Evaluation of Compost Turning Frequency vs. Compost Quality of Manure and Manure, Leaf & Yard Waste Compost

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Composting manure and using the compost is a nutrient management strategy that can benefit both the livestock and crop producer.

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INTRODUCTION

Composting is a natural biological process where micro-organisms such as bacteria and fungi use air and water to decompose organic material and produce a humus-like material called compost. There are many benefits to both the livestock and crop producer.

Benefits of composting for the livestock producer:

- Improves overall handling of manure
  - Reduces volume of manure
  - Produces drier product
- Destroys pathogens and weed seeds
- Reduces flies and eliminates breeding grounds for fly production
- Reduces unwanted odour
- Improves the aesthetics of a farm

Benefits of compost for the crop producer:

- provides organic matter, stable nutrients and beneficial organisms to soil
- increases long-term productivity and total soil carbon
- improves soil structure and tilth

- increases water holding capacity of sandy soil
- increases aeration and drainage in clay soils

- decreases soil erosion
- no time restrictions on time of harvest of horticultural crops after application
- compost can reduce some soil-borne diseases

While there are many advantages to composting there are also a few drawbacks, namely, management and cost. The objectives of this project are:

1. Determine the quality of compost vs the number of times the compost windrows are turned
2. Determine the cost of producing various stages of compost
3. Determine whether adding leaf and yard waste is beneficial to manure composting

MATERIALS AND METHODS

Site Description

The site was located at Lochwood Simmental in the Rural Municipality of Gimli. It is a mixed farming operation with 350 head cow-calf. Nine windrows 16' W x 7' H and varying in length (from 215' to 250 ') were compiled as shown below (Fig. 1). All windrows except for windrow M0x were processed once through with Compo-stages Manitoba Services Co-op's Backhus 17.50 windrow turner (Fig. 2). Approximately 270 cu.ft of leaf and yard waste (Fig. 3) was mixed with the manure in each of rows MLY1x, 3x, 5x,and 7x resulting in a 1:10 ratio mixture of leaf and yard waste to manure on a volume basis. This allowed only the first 30 ft of windrows 1, 2, 3 and 4 to contain a mixture of manure, leaf and yard waste; the rest of the windrow was manure only.

Fig. 1. Site plan

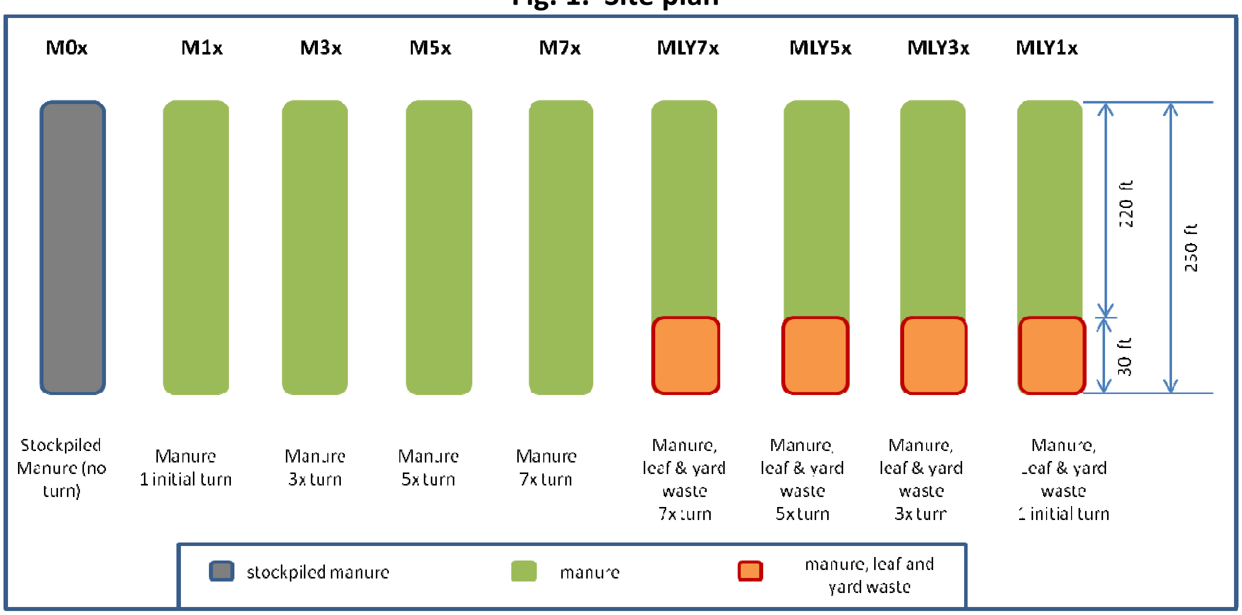


Fig. 2. Backhus 17.50 windrow turner

Fig. 3. Leaf and yard waste delivered by the RM of Gimli

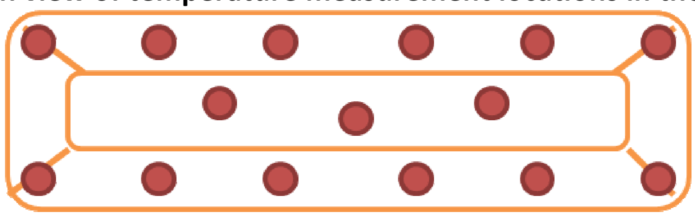
Windrow Turning

To mimic real life circumstances, windrows were turned based on the availability of the windrow turner as well as weather conditions. Windrows were turned 0, 1, 3, 5 or 7 times from July 2013 to September 2013.

Measurements

Temperature Fifteen temperature measurements per windrow were taken weekly from July to October 2013 using a 3' temperature probe. The locations of the temperature measurements are shown in figure 4.

Fig. 4. Plan view of temperature measurement locations in the windrow



Volume The initial and final volumes of the windrows were also measured to determine volume reduction during composting.

Nutrient Content and Compost Quality Three initial and three final combined samples (6 samples total) from each windrow were taken and sent to A&L Laboratories in London, ON for nutrient content and compost quality analyses. An additional four combined samples from each windrow was collected and Solvita test kits were used to determine the maturity level of the compost.

Economics The cost for turning windrows 1, 3, 5 and 7 times was determined based on the construction of windrow costs, mileage rate, cost per hour, hours required to turn the piles with the Backhus 17.50 windrow turner and cost to haul and apply the compost.

RESULTS AND DISCUSSION

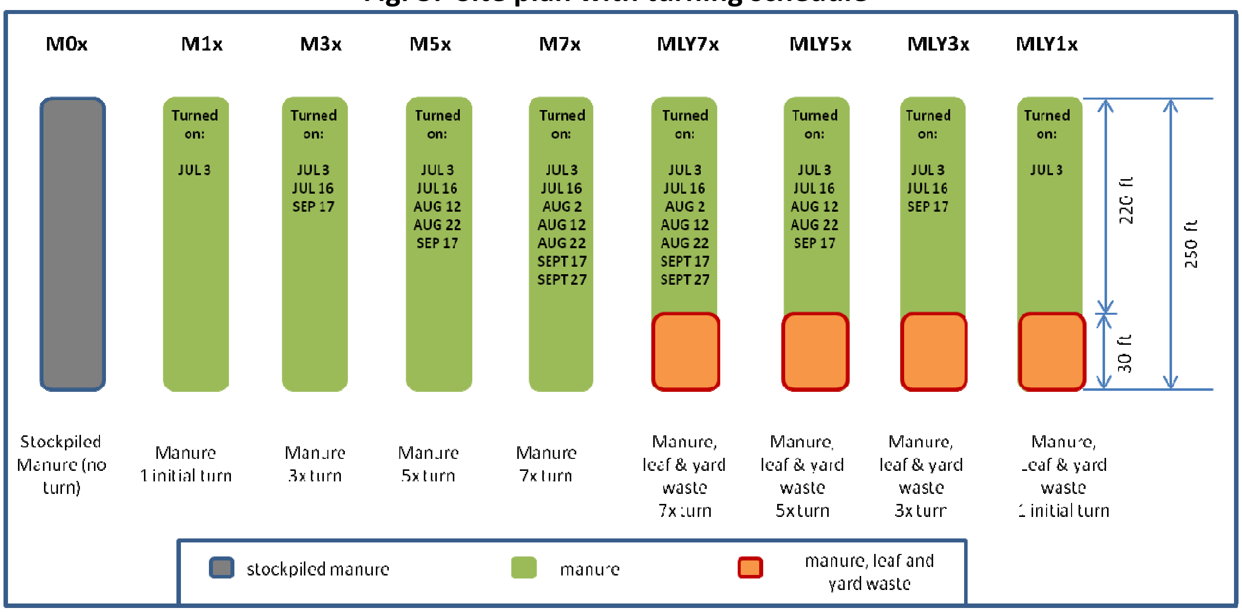
Windrow Turning

Generally in practice, manure windrows are turned weekly the first month, bi-weekly the second month and once again the third month, and subsequent times as needed based on temperature and moisture. However, since we wanted to mimic real life conditions, windrows were turned based on the availability of the windrow turner as well as weather conditions.

According to Manitoba Ag-Weather Program, from July to September 2013, the site had approximately an average of 1.8 mm of rainfall a day, with the highest rainfall of 31 mm on July 25, 2013. Due to wet conditions, some of the scheduled turning dates had to be delayed until the site was dry enough to access with the windrow turner. The wet surface also made it difficult for the Backhus to turn the windrows, sometimes resulting in the Backhus getting stuck and having the farmer pull it out. Ideally, a composting site should be properly designed for all weather access so that the windrows can be accessed any time of the year and time is not wasted pulling out compost turning equipment.

Turning dates also had to be rescheduled due to mechanical issues with the Backhus turner. As with any mechanical equipment, there are "down" times. Mechanical failure should be taken into consideration when planning your compost operation. Figure 5 shows the site plan with the turning dates.

Fig. 5. Site plan with turning schedule



Temperature

Fifteen temperature measurements per windrow were taken weekly from July 3, 2013 to October 22, 2013. The average temperatures are shown in figure 6a and 6b. MLY1x, MLY3x, and MLY5x resulted in similar temperatures trends. MLY7x appeared to increase in temperatures that were ideal for pathogen and weed seed kill (>55C). M3x, M5x, and M7x resulted temperatures generally between 40-60°C. Whereas, M0x and M1x resulted in overall decreasing temperatures as time passed.

Fig. 6a. Average temperature measurements for manure, leaf and yard waste compost windrows

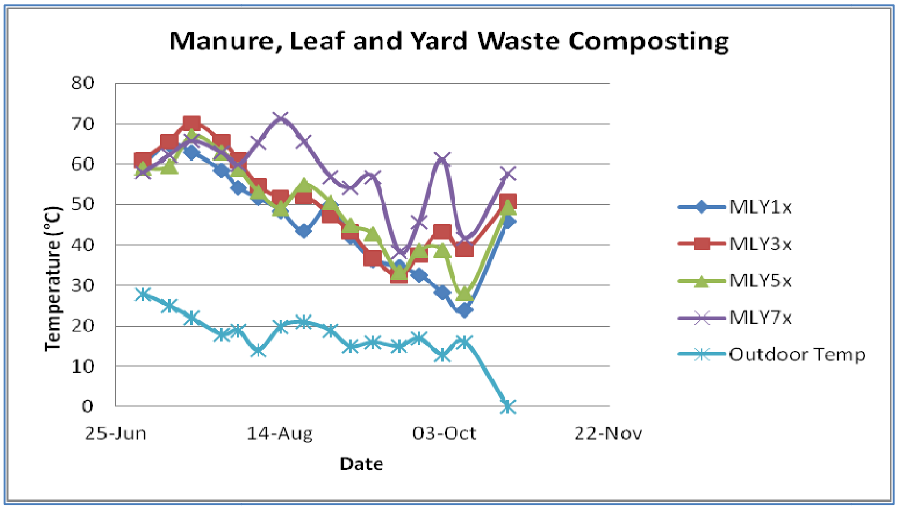
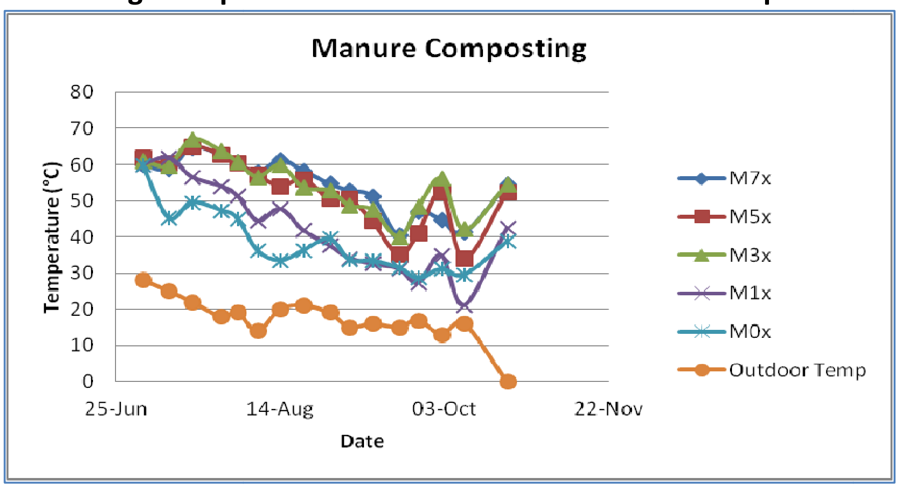


Fig. 6b. Average temperature measurements for manure compost windrows



Volumes

The initial and final volumes of the windrows were measured to determine volume reduction during composting. In general, composting reduces the volume by 50-70%. This trial showed that even with just one initial turn, the volume could be reduced by as much as 57% (Table 1). The highest volume reduction of 82% was from M7x (turning the manure compost 7 times).

Table 1. Volume reduction based on turning frequency

	1x turn	3x turn	5x turn	7x turn
Manure Compost	61%	62%	69%	82%
Manure, Leaf and Yard Waste Compost	57%	70%	77%	74%

Nutrient Content and Compost Standards

Three initial and three final combined samples from each windrow were taken and sent to A&L Laboratories in London, ON for analyses. Also, four mixed samples from each windrow was collected and Solvita test kits were used to determine the maturity level of the compost at home. Figures 7a and 7b show the final compost taken from each windrow.

Fig. 7a. Physical comparison of manure based compost

Fig. 7b. Physical comparison of manure, leaf and yard waste based compost

Nutrient Content From an agronomic perspective, total nitrogen (N), phosphate (P2O5), and potassium (K2O) are the most important nutrients. The lab results showed that for the MLY compost, the nutrient concentration of total N, P2O5, and K2O generally increased with more frequent turning (Fig. 8a). However, the nutrient concentration between MLY3x and MLY5x did not appear that different. There was no apparent difference in nutrient concentration for M1x, M3x , M5x, and M7x (Fig. 8b). However, turning the windrow at least 1 time will double the concentration of nutrients according to the lab results obtained. When comparing the volume reduction (Table 1) to nutrient concentration, it shows that a volume reduction of at least 57% will cause the nutrient concentration to at least double.

Fig. 8a. Nutrient concentration of manure, leaf and yard waste compost based on the number of turns

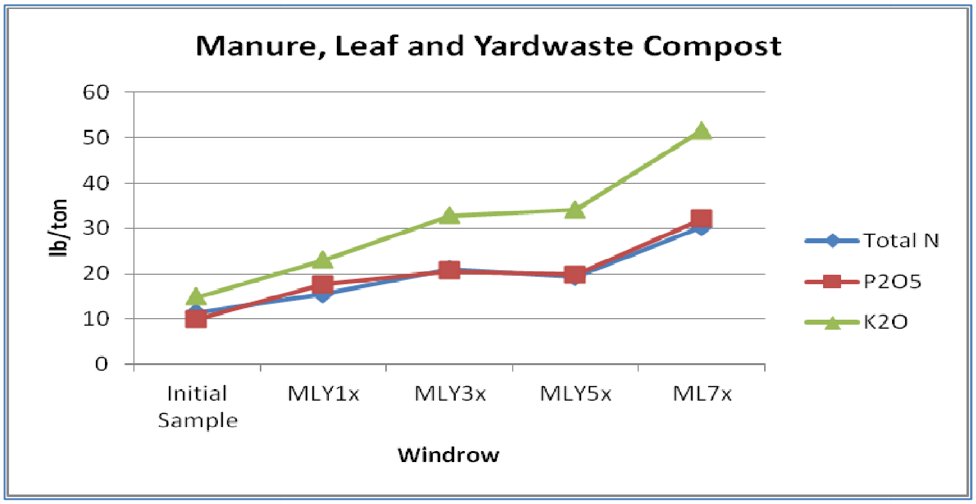
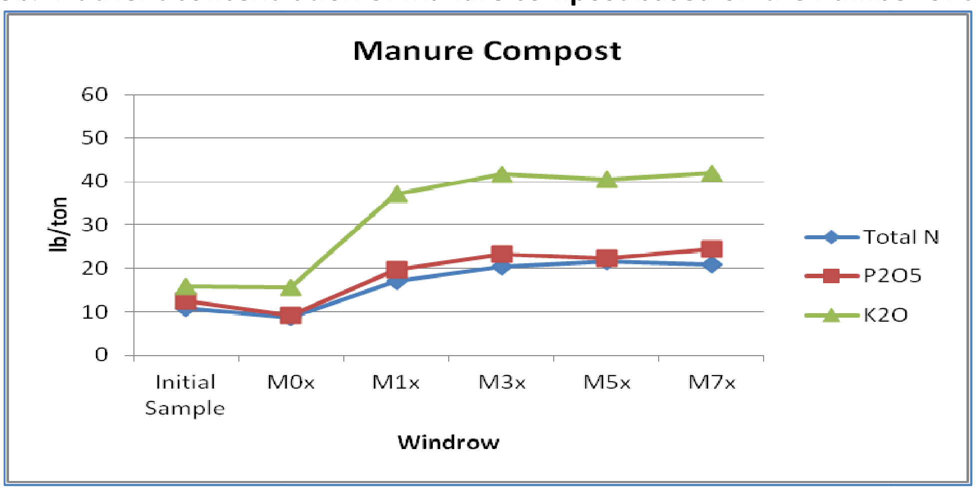


Fig. 8b. Nutrient concentration of manure compost based on the number of turns



Compost Requirements Based on the Canadian Food Inspection Agency (CFIA) standards shown in Table 2a and 2b, MLY 3x, 5x, and 7x and M 3x, 5x, and 7x all meet the standards based on the lab results from A&L Labs. M0x, M1x, and MLY1x did not meet CFIA's minimum standards which means that it would not be considered saleable compost product.

It is important to note that there was a discrepancy between the solvita test index number done at home vs the lab results. The solvita test kit done at home measures both the carbon dioxide (CO_2) and ammonia (NH_3) levels. Once the NH_3 and CO_2 results are obtained, a cross-indexing chart is used to determine a Maturity Index of 1, 2, 3, 4, 5, 6, 7, or 8; with 1 being the lowest and indicating raw compost and 8 indicating mature compost.

Four solvita tests were done on each windrow at home. The home results appeared to show a less mature compost than what was reported by A&L Labs. The discrepancy may be due to the fact that A&L labs performs a CO2 respiration test and reports the Solvita index equivalent in the analyses, so a Solvita test is not actually done, but a Maturity Index of 1-8 is still given. Another reason for the difference in numbers could be due to the storage of the Solvita test kit at home. At home the kits were stored on the shelf and subject to various room temperatures (still within the recommended storage temperature, but a constant ideal storage temperature in a fridge would have been better). Also, human error may contribute to error. The Solvita kit compares the visual colour of the indicator vs the colour chart (Fig. 9). What one person sees as a 7 may be a 6 to another.

Fig. 9. Comparing the indicators to the colour charts when using the Solvita test kits at home

Table 2a. Manure, leaf and yard waste compost lab results

	Initial Sample	MLY1x	MLY3x	MLY5x	MLY7x	CFIA Standards
Organic Matter (%)	18	21	15	19	31	minimum 15%
Moisture Content (%)	63	44	59	63	55	maximum 65%
Salmonella	Did not test	Did not test	negative	negative	negative	Salmonella non detectable
Fecal coliforms	Did not test	Did not test	<3	<3	<3	Fecal coliforms < 1000 MPN/gram TS (dry wt)
Maturity Index (Home Solvita Test)	Did not test	5	6	5	7	Compost must be mature (6, 7 or 8 indicates mature compost)
Maturity Index (A&L Labs)	Did not test	Did not test	8	7	8	

Table 2b. Manure compost lab results

	Initial Sample	M0x	M1x	M3x	M5x	M7x	CFIA Standards
Organic Matter (%)	21	12	15	19	21	20	minimum 15%
Moisture Content (%)	71	59	62	56	63	55	maximum 65%
Salmonella	Did not test	Did not test	Did not test	negative	negative	negative	Salmonella non detectable
Fecal coliforms	Did not test	Did not test	Did not test	<3	<3	8	Fecal coliforms < 1000 MPN/gram TS (dry wt)
Maturity Index (Home Solvita Test)	Did not test	3	5	5	6	6	Compost must be mature (6, 7 or 8 indicates mature compost)
Maturity Index (A&L Labs)	Did not test	Did not test	Did not test	7	7	7	

Economics

The economics were calculated based on the following assumptions:

- Cost of windrow constructions = $1500
- Initial volume = 94,300 ft3 ~ 8 windrows = 11,788 ft3
- Trip cost of Backhus from LaBroquerie to Gimli = $288 per trip
- Cost of Backhus rental: $500/h for the first hour and $275/h for subsequent hours
- Hauling and spreading cost of compost provided by the farmer = $4800
- Cost to stockpile, haul and spread same amount of manure cost provided by the farmer was $11,200.

When comparing the cost of composting and spreading vs stockpiling and spreading for this operation, the cost of composting and spreading 1x, 3x, 5x and 7x is estimated to be $0.09, $0.12, $0.14, and $0.18/ft3, respectively. Stockpiling, hauling and spreading alone is estimated to be $0.12/ft3. Therefore, turning the windrows 1, 3 or 5 times may be economically feasible on operations similar to Lochwood Simmental. Furthermore, compensating a farmer to incorporate and compost leaf and yard waste with manure would improve the economics of composting on-farm.

CONCLUSION

In summary, all the objectives of the project were met.

1. The quality of compost vs the number of times the compost windrows were turned was determined. From this project, it appears that turning 3x may be the most ideal when the overall agronomic values, compost quality and volume reduction are taken into consideration.

2. The cost of composting a material using Compo-stages Manitoba Services Co-op's Backhus windrow turner at 1, 3, 5, and 7 times turning frequency, hauling and applying it to the field was determine to be $0.09, $0.12, $0.14, and $0.18/ft3, respectively. In comparison to stockpiling, hauling, and applying manure to the field the estimated cost is $0.12/ft3.

3. Adding leaf and yard waste to beef manure for composting was not detrimental to the quality of the compost and improved the nutrient concentration of the compost.

In addition, this project increased the awareness of farm-based composting. A composting field day at the composting site was held on July 16th, 2013 in cooperation with the East Interlake Conservation District (EICD). Over 30 people including farmers, government officials and staff, local gardeners, and interested composters attended. Information from this project will be further disseminated via articles through various newsletters.

Another benefit of this project was that EICD was able to take advantage of Compo-stages Manitoba Services Co-op's Backhus windrow turner being in the Gimli area (thus, not having to pay for the mileage from LaBroquerie to Gimli) and offer their own program to farmers in the area that were interested in composting on-farm. There was a high uptake for EICD's compost funding program and they are hoping to offer the program again for 2014/15.