Guidelines for Managing Compost Bedded-Pack Barns

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Guidelines for Managing Compost Bedded-Pack Barns

Abstract
This guideline is designed to provide general information about proper construction and management of compost bedded-pack dairy barns in the United States. The compost bedded pack barn consists of a large, open resting area, usually bedded with sawdust or dry, fine wood shavings that are composted in place, along with manure, when mechanically stirred on a regular basis. Facility design, ventilation, timely addition of fresh, dry bedding, frequent and deep stirring, and avoidance of overcrowding are the keys to a good working compost bedded-pack barn.

Preface
This guideline was originally prepared in January 2010 by Jeffrey Bewley and Joseph Taraba, University of Kentucky.
Other contributors included: Robert Graves, Dan McFarland, John Tyson, Brian Holmes, Peter Wright, Paul Garrett; Stan Weeks, John Porter, and Dave Kammel

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Guideline Preparation and Review Process
Guideline development within The Dairy Practices Council (DPC) is unique and requires several levels of peer review. The first step in the process of guideline development starts with a Task Force subcommittee made up of individuals from industry, regulatory and education interested in and knowledgeable about the subject to be addressed. Drafts, called ‘white copies’, are circulated until all members are satisfied with the text. The final white copy may then be distributed to the entire task force, DPC Executive Vice President and the Task Force Director feels would add to the strength of the review. Following final white copy review and correction the next step in the process requires a yellow cover draft that is circulated to the member Regulatory Agency representatives that are referred to as “Key Sanitarians”. The Key Sanitarians may suggest changes and insert footnotes if their state standards and regulations differ from the text. After final review and editing the Guideline is distributed in the distinctive DPC green cover to people worldwide. These guidelines represent the state of the knowledge at the time they are written.
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BACKGROUND

Lactating dairy cows have traditionally been housed in loose-housing, bedded-pack, tie-stall, or freestall barns. Innovative dairy producers have introduced a variation on the loose-housing bedded-pack system. It is generally referred to as a compost bedded-pack barn (Figure 1). Its key component is a large, open resting area, usually bedded with sawdust or dry, fine wood shavings that are composted in place, along with manure, when mechanically stirred on a regular basis. The most critical success factor for managing a compost bedded pack barn is providing a comfortable, dry resting surface for lactating cows at all times.

The general concept of composting is mixing a carbon source (bedding) with a high nitrogen organic material (manure/urine), while providing conditions (porosity) to encourage air infiltration into the pack, and maintaining the moisture level to achieve rapid microbial breakdown of organic matter until there is little easily degraded organic matter remaining. It is important to note that composting in place within a barn where manure, urine, manure and bedding are continuously added results in compost at cleanout that is not completely finished, or cured.

The compost bedded pack barn is a relatively new housing system. Very little controlled research has taken place, so most recommendations are based on producer experience. Much of the research that has been conducted with this system was performed by the University of Minnesota.

Compost bedded pack barns can be the primary housing in smaller herds or provide special needs housing in larger herds. Cows can be managed in a single group within the barn or in multiple groups subdivided within the barn. These barns are intensively managed to encourage composting of manure and organic material, unlike more traditional straw-based bedded-packs. Proper composting increases the bedding temperature and decreases the bedding moisture by increasing the drying rate. Keeping the top layer of bedding material dry is the most important part of managing a compost bedded pack barn. The pack is stirred at least two times per day. Stirring is typically accomplished while the cows are being milked, using various types of cultivators or roto-tillers. Facility design, ventilation, timely addition of fresh, dry bedding, frequent and deep stirring, and avoidance of overcrowding are the keys to a good working compost bedded-pack barn (Figure 2). Poor management and coordination of these factors may lead to very undesirable compost bed conditions, elevated somatic cell counts, and increased clinical mastitis incidence.

NOTE: Make sure that you contact your local Regulatory Agency early in the planning stage to discuss requirements and concerns. Local or state agencies responsible or building construction, zoning, and water pollution may also need to be involved.

DESIGN CONSIDERATIONS

SITE PREPARATION
As with any dairy facility, site selection is critical. To maximize natural ventilation, the barn should be located to take advantage of prevailing summer winds, as well as orientation with respect to the sun. Barn ventilation must allow for supply of fresh air since the composting pack generates additional heat and moisture that must be exhausted from the barn compared to a similarly populated freestall or bedded-pack barn, particularly in the summer. The barn building site should also be elevated slightly so that exterior surface drainage is diverted around and away from the building footprint to minimize rain and snow runoff infiltrating into the pack. Although it is unlikely the pack will be wet enough for drainage from the bottom, selecting a location with minimal potential for environmental risk from pack seepage is also important. Building sites that require excavation or cuts into slopes may expose groundwater sources that discharge within building footprint, especially during wet periods of the year. The emergence of water under the compost bed will be a problem that contributes to higher compost bed moisture. Drainage tile will be required to remove this water from the building site.

The pack base should be either clay, gravel, or concrete. A concrete base has no real advantages, so new facilities are generally constructed using a clay base, which is potentially cheaper. Either concrete or clay can reduce seepage from the pack into the underlying soil. However, some states require concrete or the equivalent compacted base to prevent groundwater being contaminated by the seepage. You should check with the appropriate state agency.
during the building planning stage. But a well-managed compost bed will not drain since the optimum moisture content for operating a compost bed is below the bedding material water holding capacity.

**COMPOST BARN LAYOUT**

Most newly constructed compost bedded-pack barns are built by modifying existing designs for two, three, or four-row freestall barns with wooden, steel, or hoop frames. Some producers have even built their barns with dimensions that allow flexibility for converting to a freestall barn later by adding concrete alleys, freestall platforms, dividers, and waterers. These modifications allow flexibility in case the producers find the facility does not meet their needs or a changing market or bedding supply makes modifications necessary. For more information on design and construction of freestall barns, consult the Guideline for Planning Dairy Freestall Barns, DPC 1.

While a number of different barn designs exist, a suggested layout from the University of Minnesota and University of Wisconsin are depicted in Figure 3. These designs are a single building with sufficient side wall open area and ridge vent width for proper ventilation. The single structure includes the compost bedded open resting area with a concrete alleyway for access to the feedbunk and waterers.

The bedded-pack is surrounded on all sides by 2 to 4-foot walls, including a wall to separate the bedded-pack from the feed alley. These walls may be cast-in-place concrete, moveable concrete panels, highway guard rail, or wooden panels (Figure 4). Design walls considering the pressure from the manure pack. Wheeled equipment on the compost bed also increases the wall design surcharge pressure.

As the compost depth rises, these walls no longer are barriers and cow safety becomes a concern (Figure 5). Topping the barrier with wire fencing, steel cable, high-tension wire (a 4-6” board should be placed so the cow realizes there is a fence there), bars or wood planking will eliminate this risk (Figure 6). Fencing should be minimized to avoid negative airflow implications.

**FEED AND WATER ALLEYWAY**

For optimum animal performance and health, feed and water should be easily accessible and readily available at all times in a feed alleyway. Feeding areas may be located in the barn or under a separate roof outside the barn. But feeding areas in the barn are preferred to encourage more feed intake. If a separate feedbunk and waterer is utilized, cows will prefer resting over travel if distances are greater than 300 feet. Provide a minimum of 24 to 30 inches of feed bunk space per cow, 3 feet of water tank perimeter per 15 to 20 cows, and at least 2 separate water locations per pen. Do not reduce feed and water access in an effort to build a low-cost facility.

Concrete feed alleys should be 14 to 16 feet wide, with access to the bedded-pack located every 60 to 80 feet and at each end. The feed alley, located on one long side of the barn or on both sides of a drive-through feeding barn, allows cows access to feed and water without traveling long distances. Because cows defecate and urinate more around feed and water, they should have access to waterers only on the alley side. Alley-only access minimizes excess moisture in the pack and keeps water cleaner. It also eliminates the need to alter waterer height as the pack depth changes.

Manure and urine in the cow feed alley needs to be removed daily and may need to be handled as a liquid, separately from the compost; the liquid manure will require its own manure storage. Another option is to use a slotted floor in the feeding alley with manure storage beneath. Consult with your state’s environmental agency or Extension, prior to starting construction, for details on manure storage structures and application requirements. Dairy Practices Council Guidelines 27 and 15 may also be helpful.

**COMPOST BED AREA REQUIREMENTS**

A guide for sizing a compost bedded-pack barn is in Worksheet 1. First, one needs to decide how much space to allocate per animal. In general, the pack area should provide at least 100 square feet of resting space per cow (85 square feet for Jerseys). Pack space per cow needs to be increased 10 square feet for each 25 pound/day of increased milk production above 50 pound/day because these cows will produce more urine and manure as a result of taking in more feed and water. In facilities for special needs cows, producers should provide 125 square ft of resting space.

Cows will generally use the resting space provided more efficiently when they have multiple entry access points along the long side of the rectangular resting area. If the entrance to the barn is on the narrow end with only one entry access point, a wet,
dirty area may develop at the entrance because of increased cow traffic. Additionally, cows are less likely to distribute themselves throughout the barn.

**NATURAL VENTILATION – BARN STRUCTURAL DIMENSION REQUIREMENTS**

Adequate ventilation is essential. However, ventilation needs vary between cold and hot temperatures necessitating a consideration of ventilation trade-offs (i.e. very open in the summer versus open with curtains in the winter). Ventilation removes heat and moisture created by the cows and the extra heat and moisture created by the composting process. Proper ventilation generally includes natural air movement through the barn but mechanical ventilation, through fans, can also be used. Mechanical circulation of air within the building prevents stagnant areas. Proper ventilation can improve cows’ overall health and immunity by controlling dust and fine particles that may lead to respiratory problems, cooling cows in the summer, and drying the pack surface (which helps keep cows clean).

**Sidewalls** should be constructed to allow for at least 12 feet of open space for air flow above the retaining wall or outside curb for barns that are less than 40 ft wide while a 14 ft height is recommended for barns wider than 40 ft. For example, if a 40 ft wide barn has a 4 foot concrete wall, the total sidewall height should be 16 feet. To maintain adequate natural ventilation under heat-stress weather conditions, the total open area of a windward barn sidewall plus an endwall is suggested to be at least seven ft²/cow with the target of 11 ft²/cow (Tyson, 2010). The compost bedded-pack barn sidewall area target is 11 ft²/cow since the composting bedding material produces additional heat and moisture to that produced by the cows.

**Eave overhangs** should be equal to 1/3 the height of the sidewall to minimize rain from reaching the pack and install roof gutters to reduce roof runoff from blowing into the pack.

**Sidewall curtains** help minimize the effects of winter winds and inclement weather on compost temperatures. Excessive winter ventilation from open sidewalls increases compost bed moisture evaporation causing bed cooling and heat loss that may not be replaced by compost heat generation. This perspective is different from windrow composting. Compost beds have a larger surface area to heat generating volume compared to compost windrows. The side wall curtains need to maintain a minimum under eave opening of one-half the ridge opening to prevent a barn from becoming a “warm barn” in winter that results in high levels of condensation, fog, ammonia and cow pneumonia. (See the following section on Continuous Ridge Vent Opening requirements.)

**Roof pitch** of barns of less than 4:12 will limit the natural ventilation rate per cow. The structure roof pitch affects natural ventilation. Too flat of a roof for a wide barn limits the natural ventilation rate and makes it easier for pockets of warm moist air to become trapped. This is a greater issue when warm moist air is trapped against cold roof surfaces during winter weather conditions (Stowell et al., 1998).

**Barn orientation** that is east-west takes advantage of prevailing southerly summer winds and reduction of late afternoon sunlight entering the barn. Different prevailing winds can be regional or site specific due to the local terrain and barn position within the landscape. Under these situations, the barn should ideally be oriented from a ventilation standpoint so the prevailing summer wind is perpendicular to the longitudinal sidewall if possible. Extending the roof eave may be required to reduce afternoon sunlight from entering the barn.

**Continuous ridge vent opening** of at least 3 inches for each 10 feet of building roof width is recommended with a minimum opening of 12 inches for barn widths of less than 40 ft. The basic air movement in a compost bedded-pack barn flows into the barn through the windward sidewalls and is exhausted through the ridge vent and the leeward wall opening. Ridge vents are generally more effective if the prevailing winds are perpendicular to the ridge line. Orientation should favor ventilation. An overshot (half monitor) ridge opening should face away from the winter prevailing winds. Alternate ridge opening designs can be found in **Ridge Openings for Naturally Ventilated Dairy Shelters** (McFarland, Graves, Tyson, Wilson. DIP 811, Penn State University, 2007) that address concerns about precipitation entering the barn through the ridge opening. The barn site may dictate a different orientation due to terrain, cost of site preparation to achieve the best orientation, or other buildings. The disadvantages of barn orientation may be overcome with floor design and eave extension to reduce...
sunlight penetration and mechanical ventilation to overcome reduced natural ventilation.

**CIRCULATION FANS**

Without circulation fans in the barn, cows may congregate in areas where natural air flow is higher during heat stress conditions. Petzen et al. (2009) reported that cows congregated in the center of a barn when temperatures exceeded 80°F. Congregation of animals in one area leads to excessive manure and urine accumulation and ineffective composting from too high moisture. Circulation fans (ceiling or big box) are recommended to help keep the pack dry and ensure adequate air speeds throughout the barn. Many farms have installed high volume/low speed ceiling fans in their compost bedded-pack barns and these appear to work well. When installing fans, it is important to ensure that there is enough clearance for tillage equipment to work underneath them at maximum pack depth and that fan blades do not damage barn trusses.

### UNDERSTANDING COMPOSTING

Composting relies on aerobic microorganisms to break down organic matter and produce carbon dioxide, water, and heat. In a compost bedded-pack barn, the manure and urine released by cattle and the added bedding provide the essential nutrients (carbon, nitrogen, moisture, and microorganisms) needed for the composting process.

Composting is an aerobic process. The continuous introduction of oxygen (air), carbon and nitrogen (through manure) and moisture control (new bedding) is REQUIRED for success. In a compost bedded-pack barn, the oxygen comes from stirring (aerating) the bedding and from the air that diffuses into the bedding surface, which should be fluffy to encourage the air infiltration. How well the compost bedded-pack works depends on maintaining the appropriate balance of carbon, nitrogen, oxygen, moisture, temperature, and microbial activity populations. When the proportions of bedding, cow stocking density, oxygen, and moisture are optimally balanced, the microorganisms population will thrive and produce sufficient heat to dry the pack and maintain active aerobic bacteria to continue the composting process. This may result in reduction of pathogens, fly larvae, and weed seeds.

The pack’s temperature provides a good indication of the level of microbial activity. Temperatures near the surface of the pack are closer to the air temperature because moisture, evaporation, and air movement dissipate heat. The bedding surface- temperature under a resting cow will rise, however. The ideal pack temperature goal, measured at approximately 6-12 inches below the surface, is between 110 and 140°F. When temperatures exceed 150°F, surface temperatures may increase to the point where cows do not want to lie down on the pack. A temperature in that range indicates that organic materials are breaking down rapidly. When the temperature is lower, the composting process is too slow, often because inadequate oxygen from stirring, too high moisture, or high heat loss during the winter. When it is above this range, the beneficial aerobic bacteria are killed.

Temperatures can be measured with a long cooking thermometer. If a thermometer is not available, you can feel the material (at 12 inches beneath the surface) with your bare hands. If the pack is hot almost to the point that you do not want to touch it, the temperature is likely high enough (> 130°F). Packs at varying temperatures are shown in Figure 10.

Manure, urine, and microbial activity produce a pack’s source of moisture, which ideally should be between 45-55% but an operating range that can still have significant activity for success is 40 and 60%. When moisture is too low, the microbes won’t have enough water, and the compost will be too cool, resulting in a compost rate that’s too slow. If the moisture level is too high, the pack becomes anaerobic (lacking oxygen); the rate of microbial decomposition will slow; and again, composting and heat generation will be too slow.

As a simple moisture check, grab a handful of bedding and squeeze it. If you can squeeze water out or if water droplets drip from or appear on the surface of squeezed bedding, the pack is too wet. This is a sign that new dry bedding should be added to the pack. If you can’t form a ball, the pack is too dry. This condition may actually occur when bedding is added too frequently. When the pack is working well, the bedding material will appear loose and fluffy, not compacted and chunky.

Generally, temperatures are higher when the pack is fluffy because air promotes microbial activity.
When the pack is compacted and has excessive moisture, you’ll see reduced temperatures. Moreover, when moisture is excessive, the bedding and manure will more readily stick to the cow’s hide and udder.

Excessively high temperatures in the compost bed (more than 150° F) occur when there is high microbial activity due to the presence of easily digestible organic matter and moisture is near the low end of the optimal range. Under these conditions, the pack doesn’t have enough water for evaporative cooling. Lack of water may occur when cow density is low, when air movement dries the pack more quickly, or in warm, dry weather.

Ideally, the C:N ratio for a peak composting rate needs to be between 25:1 and 30:1. New bedding material, besides absorbing water, will also aid in achieving this ratio. If you can smell ammonia in the barn, the C:N ratio is likely below 25:1.

**BEDDING MATERIAL**

Minnesota researchers and dairy producers suggest dry, fine wood shavings or sawdust, preferably from pine or other softwoods, as the bedding materials of choice in compost bedded-pack barns (Figure 7). Chipped wood (Figure 8) is less desirable. Wood chipped with blades has smooth surfaces that hold less water than sawn or hammer-milled wood that result in rough surfaces. Wood chipped with flails or hammers may have sharp edges, like toothpicks, that can injure cows.

Kiln-dried sawdust is preferred, but the pack will perform well as long as the moisture content for sawdust is less than 18% when it is put in the compost-bedded pack. Green sawdust is generally wet and may harbor Klebsiella bacteria. If green sawdust is used, the amount used is higher than kiln-dried because its higher water content reduces the amount of water that can be absorbed. Cedar should be avoided because it contains oils and organic materials that inhibit the microbial activity necessary for composting. Black walnut has been shown to cause laminitis in horses, though there is no research to support this result in dairy cattle.

The size of bedding particles is particularly important for regulating microbial access to the food source—manure and urine. At the same time, the high lignin content of these wood materials provides some resistance to microbial breakdown, which makes it last longer. Kiln-dried sawdust is a fairly fine, coarse material that provides a suitable ratio of surface area to volume, is easy to till, and absorbs and holds liquids well. Alternate bedding materials with large particles do not work well and need to be finely chopped (Figure 9). In early research studies, finely processed corncobs, soy straw, or flax straw, ground through a 3/4-inch screen, have performed well. Such fine materials may be used in a mix with sawdust to stretch sawdust supply. Long lengths of corn stalks; waste hay; and oat, barley, and wheat straw tend to retain too much water because they are slow in drying. Moreover, if the waxy outer surface coating still remains on wheat straw, water is slower to be absorbed or dried. If you use these alternate bedding materials, you may find it hard to stir and aerate the pack, or you may create a pulp or chunks.

Some innovative producers continue the composting by stockpiling compost material after the pack is cleaned out. They turn this material to accelerate drying and then re-introduce this dry product into the pack along with new sawdust to stretch the sawdust supply and jump start the composting process.

**MANAGEMENT ESSENTIALS**

As with any facility, the success of a compost bedded-pack barn hinges largely on how well it is managed. Maintaining proper aeration and stocking density are fundamental. When the pack is stirred frequently and uniformly, the manure and urine from the surface are stirred into the pack while oxygen and moisture are incorporated. The result is better heating and aerobic decomposition of organic material. The following are management essentials.

**COMPOST BED START-UP.** Compost bed start-up in a new barn or after barn cleanout requires 1 foot of bedding to be applied to the barn floor. Depending upon barn size, cow numbers, and pack area, several semi-loads of sawdust may be required to start the pack. Make sure to add enough sawdust so that the mixing equipment does not encounter the barn floor. Starting a new bed should occur when 4 to 6 weeks of weather with highs generally above 50° F are expected. Ideally, the new compost should be started so that heat generation rate reaches a peak before the
arrival of temperatures that may freeze the pack in any part of the barn. Not achieving an actively composting bed going into winter may result in low heat production that does not overcome the heat losses and poor bed performance results throughout the winter.

**Moisture control of bedding in the 40-60% range and twice daily bed stirring are critical for success. The compost bed can get out of balance if management does not recognize poor moisture conditions before temperatures start falling, cow hygiene deteriorates, and the risk of environmental mastitis rises. Moisture control depends on recognizing the moisture range by the hand squeeze test and responding with added bedding, lower cow numbers, and increasing stirring effort for improved drying and aeration. **

**RESPONSIVE MANAGEMENT IS ESSENTIAL.**

**COMPOST BED CLEANOUT.** The bedding area is generally cleaned out in the fall or spring, with the used bedding applied to the land. Some producers also clean the packs in the spring that would allow maximum nitrogen retention for crop uptake. The pack depth may reach 4 feet before cleaning depending on sawdust used and composting intensity. Most producers return 6 to 12 inches of old material to help start microbial activity in the new pack. If it is possible to conserve the top layer of the old compost bed, this is the most active, acclimated microorganisms to continue the composting process in the new bed.

Compost samples should be analyzed for fertilizer value and recorded for manure management plans. Alternatively, the bedding may be removed from the barn, managed to produce finished compost, and sold.

**COMPOST BED STIRRING/AERATION.** Uniform stirring and mixing provide a clean, soft, dry surface upon which the cows lie. Aerate the compost bed to a depth of at least 12 inches. Periodic deep stirring, up to 18 inches, with a chisel plow reduces the amount of bedding you’ll need and increase pack temperatures. Some producers plow the pack twice during each stirring event, both lengthwise and crosswise, to further increase aeration.

Stir the compost during every milking, while cows are out of the barn. Not only is it easier to stir while cows are out of the barn, but this practice also minimizes the chances of the dust created during stirring causing respiratory issues for the cows. The person doing the stirring should consider wearing a mask to avoid respiratory problems. If possible, cows should be kept off the pack for at least an hour after stirring to allow the top layer of bedding to dry (especially during the winter). Running fans after stirring helps dry the surface throughout the year, not just during warmer conditions. Most producers begin stirring about a day after new sawdust is added to the pack.

**EQUIPMENT REQUIRED.** A variety of methods are used to stir. Most producers use a cultivator, tines, or a rotary tiller attached to a skid steer or small tractor (Figure 11). It is important to breakup tractor tracks by positioning mixing tools to follow the tires. If heavy equipment is used, wheel tracks won’t be broken up; also, if the pack is too wet, the pack may become compacted, limiting oxygen and causing lower temperatures. Compaction also leads to higher bed moisture and thus inadequate aeration.

**ADDITION OF NEW BEDDING MATERIAL.** Use the simple moisture check--grab a handful of bedding and squeeze it. If you can form a tight ball, squeeze water out or if water droplets drip from or appear on the surface of squeezed bedding, the pack is too wet. New bedding (4 to 8 inches) is added to the pack before the moisture increases to the point where the tight ball is formed. Waiting until bedding starts to stick may be too late. The frequency of adding bedding depends on how much evaporation occurs, how much manure and urine are introduced, season, ambient temperature, and ambient humidity. Generally, the new bedding is added every one to six weeks. Some producers add smaller amounts of bedding more frequently. More bedding may be used during humid or wet weather or if the barn is overcrowded. When using green sawdust, more bedding will be used since it will not absorb as much moisture as kiln-dried sawdust.

**OTHER MANAGEMENT CONCERNS.**

**OVERCROWDING.** In an overcrowded barn, there may be too much moisture in the pack, dirtier cows, and higher somatic cell counts, for these reasons:

- Manure and urine going into the pack increase, which causes the pack’s moisture level to rise to excessive levels and the composting process to slow considerably.
• Physical packing of the bedding material increases, which reduces airflow in the pack.

• The amount of fecal contamination (non-ag Streps and coliforms) in the lying space increases as a result of more manure, which can lead to greater incidence of environmental mastitis.

**WINTER MANAGEMENT.** Winter management of compost bedded-pack barns is the most challenging and requires the most bedding. In freezing conditions, manure piles may freeze during the night and thaw during the day. When pack moisture levels exceed acceptable levels in the winter resulting in dirty cows, many dairy producers alter their management toward more frequent addition of thin layers of fresh bedding to keep cows dry and clean. Bedding usage during the winter time is generally 2 to 3 times more than during the summer.

**PATHOGEN LEVELS.** Even when the compost process works well, pathogen levels in a compost bedded-pack barn are high. Minnesota research showed large numbers (9,122,700 cells/cc) of mastitis-causing pathogens on the surface of compost-bedded packs, including coliforms, environmental *Staphylococcus* species, and *Bacillus* (Barberg et al., 2007a).

Vaccination of cows with an *E. coli* vaccine may also prove beneficial. Some concerns have been expressed about the risk of respiratory problems associated with excessive dust.

**ECONOMIC CONSIDERATIONS**

Before building a compost bedded-pack barn, the costs of construction must be considered, along with annual maintenance and bedding and the profitability of a new barn. Building costs vary because concrete, steel, and wood prices fluctuate. How much of the barn you build yourself and what options you add are also cost factors. Per cow construction costs for a compost bedded-pack barn are generally lower than for a freestall barn, despite more area required per cow. Less concrete is used and there is no investment in freestall partitions and bases. It may cost you more if you build a facility for on-farm storage of sawdust (to assure availability and enable you to buy it when prices are lower).

While initial investment is lower than for a freestall barn, annual maintenance is typically higher. For a 100-cow herd, assume a semi-truckload of sawdust (about 18 tons) is used every two to five weeks. At these rates, bedding costs have ranged from $0.35 to $0.85 per cow per day. Compost barn managers are also advised to clean shade cloth and ventilation inlets frequently because of the amount of dust stirred throughout the year. Also consider the cost of handling manure. Compost bedded-pack barns reduce the amount of manure storage, but require equipment to handle both liquid and dry manure. Keep in mind that dry manure can be easier to handle and does not have to be applied as frequently. Furthermore, composting stabilizes the N, P, and K concentrations of the manure. Storing manure within the barn reduces the amount of precipitation that must be hauled from storage.

In calculating labor costs, assume that 10 to 15 minutes per 100 cows is required for stirring and scraping the feed alley, which is generally accomplished twice daily during milkings. To offset costs, you may find a market for selling the final compost.

**POTENTIAL LIMITATIONS**

The primary limitation for compost bedded-pack barns to date has been sawdust availability. These barns require three to four times the amount of bedding of a typical freestall barn. In on-farm experiments, alternative materials have not performed as well as sawdust. If you’re considering a compost bedded-pack barn, make sure you have a reliable, cost-effective, timely supply of sawdust available. Demand for sawdust will go up and prices will continue to rise as more people build these barns and increased demand for sawdust comes from the biofuel, dark-fire tobacco, charcoal, and other industries.

Consider how sawdust prices affect daily and annual bedding costs (Table 1). If the pack is not managed well, the higher risk of exposure to environmental mastitis pathogens can add to your costs.
REFERENCES


Figure 1. Recommended layout for the compost bedded-pack barn with feed alley, feedbunk, waterers, retaining walls, walkways, and open resting area

Figure 2. Keys to maintaining well-managed compost bedded-pack barns
Figure 3. Compost Barn Layout for 100 cows

Layout has three walkways to access the pack, drive-by feeding, and 6-ft overhang. Waterers are against the concrete wall, separating the bedded-pack from the feed alley. They are accessed from the feed alley only. Not drawn to scale.

Source: Top: University of Minnesota (Endres and Janni, 2008). Bottom: University of Wisconsin (Kammel, 2005)
Figure 4. 4-foot side walls: cast-in-place concrete, highway guard rails, and wooden plank walls

Figure 5. Compost bed depth can create cow injury risk.: bed perimeter and alley way separation wall.
Figure 6. Barrier options: a) steel cable, b) pipe, c) fence panel, d) wood planking, and e) highway guard rail.
Figure 7. Sawdust from (A) sawn wood, (B) planed wood, (C) mixture.

Figure 8. Wood chips produced with sharp blade (left) and blunt hammer (right) (Alakangas, 2010).
Figure 9. Chopped straw (left) and straw run through hammer mill with 3/4” screen (right).

Figure 10. Examples of compost-bedded packs of various temperatures. Light and fluffy compost with ideal temperature (134.6 °F) is shown at left. Wet and chunky compost with below-optimal temperature (99.6 °F) is shown at right.
Figure 11. Examples of equipment used to stir compost bedded-pack barns.

<table>
<thead>
<tr>
<th>Step</th>
<th>Calculation</th>
<th>Formula</th>
<th>Example Inputs*</th>
<th>Example Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Required Pack Area</td>
<td>RC x NC</td>
<td>100 x 100</td>
<td>10,000 sq ft</td>
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<tr>
<td>2</td>
<td>Barn Length</td>
<td>(MC x NC)/12</td>
<td>(24 x 100)/12</td>
<td>200 ft</td>
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<tr>
<td>3</td>
<td>Pack Width</td>
<td>RPA/BL</td>
<td>10,000 x 200</td>
<td>50 ft</td>
</tr>
<tr>
<td>4</td>
<td>Total Barn Width</td>
<td>PW + FAW + EW</td>
<td>50 + 12 + 1</td>
<td>63 ft</td>
</tr>
<tr>
<td>5</td>
<td>Total Barn Area</td>
<td>TBW x BL</td>
<td>63 x 200</td>
<td>12,600 sq ft</td>
</tr>
</tbody>
</table>

Key: BL = barn length  
MC = manger space/cow  
RC = resting space/cow  
NC = no. of cows  
PW = pack width  
RPA = required pack area  
TBW = total barn width  

* Recommendations: RC = 100 sq ft/cow, MC = 24 in/row, FAW = 12 ft, EW = 1 ft.

<table>
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<tr>
<th>Bedding used cow-day</th>
<th>Bedding Cost per pound</th>
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<td>Pounds/cow day</td>
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Figure 12. Dry sawdust bedding use and costs on a daily, monthly, and annual basis. (Kammel, 2005)