Stall Design: Enhancing Cow Comfort

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Take home messages

- Research on cow comfort examines cow preferences, stall usage, and other factors including injuries and udder health.
- For example, cows prefer to lie down on softer surfaces, they spend more time lying down on softer surfaces, and use of softer surfaces reduces injuries to both front and hind legs.
- New Canadian research is beginning to provide a sound, scientific basis for recommended stall design.

Introduction

In the last century, students in animal science were taught about traditional aspects of animal husbandry, with an emphasis on housing and management skills. Over time the field of animal science has become specialized in several areas, namely nutrition, physiology, veterinary medicine, and agricultural engineering. With specialization, we have seen tremendous advances in these areas. However, some of the more basic aspects of good husbandry, such as creating more comfortable housing systems for the animals, have been left behind in the wake of other scientific advances. Although some techniques have been developed, these are not widely known by producers, extentionists or scientists, and research in the area of cow comfort is in the early stages.

Given the lack of research on animal housing, it is not surprising that dairy producers are faced with a bewildering range of recommendations concerning suitable dimensions and surfaces for free-stalls. For example, one recent producer-oriented article (Schoonmaker, 1999) suggested that stalls for adult Holsteins should be between 120 -130 cm in width and 255 –270 cm in length, whereas another recent article (Leonard, et al., 1997) recommended a width of only 111 cm and a length of 222 cm for adult cows. Some authors recommend sand bedding (e.g. Bickert, 2000,) while many farmers still use sawdust or straw. Unfortunately, many recommendations have little scientific basis, and

some that do are derived from basic work done 20-50 years ago that may not be relevant to the modern dairy cow.

In Canada, a small group of researchers is working to change this. Our group and a few others worldwide have begun to apply modern techniques to the scientific study of cow comfort. In this paper, we describe some of the research derived from three of the most promising approaches: 1) testing cow preferences for different housing options, 2) assessing stall usage in various housing designs, and 3) assessing non-behavioral effects of housing (health, productivity, and management).

Preference testing, or asking the animal to make choices between different options, is a technique that the animal welfare research community has used since the 1970s (Fraser and Matthews, 1997). The first preference tests asked hens to choose between different types of cage flooring (Hughes and Black, 1973) and preference testing has continued to be used in design of housing conditions for agricultural animals. Preferences are of interest because they can provide insight into what aspects of housing the animal finds important. In essence, preference tests ask animals to “vote with their feet” and provide information about what is important to them through their behavior.

In our work, we use preference testing as a first phase to identify key features of the free-stall that then become the focus of our research on stall usage. Our stall usage research involves restricting animals to a certain housing feature and monitoring how this treatment affects various aspects of the animals’ behavior, such as how much time they spend lying down and even how they lie down.

If differences in housing have important effects on cow comfort (by reducing how long cows spend lying down, for example), then this might in turn affect cow health and productivity. Other effects on the cows and the management need to be considered for practical reasons. For example, bedding choices may affect not only cow comfort but also udder health. Creating a stall that is comfortable to stand in might create the unwanted side effect of more feces and urine soiling the bedding in the stall. Thus options that seem favorable in terms of cow preferences and usage need to be tested under production conditions to determine their effects on production, health and management. Using this three-part framework, we will now review some of the recent literature focusing on the effects of stall bedding as an example.

■ Bedding Preference: Using Behavior to Determine Cattle Choices

Bedding for dairy cattle has been the topic of several preference tests, all comparing different surfaces in different ways. As we review below, the general conclusion from this bedding preference literature is that dairy cattle prefer "softer" surfaces. For example, Herlin (1997) compared cow preferences for concrete, rubber mats (15 mm thick), and "comfort" mats (21 mm thick), by offering 18 cows 18 stalls, 6 stalls of each type. He found that cows were more likely to spend time lying down on comfort mats than on the rubber and, they were more likely to use the rubber than the concrete (**Figure 1**). Jensen et. al. (1988) also found that cows prefer the "softer" of the options presented to them. They compared concrete with a brand of mattress (Enkamat K), both covered with straw, using three groups of 14 cows, each presented with 14 stalls (seven of each type). The cows spent more time in the concrete stalls when stalls were freshly (and more deeply) bedded with straw, but cows preferred the Enkamat K stalls when straw bedding is minimal. O'Connell and Meaney (1997) compared four treatments: 1) concrete and sawdust, 2) concrete and paper, 3) mattresses (Enkamat) and sawdust, and 4) mattresses (Enkamat) and paper, using 64 cows sixteen stalls of each type. Cows preferred to lie down in the stalls bedded with mattresses and sawdust and were least likely to use the concrete stalls with paper. Finally, the results of Gebremedhin et al. (1985) illustrated a preference by cows for stalls with more bedding. They found that cows were more likely to lie down in stalls when these had more bedding (achieved by adding a bedding retainer), regardless of whether the stall base was concrete, mat or carpet.

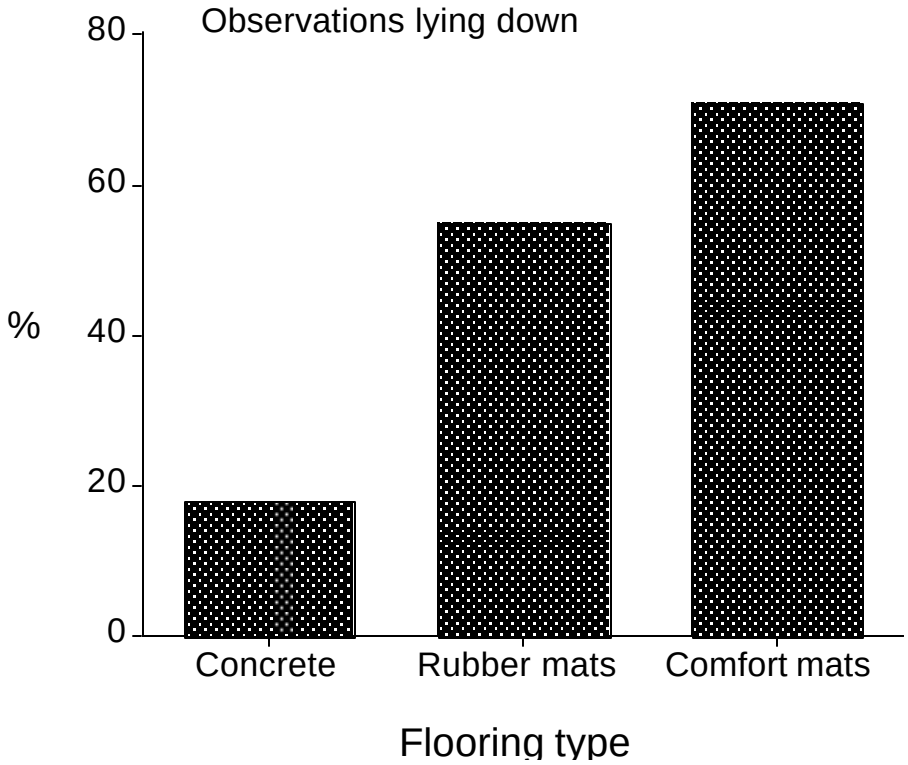

Figure 1: Preferences of 18 animals for 18 stalls, 6 of each surface. Cows were more frequently observed lying down in stalls with softer surfaces. Adapted from Herlin,1997

Two other studies have investigated bedding preferences of dairy cows by comparing different types of commercially available mats or carpets. The most recent experiment of this type compared 11 different types of mats or mattresses (Sonck et al., 1999). The different bedding surfaces were dispersed throughout a barn and thirty focal animals were followed to determine preferences. However, the authors do not determine that all focal animals had actually tried all 11 surfaces. This omission makes it difficult to conclude that the animals actually prefer a given surface.

A second experiment also compared three stall surface materials: a solid rubber mat, a layered mat (Cow Cushion), and carpet. After being restricted to each surface, cows were allowed access to all stalls. The authors conclude that the cows prefer the layered mat, relative to the carpet and rubber mat (Natzke et al., 1982). One problem with this study is that stall surface was confounded

with a particular area of the barn (the different stall surfaces were grouped in different areas of the barn). Thus an apparent preference for a particular surface may have actually been a preference for one area of the barn.

All of these results indicate that cows prefer stalls with softer surfaces. There is obviously variation in preference testing methodologies, and some are better than others in assessing cattle choice. Most importantly, preference testing must involve a choice between at least two options. But how does housing affect cows when they do not have a choice?

■ Stall Usage: Assessing Bedding Comfort with Cow Behavior

Several researchers have measured stall usage, when the animals have no choice between surfaces, to assess how different bedding types affect behavior. An important first step in assessing cow comfort is an understanding of how a cow behaves when she is comfortable. Haley et al. (2000) used a simple comparison between a space considered "high comfort" (a large box stall with mattresses) and a stall that represented "low comfort" (a tie stall with concrete flooring). They measured many behaviors including lying, standing, and eating times, the number of times the cows stood up, and various leg positions during lying. Lying times were four hours longer and cows were more willing to stand up and change positions in the high-comfort housing. Cows also spent more time standing idle in the low-comfort stalls (**Figure 2**). This study tells us which behavioral measures are likely to change if a cow is uncomfortable, namely, time spent lying and standing, and the number of times she is willing to stand up.

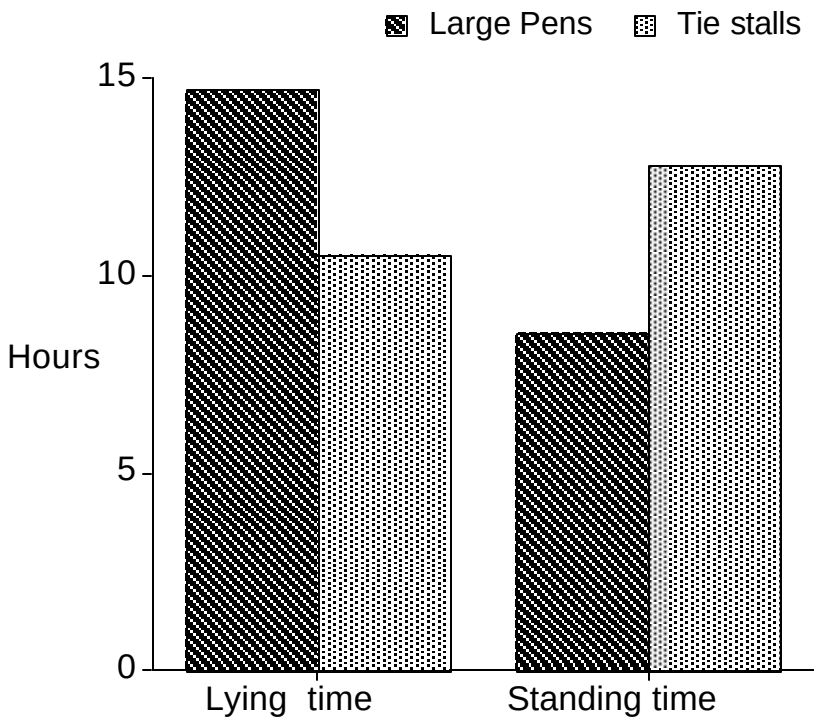

Figure 2. Cows spent more time lying and less time standing in large pens bedded with mattresses (high comfort) than in concrete tie-stalls (low comfort). Adapted from Haley et al., 2000.

Other studies have found differences in these "comfort" behaviors when comparing different stall surfaces. Muller and Botha (1997) measured how cows responded to three different bedding types: deep-bedded sand, tires covered by sand and wood planks. Some straw was added to all three surfaces. Cows spent less time lying down when forced to use the stalls covered with wood planks. Stalls with deep-bedded sand and sand over tires had comparable lying times. Unfortunately, stall surface may once again have been confounded with location in the barn. Chaplin et al. (2000) compared two types of mattresses; one made of ethylethene vinyl acetate and the other of loose rubber crumb with a polypropylene cover. Cows spent more time lying and ruminating on the rubber crumb mattresses. Another recent study compared cow behavior on two surfaces, concrete and mattresses, both covered with a small amount of straw (Pajor et al., 2000). Lying times were, on average, one and half hours longer in the tie-stalls bedded with mattresses as compared to concrete. Cows were also less willing to stand up in the tie-stalls with concrete flooring.

In summary, these stall usage results indicate that 1) cows spend more time lying down in more comfortable stalls, and 2) cows spend more time lying down on softer stall surfaces. However, in order for producers to make informed decisions about stall design, we also need to understand some of the longer term effects of stall features such as those on health, production and stall management.

■ Non-Behavioral Parameters: How Bedding Can Influence Health, Productivity, and Management

What effects can stall design have on cow health, productivity, and barn management? Creating a comfortable stall allows the cow to spend more time lying down, potentially affecting the cow in a number of ways. Decreased lying times in bulls have been associated with increased levels of plasma cortisol, an indicator of stress (Munksgaard and Simonsen, 1996, Ladewig and Smidt, 1989). In addition, lower lying times can result in a reduction in circulating growth hormone (Munksgaard and Løvendahl, 1993). This reduction in growth hormone may particularly harmful in young, growing animals and may also be linked to a decrease in milk production (Hart et al., 1978). Finally, blood flow to the udder is, on average, 28% higher when cows are lying down compared to when standing (Metcalf et al., 1992).

Cows that spend less time lying down likely spend more time standing in concrete alleyways, and therefore may be more likely to develop hoof diseases and injuries (Bell and Weary, 2000). Colam-Ainsworth et al., (1989) compared two similar herds, one of which had a history of lameness problems while the other herd did not. The only obvious difference between the herds was in the amount of stall bedding used: the problem herd received 75 % less straw per day than the healthy herd. Cows in the problem herd also spent less time lying down and more time standing on the concrete outside the stall. In another study (Leonard et al., 1994), one group of animals had access to stalls bedded with rubber mats and the other had stalls without mats. Cows using stalls without mats spent less time lying down and their claw health deteriorated more during the two months following calving.

Bedding may affect health in other ways that are not necessarily mediated by differences in stall usage. For example, bedding appears to play a role in front and hind leg injuries of dairy cattle. Weary and Taszkun (2000) scored hock lesions on twenty farms using three bedding surfaces: sawdust, sand, or mattresses (**Figure 3**). They found that lesions were most prevalent and severe on farms using mattresses and least common and less severe on farms that used sand. The prevalence and severity of hock lesions on farms using sawdust bedding were intermediate. Rodenburg et al. (1994) also scored hock lesions on different farms. They found more lesions on cows bedded on solid

rubber mats than those housed on geotextile mattresses. Finally, Wechsler et al. (2000) compared injuries on cows housed on deep-bedded straw and various types of mats. They found that the hocks of cows housed on mats had more hairless patches and small scabs than animals housed on straw. Other work has shown that injuries on the front legs are also affected by bedding. Pajor et al. (2000) compared injuries on the front legs of cows housed on geotextile mattresses or concrete, both covered with a small amount of straw. They found mattresses reduced swelling on the front knees by half, possibly because the mattresses better absorb the impact as cows lie down. There was no difference in frequency of cuts, abrasions or hair loss on the front knees between the mattresses and the concrete, indicating that mattresses are no less abrasive than concrete.

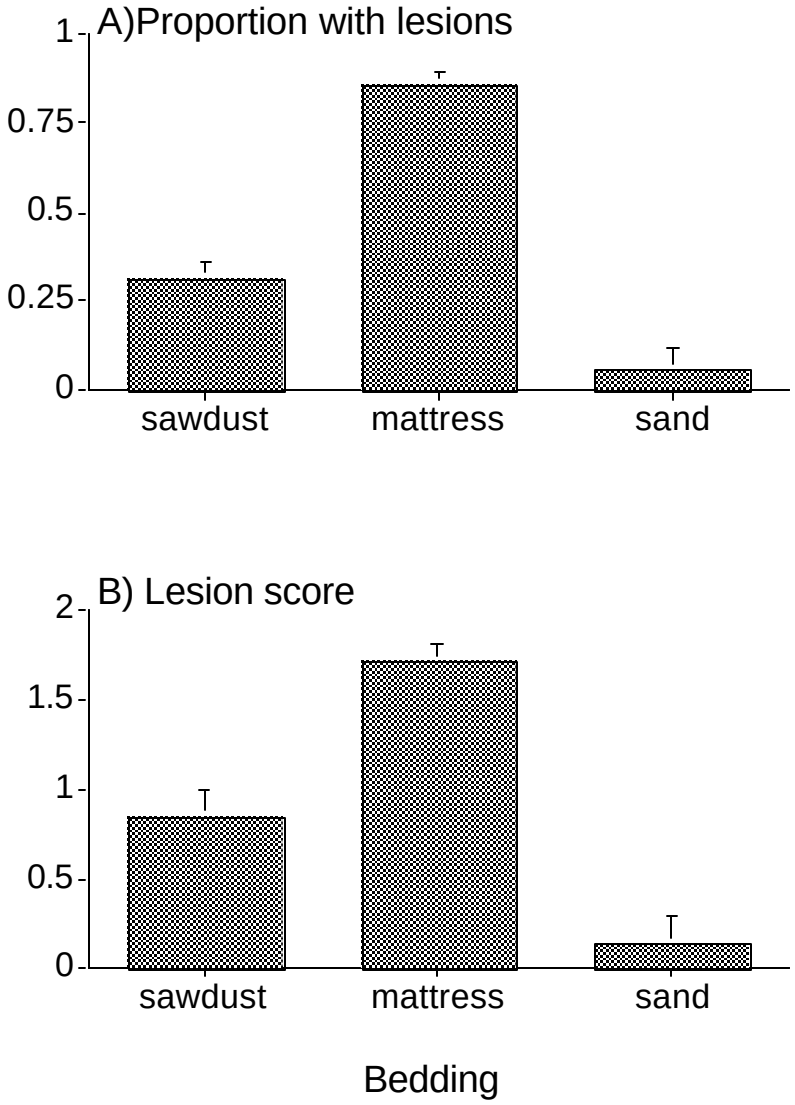

Figure 3. Cows on geotextile mattress are more likely to have lesions (A) and these lesions are more severe (B). Data shown are for the lateral surface of the tarsal joint, the area where lesions are most common. Adapted from Weary and Taszkun, 2000.

Another important consideration for producers is the effect of stall bedding on udder health. It is commonly thought that: 1) organic bedding (e.g. sawdust) is more likely to have higher bacterial counts than inorganic bedding (e.g. sand); 2) higher bacterial counts in the bedding lead to higher bacterial loads on the teat ends; and 3) higher bacterial loads on the teat ends increase the likelihood of udder infection. There is some scientific evidence that inorganic bedding does indeed contain fewer bacteria (e.g. Hogan et al., 1989, Fairchild et al., 1982). There is also evidence that higher counts in bedding translate to higher bacteria counts on teats ends (e.g. Rendos et al., 1975, Natzke et al., 1975, Bishop et al., 1981, but see also Hogan and Smith., 1997). In addition, when bacteria were sprayed on teat ends as part of an experiment, cows were more likely to develop udder infections (DeHart et al., 1975) and it has also been shown that the rate of infection is linked to level of exposure to bacteria (e.g. McDonald and Packer, 1968). However, there is little evidence to date that higher bacterial counts in bedding actually lead to an increased risk of udder infection, (Natzke et al., 1975, Hogan et al., 1989), and more work on this link is urgently required.

■ Conclusions

The study of cow comfort is still in its early stages, but a few techniques have immerged as useful. We have reviewed work on cow preferences, stall usage, and other non-behavioral effects of stall bedding. Preference testing provides information about cow choices. These preferences provide insight into the features of the stall that are likely to be important to cows. Stall usage, and in particular the time that cows spend lying down, are useful indicators of cow comfort when cows do not have the choice between different stall designs. Finally, the preference and stall usage results need to be evaluated in the context of other, non-behavioral aspects of housing, including injuries, udder health and production. Together, this information can provide a cohesive picture of how housing features impact the cow. In literature on stall bedding, it appears that cows prefer and spend more time lying down on softer surfaces. In general, these softer surfaces also result in fewer foot and leg injuries. New work by our group and other researchers is now examining other aspects of stall design, including the effects of stall dimensions such as stall width and neck-rail height.

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