Bedding key to compost dairy barn success

With proper design and management of compost dairy barns (CDB), dairy producers report several benefits to this type of housing: excellent cow comfort, less manure to haul – and labor for that job – and reduced manure odor from the dairy and during application. A CDB requires less total capital investment because 65 to 75% of manure storage needs are in the housing area.

Dry wood shavings or sawdust has been a cornerstone in successfully managed CDB. However, competition for wood products has stiffened, driving up the price for wood residue. This calls into question the future cost and availability of these products. Faced with this uncertainty, producers and researchers have explored alternative materials that could work for bedding in CDB. A national conference on CDB held in Minnesota last June highlighted some of this research.

Good bedding material
To work, a composting pack must be…well…composting. In this biological process, oxygen-loving microorganisms break down organic matter into a soil-like material. For the composting process to be effective, the microbes need approximately a 30:1 ratio of carbon, supplied mainly by bedding, to nitrogen, supplied primarily by manure. In the process, heat, water and carbon dioxide are produced.

When a composting system works properly, temperature in the top foot of the pack should stay between 120 and 140 degrees F. The pack must be moist but not wet. Moisture content greater than 55% will cause oxygen to be displaced and microbe activity to drop.

Materials that can be blended with dairy manure in a CDB to achieve active composting must possess certain physical and chemical characteristics.

- Water holding capacity (WHC) between 100% and 250%. This means the material can hold from 1 to 2.5 times its own weight in water. Higher WHC can cause plant cells to rupture, and the material becomes an undesirable pulp.
- Porosity allows air to be entrained more easily during mixing. This provides oxygen to the microbes.
- Bulk density is important if compost is transported long distances. Materials with low bulk densities can be more expensive per unit of weight to haul than higher bulk density materials.
- The carbon-to-nitrogen ratio and the pH should be in a range that brings the mix of manure and bedding to levels necessary for composting.
Alternative bedding  
Dairy producers already know that dry, fine wood shavings and sawdust work best in CDB. But if they become more expensive and hard to find, what are other choices? The University of Minnesota investigated 11 materials for their potential as appropriate bedding sources in CDB: beet pulp, corn cobs, corn stover, flax straw, wheat straw, wheat straw waste screening after processing, soybean straw, soybean hulls, elm chips, pine bark and pine chips.

After studying key chemical and physical properties, researchers determined six of the 11 materials seemed to meet the criteria for CDB bedding: pine chips, pine barn, elm chips, corn cobs, soybean straw and flax straw.

Wheat straw has potential if particle size is small and moisture content low. Straw of all kinds has a moderately-high WHC and less physical structure to withstand compaction in the pack compared with wood products. Researchers are currently studying straw in combination with wood products.

Corn cobs met the criteria for suitable bedding, but they aren’t readily available because of harvesting techniques and their use in dairy rations. Corn stover, wheat straw, beet pulp and soybean hulls were eliminated because their high WHC resulted in a wet pulp after they’re saturated with manure.

Some wood products definitely don’t make the bedding list. Alternatives are significant when evaluating timber use.

Success with compost dairy barns  
Farm experience has revealed six keys to making compost dairy barns (CDB) successful. They are:

1. Don’t overcrowd. Provide at least 80 square feet per cow of pack area; some dairies provide up to 100 square feet per cow, according to Kevin Janni, a University of Minnesota professor in the Department of Bioproducts and Biosystems Engineering.

2. Aerate and mix the composting pack at least twice a day and 10 or more inches deep to keep the pack aerobic and fluffy. Eagleview Dairy, Eagle, N.Y., found it takes one person using a small tractor and 8-foot-wide field cultivator approximately 30 to 40 minutes to aerate and mix the pack sized for 200 cows or fewer.

3. Spread 12 to 18 inches of bedding over the resting area when first preparing a compost dairy barn. A relatively higher porosity material, such as wood chips, used initially will promote more oxygen infiltration deep in the pack.

4. Add fresh, dry, fine sawdust or wood shavings when the pack begins to stick to the cows, Janni said. Frequency depends on stocking density, bedding material and climate. Some producers report that if they wait too long the pack can get very wet very quickly and impede aerobic biological activity.

5. Add fresh, dry, fine sawdust or wood shavings when the pack begins to stick to the cows, Janni said. Frequency depends on stocking density, bedding material and climate. Some producers report that if they wait too long the pack can get very wet very quickly and impede aerobic biological activity.

6. Clean out the pack twice a year, typically after corn harvest and again in spring. Producers often save the top, active layer of the pack and use it as a base to restart the pack.

Anatomy of a compost dairy barn  
The typical layout of the loose-housing system called compost dairy barn (CDB) has these components:

1. A compacted earth base that’s generously bedded. Solid 4-feet-high concrete and/or wood walls surround the resting area to contain the pack.


3. Water troughs, accessible only from the scrape alley, are installed into recessed areas of the separation wall. Ten- to 12-feet-wide walkways should run between the pack and the scrape alley. Locate walkways at each end of the barn and at 120- to 160-feet intervals.

4. A drive-through or drive-along feeding table, protected from direct precipitation.

5. Ventilation to help dry off the freshly tilled pack and to remove moisture and heat from the barn. It’s typical to have 16- to 18-feet-high sidewalls.

6. High temperatures associated with composting require more effective heat stress mitigation compared to freestall facilities.

— By Frans Vokey

Eagleview Dairy mixes the top 10 inches of the compost pack twice a day.
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according to University of Minnesota researcher Kevin Janni. Avoid wood products from cedar, black walnut and cherry, he says. Natural components of cedar are antimicrobial and may inhibit the microbes required for composting. Black walnut may negatively affect health and has caused laminitis in horses.

On-farm combinations
Eagleview Dairy, Eagle, N.Y., built two CDBs in 2006 as a joint venture between Marvin and Candida Luders and Scott Boldt. Improved cow comfort, odor control and reduced labor for manure handling were the main reasons this 350-cow dairy started with CDBs, says Marvin Luders.

The dairy is assessing pack performance when kiln-dried sawdust is combined with lower cost materials. Kiln-dried sawdust is used solely in one lactating cow group. In two other groups it’s mixed 50:50 with either chopped wooden pallets or processed soybean straw. The bedding is added weekly during the winter, and the pack is tilled twice daily.

During cold winter months, pack temperature had been below the ideal range for all treatments. However, “the fact that temperatures are still well above ambient is a sign that the composting process is working,” says Jean Bonhotal, associate director of the Cornell Waste Management Institute who provides the dairy with technical assistance on the composting process.

Bruce Tillapaugh, field crops specialist with Wyoming County Cornell Cooperative Extension, observed that the pens with the 50:50 combination of bedding don’t seem to be keeping up with the one with 100% sawdust during the cold months.

The pack appears more “squishy” to walk and drive on, something that was not observed in the summer. In cold months it’s especially important for fresh bedding to be dry and applied generously and frequently.

It’s also important to control moisture in the barn through excellent ventilation management, Tillapaugh says.

If you’re thinking of building a CDB, you can’t underestimate the important role bedding material plays in the success of this type of housing. Ensure that you have a reliable supply of quality bedding material, preferably wood shavings or sawdust. If there are doubts about the availability, at the least design the compost dairy barn in a way that makes it simple to convert the pack space to freestall housing.

Fan cool your cows for comfort
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13. How do I know I’m getting a return on investment?
It isn’t easy to calculate the net return on your investment for a heat stress mitigation system. When you look at the effects of heat stress, such as depressed appetite or reproductive problems, you can see it’s hard to attach an economic value for use in a partial budget.

Research by Rick Grant, president of Miner Institute, shows that an hour of cow lying time means 2.5 to 3.5 pounds of milk per cow. So, if a fan cooling system contributes to sustained cow lying time and milk production, you can assess the economic impacts of fan-cooling cows at least from a milk production perspective.

14. What about ceiling-mounted high-volume, low-speed fans?
When considering fan types and placement, determine if the alternatives will provide target air flow speed at cow level when cows are doing productive activities. Field measurements and observations have shown that high-volume, low-speed fans located over the center of a drive through barn don’t provide target air speeds to cows lying in freestalls.

15. In really hot weather, fans just blow around hot air. So what then?
A combination of cooling fans and sprinklers is the best way to cool a cow in the Northeast. A sprinkler system should completely wet down cows’ hair coats to the skin in two to three minutes of an overall 10- to 15-minute wetting/drying cycle. For sprinkling to be effective, nozzles should produce large water drops that penetrate the hair coat and soak the skin.

The process uses body heat to evaporate the applied moisture, reducing a cow’s temperature. Fans used with a sprinkler system provide fresh air to the hair coat so cows can evaporate additional water that’s applied. If fresh air doesn’t reach the hair coat, the evaporation process is hindered to the point where no additional evaporative cooling takes place. Good air exchange – not just circulating air – is required to remove the moisture added to the animal space.

Initiate evaporative cooling at a higher temperature – usually 78 to 80 degrees F – than for supplemental cooling fans. Don’t add water where you don’t have adequate air exchange and airflow around cows. The benefit will be minimal, and excess water will likely cause problems.

Remember this point: Cow cooling fans aren’t installed to provide barn air exchange or ventilation. Barns must have an effective natural or mechanical ventilation system to provide suitable air quality for cows. If your barns lack that, decide the best way to provide requisite air exchange rates, such as through tunnel ventilation.