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Field Test Screening and Beneficial Reuse of Large Animal Mortality Compost

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March 2013

Screening LAM compost on Farm #1.

Funding provided by the USDA Natural Resources Conservation Service Conservation Innovation Grant, the Shenandoah RC&D, and the Virginia State Dairymen Association.

Background: Disposal of large animal mortality (LAM) has become increasingly difficult in recent years. Incineration is expensive and a potential source of air pollution. Burial is subject to stringent restrictions and may impair groundwater quality. Renderers are no longer accepting cattle mortality due to regulations designed to address concerns about bovine spongiform encephalopathy (BSE) (Federal Rule 21 CFR Part 589). Landfill disposal is costly, capacity is limited, and timing of acceptance of mortalities is uncertain. Therefore, a practical, economically and environmentally-sound rapid system for properly disposing of large animal mortality is needed to ensure continued sustainability of livestock farming and protection of the environment in Virginia. A promising alternative to disposal is mortality composting, which can be cost-effective, environmentally-sound, and bio-secure.

Composting LAM at the Shenandoah County Landfill.

Large animal mortality is typically composted using passively aerated static piles. Dead animals are placed upon a two foot deep layer of absorbent material, such as woodchips and then covered with another two feet of material that will compost such as rotten silage. The entire process takes from three to six months, depending on the size of the animal and the intensity of the pile management. The composted material is then applied to farm fields as fertilizer. According to Virginia State regulations, the compost material that is the result of LAM that is generated and composted on the farm may be returned to the land as a soil amendment without a permit from the Virginia Department of Environmental Quality (DEQ).

However, LAM composting has not been adopted as rapidly as expected. One reason for slow adoption is the lack of knowledge about a practical system for managing bones remaining in LAM compost. Several Shenandoah Valley farmers have successfully composted LAM. However, on many of these farms there are bones remaining in the finished compost. Farmers do not want to spread this compost on their fields because of concerns about the unsightly appearance of the bones and a concern the bones might puncture equipment tires. Experts and practitioners from other states claim they can completely compost LAM bones within 18 months of animal death. However, their claims are not well documented. Also, there are multiple piles of compost in the Shenandoah Valley that are over 18 months old where the bones still remain. We are confident that even if some farmers can successfully compost bones, there will be many situations where the removal or destruction of bones using a screen or grinder will be desired and/or needed.

Objective: The objective of this project was to demonstrate a practical option for managing bones remaining from the composting process and to demonstrate the soil amendment and nutrient value of mortality compost in farmer's field plots.

Methodology: An Orbit Screen (http://www.orbitscreens.com/) was transported to the Shenandoah Valley in late summer 2011. The rental rate was $55 per hour (using an hour meter attached to the screen engine). Piles of LAM were screened on four different farms. The screen in the machine was one-inch mesh.

In the fall of 2012, an Allu Bucket/Grinder (http://www.allu.net/) was transported to the Shenandoah Valley. There is no established daily rental rates for this machine. The Allu Company stated the machine used in this demonstration (Model SML 2-17/25) typically leases for $2,200 per month. The machine was field tested at one dairy farm.

Table 1 summarizes the results of the screening process on the five different farms. Samples of the screened compost were analyzed at the Penn State Analytical Laboratory. Table 2 shows the estimated available nutrients in the screened compost.

Table 1: Summary of Screen Process and Nutrient Analysis of Screened LAM Compost

	Farm #1	Farm #2	Farm #3	Farm #4	Farm #5
Hours Screen Used	7	3	7	1	1
Tons of Screened Material (Fines)	100	22	71	4	20
Tons of Coarse Material (Bones and Other)	48.5	4	71	1	1.5
Density of Screened Material (Fines) lb./yd3*	1,136	1,016	1,535	1,100	1,019
Analysis of Fines (Percent Wet Basis)					
Moisture	30.30%	56.60%	35.00%	**	60.00%
Total N	1.20%	0.80%	0.49%	**	0.98%
Ammonium N	0.00%	0.09%	0.08%	**	0.018%
Phosphate	0.53%	1.01%	0.43%	**	1.24%
Potash	0.49%	0.44%	0.36%	**	0.37%
C:N	8.6:1	13.4:1	10.4:1	**	11.5:1

*Density of screened material was measured by weighing multiple samples in a five gallon bucket. Tonnage was calculated by measuring the size of the piles times the density.
** The material from Farm #4 was not tested due to the small sample size.

Table 2: Estimated Plant Available Nutrients of Screened LAM Compost*

	Farm #1	Farm #2	Farm #3	Farm #5	Average
Available N (yr. 1) lb./wet ton	2.4	2.3	1.7	2	2.1
Available N (yr. 2) lb./wet ton	1.2	0.7	0.4	1	0.8
Available N (yr. 3) lb./wet ton	1.2	0.7	0.4	1	0.8
Total P2O5 lb./wet ton	10.6	20.2	8.6	24.8	16.1
Total K2O lb./wet ton	9.8	8.8	7.2	7.4	8.3

* Available N estimated as: Year 1 = 10% of the Organic N in and 50% of the ammonium N. Year 2 = 5% of the Organic N. Year 3 = 5% of the Organic N.

Discussion:

Farm #1 is a 100 cow dairy. This farm has been composting LAM for the past 10 years. The pile screened had over 50 cows in it and ranged in age from two months to over five years. The material screened was very dusty and dry. The material flowed through the screen well. The percentage of material in the coarse pile (i.e. with the bones) would have been less if the piles had not been covered with tall weeds. Nonetheless, the screen handled the weeds well.

LAM compost on Farm #1 prior to screening.
Note the weeds in the background covered the pile.
The screen handled the weeds well.

Left Picture: Farm #1 - Coarse material (which is the pile with the bones).
Right Picture: Fines on Farm #1 (ready for land application).

Farm #2 is a 300 cow dairy. They had been composting LAM for the past year. There were about 10 animals in the pile that was screened. The material screened was somewhat wet and the screen would begin to clog. Fortunately, the farmer had some dry finished compost. He would periodically dump a loader bucket full of this material on the conveyor. The drier material had a cleaning effect on the screen.

Left Picture: Coarse material on Farm #2.
Right Picture: Fines (LAM compost with bones screened out) on Farm #2.

Screening LAM compost on Farm #3.

Farm #3 is an 800 cow dairy. The piles screened had composted about 50 cows a year prior to the screening process. The compost ranged from one year to 18 months in age. This farmer ran the screen over two consecutive days. On the first day the screen became fully clogged on two separate occasions. It appeared that he was getting about 40% fine material and 60% course (i.e. 60% of the material was with the bones). The farmer did not have any dry material to "clean" the screen. On the second day the screen did not clog. The farmer adjusted the angle of the screen. Also, it was very hot on both days. Thus, the material dried out somewhat between day one and day two. We speculate that the screen clogged on Farm #3 for the following reasons: First, the composting process was consistently too wet. Second, the feedstock used in the composting process was rotten corn silage, separated manure solids, and corn stalks. Thus, the finished compost had almost no coarse material. It more resembled topsoil than compost. Finally, it had rained about three inches a few days prior to screening. This texture combined with an elevated moisture caused the material to be excessively sticky.


Left Picture: Screened bones on Farm #3. Right Picture: Fines on Farm #3.
Note that it is 50% fines because the material was too wet for efficient screening.

Farm #4 is a beef and poultry operation with approximately 30 cows. The farmer screened a small pile of compost (about 5 tons) that included three cows that were composted about a year prior. This farmer operates a composting operation. A prevalent component of his compost is poultry litter with peanut hulls. His compost is very fine. As a result there was a relatively small portion of bones and coarse material in the "coarse" pile. The entire process took less than an hour. This made the cost of screening the compost disproportionately high compared to the other farms.


Above Right Picture: Screening on Farm #4. Note the difference in the size of the two piles. The smaller pile is the bone pile and the larger pile is the fines.

Below Right Picture: Fines from LAM compost on Farm #4.

Farm #5 is a 300 cow dairy. The Allu Bucket/Grinder, model SML 2-17/25 equipped with a "Counter Comb Screen" was field tested on this farm. The farmer used a John Deere 332 Skid Steer to operate the Allu. The piles screened had likely composted over 80 cows over the past three years (we did not screen the entire pile during the test run). Almost all the compost was over a year old. The screening process resulted in approximately 90% of the material in the "fines" pile and 10% in the coarse pile (10% of the material was the bones and a small percentage of fines). This model bucket/ grinder did not grind the bones. They tended to stay in the bucket and the operator would dump them out prior to re-filling. During operation, occasionally a bone would fly out the top of the bucket/grinder. If a farmer wanted 100% of the bones removed, he would need to have someone stand by to pick up these bones (which may have been one bone per bucket load). The skid steer handled the Allu well; however, when the bucket/grinder was full of compost, the skid steer was almost too light on the back end.

A significant amount of the compost run through this machine was very wet. The Allu never clogged during operation. We speculate that the Allu would handle wet material better than the Orbit Screen.

There is a video of the Allu operating on this farm at the following web site:

The Allu Bucket/Grinder in operation on Farm #5.

http://offices.ext.vt.edu/shenandoah/programs/anr/AgricultureandNaturalResources/Screening_Bones_from_Mortality_Compost_Using_the_Allu_Bucket-Grinder.html.

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The farmer re-incorporated the coarse material into existing LAM compost piles.

Farm #5: Screened material on the right and coarse material on the left. There are two rib bones on top of the screened pile.

Beneficial Re-Use:

Farm #1: The farmer applied the screened material to an alfalfa field and the screened bones were delivered to the local landfill. The estimated nutrient loading rate is shown in Table 3. The phosphorus and potassium soil test were 25 and 115 ppm, respectively (H– and L). This farm has both dairy and poultry. Thus, phosphorus is in abundant supply and is of no value to this farmer. Due to the fact that the field is an established stand of alfalfa it will not receive any more phosphorus for at least the next three years. The soil on this side are Edom with an alfalfa yield potential of greater than six tons per acre per year. A six ton yield will remove 87 pounds phosphate per year. This should more than remove all the phosphate added from the compost. Due to the low potassium levels in the soil the 61 pounds of potash per acre is of value to the farmer.

Alfalfa crop following application of screened LAM compost on Farm #1.

Farm #2: Due to the high phosphate content (Table 2), the screened compost was transported off the dairy. Prior to land application it was mixed with bed-pack beef manure to dilute the phosphorus concentration and applied to cropland prior to growing cover crop rye. The field will be planted to soybeans in 2012. If this farm had spread the screened compost on farmland near the dairy, he would have had to spend extra money moving his dairy manure to other fields and he would have needed to purchase extra nitrogen to fertilize the corn silage grown on the land on the land near the dairy. The coarse material and bones were re-integrated into a mortality compost pile.

Table 3: Nutrients Applied from Screened Compost

	Farm #1	Farm #3
Field Acreage	16.5	7.0
Rate Per Acre (tons/acre)	6.1	10.1
Three Year N (lb./acre)	29.0	25.0
Total P2O5 (lb./acre)	64.0	87.0
Total K2O (lb./acre)	59.0	73.0

Farm #3: The farmer applied the screened compost to a field that had been harvested as corn silage. Following application, rye was planted. The rye will be harvested in the spring for haylage followed by corn silage. The phosphorus and potassium soil test were 31 and 74 ppm, respectively (H and L). Due to the abundance of dairy manure on this farm and poultry litter in the region the phosphorus in the screened compost has no value. Both the nitrogen and potassium will help future crop production. The soil type is Frederick with a rye silage and corn silage yield potential of 10 and 22.5 tons per acre, respectively. These two crops will remove 150 pounds of phosphate per year. The coarse material still remains in a pile on the farm.

Rye planted after screened compost was applied on Farm #3.

Farm #4: The farmer applied the screened compost to a field were corn had been grown. A cover crop was planted after the compost was applied. The coarse material was integrated back into a compost pile.

Farm #5: Due to the high phosphorus content of the screened compost, this farmer applied the compost as thin as possible over a field of cover crop rye. The farmer estimated his rate of application to be one to two tons per acre. The application was made to get the benefit of the potash for his rye silage/corn silage rotation while minimizing the negative consequence of the high phosphorus content of the compost. The coarse material was integrated back into a LAM compost pile.

Manure spreader loaded with screened compost on Farm #5.

Economic Analysis: Many farmers have asked if the value of the nutrients in the screened compost is worth more than the cost of screening and land applying the material. Based on the data shown in Table 4, the short answer is no. This dilemma is exacerbated by the fact that most livestock farms in the Shenandoah Valley do not need additional phosphorus. Thus, the high P:N ratio of the material likely requires the farmer to move either manure or screened compost an added distance from their farm to find a field that needs the phosphorus. Also, if the screen were provided to the farmer at no cost, the farmer still has more machinery and labor cost involved in screening and land application than the nutrient value contained in the material.

Table 4 shows the estimated cost per ton of LAM compost screened for each of the five farmers. With the exception of farmer 4, the costs are similar. Farmer 4 had a very small pile of LAM compost (he could have screened more material in an hour).

Summary: All four farmers who used the Orbit Screen felt a more coarse screen (i.e. bigger than one inch mesh) would have provided an adequately fine material with less product in the coarse pile.

Three of the farmers who used the Orbit Screen were satisfied with the proportion of bones removed from the LAM compost. However all would have preferred to have a lower percentage of material in the coarse pile (i.e. too many fines in the coarse pile). Farmer #3 felt that he needed to use a more coarse screen and have dryer material during the screening process. The Allu Bucket/Grinder did the best job of minimizing the amount of fine material that was in the coarse pile.

Three different people transported the Orbit Screen from farm-to-farm. Two of these people and one farmer who had moved the screen on a prior occasion reported that the screen did not transport well (i.e. it swayed a lot). They felt this would be a limiting factor to renting a screen on a routine basis. Also, they reported that it would be best to use a truck slightly larger than a one-ton pickup to move the screen due to the weight and size of the Orbit Screen. In contrast, the Allu Bucket/Grinder could be placed onto a pallet or small trailer for transport to different farms. Many farmers likely have skid steers that would handle the Allu.

The Orbit Screen generated compost that was more visually appealing from a marketing standpoint compared to the Allu. There are several farmers in the Shenandoah Valley who are making compost for sale. They are doing this separate from composting LAM because DEQ Guidance does not allow the sale of LAM compost. These farmers may find that an Orbit screen would benefit multiple enterprises on their farm.

Table 4: Economic Analysis of Screening Process

	Farm #1	Farm #2	Farm #3	Farm #4	Farm #5
Hours Screen Used	7	3	7	1	1
Tons of Material in Fine Pile	100	22	71	4	20
Tons of Material in Coarse Pile	49	4	71	1	1.5
Percent Material in Coarse Pile	33%	15%	50%	20%	7.5%
Cost to Transport Screen ($50 per Farm for the Orbit Screen and $25 per Farm for the Allu)	$50	$50	$50	$50	$25
Cost to Rent Screen ($55 per Hour for the Orbit Screen and the Allu Cost was Estimated to be $25 per Hour)	$385	$165	$385	$55	$25
Cost to Run Loader Filling Screen ($75 per hour)	$525	$225	$525	$75	$75
Cost to Land Apply Screened Compost ($80 per 10 tons)	$800	$176	$568	$32	$160
Cost to Dispose of Coarse Material	?	?	?	?	?
Total Cost	**$1,760**	**$616**	**$1,528**	**$212**	**$285**
Total Cost per Ton of LAM Screened	**$11.85**	**$23.69**	**$10.76**	**$47.11**	**$13.26**
Value of Nitrogen @ $0.50 per lb.	$0	$0	$87		$40
Value of Phosphate @ $0.50 per lb.	$0	$0	$0		$0
Value of Potash @ $0.85 per lb.	$833	$165	$435		$126
Value of S, Mg, and Micronutrients	?	?	?		?
Value of Organic Matter	?	?	?		?
Total Value	**$833**	**$165**	**$522**		**$166**
Cost/Benefit	-$927	-$451	-$1,006		-$119
Cost/Bnefit per Ton for the Total Tonnage Run Through the Screen	-$6	-$17	-$7		-$6