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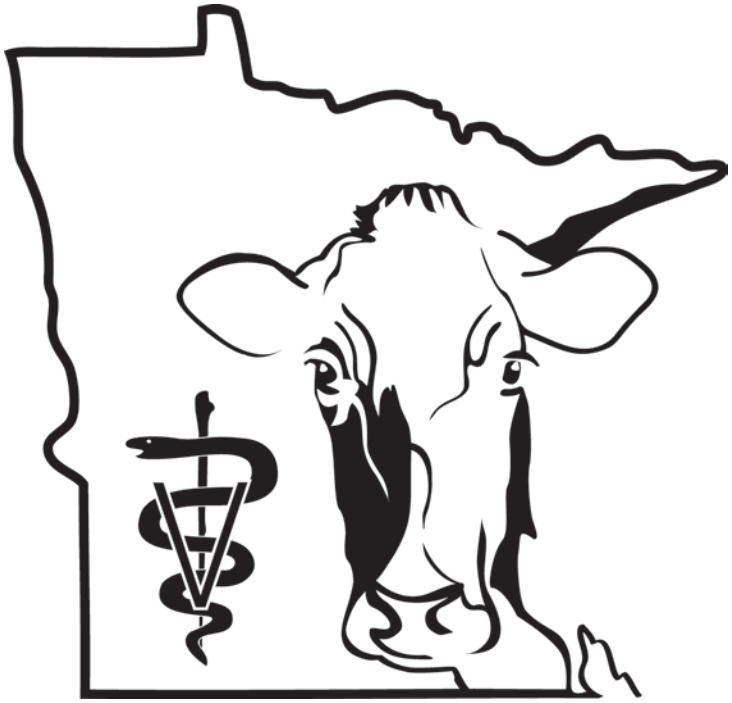

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Compost Barns: What Have We Learned So Far?

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Introduction

Compost barns, an alternative housing option, have raised much interest among dairy producers in recent months. The construction of these facilities in Minnesota has been a producer initiative with the first barn built in late 2001. A compost barn may be a reasonable, economically feasible alternative type of dairy housing facility for Minnesota dairy producers wanting to modernize their herd facilities or start a new dairy operation. It could be used for all cows in the dairy, or for larger herds, it could be used for special needs cows (e.g., transition and/or lame cows).

The main reason producers have mentioned for adopting this alternative housing system is the perception of improved cow comfort and longevity. A compost barn allows cows more freedom of movement than conventional tie stalls or free stalls. However, no studies have been reported on cow health and lying behavior in these systems.

Other reasons to adopt the system are environmental and economic. These barns may provide a reduction in manure storage costs and needed space, and a savings in labor and manure handling. A great percentage of the manure produced by the cows is 'stored' in the pack, eliminating the need to build a large manure storage facility and creating less environmental risk.

A compost barn is a loose housing type of facility bedded with fine, dry sawdust. There is a concrete feed alley separated by a four-foot high wall from a bedded pack area. It differs from a conventional bedded pack where anaerobic decomposition and soiled bedding are the norm. In the new compost barn approach, the bedding material is stirred at a depth of 8-12 inches at least two times per day to supposedly facilitate an aerobic composting process. Stirring of the pack is usually accomplished using a skid steer loader with a front mounted adapted cultivator. It is proposed that stirring is essential to incorporate oxygen for aerobic decomposition and to provide a fresh surface without accumulated manure for cows to lie down on after returning from the milking parlor and eating. The main question raised by current compost barn owners during the recent survey we conducted was about other sources of bedding material that could be used in these facilities besides sawdust.

Very little is known about the nutrient content and availability of the material in the compost barn. A study by Tiquia et al. (2002) evaluated the composting process of a mixture of partially decomposed pig manure and cornstalks from swine housed in hoop structures. Composting of manure from deep litter systems was incomplete and additional time after removal from the structure is likely needed for the compost to mature. This likely is the case with compost barns, but no previous research has specifically examined this housing system. Various types of bedding material may behave differently in the pack and result in varying levels of decomposition or composting in the pack.

Temperature below the surface has been reported by producers to be high (possibly 130° F or more) and it is suggested this might reduce the microbial load. However, temperature of these bedding packs or the effect of possible high temperatures on mastitis causing pathogens has not yet been investigated in a long term study. Mote et al. (1988) reported that static composting of manure piles of dairy waste solids resulted in little benefit toward net reduction in coliform bacterial numbers. There is

much interest from dairy producers on whether composting the bedded pack results in a reduction in the pathogenic microbial population.

Another question posed by producers relates to the temperature and humidity in compost barns, especially during the summer. It has been extensively shown that cows exposed to extended periods of high temperature and humidity will reduce dry matter intake and milk yield and produce milk with lower efficiency, affecting the profitability of dairy operations (West, 2003). There have been no reported data on the average temperature and humidity in compost barns.

As stated previously, cow comfort is one of the main reasons producers mention for adopting this system. Lameness is a major welfare and economic problem in the dairy industry. It is proposed that the use of a deep bedded loose housing system would reduce the prevalence of lameness. Singh et al (1994) reported that the incidence of sole lesions causing lameness was reduced when cows were moved from a free stall barn to a straw yard. Cows were never reluctant to lie down in the straw yard most likely because they preferred the absence of restrictions and the more comfortable surface. There are no reported data on the prevalence of lameness in compost barns.

Producers also have questions regarding herd productivity and milk quality/udder health in compost barns. Can one achieve milk production and especially somatic cell counts similar to tie stall and free stall systems? There have been no studies investigating the average herd performance and udder health in compost barns.

Study Description

Twelve dairy farms in the state of Minnesota were visited and owners interviewed during summer 2005. The main objectives of the study are: 1: Characterize the compost bedded pack system; 2: Evaluate cow comfort in compost barns; 3: Investigate producers' experience with the system.

Characterization of the bedding material and system. Using a questionnaire we learned as much as possible about the economics of and the reasons for building this alternative system, daily bedding costs, what the producers liked or did not like about their barn, manure management and use of bedding material, etc. We took measurements of barn dimensions and calculated space allowance per cow in each barn (including bedding area, feed bunk, and waterers). Using a grid to determine sampling location, we measured bedding pack temperature at 6, 12, 24, and 36 inches below the surface using specially designed temperature probes (according to pack depth). At the same sampling locations, we used a soil sample probe to take12 core samples of bedding material at two depths per site for chemical analysis. There is a lack of data on Carbon:Nitrogen ratios, phosphorus, potassium, soluble salts, pH, ammonia, etc, and the variation on these characteristics across the pack area. We also took 12 surface samples of bedding material for microbial analysis. Barn temperature and relative humidity were recorded with dataloggers (HOBO H8 Pro RH/Temp, Onset Computer Corporation) set to record every 30 minutes and placed in each of the compost barns used in the study for a period of seven days.

Lying behavior. Lying behavior was collected on a subset of cows in each dairy (average of 15 cows per dairy) for a period of seven days using electronic devices (IceTag 1.003, IceRobotics Limited, Scotland, UK). Results are being summarized. Data collected with these devices include lying/standing/walking time, number of steps, number of lying/standing bouts, and duration of lying/standing bouts. We also performed visual observation of cow lying positions every 15 minutes for a four-hour period on both days we visited each dairy. Data measured included percentage of cows adopting specific lying positions recognized as natural ones: flat on side, head back, head on ground, head up. We also observed social behavior during the same two four-hour periods and

recorded continuously the frequency of chasing away, pushing away, head butting, and social grooming.

Herd management and individual cow factors. Using a standard questionnaire we interviewed each producer about management strategies used on the dairy. We collected as much information as possible on bedding management, transition cow management, footbath and hoof trimming protocols, feeding management, and other aspects of the dairy system that could potentially affect cows' health and productivity. We are summarizing cow records, including milk production and composition (% fat and protein), somatic cell counts, death and cull rates, reproductive performance, and others, including historical data whenever available. We are summarizing daily bulk tank data for the year before they started using the system and all subsequent years to study variation using Statistical Process Control tools.

We scored cows for body condition on a scale of 1 to 5, where 1 = thin and 5 = obese (Ferguson et al., 1994). Cow hygiene was measured using a hygiene score system ranging from 1 to 5, where 1 is clean and 5 is very dirty (Reneau et al., 2005). Cows were evaluated for their lameness status using a 5-point locomotion score (Sprecher et al., 1997) with additional observations as suggested by O'Callaghan et al. (2003), where 1 is normal locomotion, 2 is imperfect locomotion, 3 is lame, 4 is moderately to severely lame and 5 is severely lame. Additional observations included tracking (hind feet on fore feet position), head bob (extent of movement and level of bobbing) and abduction/adduction (rotation of feet from the direction of travel). We noted the presence and severity of hock lesions in 3 categories: no lesion, hair loss (mild lesion) or swollen hocks (more severe lesion).

Preliminary Results

Economics and general satisfaction about the system:

- The cost of building the barn ranged from $33,000 to $300,000, with an estimated cost of approximately $1,200.43 per cow (barn only).
- The main reasons for building this type of housing system were for improved cow comfort, cow health and longevity, and ease of completing daily chores.
- The largest concern expressed by owners was the cost and availability of bedding, especially as additional compost barns are built. Cost can be as high as $.85/cow/day. All the dairy farms we visited were using sawdust for bedding, with an average of approximately $.55/cow/day.
- All of the producers were generally satisfied with their decision to build a compost barn and believe that it was the right choice for housing their dairy herd.

Udder health related aspects:

- The average DHIA somatic cell count was 325,000 cells/mL with a range of 85,000 to 658,000 cells/mL (Figure 1).
- Bulk tank cultures were performed on a composite sample of four or five bulk tank pickups. Two out of 12 farms had a high level of *Strep. agalactiae*, one farm was found to have a high level of *Staph. aureus*, six farms had high levels of Non-ag *Strep*, and four farms had high levels of coliforms in the milk.
- Bacterial counts in bedding samples averaged 9,122,699 col/mL with a range of 2,035,563 to 22,562,604 col/mL. Therefore, milking prep procedures are very crucial.

Cow scoring averages:

• On average, only 7.8% of the cows were clinically lame (Figure 2). A recent lameness prevalence study that we conducted in Minnesota estimated that approximately 25% of cows were lame in freestalls.
• On average, 77.7% of the cows had no hock lesions, 22.3% showed mild lesions (hair loss) and only 0.97% of cows had severe lesions (swollen hocks plus hair loss).
• The average body condition score was 3.04 with a range of 2.88 to 3.17.
• Cow hygiene scores averaged 2.7 in a scale of 1 to 5 (1=clean; 5=dirty). That is similar to a freestall barn or slightly cleaner.

Some barn characteristics:
• The average lying space was 90.2 ft^2 per cow and ranged from 38 to 154 ft^2 per cow. We recommend not less than 80 ft^2 per cow in the bedded pack area.
• The average temperature across depths was 108° F, with a range of 76 to 138° F.

Most of the locations (98%) tested had temperatures below 130° F, which is considered to be a minimum temperature for composting to take place. Therefore, the material is not really composting in the pack, but maybe the process is started, so it should take less time to finish composting once the material is removed from the barn (just a hypothesis, we have not tested it). Some biological activity is taking place and additional studies are needed to further investigate this finding.

In summary, results so far have shown that compost barns can be a good alternative for housing dairy cows. Like any system, they require optimum management to work properly. Special attention should be given to milking prep procedures and maintenance of minimum space per cow to avoid high levels of somatic cell counts.

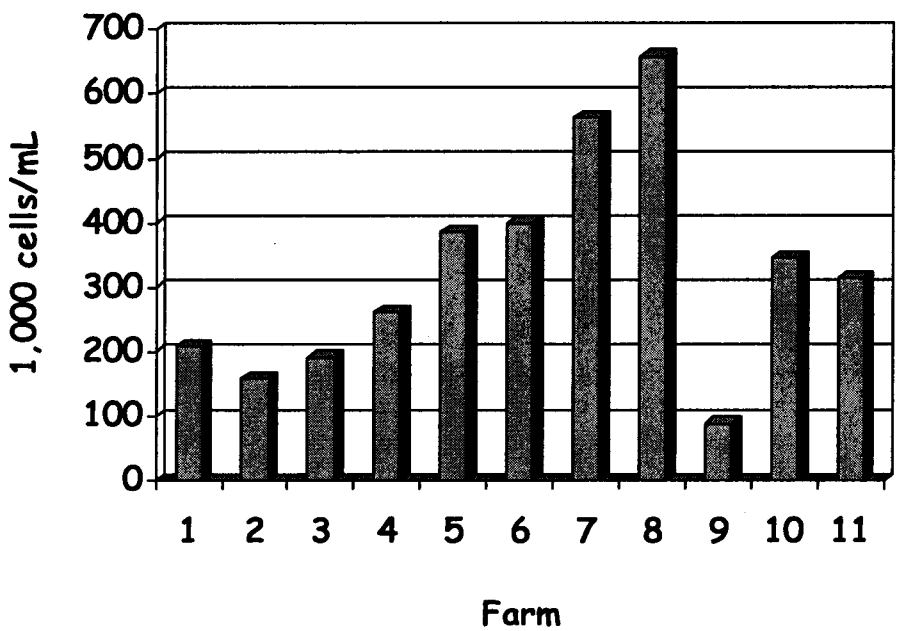

Figure 1. Somatic Cell Count Averages

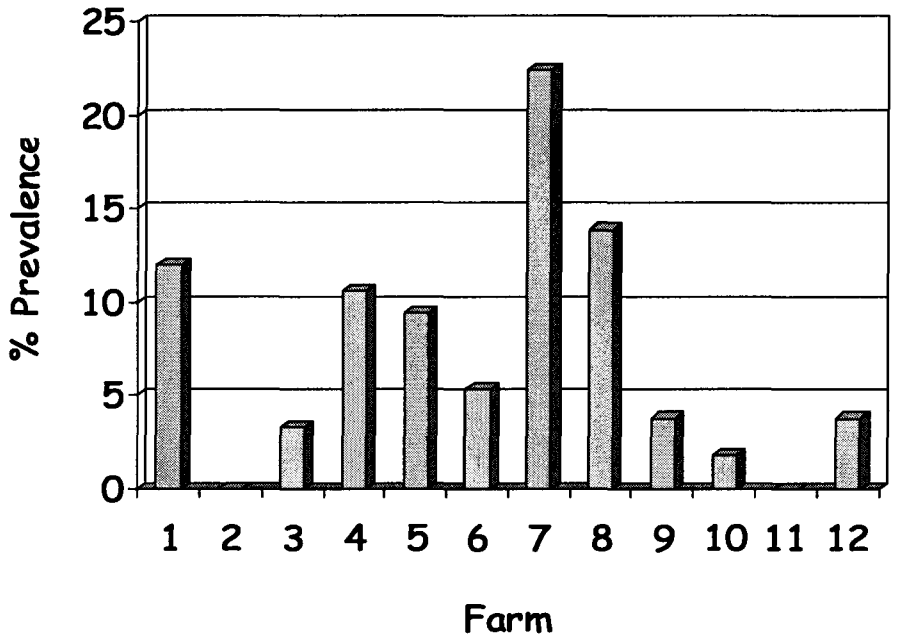

Figure 2. Lameness Prevalence Averages

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