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Viable Alternative Bedding Materials for Compost Bedded Pack Barns

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Introduction

Compost bedded pack barn use in the dairy industry is increasing in popularity throughout Kentucky and the southeastern United States. The key component for successful composting in these barns is a large open resting area that is generally bedded with sawdust. These barns are intensively managed to ensure compost material is increasing the bedding temperature which promotes the reduction of disease spreading microorganisms as well as maintaining the correct moisture homeostasis.

Compared to traditional freestall barns, cows have more freedom to move or lie down naturally. Reported benefits of these barns include improved cow comfort, longevity, an increase in heat detection and productivity, along with reduced somatic cell counts, culling rates for lameness, and a reduction in fly populations.

Previous research has suggested that the best material for these compost barns is fine wood shavings or sawdust from pine or other softwoods. Theoretically, the large surface area of these particles holds liquids well and makes the compost easier to till, which is necessary for aeration. The particle size also plays an integral role in limiting microbial access to food sources, mainly manure and urine. In addition to limiting food sources, the lignin content of the sawdust helps the compost to resist being broken down quickly by any microorganisms that may exist. This resistance is important in allowing the existing compost material to last as long as possible.

The primary limitation for compost bedded barns is sawdust availability. These barns require three to four times the amount of bedding material that conventional freestall barns use. Demand for sawdust is continuing to rise as more of these barns are built and additional uses of sawdust are found (biofuels, broiler barns). With an increase in demand for sawdust, prices for these materials will continue to rise. Limited availability of wood-based materials with an increase in demand for these materials has contributed to a major problem of sustainability for the dairy industry in Kentucky. Dairy producers, extension agents and industry professionals are all interested in alternative and affordable bedding material that could increase the accessibility of these barns in the southeast region of the United States. Identification of an alternative bedding material for these beds could increase the sustainability of these barns especially, in small or start-up dairy operations.

Methods

Ideal characteristics of materials for these barns are coarse, fibrous, easily available and absorbent. Materials selected for the project were kiln dried sawdust as a control comparison, green (non-dried) sawdust, particleboard sawdust, rice hulls, peanut hulls, switchgrass[1], wheat straw[1], corn stover[1], kenaf[1], miscanthus[1], tobacco stalks[1], wood shavings, and wood shavings

mixed with sawdust. To determine initial moisture content, approximately 100 grams of material was weighed than dried in an oven at 100° Celsius for 24 hours and reweighted. Initial Moisture Content (IMC) is calculated by $IMC = \frac{(initial\ mass - final\ mass)}{initial\ mass} * 100\%$. Water Holding Capacity (WHC) was determined by saturating material with water, stirring for three minutes and soaking for ten minutes. The saturated material was placed in a Buchner funnel on top of an Erlenmeyer flask, covered with parafilm and allowed to drain for 24 hours. The test was in an environmental chamber set to 45% relative humidity at 25° Celsius. After draining, material was dried for 24 hours in an oven to determine moisture content. Water Holding Capacity is determined by $WHC = \frac{[(W_s - W_i) + IMC * W_i]}{(1 - IMC) * W_i}$ where W_s=dried mass, W_i = initial mass and IMC=initial moisture content. This equation shows the grams of water held per gram of material.

Results and Discussion

[2]Material	Initial Moisture Content	Water Holding Capacity
Wood shavings, with dust[A]	7.37±.41%	4.41±.16[B,C,D,E,K]
Wood shavings, no dust[B]	7.36±.04%	2.94±.28[A,C,D,E,F,G,I,J,K]
Corn stover[C]	8.06±.23%	6.70±.62[A,B,F,G,H,I,J]
Kiln dried sawdust (control)[D]	12.03±.39%	7.04±.47[A,B,F,G,H,I,J,K]
Kenaf[E]	8.72±.27%	7.36±.60[A,B,F,G,H,I,J,K]
Particleboard sawdust[F]	5.27±.11%	4.52±.15[B,C,D,E,H,K]
Peanut hulls[G]	8.48±.13%	5.48±.04[B,C,D,E,G]
Rice hulls[H]	8.37±.16%	3.28±.29[C,D,E,F,G,I,J,K]
Switchgrass[I]	7.10±.20%	4.89±.58[B,C,D,E,H]
Non-dried sawdust[J]	25.40±2.64%	4.79±.19[B,C,D,E,H]
Wheat straw[K]	8.44±.18%	5.68±.37[A,B,D,E,F,H]
Miscanthus[L]	9.20±.20%	3.43±.55[C,D,E,G,K]
Tobacco stalk[M]	11.86±.00%	3.44±.58[C,D,E,G,K]

Water Holding Capacity is a critical characteristic in materials being considered for compost barns. For beds to optimally perform, the moisture content of compost should be around 40-60%. Water Holding Capacity of a material can be used in management practices to ensure that enough material is placed in the barns to prevent runoff from occurring. This adds an economic benefit as well; common construction of the barns includes a concrete barrier on the bottom to avoid groundwater contamination. If the beds are managed properly, the compost will never reach or exceed their maximum holding capacity, thus eliminating the need for the extra concrete.

Kiln dried sawdust is the standard material for these barns. No material was found to be significantly higher than kiln dried sawdust in terms of water holding capacity. Materials that were found to perform similarly were corn stover and kenaf. All remaining materials were found to perform worse than kiln dried sawdust.

Sawdust that has not been dried is a very popular alternative due to availability and cost. While it is significantly lower than kiln dried sawdust in terms of Water Holding Capacity, using increased amounts of material and intensely managing the bed has made this substance perform well. Materials that perform similarly to this type of sawdust include peanut hulls, switchgrass, wheat straw and particleboard sawdust. Corn stover, kenaf and kiln dried sawdust perform better; all other materials perform worse.

Conclusions

These tests identified possible alternatives to the two common sawdusts used in compost barns for dairy cattle. During these tests, observations were made about material consistency and performance in water that have led to more questions. Kenaf is a material that clumps easily which may lead to problems when aerating the bed and may cause it to be a less desirable alternative. Particleboard sawdust dissolves when exposed to large amounts of liquid and reforms in a very solid clump. This would also lead to issues when aerating the bed. Further tests should be performed to look at other particle characteristics as well as modeling performance in a bed to develop a more complete understanding of ideal materials for compost beds.

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Footnotes

[1] Materials were additionally processed to approximately one inch in length prior to tests.
[1] A,B,C… indicates significantly different results.