Bedding Options for Dairy Cows

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Take-Home Messages

- Cows need a soft, dry, comfortable surface to rest on in order to be healthy and productive.
- Bedding is an important factor influencing cow comfort and lying time, and consequently milk production and dairy farm profitability.
- Bedding is also an economic consideration in a dairy enterprise.
- Deep bedded stalls provide better comfort than mattresses with small amounts of bedding.
- Best bedding options for freestalls in priority order based on observational studies on cow welfare – deep sand, deep recycled manure solids, solids on top of mattresses (different levels of comfort depending on the type of mattress), other organic materials on top of mattresses.
- Best bedding options for compost bedded pack barns based on demonstration studies and producer experiences – dry sawdust, wheat straw dust, mix of wood chip fines and sawdust, mix of wood chip fines and ground soybean straw, ground corn cobs, flax chives, ground soybean straw, and ground rye straw.

Why use bedding?

Providing a clean, dry, and comfortable surface for cows to rest on is important to the well-being of dairy cows as they spend 10-12 hours per day resting (Haley et al., 2001). Comfortable stalls are those which do not interrupt the natural movements of rising and lying behaviors. Several animal-based measurements such as cow preference, standing and lying behaviors, and the prevalence of lameness and hock lesions have been used to evaluate the comfort of freestalls. Observed differences in these measurements are often associated with stall surface, design, dimensions, and bedding management (Cook, 2003; Tucker and Weary, 2004). Bedding is an important factor influencing cow comfort and lying time, and consequently milk

WCDS Advances in Dairy Technology (2012) Volume 24: 361-369

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Research has shown that when cows were given softer resting surfaces they spent more time resting and less time standing (Haley et al., 2001). Greater amounts of bedding material provided on top of mattresses improved cow comfort as measured by lying times and cow preferences (Tucker and Weary, 2004).

■ Mattresses vs. Deep Beds

Decreased lying comfort and the use of mattresses as a stall base have been implicated as risk factors for lameness (Dippel et al., 2009), which is considered one of the greatest welfare concerns in the dairy industry. Lameness was found to be less prevalent in herds using deep bedded sand stalls than herds using mattresses (Cook, 2003). Cow comfort, as measured by the cow comfort index was greater for cows in deep bedded sand stalls than for cows housed on mattresses (Cook et al., 2005). Deep bedded stalls with either sand or sawdust bedding were preferred by cows compared to mattresses with 2 to 3 kg of sawdust (Tucker et al., 2003).

Stall surface has also been shown to affect the prevalence of hock lesions, which are indicative of inadequate lying surfaces. Lesions were observed less frequently in cows housed in deep bedded sand stalls than cows on mattresses (Fulwider et al., 2007).

In a study we conducted in 50 randomly selected freestall herds in Minnesota, we found that the prevalence of lameness (proportion of cows with locomotion score ≥3 on a 1-to-5 scale, where 1 = normal and 5 = severely lame) was greater for herds with mattresses (27.9%) than herds with deep beds (17.1%). Sand offers more cushion and traction than mattress surfaces with limited amounts of bedding. In addition, hock lesion prevalence (proportion of cows with a lesion score ≥ 2 on a 1-to-3 scale where 1= normal, 2 = hair loss, and 3 = swelling) was 71% for mattresses, 29% for deep beds. The severe hock lesion prevalence (score 3) was 14% for mattresses and 2% for deep beds. The odds of having a hock lesion were 9.12 times higher for cows on mattresses than cows on deep sand.

■ What About Using Recycled Manure Solids for Bedding Freestalls?

Animal Welfare

The welfare of dairy cows across various housing systems has been documented (Fulwider et al., 2007). However, little if any information exists

regarding the welfare of cows bedded with recycled manure solids. Increased costs and reduced availability of other common bedding sources has prompted many dairy producers to search for more feasible alternatives such as sand or manure solids. Although sand can be considered the ideal bedding source for dairy cows, not all producers are willing and able to convert to sand bedding as it presents some challenges related to manure management. There is growing interest in manure solids for bedding and information is lacking related to its use on farms and influence on the welfare of dairy cows. Therefore we conducted a study with the objective of describing animal welfare and investigating the association between stall surface and various animal welfare measurements (locomotion, hock lesions, hygiene, mortality, herd turnover rates, milk production, and clinical mastitis incidence) in herds using manure solids as bedding for dairy cows.

The study included 34 dairy operations with herd sizes ranging from 130 to 3700 lactating cows. Forty five percent of the herds had mattresses and 55% had deep bedded stalls. Farms were visited once in the summer. At the time of visit, approximately 50% of the cows in all lactating pens were scored for locomotion, hygiene, and hock lesions. On-farm herd records were collected for the entire year and used to investigate mortality, culling, milk production, and mastitis incidence.

Stall surface was associated with lameness and hock lesion prevalence. Lameness prevalence (locomotion score ≥3 on a 1 to 5 scale) was lower in deep bedded freestalls (14.4%) than freestalls with mattresses (19.8%). It is interesting to note that lameness prevalence, even for farms using mattresses, was similar to lameness prevalences we have observed in herds with deep bedded sand stalls. Severe lameness prevalence (locomotion score ≥4) was also lower for cows housed in deep bedded freestalls (3.6%) than for cows housed in freestalls with mattresses (5.9%). Again, those prevalences are similar to what we have found in sand-based freestalls. Producers were using large quantities of solids on top of mattresses because the bedding material is readily available.

In addition, the prevalence of hock lesions (hock lesion scores ≥2 on a 1 to 3 scale) and severe hock lesions (hock lesion score = 3) was lower in herds with deep bedded freestalls (49.4%; 6.4%) than in herds with mattresses (67.3%; 13.2%). Herd turnover rates were not associated with stall surface; however, the percentage of removals due to voluntary (low production, disposition and dairy) and involuntary (death, illness, injury, and reproductive) reasons was different between deep bedded and mattress based freestalls. Voluntary removals averaged 16.1% of all herd removals in deep bedded herds, whereas in mattress herds these removals were 7.9%. Other welfare measurements such as cow hygiene, mortality rate, mastitis incidence, and milk production were not associated with stall surface.

Factors Associated with SCC

One major concern expressed by producers considering the use of manure solids for bedding is the possibility of increased somatic cell count (SCC). Therefore we investigated the association of SCC with various management and herd risk factors in 38 farms using manure solids for bedding freestalls. Bedding, milk, and feed samples were collected, cows were scored for hygiene, hock lesions, and locomotion, management practices were recorded, and milking preparation procedures were observed. Our goal was to collect as much information as possible during the farm visit and from farm records throughout the year. In the end, 23 variables were used for our analysis of their association with bulk tank SCC.

We found that yearly average bulk tank SCC was 275,000 cells/mL (range - 121,000 to 688,000 cells/mL). This average is not very different from the average in the region (~290,000). Eighteen percent of the herds had a yearly bulk tank SCC less than 200,000 cells/mL and 9% had more than 400,000 cells/mL. Digested manure solids were used on 23 (68%) farms, 7 (21%) farms used separated raw manure solids, and 4 (11%) farms used mechanically composted manure solids. All herds used pre and post-milking teat disinfection, individual towels for drying udders, and routine dry cow therapy at dry off.

The type of manure solids used – digested, raw or composted – had no association with SCC. Some might find that surprising. Interestingly, although coliform counts in fresh bedding were zero for composted solids, 1,100 cfu/mL for digested solids, and 16,000 cfu/mL for raw solids, once the materials were used in the stalls coliform counts were similar for all three bedding types (approximately 145,000 cfu/ml).

Percentage of culls due to mastitis, type of stall surface (deep bed vs. mattress), presence of contagious pathogens in milk, bedding frequency, presence of fans over the freestalls, use of automated scrapers, and stall bedding pH, NDF, non-fiber carbohydrates, total carbon and ash content were not associated with SCC.

The variables associated with SCC were cow hygiene scores, environmental Streptococci and coliform bacterial counts in bulk tank milk samples, type of housing facility used for dry cows, and stall bedding moisture, total N, and total bacterial counts. These variables can be considered risk factors for high SCC; however, they are not necessarily causally related to SCC. But they do suggest things to pay close attention to when using manure solids for bedding.

Cows in this study were on the average cleaner than any other freestall study we have conducted. In spite of this, cow hygiene was still a significant risk

factor for high SCC. The lowest percentile herds for SCC (which averaged 186,000 SCC) had an average hygiene score of 2.38 (1-to-5 scale where 1 = clean and 5 = very dirty); the highest percentile herds (average of 430,000 SCC) had an average hygiene score of 2.62. Cleaner cows are easier to prepare prior to milking and are less susceptible to mastitis. Stall maintenance and speed of moving cows to the parlor can influence cow hygiene.

Counts of coliforms and environmental Streptococci in bulk tank milk are indicators of the quality of milking practices and milking equipment sanitation. Coliform counts in particular are often used to assess the effectiveness of cow preparation at milking time since the primary source of coliform bacteria is dirty teats.

Stall bedding moisture was 45.5% for the lowest percentile herds and 59.5% for the highest percentile herds. Moisture is one of several essential factors necessary for bacterial growth in bedding materials. Therefore, it is important to keep bedding as dry as possible to minimize exposure to environmental mastitis pathogens. Additional methods to help dry stall bedding (use of a blower, good barn ventilation, adding equipment to remove moisture after separation) could help reduce stall bedding moisture.

In conclusion, excellent cow preparation at milking time, sanitation of milking equipment, cow hygiene, adequate dry cow housing, and bedding/stall management appeared to be critical in maintaining a low SCC when using manure solids for bedding and making it work. These practices are important when using any type of bedding and even more so with recycled manure solids.

■ What About Bedding for Compost Bedded Pack Barns?

Compost bedded pack dairy barns are an alternative loose housing system for dairy cows. Most of the commercial dairy facilities of this type in the state of Minnesota consist of a large bedded pack resting area that is separated from a concrete feed alley by a 1.2-m high concrete wall. They can be laid out for drive-by feeding, covered drive-by feeding, or drive-through feeding with pens on both sides. They can also be used with feed bunks outside. Bedding material is added when bedding in the pack is visually adhering to the cows. Bedding can accumulate in the pack up to 1.2 m deep. Unlike conventional bedded packs, compost packs are tilled twice daily to incorporate the manure to provide a fresh, dry surface when cows return from the parlor. Various types of equipment can be used for tilling, including cultivator, rotary tiller, and chisel plow, and the depth of tilling is usually approximately 25 cm. The main goals for building this type of barn are improved cow comfort, health, and longevity, and ease of completing daily chores (Barberg et al., 2007).

Availability of bedding material for compost bedded pack barns is a concern for dairy producers who use this type of alternative housing system. The material most commonly used in these barns is dry sawdust. We conducted a descriptive study with the objective of evaluating different types of bedding material that could potentially substitute or partially substitute for sawdust in these housing systems. The study was conducted at the West Central Research & Outreach Center in Morris, Minnesota. Materials included: pine sawdust, corn cobs, pine woodchip fines, and soybean straw. Some of these materials were evaluated as mixtures on a 2:1 volume-to-volume ratio. These mixtures included: woodchip fines/sawdust (WC/SD), woodchip fines/soybean straw (WC/SS), and soybean straw/sawdust (SS/SD). Experimental bedded packs were used and 16 cows were placed on each pack. Replicated samples of the bedded pack material were collected twice a month and analyzed for dry matter; C:N ratios and pH were analyzed monthly. Temperatures of each pack were measured weekly at various depths (15.2, 30.5, 45.7, and 61.0 cm). Cows were scored for hygiene (1=clean, 5=dirty) twice a month.

We found that moisture content of sawdust was 59.7%; corn cobs, 44.5%; WC/SD, 60.6%; SS/SD, 58.2%; WC/SS, 60.7%; and soybean straw, 60.6%. Sawdust pH was 8.7; corn cobs, 7.7; WC/SD, 8.6; SS/SD, 8.6; WC/SS, 8.3; and soybean straw, 8.6. The C:N ratio of sawdust was 37.3; corn cobs, 29.2; WC/SD, 47.5; SS/SD, 25.6; WC/SS, 31.0; and soybean straw, 22.8. Hygiene score of cows on sawdust was 2.4; corn cobs, 2.7; WC/SD, 2.5; SS/SD, 2.9; WC/SS, 2.6; and soybean straw, 2.8. Based on these results and our observations, it appeared that any of the bedding materials evaluated in the study would work in compost barns if proper bedding management is applied on a consistent basis.

In another study we described management practices of dairy operations utilizing alternative bedding materials for partial or total replacement of sawdust in their compost barns. This study was conducted on six Minnesota dairy farms having compost bedded packs. Bedding materials used on these farms included: sawdust, wood chips, flax straw, wheat straw, oat hulls, wheat strawdust (a byproduct of manufacturing boards with wheat straw), and soybean straw. Each farm was visited four times, once each season. Replicated samples of the bedded pack material were collected during winter and summer. Samples were analyzed for dry matter, carbon, nitrogen, C:N ratios, ammonium, nitrate, pH, and bacterial counts. Temperatures of each pack were measured seasonally at various depths. Cows were scored for hygiene, body condition, locomotion, and hock lesions. Aerial ammonia and hydrogen sulfide concentrations, air velocity, and light intensity were measured each season.

Overall average aerial ammonia was 3.9 ppm and hydrogen sulfide was 22.8 ppb across all farms and seasons. Average light intensity was 3,250 lux and

air velocity was 0.81 m/s. Bedding pack material averaged 15.8% for total C, 0.93% for total N, 17.8 for C:N ratio, 37.3% for dry matter, 8.83 for pH, 4.25 mg/kg for nitrate, 955 mg/kg for ammonium, 15 g/kg for total potassium, 2.8 g/kg for total phosphorus, 8.5 dS/m for EC (salts), 31.7°C for pack temperature, 7.6°C for outside temperature, and 9.42 million cfu/mL for total bacterial counts in the bedding. Based on our observations, it appeared that any of the bedding materials used by producers during the study to substitute or partially substitute for sawdust can work well in compost dairy barns.

From these studies it was concluded that ideal bedding material for compost barns should be dry, processed to less than 2.5 cm long, offer structural integrity, and have good water absorption and water holding capacity. It is important that the pack be consistently well managed by tilling twice daily and providing proper ventilation to keep surface of the pack dry. Fan placement with air flow directed at the surface of the pack appeared to result in better drying. New bedding should be quickly added to the pack as soon as the old bedding starts to adhere to the cows' hair/skin. Our observations indicate that bedding moisture should be 60% or less at all times to provide a comfortable surface.

■ Comparison of Sand Freestall and Compost Bedded Pack Dairy Barns

Using a cohort study design we investigated animal welfare in compost bedded pack barns, cross-ventilated sand freestall barns, and conventional naturally ventilated sand freestall barns. The study was conducted in 18 commercial dairy farms, six of each housing type, in Minnesota and eastern South Dakota. Farms were visited four times (once in each season) between January and November and approximately 93% of all animals in each pen were visually scored on each visit.

Outcome-based measurements of welfare (locomotion, hock lesions, body condition, hygiene, respiration rates, mortality, and mastitis prevalence) were collected on each farm. Lameness prevalence in compost barns (4.4%) was lower than in cross ventilated freestall (15.9%) and naturally ventilated freestall (13.1%) barns. Lameness prevalence was similar between the two types of freestall barns. Hock lesion prevalence was lower in compost barns (3.8%) than cross ventilated (31.2%) and naturally ventilated barns (23.9%). Hygiene scores were higher for compost barns (3.18) than cross ventilated (2.83) and naturally ventilated (2.77) barns with no differences between the two types of freestall barns. There were no differences in body condition scores, respiration rates, mastitis prevalence, culling, or mortality rates among housing systems. The freestall barns were evaluated using the cow comfort index (proportion of cows lying down in a stall divided by all animals touching a stall) and the stall usage index (proportion of cows lying divided by all

animals in the pen not eating). The cross ventilated barns tended to have greater cow comfort index (85.9%) than the naturally ventilated barns (81.4%) and had greater stall usage index (76.8% and 71.5%, respectively).

In conclusion, dairy cattle housed in compost barns had reduced lameness and hock lesions compared to the freestall barns and no adverse associations with body condition, respiration rates, mastitis prevalence, culling, or mortality. When comparing the two freestall housing options, cross ventilated barns had better cow comfort indices than naturally ventilated barns. Although cows in compost bedded pack barns had better feet and leg health as indicated by the reduced lameness and hock lesion prevalences, ability of acquiring bedding and managing the bedded pack can limit their use.

Final Thoughts

Dairy producers have various options for bedding. The decision on what type of bedding to use depends on price, availability, its effect on cow comfort, manure handling system on the farm, handling ease of the material, preference, etc. Cost of bedding freestalls can vary from 9-15 cents per cow per day for deep sand to 30-60 cents per cow per day on top of mattresses. In compost bedded packs, producers have reported spending anywhere from 40 to 95 cents per cow per day.

Acknowledgments

Projects were funded by grants from the UDSA-SARE and University of Minnesota Rapid Agriculture Response Fund. Graduate student Karen Lobeck was also funded by a Hueg-Harrison Fellowship. Other graduate students working on this research were Luis Espejo (50-herd study), Adam Husfeldt (manure solids study) and Erika Shane (compost barns study).

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