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## Effects of flooring on cow behavior and production

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Approximately 70% of all medium and large (>100 cows) U.S. dairy herds primarily house lactating cows in free-stalls (USDA, 2007), and concrete is the principal flooring surface used in these barns. Concrete flooring offers many advantages for the dairy producer, being relatively inexpensive in comparison to other flooring surfaces because of its durability and long life, and it is easy to clean. However, concrete flooring can be problematic for dairy cows, due to the hardness of the surface, and the potential for the floor to be too slippery or too abrasive, depending on the quality of the surface finish and the amount of manure slurry present.

Lameness is one of the most prevalent health problems in dairy cows. Producers reported that 14% of their cows experienced an episode of lameness during 2006 (USDA, 2007), however, other studies suggest an even higher incidence of lameness (Clarkson et al., 1996; Cook, 2003). In 50 high-producing Holstein herds in Minnesota housed in free-stalls, on average 24.6% of cows were identified as lame on the day that researchers visited, and this was 3.1 times greater than the number estimated by the herd managers on each farm (Espejo et al., 2006).

Lameness is also associated with considerable economic losses because lameness reduces milk production (Rajala-Schultz et al., 1999; Green et al., 2002) and decreases reproductive efficiency (Melendez et al., 2003; Hernandez et al., 2005). There is also the time and expense associated with treating lameness, and lameness is an important cause of culling, either through its direct effects on the cow or by its indirect effects on reproductive performance. Dairy producers reported that 16% of cows were culled specifically for lameness or injury reasons (USDA, 2007), although the number culled because of the indirect effects on reproduction is likely to be much higher (Rushen, 2001).

Three primary considerations in the assessment of animal welfare are: 1) is the animal functioning (i.e., producing) well, 2) is the animal free of pain or distress, and 3) is the animal able to perform natural behaviors? Lameness fails to meet any of these considerations (Shearer, 2010). Thus, lameness is considered to be one of the most serious welfare problems in dairy cows (Rushen, 2001).

While the underlying causes of lameness are multi-factorial, the use of concrete flooring is often implicated as a major contributor to the development of lameness. An increased incidence of claw lesions and lameness has been observed when cows are housed on concrete compared to dirt, straw or on pasture (Vermunt & Greenough, 1996; Livesey et al., 1998; Somers et al., 2003; Laven & Livesey, 2004; Haskell et al., 2006). Hence, there is increasing interest in the use of softer, less slippery flooring surfaces than concrete to improve the behavior, productivity and welfare of dairy cows.

### *What do cows prefer?*

Several studies have investigated the preferences of dairy cows for different flooring surfaces. Telezhenko et al. (2007) conducted two experiments where concrete was replaced with rubber, in

half the holding pen and along half of the alleyway from the parlor. Through video recordings, the researchers found that about 70% of cows stood on the side of the holding pen that had rubber, compared to 50% when only concrete was available. Similarly, about 65% of cows walked exclusively on the side of the alleyway that had rubber, whereas only 30% of cows exclusively walked on one side of the alleyway when only concrete was present. In a similar study using rubber along the walkway to the parlor, Platz et al. (2008) found that when given a choice between a concrete or rubber surface, two-thirds of cows chose to walk on the side of the walkway with the rubber surface, and fewer cows changed sides during the walk. When the surfaces on both sides of the walkway were the same (all concrete or all rubber), no preference in side was observed and crossing from one side to the other occurred more often.

The preferences of cows for different flooring surfaces in front of the feed bunk have also been assessed. When individually housed, non-lactating dairy cows were given the choice to stand on a concrete or deep-sawdust filled platform to access feed, the cows spent more time eating, more time standing without eating, and more total time on the sawdust platform (Tucker et al., 2006). When concrete and rubber flooring surfaces were in front of the feed bunk, similar results were observed, with cows spending more time standing near the feed bunk (eating and not eating) when the rubber surface was available (Tucker et al., 2006). Thus, the results of these preference studies suggest that cows clearly prefer to stand and walk on softer flooring surfaces than concrete.

#### *Effect of flooring on feeding, standing and lying behavior*

The preference studies described above suggest that cows may change their behavior in response to the flooring surface provided, and these changes may be of benefit both to the producer and the cow. A number of studies have investigated the effect of different flooring surfaces on feeding, standing and lying behavior of dairy cows. The effect of flooring surface on feeding behavior is variable. Some studies have reported cows spent more time feeding when softer flooring was provided (Olsson et al., 2005; Tucker et al., 2006), while other studies have found no difference in the feeding time of cows on concrete and alternative flooring surfaces (Fregonesi et al., 2004; Boyle et al., 2007; Haufe et al., 2009; Pempek & Botheras, 2009). However, even for studies where differences in feeding time were noted, the increase in feeding time was often small (30-60 min).

Standing and lying behavior may also change. Several studies found that cows spent less time lying down and more time standing in the pen (Fregonesi et al., 2004; Olsson et al., 2005) or less time standing in the stall and more time standing in the pen (Boyle et al., 2007; Haufe et al., 2009) when softer flooring was provided. At least one study reported cows lying down in rubber-covered alleyways when free-stall design was poor (Tucker et al., 2006). A reduction in total lying time, increased time standing in the pen or at the feed bunk without eating, and lying on dirty floors are not necessarily desirable behaviors, due to the increased risk of injury, lameness and mastitis. Therefore, if rubber flooring is going to be installed, it is important to provide comfortable stalls that cows are more willing to stand and lay down in than on the floor.

#### *Effect of flooring on estrus behavior and reproductive performance*

The flooring surface can also influence expression of estrus behavior (Britt et al., 1986; Vailes & Britt, 1990; Phillips & Schofield, 1994). Display of estrus behavior is of value to the producer as

it indicates the correct time for insemination. Standing immobile when mounted is the most reliable visual sign of estrus. However, if the floor is too slippery for safe mounting, visual estrus detection may be of limited effectiveness, and this may influence reproductive success (Kerbrat & Disenhaus, 2004).

In one recent study, Boyle et al. (2007) found that rubber flooring had no effect on standing estrus events, or reproductive performance. However, it was suggested that the rubber flooring surface used in this study may have been as slippery as concrete. In contrast, Platz et al. (2008) observed estrus behavior before and after installation of rubber flooring, and noted a total of 23 mounting events before rubber flooring was installed (28 cows in estrus), while 112 mounting events were observed after (49 cows in estrus). On concrete, 0.8 mounts occurred per cow in estrus, while on rubber, 2.3 mounts per cow occurred. Furthermore, collapsing and slipping during mounting were also monitored. In 19 of 23 mounting events on concrete, slipping was observed, while not a single collapse or slip was observed in the 112 mounting events on rubber.

#### *Effect of flooring on milk production*

Changes in the feeding behavior of dairy cows housed in pens where softer alternative flooring surfaces are provided in front of the feed bunk may benefit milk production. However, Kremer et al. (2007) found no difference in the mean daily milk yield of cows housed on concrete or rubber slats, and no changes in the mean daily milk yield over a 305 d lactation period. Similarly, Pempek & Botheras (2009) found no differences in the milk yields of cows in pens with rubber or concrete flooring. However, no differences in the behavior of the cows were observed.

#### *Effect of flooring on locomotion and ease of movement*

It is important that cows are able to move around their environment easily and with confidence. Concrete flooring can impair locomotion. On rubber flooring surfaces, cows are observed to take an increased number of steps, indicating that they are more active (Kremer et al., 2007; Platz et al., 2009; Ouweltjes et al., 2009). Cows also take longer strides (Telezhenko & Bergsten, 2005; Flower et al., 2007; Platz et al., 2008; Haufe et al., 2009) and walk faster (Rushen & de Passillé, 2006; Flower et al., 2007) on rubber, suggesting that they are more confident in their footing, and a decrease in slipping is also observed (Rushen & de Passillé, 2006). Importantly, lame cows are observed to walk substantially better on softer flooring surfaces (Telezhenko & Bergsten, 2005; Flower et al., 2007).

#### *Effect of flooring on lameness*

Vokey et al. (2001) compared cows housed on grooved concrete or rubber alley mats over a 15-week period, and concluded that the flooring surface did not lead to significant differences in claw lesions or lameness. However, these results may have been confounded by group differences in stage of lactation and parity. Conversely, Vanegas et al. (2006) reported that a soft flooring surface was beneficial for hoof health. Non-lame cows housed on concrete for 20 weeks were 5 times more likely to be diagnosed as lame at the end of the study than cows housed on rubber. More recent studies have found no difference in the incidence of lameness for cows on concrete and rubber surfaces (Kremer et al., 2007; O'Driscoll et al., 2009; Ouweltjes et al., 2009). However, the short duration of some of these studies may not have allowed enough time

for lameness issues to resolve, and the causes of the lameness conditions may have been unrelated to features of the flooring system.

### *Conclusions*

Dairy cows clearly prefer to stand and walk on softer, less slippery flooring surfaces than concrete. Cows also move around their environment more and walk more confidently on non-slip flooring, and this type of flooring may help prevent injuries from slips and falls. Changes in the feeding behavior of cows housed in pens with rubber flooring in front of the feed bunk may sometimes be observed, which could improve milk production, however few studies have investigated the relationship between flooring surface and milk yield. Cows may also show clearer estrus behavior on less slippery, softer floors, which could assist with reproductive performance. However, the benefits of alternative flooring surfaces for preventing claw lesions and lameness remain unclear. Other potential issues with rubber flooring can occur if the floor is more comfortable than the free-stall, and cows choose to lay in the alleyways rather than the stalls.

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