beaters), the windrow is turned once to help form it and mix it. The composting process takes about 10 to 12 weeks with 10 or 15 turns of the windrow. The frequency of turning is determined by windrow temperature and oxygen measurements. Turning provides mixing and aeration. When the oxygen level in the windrow falls below atmospheric oxygen levels, then the windrow will benefit from turning. The porosity of the windrows is related to moisture content and structure from particles like cornstalks or wood chips.

Operations. In the first 11 months of operation, the facility has received approximately 8,056 tons of materials or about 732 tons/month. About 85% of the materials come from the dairy farm as various forms of manure—manure

pack, solids from the separator, and general manure scrapings. The remaining 15% of incoming materials are as follows: 7% campus yard and greenhouse wastes, 6% manure from other ISU livestock farms, and 2% from a variety of sources, primarily ISU Dining food waste. The ISU Dining food waste stream started in August 2009 and is about 40 tons per month when classes are in session. At this rate, ISU Dining will produce 350 to 400 tons annually or about 4 to 5% of the total incoming materials. A seasonal influx of leaves from campus and harvested biomass from research occurs in the fall.

A projected annual incoming flow of material will be 10,000 tons. The breakdown is expected to be about 75% dairy manure, 5% other manure, 5% campus and greenhouse waste, 10% biomass research waste and 5% dining waste.

The compost is primarily used as a soil amendment or as a component of amended soil for university construction projects. There is no sale of compost to the public. Wholesale marketing of excess compost to area businesses and state governmental units is being explored. The original plan was to provide compost to the contractors to make improved soil around new buildings. However, it was learned that the contractors preferred having finished amended soil sent to the site. The amended soil is made by mixing topsoil, compost, and sand. Most amended soil has been 3 parts topsoil, 2 parts compost, and 1 part sand; although a 1 part topsoil, 2 parts compost, and 1 part sand mix is also used. Construction projects at Jack Trice Stadium, BioCentury Research Farm, College of Veterinary Medicine, College of Design Pavilion, and BioRenewables Lab have used amended soil. The new "green" roof on the Design Pavilion is planted in amended soil from the University Compost Facility.

Compost analysis. The average analysis of the compost produced in the fall was 26% moisture, 83% organic matter, and 9-7-9 lb/ton of total N-P_20_5 and K_20. Ammonia nitrogen was 6 to 13% of total nitrogen. The three samples were similar in fall 2008 and 2009.

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