Performance and Welfare of Dairy Cows in an Alternative Housing System in Minnesota

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ABSTRACT

The compost bedded pack dairy barn is an alternative housing system for lactating cows that has received increased attention in the last 2 yr. No descriptive data were available about this housing system. Therefore, a study of 12 compost dairy barns in Minnesota was conducted between late June 2005 and September 2005. The objectives of this study were to describe the housing system, identify management practices used in these herds, observe cow welfare, analyze herd performance and udder health prior to and following the change in housing system, and measure producer satisfaction with the system. Producers were interviewed on various aspects related to the housing system and herd management, samples of milk were collected, and cows were scored for locomotion, body condition, hygiene, and hock lesions. In addition, historical bulk tank information and Dairy Herd Improvement Association data were collected when available. At the time of the visit, the Dairy Herd Improvement Association somatic cell count (SCC) was $325,000 \pm 172,000$ cells/mL, rolling herd average was $10,457 \pm 1,138$ kg per cow, and herd size was 73 ± 35.5 lactating cows. The body condition score was 3.04 ± 0.11 , the cow hygiene score was 2.66 ± 0.19 , and 7.8% of all cows were clinically lame (locomotion score ≥ 3 on a 1 to 5 scale). No hock lesions were present on 74.9% of the cows; 24.1% of cows had a mild lesion (hair loss), and 1.0% had a severe lesion (swollen hock). Historical analysis of the bulk tank SCC showed that 3 out of the 7 herds analyzed had a significant reduction in bulk tank SCC when compared with the previous housing system. Mastitis infection rates decreased significantly by 12% on 6 of the 9 farms analyzed. Reproductive performance significantly improved for 4 out of the 7 herds analyzed, with 25.9 and 34.5% improvement in heat detection rates and pregnancy rates, respectively. The main reasons producers reported 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 was the cost and availability of bedding, especially as additional compost barns are built. Overall, all producers were satisfied with their decision to build a compost barn.

Key words: alternative housing, welfare, udder health, lameness

INTRODUCTION

Dairy housing systems have a substantial impact on the overall health and longevity of dairy cattle. Housing systems in the Midwest of the United States have transformed from pasture-based systems to indoor housing with limited outdoor access. In recent years, there has been a trend for housing dairy cows in deep-bedded sand or mattress-based freestalls instead of the historical straw- and sawdust-bedded tie stalls. This change has taken place to improve the efficiency of labor use in dairy operations. More recently, dairy producers, particularly in Minnesota, are building an alternative loose-housing system, commonly referred to as a compost dairy barn, for improved cow comfort and longevity of their herd.

Compost dairy barns are an alternative loose-housing system first built in Minnesota by a dairy producer in 2001. The system typically consists of a large bedded pack area (resting space) separated from a feed alley by a 1.2-m high concrete wall. The bedding material (predominantly dry fine wood shavings or sawdust) is aerated twice daily using a cultivator type of equipment to dry the surface and incorporate manure into the pack. In the last 2 yr, there has been increased interest by dairy producers in Minnesota, central and eastern United States, and some foreign countries in building these types of barns. There has been no descriptive research to date on compost barns.

Dairy cattle housing has a large impact on the health of feet and legs of dairy cows. Lameness in dairy cows is a major welfare problem in the dairy industry today, as well as a large source of economic loss to the industry. Housing systems including concrete flooring, uncomfortable freestalls, or both increased the incidence of lameness and hock lesions (Weary and Taszkun, 2000;

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Somers et al., 2003; Cook et al., 2004). Lameness negatively affects the reproductive efficiency and performance of dairy cows (Sprecher et al., 1997; Vermunt, 2005) and is a major reason for culling in a dairy herd (Esslemont and Kossaibati, 1996). Straw yards (a system that is somewhat similar to a compost dairy barn in terms of resting area) improved hoof health (Phillips and Schofield, 1994). Nevertheless, no data are available to date on the prevalence of lameness and hock lesions or reproductive performance and culling in compost barn housing systems for dairy cattle.

Cows in compost dairy barns are housed in a bedded pack. Bedding materials are a primary source of environmental mastitis pathogen exposure to the teat ends of dairy cows. The type and number of bacteria in the bedding material are related to the total bacterial load on the teat ends and rates of clinical mastitis in lactating dairy cows (Hogan et al., 1989). Sawdust bedding (along with other organic bedding materials) often contains $>10^6$ cfu/g of coliform bacteria when used as bedding for dairy cattle (Bramley and Neave, 1975). This level caused an increased prevalence of udder infection (Jasper, 1980). Sawdust is the main bedding material utilized in compost dairy barns. No data were available on bacterial counts in bedding and milk or prevalence of mastitis on these farms.

The objectives of this study were to 1) describe the housing system, 2) identify management practices utilized in compost barn herds, 3) observe cow welfare, 4) analyze herd performance and udder health prior to and following the change in housing system, and 5) measure producer satisfaction with their compost dairy barn.

MATERIALS AND METHODS

A study of 12 dairies in Minnesota utilizing a compost dairy barn for their lactating herd was conducted between late June 2005 and September 2005. Individual herds were selected on the basis that they had used the alternative housing system for their lactating herd for at least 6 mo prior to our farm visit. Dairy producers utilizing this housing system were identified by extension educators. Following the identification of potential compost barn study herds, letters of invitation were sent to the producers to confirm whether they met the criteria of occupancy date and utilizing the barn for their lactating herd as well as to obtain their consent to participate. The dairies represented approximately 92% of all dairies in Minnesota meeting the criteria. One dairy had cows housed in this system since fall 2001, 5 since fall 2003, and 5 since fall 2004. Only one dairy had been using this system for only 6 mo at the time of our visit. Each farm was visited once to collect

on-farm data. Data were collected using direct observation of the cows and their environment, examination of DHIA records when available, and evaluation of historical milk bulk tank information from the milk processors when accessible.

Data Collection

A questionnaire was provided to the herd manager at the time of the initial farm visit to obtain data regarding their characteristics and management practices. The survey included 65 questions related to herd size, reasons for building the compost barn, pack management strategy, cow grouping and transition cow management, feed management practices, milking procedure, building measurements and design, other herd management strategies, and overall satisfaction with the alternative housing system. Dairy herd records were obtained from the DHIA for 11 of 12 of the dairies. Historical DHIA data were obtained for 2 yr prior to building the compost dairy barn up until March 2006 when available. Historical milk bulk tank data were obtained from the milk processors for at least 1 yr prior to building the compost barn through December 2005 when available.

Herd Characteristics. On-farm data of dairy herd characteristics were collected during the farm visit. Individual cow data collected included BCS, locomotion, hock lesion, and hygiene scores. Cows were scored for BCS by the same experienced observer on a scale of 1 to 5, where 1 = thin and 5 = obese (Ferguson et al., 1994). Cow hygiene was measured by the same observer using a hygiene score system ranging from 1 to 5, where 1 = clean and 5 = very dirty (Reneau et al., 2005).

Cows were evaluated for their lameness status using the 5-point locomotion scoring system of Sprecher et al. (1997), using additional observations suggested by O'Callaghan et al. (2003), where 1 = normal locomotion, 2 = imperfect locomotion, 3 = lame, 4 = moderately to severely lame, and 5 = severely lame. Clinical case of lameness was indicated by a locomotion score ≥ 3 . Additional visual observations of cow movement included tracking (hind feet on fore feet position), head bob (extent of movement and level of bobbing), and whether feet point in the direction of travel. Locomotion scoring was performed by the same observer at the exit of the milking parlor while cows walked on a flat surface. The prevalence of clinical lameness (score ≥ 3) was calculated as a percentage of cows affected in each herd at the day of visit. Cows were individually scored for the presence of hock lesions. They were identified as having no lesion, mild lesion (hair loss), or severe lesion (swollen hocks).

Feed Analysis. The TMR samples were collected as a composite of several areas across the feed bunk. Samples were collected immediately after fresh feed was delivered to the cows. Samples were analyzed for NDF and CP using standard methods outlined below. Samples were dried in a 60°C forced air oven and ground in a Wiley mill (Swedesboro, NJ) to pass through a 1-mm screen. Final DM was obtained by drying samples at 100°C for 24 h. Samples were analyzed for NDF using the Ankom200 fiber system (Ankom Technology Corporation, Fairport, NY). Sodium sulfite and heat stable α -amylase were included in the neutral detergent extraction, and heat stable α -amylase was added during the first 2 rinses (Hintz et al., 1996). Samples were analyzed for CP using a TrueSpec Protein Nitrogen Analyzer (Leco Corporation, St. Joseph, MI; AOAC, 1995).

Milk Quality Evaluation. Bulk tank milk samples were collected from 4 or 5 consecutive bulk tank pick-up days (samples were taken at the time milk was collected from the dairy by the processor after thorough mixing of the bulk tank milk) and frozen daily before being taken to the Laboratory for Udder Health, University of Minnesota and used for bacterial analysis. Samples were thawed in a refrigerator. Once thawed, samples were thoroughly mixed, and 2 mL was removed from each sample and pooled into a sterile tube. After mixing, serial 10-fold dilutions were made in sterile brain heart infusion broth. Two hundred microliters from each dilution were spread over the surface of separate MacConkey agar, thallium sulfate-crystal violet-B toxin blood (TKT) agar, and Factor agar plates. After 24 h of incubation at 37°C, the plates having 30 to 300 colonies were chosen for enumeration of bacteria. Those colonies that appeared to be *Staphylococcus aureus* were presumptively identified by catalase activity, tube coagulase test, and biochemical reactions using the API-STAPH (BioMerieux, Hazelwood, MO). Bacterial counts are expressed as number of bacteria per milliliter of bulk tank milk.

Udder Health Evaluation. Herd mastitis infection rates were calculated from the DHIA records for 2 yr prior to housing in a compost dairy barn and at least 1 yr after housing the cows in a compost dairy barn (until March 2006 for all dairies). A cow was considered infected when her SCC was $\geq 200,000$ cells/mL on a DHIA test. The herd mastitis infection rates were calculated as a percentage of infected cows in the lactating herd.

Reproductive Performance and Culling. Heat detection and herd pregnancy rates were collected from the DHIA records for 2 yr prior to housing in a compost dairy barn and at least 1 yr after housing the cows in

a compost dairy barn (until March 2006 for all dairies). The percentage change of each variable was calculated for each farm when data were available. Culling (herd turnover) rates were calculated for 7 of the herds before and after housing in a compost barn where data were available.

Analysis of Bedding Material. Bedding samples were collected for bacterial analysis. Each barn was divided into 12 equally sized regions. A composite of 4 bedding surface samples (top 5 cm) was collected in each of the 12 areas within the barn immediately prior to milking, when the exposure to mastitis causing pathogens was expected to be the greatest. The bedding samples were immediately cooled and later frozen until analysis by the Laboratory for Udder Health, University of Minnesota. The samples were thawed in a refrigerator. Fifty cubic centimeters of bedding material was measured using a sterile container and placed into a Whirl-Pak bag (Nasco, Fort Atkinson, WI). Two hundred fifty cubic centimeters of sterile distilled water were added to the bedding material, which was mixed and allowed to stand for 10 min. The sample was mixed again, a subsample was removed, and serial 10-fold dilutions were made in sterile Brain Heart Infusion broth. Sample dilutions were plated (200 μ L) on colistin naladixic acid agar (BBL, Sparks, MD), MacConkey agar (BBL), and TKT agar medium. Colony counts were determined for each sample after 24 h of incubation at 37°C. Bacterial groups were identified as coliforms (lactose-positive colonies on MacConkey's agar), *Streptococcus* species (growth on TKT agar) and CNS (growth on the colistin naladixic acid agar and catalase activity). Bacteria counts are expressed as colony-forming units per milliliter of bedding sample (Gabler et al., 1998).

Statistical Analysis

Descriptive statistics (mean, SD, and range) were used to describe individual herd characteristics (Microsoft Excel, Microsoft Corp., Redmond, WA). The PROC ARIMA modeling technique of the time series analysis of SAS (SAS Inst. Inc., Cary, NC) was utilized to analyze the impact of moving cows from the previous housing system to a compost barn on mastitis infection rates, 305 mature equivalent milk production [adjusted 305-d mature cow equivalent milk production (i.e., all lactation milk yield values for 305 d, 2 $\times$ milking, standardized for age, month of calving, and previous days open)], milk components (% milk fat and % milk protein), heat detection rates, pregnancy rates, and milk bulk tank SCC. Milk bulk tank SCC (BTSCC) was transformed to a linear score for each value prior to statistical analysis.

Figure 1. Compost dairy barn layout (not to scale) for 75 cows with 2 walkways, drive-by feeding, and 2-m overhang. Waterers are against the concrete wall separating the compost bedded pack area from the feed alley and are accessed from the feed alley only (adapted from Janni et al., 2006). Adapted with permission from the American Society of Agricultural and Biological Engineers (ASABE).

RESULTS AND DISCUSSION

Compost dairy barns are a loose-housing system with a large bedded area (resting area) separated from a feed alley by a 1.2-m high concrete wall (Figure 1). There was some variation in barn layout, but the majority of barns were built like a 3-row free stall barn, with or without a roof over the feed lane. One barn was built more like a 4-row barn with a drive-through center feed lane. The previous housing system for the farms enrolled in the current study was a tie stall barn bedded with straw, with the exception of 1 dairy that had a free stall barn with mattresses. All the compost barns were newly built.

The average herd size was 73 ± 35.5 (mean $\pm$ SD) cows (1 farm had a separate herd in another housing system). Nine of the herds consisted of Holstein cows, whereas 3 herds had mixed breeds. The DHIA rolling herd average (RHA) was $10,457 \pm 1,138$ kg (range of 8,321 to 12,411 kg) and milk composition was $3.69 \pm 0.37\%$ milk fat and $3.06 \pm 0.15\%$ milk protein for the DHIA test nearest to the date of the farm visit. The DHIA SCC was $325,000 \pm 172,000$ cells/mL. The BTSCC for the month prior to our visit was $261,000 \pm 98,000$ cells/mL.

Management Practices

Bedded Pack. The pack (resting) area was typically bedded with dry fine wood shavings or sawdust. The bedding material was aerated to a depth of 18 to 24 cm twice daily while cows were away at the parlor, most

often using a modified cultivator on a skid loader or small tractor. It was recommended that the bedded area provide at least 7.4 m^2 of resting space per cow (Janni et al., 2006). The average resting space for the 12 compost barns we studied was $8.6 \pm 2.6 \text{ m}^2$ per cow.

Typically, a semitruck load of fresh dry sawdust (approximately 14 metric tons) was added every 2 to 5 wk, varying by season, weather conditions and cow density. Some dairies preferred to add a smaller amount of sawdust more frequently, such as once weekly. Typically no bedding material was removed from the pack area during the year, except in fall and spring. The bedded pack area was cleaned out entirely once annually in September or October. A load of clean sawdust was added after removal of the soiled bedding to provide a bedding layer 30 to 45 cm high to start the new pack. By the end of summer, most packs averaged 120 cm high. Several farms removed a portion of the pack material in the spring to provide space for bedding accumulation during the summer. The soiled bedding was spread on the fields according to the farm manure management plan. Two producers piled the spent bedded material to produce finished compost.

Dry Cows. All herds treated all cows with a dry cow treatment at dry-off. The target dry period length was 45 d for 2 dairies and 60 d for 10 dairies. Dry cows were housed on pasture, in a separate or the same area of the compost barn as the lactating cows, or in an alternative housing area.

Feeding. Eleven of the herds were fed a daily TMR under the recommendations of a nutritionist and 1 pro-

ducer formulated the ration for his herd. Two producers allowed the herd to graze on pasture and 1 of the 2 herds fed free-choice baleage. Diets most often contained processed high-moisture or dry corn, hay or haylage, corn silage, and a concentrate or protein mix. Some diets included oats, sunflower seeds, sunflower meal, soybeans, whole cottonseed and minerals as individually added components. The NDF content was $32.3 \pm 1.5\%$ of DM (range of 30.3 to 35.7%). The CP content was $17.0 \pm 0.6\%$ of DM (range of 16.2 to 17.7%).

Cows were fed the TMR once or twice daily. Feed was pushed up by the person responsible for feeding the cows zero to 6 times per day between feedings. Nine farms mixed the ration with a vertical mixer. Three farms utilized a horizontal mixer. Forages were stored in bags, bunkers, or stave silos. Concentrates were stored in commodity sheds.

Milking. All herds used a complete milking routine, and milked cows twice daily. In general, recommended udder sanitation practices such as the use of predrip, forestripping, individual drying towels and postdrip were highly adopted. Two producers washed udders rather than using a predrip prior to milking. One producer used 1 towel to dry 2 cows. Most of the compost barns had a milking parlor. Two herds were milked in old tiestalls and 2 herds were milked in a tiestall barn that was modified into a flat barn 8-stall parlor. The other herds built or modified barns into a double-10 or double-12 swing parlor, a double-6 herringbone parlor, a double-6 step-up flat barn parlor, a double-8 parallel parlor, or a double-8 parabone swing parlor.

Three of the producers utilized bST for their lactating herd. One producer used bST only on late lactation problem breeder cows. Two producers started most cows on bST around 70 DIM.

Tail Docking. Four producers used tail docking as a management tool. Two producers tail docked their cows once they entered the lactating herd. Another herd tail docked calves at birth. One producer only tail docked cows as needed.

Reproduction. One herd was bred mainly by herd bulls, whereas all of the other herds solely used AI. The reproductive protocol of 7 herds consisted of a voluntary waiting period of 45 to 50 d and watching for natural heats. One producer made use of alert patches on the rump of the cows to assist in heat detection. Additionally, 1 producer utilized a mating service to select 6 bulls for their herd to be bred to each year. Three herds used hormones in their reproductive protocols. One herd used LH only if a cow was not pregnant by 150 DIM. One producer utilized GnRH and PGF_{2α} on the advice of the herd veterinarian during herd health check-ups. One producer applied the OvSynch protocol to their entire herd.

Hoof Trimming and Footbath Protocols. Hooves were trimmed as needed (farms performed hoof trimming when the manager decided cows needed it because of hoof overgrowth or lameness). One producer had all hooves trimmed prior to dry-off and another producer had all hooves trimmed once annually. Footbaths were utilized periodically on 2 farms. One farm used a footbath only 3 to 4 times annually with a copper sulfate mixture. The other producer used the footbath only as needed.

Cow Welfare

Most cows in all compost dairy barns were scored for body condition, hygiene, locomotion, and hock lesions. The average BCS for all cows ($n = 726$) was 3.04 ± 0.11 (range of 2.88 to 3.17). Cow hygiene scores ($n = 786$) were 2.66 ± 0.19 (range of 2.3 to 2.9). In a recent study of 50 herds having freestalls (M. I. Endres and L. A. Espejo, Univ. Minnesota, St. Paul; unpublished data), observed that cow hygiene scores were 2.82 ± 0.5 . It appears that cow hygiene was not negatively impacted by housing cows in a compost dairy barn.

Overall, 7.8% of cows ($n = 793$) were clinically lame (locomotion score ≥ 3), with 2 herds having no lame cows. Lameness prevalence for individual herds ranged from 0 to 22.4%, with an interquartile range of 3.0 to 11.0%. The herd with the highest prevalence of lameness previously housed half of the cows in a poorly designed free stall barn, and cows might have been recovering from injuries sustained in that housing system. In addition, producers indicated that they were able to keep lame cows in the herd longer because they were able to more easily stand up and lie down on the bedded pack area. The average prevalence of lameness in compost dairy barns was much lower than the 24.6% (Espejo et al., 2006) and 27.8% (Cook, 2003) prevalence recently reported in freestall barns; and the 19.6% observed in tiestall herds (Cook, 2003).

Overall, 25.1% of cows ($n = 796$) exhibited a hock lesion, with 24.1% having hair loss and 1.0% having a swollen hock. The prevalence of hair loss ranged from 2.0 to 43.9%, with an interquartile range of 12.2 to 34.0%. The prevalence of severe lesions (swollen hocks) ranged from 0 to 3.3% with an interquartile range of 0 to 1.9%. Seven herds had no severe lesions. Hock lesions that occurred in the previous freestall, tiestall or stanchion barn were most likely still present or healing in the compost barn. Weary and Taszkun (2000) reported that 73% ($n = 1,752$ cows) of cows housed in freestalls had at least one hock lesion, nearly 3 times the prevalence we observed in compost barns. Furthermore, Endres et al. (2005) observed in freestall herds ($n = 5,328$ cows) that 14.1% of cows housed on mattress based

freestalls and 1.8% of cows on sand-based freestalls had swollen hocks. Results on the prevalence of lameness and hock lesions in the current study suggest that cow welfare in compost barns could be better than in stall systems. Nonetheless, lameness and hock lesion prevalence data from the previous housing system in these farms were not available for a direct comparison.

Milk Production

Historical DHIA data were available for 9 of the dairies. The data included 2 yr of DHIA test information prior to building a compost barn and all test data (until March 2006) since the cows had been housed in this system. Therefore, 1.5 yr or more of data after housing in the compost dairy barn was available for most herds, with the exception of 1 herd, where 1 yr of data was used. Eight of the dairies had an increase ($P < 0.05$) in 305-d mature equivalent milk production. The increase was 955 ± 315 kg/cow per year (range of 395 to 1,331 kg/cow per year). One farm had a reduction ($P < 0.05$) in milk of 570 kg/cow per year. This dairy added several Jersey cows to their Holstein herd when they built the compost dairy barn, which likely reduced their average milk production. It appears that the potential improved cow comfort in compost dairy barns could result in increased milk production. Still, other changes probably occurred in the process of changing to the new housing system that could have contributed to the observed increase in milk production.

The milk fat content of the 9 dairies was $3.77 \pm 0.31\%$ prior to building the compost barn and $3.88 \pm 0.22\%$ after moving cows to a compost barn. Three dairies had an increase ($P < 0.05$) of 9.8% (range of 4.1 to 15.9%) in milk fat content. The milk protein content of the 9 dairies was $3.13 \pm 0.12\%$ prior to being housed in a compost barn and $3.21 \pm 0.10\%$ after moving cows to a compost dairy barn. Three farms had an increase ($P < 0.05$) of 3.5% (range of 2.9 to 4.2%) in milk protein content. These observations deserve further and more definitive investigation.

Milk Quality

The average DHIA SCC for the test date nearest to each farm visit was $325,000 \pm 172,000$ cells/mL (range of 88,000 to 658,000 cells/mL). The state average SCC for Minnesota herds enrolled in the DHIA was 357,000 cells/mL for Holsteins in 2005 (MN DHIA, 2006), slightly greater than herds in the current study. The total bacteria count (TBC) serves as an estimate of farm sanitation efficacy, overall udder health, and proper milk handling and storage temperatures (Hayes et al., 2001). The TBC for the herds was 3,420 cfu/mL

Figure 2. Average bulk tank SCC (BTSCC) of 7 herds before and after being housed in a compost barn. Gray = average bulk tank SCC prior to compost dairy barn housing; black = average bulk tank SCC after moving cows to a compost dairy barn. * $P < 0.01$.

(range of 180 to 16,633 cfu/mL). The single farm above 6,000 cfu/mL (16,633 cfu/mL) was going through a transition period while building a new milking parlor, and therefore, sanitation and milking routines were probably compromised, negatively affecting the TBC of the herd. Rodrigues et al. (2005) reported a TBC ($n = 92$ farms) of 15,392 cfu/mL in Wisconsin, much higher than was documented in the current study.

In general, a low level of contagious pathogens was detected in the milk bulk tank samples. One out of 12 farms had a high level of *Streptococcus agalactiae*, 1 farm had a high level of *Staphylococcus aureus*, 6 farms had high levels of nonagalactiae streptococci, and 5 farms had high levels of coliforms (i.e., *Escherichia coli*, *Klebsiella*, and *Enterobacter*) in the milk. *Mycoplasma* was not isolated from any of the bulk tank milk samples. There was no association between high BTSCC and level of contagious pathogens in the herd, contrary to what has been found in other studies (Elbers et al., 1998; Rodrigues et al., 2005). It is possible that herds in the current study were discarding milk from chronically infected cows; therefore, the association was not found. More research is needed in this area.

The TBC found in the bedding was 9,122,700 cfu/mL (range of 2,035,562 to 22,562,604 cfu/mL). Type and number of bacteria in the bedding material are related to the total bacterial load on the teat ends and rates of clinical mastitis in lactating dairy cows (Hogan et al., 1989). Therefore, effective cow preparation procedures at milking time are essential for achieving high quality milk in this housing system.

Historical milk bulk tank data were available for 7 of the dairy farms and were utilized to measure the milk quality of the dairies. One producer did not milk cows prior to building the compost dairy barn, and the data prior to building the barn were not accessible for the other 4 dairies. Three of these 7 dairies had a shift downwards in BTSCC ($P < 0.01$; Figure 2). Two of these

Figure 3. Average DHIA mastitis infection rates for 9 herds before and after being housed in a compost dairy barn. Gray = average mastitis infection rates prior to compost dairy barn housing; black = average mastitis infection rates after moving cows to a compost dairy barn. * $P < 0.05$.

3 dairies had a decrease ($P < 0.01$) in day-to-day BTSCC variation. One dairy that did not have a significant decrease in BTSCC only had 2 mo of data prior to building the compost barn and also had only 1 of their 2 herds on the bedded pack, with both herds milked into one bulk tank. The reduction in BTSCC in the 3 dairies was $90,310 \pm 50,340$ cells/mL (range of 32,600 to 125,100 cells/mL). One herd had an increase ($P < 0.01$) of 54,600 cells/mL. This herd also had an increase in variation. Effective management of the bedded pack and milking parlor and excellent cow preparation procedures at milking time appear essential for achieving low BTSCC.

Udder Health

A comparison of mastitis infection rates before and after housing the herds in a compost barn was performed for 9 of the dairies as an indicator of udder health. Three farms were not analyzed because one was not a member of DHIA, one did not move cows from another type of housing, and one did not keep sufficient records prior to building a compost barn. Six of the 9 dairies had a reduction ($P < 0.05$) in herd mastitis infection rates (Figure 3) with an average reduction of 12.0% (range of 6.6 to 19.6%). Three of the dairies had a decrease ($P < 0.05$) in variation as well. One herd had an increase ($P < 0.05$) of 3.6% in mastitis infection rates. The overall mastitis infection rate was 35.4% prior to moving cows to a compost barn and 27.7% after cows were moved to the compost dairy barn. The 2005 DHIA average percentage of cows infected in herds was 32 (MN DHIA, 2006).

Studies have shown that housing lactating cows in a conventional straw yard was a risk factor for clinical mastitis (Peeler et al., 2000; Ward et al., 2002). Other studies reported no difference or an increase in mastitis infection rates in cows housed in straw yards compared

with cubicle housing (Fregonesi and Leaver, 2001). It appears that the practice of aerating the pack to help dry the surface and incorporate manure into the pack might help achieve better udder health in a compost dairy barn than in a conventional bedded pack.

Reproductive Performance and Culling

A comparison of heat detection rates and pregnancy rates before and after housing cows in a compost dairy barn was possible for 7 of the dairies, where complete data were available. The heat detection rate for the 7 dairies was $36.9 \pm 6.5\%$ prior to being housed in the compost barn and $41.4 \pm 7.2\%$ after being moved to the compost barn. The heat detection rate for herds with similar RHA in Minnesota for 2005 was 38% (MN DHIA, 2006). Four of the 7 dairies had an increase ($P < 0.05$) in heat detection rate of 20.3 to 32.8%, with an average increase of $25.9 \pm 5.8\%$. The pregnancy rate for the 7 dairies prior to being housed in a compost barn was $13.2 \pm 1.7\%$, similar to the Minnesota average of 13% (MN DHIA, 2006), and $16.5 \pm 2.7\%$ after moving cows to a compost barn. Five farms had an increase ($P < 0.05$) in pregnancy rate of 21.9 to 48.6%, with an average increase of $34.5 \pm 10.6\%$.

Annualized culling (herd turnover) rate was $25.4 \pm 10.7\%$ before cows were housed in a compost barn and $20.9 \pm 11.7\%$ after cows were moved to a compost dairy barn. Percentage of the herd removed prior to 60 DIM was $7.1 \pm 4.2\%$ and $6.2 \pm 3.8\%$ before and after moving cows to a compost barn, respectively.

Producer Satisfaction with the System

Qualitative responses regarding the reasons for building a compost barn and concerns for future producers to consider were similar among all producers. All producers identified cow comfort as the main reason for building a compost barn, along with increased cow longevity and ease of completing daily chores. Some producers opted for this housing system because of the reduced initial investment cost compared with a free-stall barn. The main concerns were centered on the cost and availability of the bedding material, particularly as additional barns are built. A few producers mentioned concerns of high levels of dust during the initial days after addition of fresh bedding, which may predispose the cows to eye irritation or pneumonia. Overall, all producers were satisfied with their compost dairy barn.

Economic Implications

Bedding costs in compost dairy barns can be high. The material purchase price ranged from \$0.35 to \$0.85/

cow per day. Yet, some of the observed cow comfort benefits, such as low lameness prevalence, could help offset these costs. The total cost per case of lameness was estimated at \$404 (C. Guard, Cornell University, Ithaca, NY; personal communication). Therefore, a reduction in lameness cases could result in significant financial benefit. Data for lameness prevalence for the dairies in the current study prior to moving to the compost dairy barn were not available, but as indicated previously, lameness prevalence in other types of dairy housing systems in Minnesota and Wisconsin was reported greater than the prevalence observed here. In addition, dairy processor bonuses or premiums for milk with low SCC could increase the price of milk. For example, using the average change in BTSCC for the 3 herds that had a significant reduction in BTSCC, there was a \$0.21 increase in bonuses received per hundred-weight at 3.0% milk protein, with a range of \$0.06 to \$0.30 (bonus values from First District Association, milk processor, Litchfield, MN). The average RHA of these 3 dairies was 10,890 kg. Using the calculated milk quality premium value increase of \$0.21 per hundred-weight (\$0.46 per 100 kg) could result in approximately \$50 increase in profit per cow per year, with a range of \$13.77 to \$79.60 increased profit per cow per year for the 3 herds. The decrease in SCC can result in increased milk production, providing another cost advantage of lowering BTSCC. Other economic benefits could be attributed to improvements in reproductive performance.

CONCLUSIONS

Based on the results of this descriptive study, it appears that the main objectives for building a compost bedded pack barn for dairy cows (cow comfort, cow longevity, and ease of chores) are being achieved. Our observation of low prevalence of hock lesions and lameness helped to substantiate the goals of the producers for using this housing system. Producers utilizing compost barns for their lactating dairy cattle practice many of the same management techniques used on other conventional dairy farms. Overall, producers were satisfied with this housing system. Special attention to cow preparation procedures at milking time are a must for achieving satisfactory milk quality when cows are housed in compost dairy barns. Additional research is needed to address a main area of concern on what alternative bedding sources can be utilized in this system. In addition, air quality and possible dust issues in compost dairy barns need to be evaluated.

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