Designing Better Environments for Cows to Walk and Stand

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Take Home Message

- Lameness is one of the most serious ailments facing dairy cows, and inappropriate flooring has been implicated as a cause. Use of concrete flooring has been associated with increased hoof problems.
- Increasing both the softness and the degree of surface friction of the floor improves cow mobility and reduces the risk of injury from falls.
- Softer flooring in front of feed bunks can increase the time cattle spend close to the feeder and may increase feed intake.
- Flooring must have adequate drainage to protect cows' hooves from excessive wetness. Cows' hooves absorb water quickly and become soft, making them more susceptible to wear and damage.
- Manure on passageways reduces cow mobility and increases the chance of cows slipping and falling.

Introduction

We are interested in improving the places where cows walk and stand because this may improve the mobility of cows, making routine tasks such as milking more efficient, and because improved walking/standing surfaces may help reduce the incidence of lameness, which is now one of the most common ailments of dairy cattle and a serious animal welfare problem. Improving the standing surfaces in front of feed bunks may also help increase feed intake.

■ Lameness in Dairy Cows

Lameness is now one of the most widespread ailments inflicting dairy cows. Dairy farmers tend to underestimate how many cows in the herd are lame: research has shown that farmers, on average, are aware of only one out of three or four cows that are lame (Wells et al., 1995; Whay et al., 2003). Large scale studies in a number of developed countries, especially in Europe, show that the average incidence of lameness in a dairy herd is between 10 and 25 new cases per 100 cows within a lactation (Wells et al., 1995; Whitaker et al., 2000). However, the incidence differs greatly between farms. On some farms, a large majority of cows will become lame at least once during a lactation while on other farms less than 5% of cows will become lame. This suggests that some dairy farmers know how to control lameness – we now need to know what these farmers are doing right.

Cows can become lame for a number of reasons but mostly because of problems in the hoof. These hoof lesions may result from infections, such as digital dermatitis, metabolic problems associated with laminitis, or from physical injury, such as bruises or excessive wear. Not all hoof lesions affect the gait of the cows sufficiently for this to be noticeable and many more cows suffer from hoof injuries or lesions than are obviously lame; one Swedish study found that over 70% of dairy cows had some form of hoof lesion (Manske et al., 2002). Equivalent studies have not been done in Canada, but we can expect a similar incidence of lameness and hoof lesions. One study by Erin Bell in our research group found that over 86% of dairy cows on farms in BC's Fraser Valley had lesions on the sole of the hoof, and 35% of cows had severe haemorrhages and ulcers.

The direct costs of treatment represent only a small proportion of the total costs of lameness. A number of researchers have provided some estimates of the effects of lameness on milk yield. One study in the UK estimated that lameness reduces 305-day milk production by an average of 360 kg, and the reduction in milk yield can begin up to 4 months before the farmer becomes aware that the cow is lame and last a further 5 months after treatment (Green et al., 2002). Certain types of lameness can have even larger effects: foot rot has been associated with a 10% decrease (~860 kg over 305 days) in milk yield (Hernandez et al., 2002). Lameness has a marked negative affect on reproduction, for example increasing the interval from calving to conception. Some cows that are culled because of obvious reproductive problems may in fact be suffering from undetected lameness (Sprecher et al., 1997). A number of estimates made in different countries suggest that lameness costs the average dairy farmer thousands of dollars.

Lame cows limp because they are in pain, and lameness is widely recognized as one of the most serious animal welfare issues facing the dairy industry.

■ Lameness and Housing

The physical environment of the cow can affect the likelihood that she will become lame. For example, the incidence of lameness and of hoof problems is higher when lactating cows do not have access to pasture, and is higher when cows are kept in free stalls rather than on straw packs (e.g. Somers et al., 2003). This may occur partly because of the surface on which the cows tend to walk and stand. The cow's hoof has evolved for walking on softer, resilient surfaces typical of pasture. However, most cows in free stall barns spend much of the time walking and standing on a concrete surface that is often wet and covered in slurry. There is now enough evidence to show that concrete floors are partly responsible for the high incidence of lameness that occurs among dairy cows. Studies done in the Netherlands and the US have shown that hoof health tends to be worse when cows have to walk and stand on concrete (Vokey et al., 2001; Somers et al., 2003). Fortunately, a number of alternative materials are now available, and increasingly dairy farmers are putting special rubber flooring in places where the cows walk and stand most often. Our research (which we describe below) shows some of the other advantages of doing this.

■ Improved Flooring and Cow Mobility

First we looked at whether improved flooring led to better cow mobility by constructing special walking corridors with different types of floor surface. These corridors included many of the "challenges" facing cows when walking, such as sharp turns and open gutters that had to be stepped or jumped over. Using these corridors and multiple video cameras we were able to get precise measures of how fast cows were moving and the likelihood that the cows would slip or fall when walking.

First, it was obvious that the cows walked more slowly and were more likely to slip when the concrete floor was covered in manure and slurry. When covered with slurry, walking speed was reduced by 7% and cows were three times more likely to slip compared to when walking on a dry floor. Clearly, walking surfaces for cattle should be kept as clean and as dry as possible. Dry flooring is also important for improving hoof health, as we discuss below.

In a second experiment, we compared un-grooved concrete flooring with some of the softer rubber flooring that is available. We used Animat®[1] (Animat Inc. St. Élie d'Orford, QC), which has a rough surface providing good friction. When walking on Animats®, the cows walked about 8% faster and slipped less: 70%

[1] The use of Animats does not imply that these are endorsed by the authors or their institutions.

of cows slipped at least once when walking on the concrete but only 20% slipped when walking on Animat®. The difference between the materials was most apparent when the cow had to turn a corner or jump over an open gutter. When the cows were walking on concrete, the handler had to intervene for all cows in order to encourage them to jump over the gutter or continue walking down the corridor. With Animat®, the handlers had to intervene with only 70% of the cows. Thus, improved flooring may also reduce the amount of labour moving the cows. We found that these advantages to Animat® were apparent both when the floors were dry and when covered with slurry.

A more common way of providing better footing is to use grooved concrete rather than the un-grooved concrete that we used. However, while this may improve the footing, the cow is still walking on a hard surface. Therefore, we did some follow-up experiments to see whether the degree of softness of the floor was itself important for cows. We covered both the Animats® and the concrete that we used in the previous experiments with the same high friction surface material, so that they would both have the same degree of surface friction. Our results suggest that the cows' walking speed was increased more by making the floor softer than by increasing the surface friction. When the degree of friction of the surface was kept constant, the walking speed on the softer floor was higher by nearly 12%. Thus, it is important to have flooring that provides both good footing and some cushioning for the hoof. Our estimates of the effect of different flooring surfaces on the cows' walking speed and on the chance of slipping are shown in Figure 1.

We confirmed the advantages of having softer flooring by finding that the cows walked faster when on other softer surfaces, such as geotextile mattresses, covered with high friction surface material. In another experiment, Frances Flower from the University of British Columbia found that the gait of cows also improved when walking on softer flooring. We speculate that the softer flooring may reduce the pain of cows that are lame or becoming lame, although we need further research to be sure of this. Together, our results indicate that cow's mobility is improved on softer floors.

Because of our results and the fact that concrete floors tend to be associated with a higher incidence of lameness and hoof problems, we recommend that dairy farmers provide softer flooring (with an appropriate degree of friction) where cows most often walk and stand.

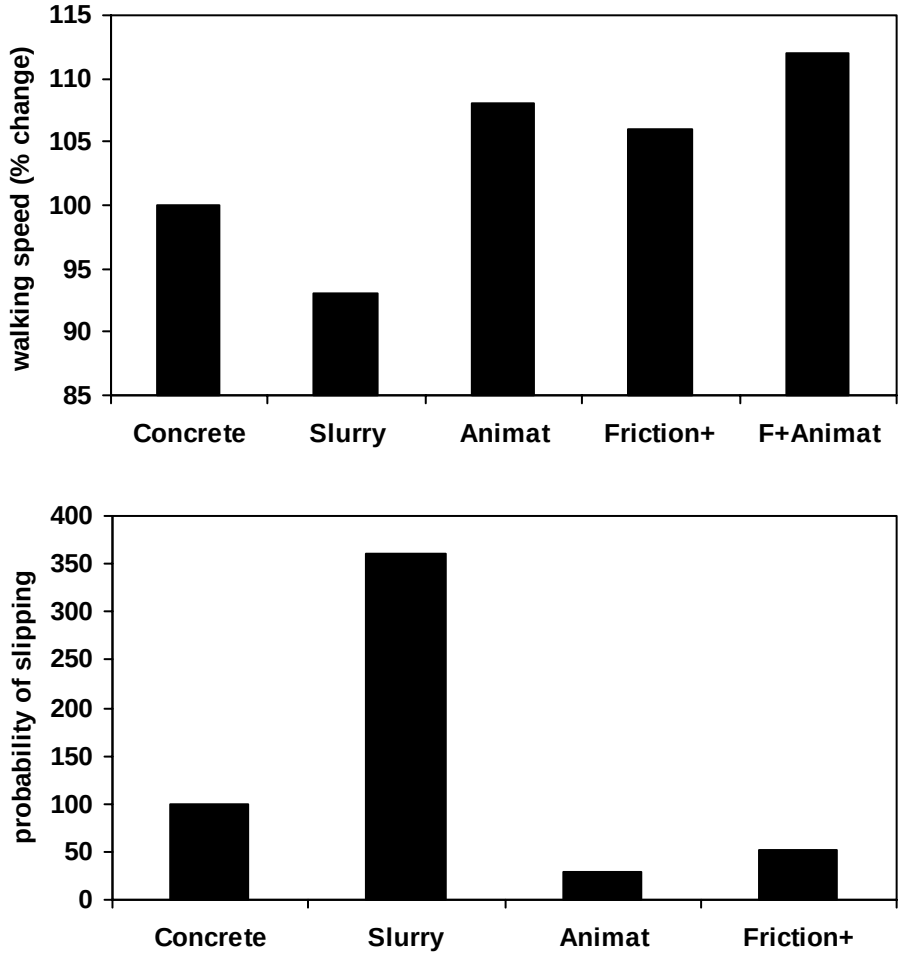

Figure 1. Estimates of the relative speed of walking (Top figure) and chance of slipping (Bottom figure) of cows when walking on dry un-grooved concrete, concrete covered with slurry, Animats, Concrete covered with a thin high friction material (Friction+) and Animat covered with a high friction material (F+Animat). The values for dry un-grooved concrete are given as the reference value (100%). (These estimates are only approximate and are derived from the results of the research discussed in the text.)

■ Better Flooring in Front of the Feed Bunk

Most of the time that cows spend standing up is when they are eating, so making the feeding area comfortable is particularly important (see companion paper by von Keyserlingk and DeVries in this volume for more details). In free stall housing, many farmers are now putting some form of rubber flooring in front of the feed bunk. We have finished some experiments at Lennoxville to see how this affects the cows' feeding behaviour and feed intake. We compared dry cows that were kept in a pen where the floor in front of the feed bunk was either slatted concrete or slats covered with Animat®. With the Animat®, we found that the cows spent longer standing at the feed bunk (an average of 5.5 hours per day) than when there were concrete floors in front of the feed bunk (4.8 hours per day). One interesting result of this was that the cows spent less time standing in the stalls. In free stall barns, cows are often seen standing in the stalls. This is generally undesirable since it leads to dirtier stalls, increases wear on the stall flooring and prevents other cows from lying down in that stall (see companion paper by Tucker et al. in this volume). We concluded from our results that cows often stand in their stalls because they do not have other places to stand that are sufficiently comfortable.

A companion experiment at the University of British Columbia found similar effects. In this companion experiment, lactating cows were first allowed to choose between standing on a platform with an un-grooved concrete floor or one with a deep (8-15 cm) layer of packed sawdust while feeding. Cows showed a clear preference for standing on the sawdust. Although they did not completely avoid the concrete, about 65% of the time spent feeding was done on the sawdust floor. In another phase of the experiment, the cows were not allowed to choose. On some days they were forced to stand on the concrete floor in order to eat, and on other days, they were able to stand on the sawdust in order to eat. Although the cows visited the feeder the same number of times each day (11-12 times per day), they spent 40 minutes longer each day near the feeder, when they were able to stand on the sawdust. Cows clearly find it less comfortable to stand on concrete than on a layer of sawdust. The greater comfort of the sawdust seemed to also have some effect on feed intake: in this experiment cows ate 0.8 kg more when they were able to stand on the deep sawdust.

However, not all types of rubber flooring are equivalent. In another experiment done at UBC (Fregonesi et al., in press) the floor in front of the feed bunks was covered with the hard rubber that is used for conveyor belts. As reviewed by von Keyserlingk and DeVries in this volume, this surface slightly increased standing time in the feeding area but had no effect on the time cows actually spend feeding. Our other results showed that the degree of softness of the floor is particularly important. Possibly the type of rubber used in conveyor belts is too hard to affect the cows' feeding behaviour.

Our experiments show that cows prefer to stand on softer surfaces when feeding and when there is a soft floor in front of the feed bunk. However, we still do not know the degree of softness that is necessary, nor do we know which types of commercially available materials are most suitable.

Lame cows have a reduced feed intake: Bareille et al. (2003) reported that each instance of lameness was associated with a reduction of 28 kg in dry matter intake. This occurs perhaps because it is too uncomfortable for cows to stand while feeding. Thus softer floors in front of feed bunks may also help alleviate some of the negative effects of lameness on production.

We recommend that dairy farmers place softer flooring (with an appropriate degree of friction) in front of feed bunks, to improve comfort in this area and to reduce time spent standing in stalls.

■ Floors Should Be Dry

One of the most common problems with the floors in free stall dairy barns is that they are often wet or covered with slurry. Good drainage is essential in keeping floors “cow friendly”. We mentioned above that flooring covered with slurry greatly increases the chance that cows will slip and fall when moving, and also reduces the speed that cows walk.

Wet flooring may also increase the chance of lameness. Wet flooring may increase the risk of transmission of the bacteria that cause digital dermatitis or other infectious hoof diseases, and we know that wet flooring reduces hoof hardness and increases susceptibility to wear and damage.

We have done some experiments looking at how much cows’ hooves absorb water and how soft they become as a consequence. We soaked pieces of the hoof of cows in water for various times and weighed them to measure the amount of water absorbed. We also measured the hardness of the hooves. When soaked for 12 hours, the horn tissue of the hoof absorbed an amount of water equal to about 2% of the initial weight of the horn. Furthermore, as the cows’ hooves absorbed water they became substantially softer. After 12 hours of soaking the hooves were only about 80-90% as hard as they were when dry. Furthermore, cows’ hooves absorb water fairly quickly: 36% of the total water absorbed in 12 hours of soaking was absorbed in the first hour and a further 12% during the next hour. When the hooves were allowed to dry, they lost water and became harder. However, when allowed to dry out, the hooves appeared to lose water more slowly than they absorbed water during the soaking. From our results, we estimated that to lose the water absorbed in the first hour of soaking, the hooves would need to be kept dry for 4-6 hours. These results lead us to worry that on some dairy operations, the cows’ hooves may never dry out adequately.

Our results show that cows' hooves absorb water fairly quickly and become noticeably softer in only a short period of time. It is likely that this will make the hooves more susceptible to wear and physical damage. We examined the hoof quality of the cows at Lennoxville in two consecutive months. The cows that had softer hooves (especially at the sole) during the first examination had more erosion of the heel horn one month later.

To control the incidence of lameness, it is important that cows have dry flooring available for standing.

■ Flooring should be in Good Condition and Free of Obstacles

Physical injuries to the hoof can result from uneven or poorly maintained surfaces, and from obstacles that cows must walk over. Erin Bell's study of hoof lesions on BC farms found that several such factors increased the risk of injuries for cows. For example, cows from farms with steps 10 cm or higher were more likely to have hoof lesions than cows from farms without such steps. Cows from farms with holes or large cracks in the flooring were also more likely to have bruised feet.

In addition to these more obvious design and maintenance problems, other common flooring features may act as obstacles. For example, cows must step over automatic alley scrapers several times a day, and cables driving these scrapers can also act as an obstacle. Erin Bell found that cows on farms using these scrapers had more hoof injuries than cows from farms using other manure handling systems.

To reduce the chance of hoof injuries, flooring should be well maintained and free of obstacles for the cows.

■ Cow Mobility and Automated Milking Systems

The economic importance of lameness will be largest when cows must walk in order to access food or water or to be milked. Automated milking systems (in which cows voluntarily enter the milking robot) are becoming increasingly popular, but rely on the cow choosing to visit the robot several times a day. Although they are currently used on only a small percentage of dairy farms in Canada, it is probable that automated milking systems of one form or another will play a major role in the dairy industry of the future. Canadian dairy farmers who invest in an automated milking system are sometimes disappointed that the cows do not visit the milking robot often enough.

We recently visited farms in Quebec that had installed automated milking systems and examined the gait of cows that visited the milking robot most often and those that visited least often. We found that those cows that visited the robot most often had better gait than cows that did not go often enough. This suggests that sub-clinical lameness may be one factor that is responsible for the low number of milkings by some cows in automatic milking systems.

Increased use of automated milking systems requires that more attention be paid to improving the mobility of cows both by reducing lameness and by improving the surfaces on which the cows walk.

Conclusions

Lameness is one of the most serious maladies facing dairy cows, and is one of the major animal welfare issues for the dairy industry. Reduced cow mobility is likely to have even greater economic impact once automated milking systems become more common. Inappropriate flooring has been implicated as a cause, with the use of concrete flooring being associated with an increased risk of lameness. Increasing the softness of flooring and ensuring an adequate degree of surface friction increases cows' walking speed and reduces slips and falls. Softer flooring in front of feed bunks can increase the time cattle spend close to the feeder and may increase feed intake. In addition, flooring must have adequate drainage to protect cows' hooves from excessive wetness. Cows' hooves absorb water quickly and become soft, making them more susceptible to wear and damage. Manure or slurry covering the floors also reduces cow mobility and increases the labour required to move cows. Poor quality flooring may be partly responsible for the higher incidence of lameness in free stalls. Dairy producers are encouraged to pay more attention to the quality of the surfaces where cows stand and walk and to consider some of the alternative flooring surfaces available.

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