Western Beef Development Centre

NUTRIENT CHANGES IN COMPOSTED BEEF CATTLE MANURE

Introduction

On a growing number of farms, manure is more of a liability than an asset. Disposal of manure is a problem where feed is not grown on the farm, previously rented land is lost, or when cattle numbers increase beyond the farm's sustainable capacity. Other concerns include runoff from manure spread on frozen ground and nitrate contamination of ground water. Finally, odor complaints are becoming common in more populated areas. Composting has the potential to alleviate these problems.

Composting is a biological process in which organisms convert organic material such as livestock manure into a soil-like material called compost. During the composting process, heat, various gases (ammonia (NH_3), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (NO_2)) and water vapour are released, reducing the mass and volume of the composted material. Carbon dioxide (CO_2) and water losses can amount to half the weight of the initial materials.

There are over two million cattle and calves producing four million tonnes of manure annually in Saskatchewan. To ensure responsible management of this resource, composting is an attractive alternative gaining more attention from livestock producers, public officials and environmentalists.

Benefits of Composting

Composted manure offers several benefits including improved handling, increased bulk density, an excellent soil conditioner through transport of more nutrients than in fresh manure and reduced risk of pollution and nuisance complaints. As well, weed seeds and pathogens are destroyed and stable organic compounds are released slowly providing plants with a more sustained source of nutrients.

Drawbacks of Composting

Drawbacks to on-farm composting include time equipment and money, odor, weather, diversion of manure nutrients and crop residues from cropland, potential loss of nitrogen and slow release of nutrients.

Objectives

During the winter of 2001-2002 the Western Beef Development Centre initiated a composting project to demonstrate to cow-calf producers the economics and opportunities in composting fresh cattle manure. The objectives of this project were to determine changes in moisture, carbon (C), nitrogen (N) and phosphorous (P) levels in composted beef cattle manure during winter and spring conditions in east central Saskatchewan.

Mixing and Windrow Formation

Composting begins by collecting suitable organic materials that are then mixed to achieve the desired C:N ratio, moisture content and pore space. Usually the primary material is livestock manure.

The first essential step was to stockpile the manure and form the mixture into windrows. On August 8, 2001, during normal clean out of wintering pens at Termuende Research Farm, manure was removed from the pens bedded with straw and formed into windrows in a separate site area. These windrows represented roughly one-fifth (~180 tons) of the manure from backgrounding 1000 yearlings during the winter 2001-2002.

Within 24 hours a tractor front-mounted Brown Bear PTO - PA35 aerator was used to turn the manure and aerate the material. With the windrow system, this initial mixing must proportion the raw materials and blend them to some degree of consistency. Subsequent turnings mix the materials more thoroughly. Frequent turnings improve compost consistency and diminish the importance of the initial mixing. Windrows were aerated every week for two months after initial rowing, then bi-weekly for the following three months.

Moisture

Moisture content is necessary to support the metabolic processes of the microbes. Composting materials should be maintained within a narrow moisture content range, generally between 40% and 65%. Biological activity ceases entirely below 15% moisture content.

Curing, Storage and Compost Handling

Following active composting, compost requires a curing period of at least one month to finish the process and allow the compost to develop the desired characteristics for its intended use.

Sampling

Manure samples were collected from each of the eight windrows between August 1, 2001 and April 30, 2002. Initial samples of fresh manure were taken for chemical analysis.

Samples were also taken after active composting and after curing. All samples were stored at 0.5 °C to minimize biological activity prior to laboratory analysis. Moisture content, total N, total P, total K, and total S were measured on all samples (Table 1).

Table 1. Physical and chemical characteristics of beef cattle manure actively composted during winter 2001/02.

Properties (%)	Fresh manure Aug 15, 2001	Active composting Oct 18, 2001	After curing March 7, 2002
Moisture % wet wt	**70**	**42**	**41**
Total Carbon	**34.57**[1]	**28.17**	**27.20**
Total Nitrogen	**1.63**	**2.18**	**2.39**
Total Phosphorous	**0.41**	**0.56**	**0.56**
Total Potassium	**2.94**	**2.98**	**2.66**
Total Sulphur	**0.37**	**0.63**	**0.53**
C/N Ratio	**18:1**	**14:1**	**13:1**

[1]Dry weight basis

Results

Active winter composting resulted in changes to carbon, nitrogen and phosphorous content. During the active composting phase, carbon content was reduced by 19%. Moisture content of fresh manure was 70% (wet weight basis) (Table 1), which is within the optimal range for composting. During the active composting phase in winter the moisture content was reduced to 42%. Table 2 represents physical and chemical characteristics of manure and compost on a pound per ton basis.

Curing the compost during winter reduced the carbon content by 22% of that originally present in the fresh manure. The nitrogen concentration of fresh manure was 0.49 %, which means 1 m^3 contained 0.5 kg N. The nitrogen concentration of compost was 1.41 %, therefore 1 m^3 contained 5.6 kg N or 11 times more N than fresh manure.

Effect on Pathogens and Weed Seeds

Windrow composting of straw based manure will reduce pathogen (*E.coli*) concentrations to near the minimum detection limit after only 14 days. Further to this, land application of compost to cropland will therefore introduce little on no *E. coli* onto manured land compared to fresh manure (Miller et al. 1999).

Composting also ensures the destruction of any viable weed seeds through the high heat environment (50° to 70° C) and decomposition. After 14 days, composted green foxtail, redroot pigweed and wild oat seed all had a viability to germinate of 4-6% compared to 73-88% in the control. By day 29 this dropped to 0.5-2%, and by day 70 viability was zero for all three species (Larney, 1999).

Table 2. Physical and chemical characteristics of beef cattle manure actively composted during winter 2001/02.

Properties (lbs/Ton)	Fresh manure Aug 15, 2001	Active composting Oct 18, 2001	After curing March 7, 2002
Total Nitrogen	10	25.3	28.3
Total Phosphorous	2.7	6.3	6.3
Total Potassium	17.7	34.7	31.3
Total Sulphur	2.3	7.3	6.3

Costs

The quantity of nutrients transported to the field is a key factor in determining the economics of hauling manure and compost. Costs associated with this project are at the value of cost per pound of nitrogen.

A comparative value can be assessed between fresh manure and compost. Fresh manure has 10 lbs N/ton and N valued at $0.45 per pound represents a value of $4.50/ton. The compost had a concentration of 28 lbs N/ton; therefore a ton of compost can be valued at $12.60/ton. Average N application on perennial forages is 50 lb N/acre, therefore only 1.8 tons of compost needs to be applied per acre to meet requirements, compared to 5-ton/acre fresh manure.

However this increased fertilizer value must be weighed against the custom rates for windrowing equipment of $75/hour plus travel expenses.

Conclusions

Composting beef cattle manure reduced the carbon mass during the winter trial. Composting also increased density, allowing more nutrients to be transported in cured compost than in fresh manure. Finally, composting may have an advantage when compared to spreading fresh manure on crops, due to concentrated crop nutrients, reduced weight and volume when transporting to the field and less problems due to non-viable weed seeds in the composted material.

References

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