Composting of Feedlot Waste-Update of Research Activities

Gary Lesoing
University of Nebraska-Lincoln, glesoing2@unl.edu

Terry J. Klopfenstein
University of Nebraska-Lincoln, tklopfenstein1@unl.edu

Daniel Duncan
University of Nebraska-Lincoln, dduncan1@unl.edu

Mark A. Schroeder
University of Nebraska-Lincoln, mschroeder1@unl.edu

Composting of Feedlot Waste—Update of Research Activities

Gary Lesoing
Terry Klopfenstein
Dan Duncan
Mark Schroeder[1,2]

Composting of feedlot manure is an alternative waste management system that is environmentally sound, provides flexibility in application as a nutrient source, and is economically feasible.

Summary

Composting of beef feedlot manure at the ARDC Integrated Farm has been a feasible waste management system from 1993 to 1996. Composting of feedlot manure provides flexibility in application, reduces the need for purchased P, reduces odor, provides a stabilized N and P source, reduces volume, and kills weed seeds and pathogens. Cost of composting and spreading ranges from $3.75 to $6.00/ton, but value of N and P in compost generally ranges from $5.00 to $8.00/ton. Spreading of compost on cropland in a uniform manner is a concern and equipment is being evaluated that will best improve this situation.

Introduction

In 1993 a composting operation was started between the Integrated Farm Project and the Agricultural Research and Development Center (ARDC) Feedlot. Progress of this project was reported in the *1996 Beef Cattle Report.* This project has continued in 1995 and 1996. Results from the first two years of this project show that composting is a feasible waste management system for beef feedlots. Many large commercial feedlots throughout the state are composting cattle waste. Composting reduces fly and odor problems associated with stockpiled and land applied manure, stabilizes nitrogen and provides flexibility for land application, and kills weed seeds and pathogens in the manure through the composting process. While composting has many advantages, it requires additional labor, time, money, land, and careful management. There is potential for greater loss of nitrogen during the composting process compared to conventional manure handling systems and it may require the purchase of additional equipment to turn and spread the compost.

In 1995 and 1996, evaluation continued on the cost of composting, nutrient content of compost and crop response to application of compost. New projects investigated alternative methods to improve the composting process and management of the composting site.

Procedure

Economic Evaluation

Composting continued in 1995 and 1996 as the ARDC feedlot hauled manure to the compost site and put it in windrows for composting. In 1995, approximately 450 tons of feedlot manure were composted at the site. Manure hauled to the site early in the spring was wet, but later in the year as the weather became hot and dry, much of the manure hauled to the site was dry. Composted beef feedlot manure was turned an average of four times during the summer. Costs of composting and spreading compost were estimated by two methods. One method is similar to the one described in the *1996 Beef Report* for 1994. The other method involves use of custom labor and trucks to haul compost to the field and spread compost with a rented tractor. This is the procedure currently being used to spread much of the compost on the ARDC. Costs are based on $1/mile for truck usage, $30/hr for a loader and operator, $11/hr for labor, and $19.50/hr for tractor rental. We own our spreader, but estimate it costs approximately $.60/ton of compost spread. Compost was loaded twice, which added to the cost of spreading. Average distance to the field was 2.4 miles.

Crop Response

Each windrow of mature compost was sampled at several locations within the windrow, and a composite sample was analyzed for dry matter, N, and P. Compost has been applied to production fields which have tested low in soil P. Compost is applied at a rate of approximately ten tons/acre. There have been thirteen check strips established in these fields to compare crop response from compost application. Check strips run the length of the field, are 50 feet wide, receive no compost, and receive commercial N only if needed. Crop yields were monitored on these check strips in 1995.

In spring 1995, an experiment was initiated in cooperation with the Biological Systems Engineering Department (BSE). Compost was applied in alternating 20 ft.-wide strips across the length of a 36-acre center pivot at the rate of ten tons/acre in early March. One half of the pivot was planted to corn following soybeans and one half to soybeans following corn. Both crops were planted no-till. Crop yields were measured on the paired strips for both corn and soybeans in the fall of 1995. Strips were sampled to obtain baseline information on P content of soil. Observations were also made on weed pressure.

Composting Process Improvements

As previously mentioned, much of the manure hauled to the compost site was very dry. This material did not heat up or compost well. An experiment was conducted to compare manure with added water to manure which received no water. The effects of the water on compost temperature and final nutrient content were measured. Another project involved the addition of sawdust and swine lagoon water to feedlot manure compared to adding only swine lagoon water to manure for composting. Sawdust was added to give the beef feedlot manure a more favorable carbon:nitrogen ratio to help conserve more N. After composting was complete, both composts were sampled for N, P, and dry matter composition.

Environmental Concerns

The possibility of nitrates leaching below the compost site and into the groundwater is a concern of composting. To address this issue, in the summer of 1995 we collected several soil cores at our compost site as deep as 17 ft. at locations adjacent to compost windrows or where windrows were the previous year. These were compared to samples taken at the site in areas where compost had never been made or stored to see if there was any accumulation of nitrates below the site.

Results

Economic Evaluation

Costs of composting were similar to 1994, when the same method was used to estimate costs in 1995. Costs were $3.75/ton for producing beef compost, delivering it to the field, and spreading the compost. Costs of turning the compost were $1.25/ton and $2.50/ton for spreading. Cost of composting when the custom application method was used was much more expensive. Cost of spreading was approximately $4.75/ton, with turning costing $1.25/ton, for a total cost of $6.00/ton. Even though having the compost applied in this manner is expensive, the value of N and P in the compost usually equals or exceeds the cost of making and spreading the compost. Based on commercial fertilizer values ranging from $0.149 to $0.186/lb for N and $0.263 to $0.286/lb of P_2O_5, the value of compost averaged $7.44/ton in 1995. Composition of composted feedlot manure averaged 11.1 lbs N/ton and 12.3 lbs P_2O_5/ton on an "as is" basis. Dry matter of compost was 82.85 percent, very similar to 1994. N content of compost was slightly lower than in 1994, but compost was quite variable. Phosphorus content was lower in 1995, but this may be due to diets lower in P.

Crop Response

Yield response has been variable to compost additions the past three years. Corn appears to respond the most to compost the year after application. Corn yield has increased by an average of 9 percent the first year after compost additions compared to no compost additions. There was no response in corn yields the second year after compost

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application. Wheat planted shortly after compost application has shown the greatest response. Yields were increased 14 percent compared to wheat with no compost applied. Soybean yields increased an average of three percent following the first year and 13 percent following the third year of application.

In the winter of 1995, compost was applied and check strips established on an irrigated continuous corn field where ridge-till and conventional disk-plant tillage systems were practiced on different parts of the field. Yield results showed a 19 percent increase in yield (108 vs 91 bu/acre) from compost addition for the conventional tillage, with only a three percent increase on the ridge-till (93 vs 90 bu/acre). In previous years, crop yields were similar for compost applied to no-till or conventional tilled (disked) fields. This is a concern since most of the compost on our fields is surface applied under no-till conditions. We will continue to monitor crop yields and soil characteristics on compost check strips for several different crops over the long-term on production fields.

We know the application rate of compost per acre is accurate, but there is a concern about the uniformity of distribution. The variability across the width and length of the spread is great. This is the most limiting factor in getting producers to use either manure or compost as a resource rather than a waste. The machinery industry and the University are working to improve this situation.

Soil samples (0 to 6") taken from the compost study established with BSE in the spring of 1995 indicate P levels of 17 ppm with a range of 14 to 22 ppm on the soybean field and 19 ppm on the corn field ranging from 11 to 29 ppm. These average P levels fall within the medium range for P, in which additional application is not recommended for corn or soybeans. Levels below 15 ppm are considered low, and P is generally recommended for these crops. With the 10 tons/acre application of compost, approximately 200 lbs/acre equivalent of P_2O_5 were applied. These should meet P needs on this field for many years. Crop yields measured on these fields in the fall of 1995 showed a four percent increase on corn strips which received compost (159 vs 153 bu/acre). One half of the strips was cultivated to facilitate incorporation of the compost, while the other half was not. Yields were not affected by cultivation. Soybean yields were only increased one bu/acre (47 vs 46 bu/acre) with compost addition.

Weed pressure was observed on the compost and no compost strips for both soybeans and corn. Many species of weeds were present in compost and no compost strips. There was concern that compost did not heat up sufficiently to kill many of the weed seeds. It appeared shattercane, lambsquarters, and kochia weed seeds may have been in the compost. A study is currently being conducted at the compost site to determine the effectiveness of composting in killing different species of weed seeds. Yields and soil characteristics on this project will continue to be measured in future years.

Composting Process Improvements

Adding water to beef feedlot manure successfully increased the temperature of compost, which is important for stabilizing nitrogen and killing weed seeds and pathogens. Water was added during the turning process. Ideally, moisture content of manure for composting should be 40 - 60 percent, but this manure contained only 10 percent moisture, and was increased to 25 percent by adding water. Compost that received water was turned two days later, and again as temperature increased. Compost that received water was turned five times, but that without water only twice. Compost temperatures heated up to 160°F following addition of water, while compost without added water only heated up to 121°F. Nitrogen content following composting was 14.8 and 14.4 lbs/ton for compost without water and compost plus water, respectively, on an "as is" basis. This demonstrates that water additions can be made to compost to facilitate the composting process without substantial loss of N if temperatures are monitored closely.

A second project evaluating the use of sawdust as a carbon source to provide a more favorable C:N ratio did not increase N recovery. For greatest retention of N in composting, there should be at least a 20:1 C:N ratio. Unfortunately, the C:N ratio of feedlot manure usually ranges from only 10:1 to 15:1. It usually is not economical to add a carbon source or water to the manure unless the value is increased enough to make it a more marketable product. Sawdust added to manure only increased the C:N ratio to 15:1, but manure without sawdust addition had a C:N ratio of only 10:1. Swine lagoon water was pumped on the compost during turning to facilitate composting of manure that was approximately only 13 percent moisture. Adding water brought moisture levels up to over 30 percent. Swine lagoon water was very dilute, and nitrogen additions from it would be negligible. Feedlot manure was highly decomposed, and very high in ash, (approximately 80% DM). The material did not heat up very well during composting, 120°F and 140°F for manure only and manure plus sawdust, respectively. Nitrogen recovery rates were high for both treatments, approximately 90 percent due to the low temperatures generated. Nitrate levels and C:N ratios after composting were 272 and 1303 ppm and 9:1 and 8:1 for compost plus sawdust and compost without sawdust, respectively. The low nitrate levels indicate the addition of sawdust successfully composted a more stable final product.

While these practices may not be economical for producers at this time, there may be opportunities when waste carbon materials are available and the value of compost could be enhanced to make it feasible. These practices will continue to be investigated.

Environmental Concerns

Results of soil samples at the compost site indicate the concern for nitrates leaching below the site was justified. Nitrate levels averaged 16 ppm per ft. in the top 5 feet below the surface, and 10 ppm per ft. at the 5- to 10-foot depth. This compares to 4 ppm per ft. in the 0 to 5' depth and 5 ppm per foot at the 5- to 10-foot depths for the control. Due to the higher nitrate levels below the compost site, we decided to move most of the site across the road and plant alfalfa in the spring of 1996 on the old site. Alfalfa will be used to scavenge excess nitrates out of the subsoil at lower depths before leaching into the groundwater. Part of the old site remained and composting continued in 1996, while nitrates are being monitored below the site. Alfalfa was established, but germination was poor in locations of windrows in 1995, probably due to a high salt content. Surface soil in these areas will be sampled for confirmation. The plan is to rotate between compost sites every three to four years and grow alfalfa following composting as a nitrate scavenger to prevent groundwater pollution.

Conclusions

Composting of beef feedlot manure at the ARDC Integrated Farm has been a successful method of waste management from 1993-1996. Although it requires careful management and more labor, land, and equipment, it provides flexibility in application and reduces the need for purchased P. The greatest challenge is to be able to spread compost uniformly in the field. Long-term impact of compost on crop production needs to be monitored. The addition of water and sawdust to facilitate the composting process, improve nitrogen stabilization, and increase temperatures to kill weed seeds and pathogens may have potential. Management of the compost site is important to prevent nitrates from leaching into the groundwater. Relocation of the compost site and use of alfalfa as a nitrate scavenger should solve this problem.

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[1]Gary Lesoing, Research Assistant Professor, Center for Sustainable Agricultural Systems; Terry Klopfenstein, Professor, Animal Science, Lincoln; Dan Duncan, Director ARDC, Ithaca; Mark Schroeder, Farm Manager ARDC.

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