Don’t be so lame- Time to Implement Solutions to Sore Feet

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Introduction

Despite increased awareness of lameness in dairy cattle over the last decade, it remains a major concern for the industry. Lameness control is fundamental to the successful management of the dairy herd, because it impacts how a cow rests, eats and behaves, thereby reducing the ability of the cow to produce milk efficiently, reproduce and survive.

Table 1 documents the peer-reviewed surveys of lameness prevalence published over the last 20 years. With a few exceptions, it should be noted that lameness prevalence is higher in freestalls compared to tiestalls, compost barns or bedded packs and grazing herds, higher in larger compared with smaller herds, and higher in higher milk producing herds.

Most notably, in the most recent large scale survey of North American dairy herds, lameness affected one third to one half of the cows in larger, high producing freestall housed herds.

In Wisconsin, I have been working on lameness prevention programs for more than a decade and recently we launched The Dairyland Initiative (www.thedairylandinitiative.vetmed.wisc.edu) with a focus on facility designs for dairy cattle that promote excellent hoof health. I believe that it is possible to manage high producing dairy cows in freestall housed herds with high standards of health and well-being and this paper will detail the progress being made to achieve that goal, highlighting the essential management steps necessary to maintain low levels of lameness in confinement housed dairy herds.

Table 1. Lameness prevalence surveys published in peer review 1993-2013.

Study	***Country***	***# Herds***	***Housing/Management***	***Herd Size***	***Milk Production (lb)***	***Lameness Prevalence***
Wells et al.,	US	17	Mostly Tiestall	50	17,906	13.7 (summer)
Clarkson et al., 1996	UK	37	Freestall/Grazing	?	?	20.6
Cook, 2003	US	30	Freestall/Tiestall	121	23,060	21.1 (summer) 23.9 (winter)
Haskell et al., 2006	UK	37	Grazing and Zero-grazing freestall	?	?	15% grazing 39% zero-grazing
Espejo et al., 2006	US	50	Freestall	?	83	24.6
Amory et al., 2006	Netherlan ds	19	Freestall/Grazing	76	18,566	16.5 (arch back only)
Barberg et al., 2007	US	12	Compost Barns	74	23,005	7.8
Rutherford et al., 2009	UK	80	Organic v Conventional, Fstall/Bedded Pack	147	16,084 (O) 18,559 (C)	16.0-18.0 (O) 19.1-23.1 (C)
Dippell et al., 2009a	Austria	30	Freestall/Grazing	35	18,062	31
Dippell et al., 2009b	Germany/ Austria	103	Freestall/Grazing	48	17,633	33
Barker et al, 2010	UK	205	Freestall/BP/Grazing	163	15,844	36.8
Ito et al., 2010	Canada (BC)	28	Freestall	177	22,955	28.5
Lobeck et al., 2011	US	15	Crossvent/Conventional Fstall/Compost Barn	121-1000	24,879*ME	4.4 (CB) 13.1 (CV) 15.9 (NV)
Von Keyserlingk et al., 2012	Canada and US	121	Freestalls in British Columbia, California, New York and Pennsylvania	42 (BC) 1796 (CA) 826 (NY)	25,815 *ME (BC), 26,464 (CA), 26,924 (NY)	28 (BC), 31 (CA), 55 (NY/PA)

Wisconsin Cluster Analysis Survey

In the summer of 2012, we used the AgSource Cooperative Services (Verona, WI) herd database to identify herds over 200 cows (likely freestall housed) in Wisconsin and neighboring states with monthly DHIA tests records. Using a principle components analysis of DHIA data from these herds, we identified 16 variables that were able to characterize performance variation between herds and subjected the 557 herds to a cluster analysis. Herds were clustered into 6 groups and we visited 22 herds in each of groups 1, 2 and 6 (66 total herds). These clusters were representative of the highest milk production. For each herd we evaluated the physical well-being of the high producing mature cow group(s) and measured lameness using a 5-point locomotion scoring system where scores >2 qualified as 'lame'. Overall, mean lameness prevalence was 13.1% - lower than recent reports of high producing housed dairy herds in the US and Europe, and lower than we had found previously in similar herds (Table 2). Sixty four percent of herds used sand bedding and lameness prevalence was significantly lower in these herds compared to herds using mattress stalls.

Table 2. Lameness prevalence comparison between freestalls with sand bedding and rubber crumb filled mattress beds in herds located in the Upper Midwest.

Free stall herd comparison	Cook, JAVMA 223:1324, 2003	Espejo et al., JDS 89:3052, 2006	Cook et al. Unpublished 2013
No. Herds (sand/mat)	16 (9/7)	53 (16/37)	61 (41/20)
% Lame: Sand Herds	19.8	17.1	11.0
% Lame: Mattress Herds	30.2	27.9	17.5

So, how can these herds manage cows successfully in large scale freestall housed dairy operations and still achieve excellent standards of lameness control? Obviously there is no one pathway that all herds follow, but there are some consistent features that I shall focus on here.

1. Sand bedded stalls
2. Time available for adequate rest
3. Excellent hoof health management
4. An effective footbath program
5. Good flooring to avoid the risk of slipping, wear and trauma
6. Adequate heat abatement

I will briefly summarize the relative impacts of each of these critical steps to lameness control.

1. Sand bedded stalls

Sand bedding appears to benefit the cow with respect to lameness management in several different ways.

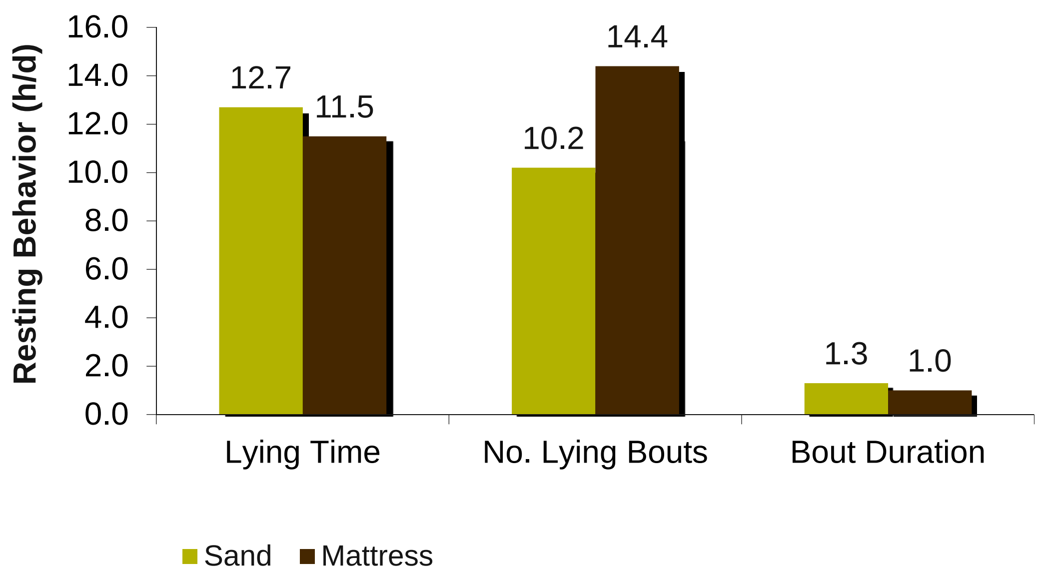
1. Creates more secure footing in alleys

Sand unquestionably reduces the risk for slipping and trauma to the foot in the alleys, reducing the risk for white line lesion development.

2. Promotes long lying bouts and fewer bouts per day

Sand, because of its ability to conform around the bony prominences of the cows' hips and hocks promotes longer lying bouts compared to rest on rubber crumb filled mattresses (Figure 1). Since cows are motivated to rest for around 12 h/d, cows on sand take fewer lying bouts per day to achieve their resting goal compared to cows on mattresses. This behavioral change is of little consequence for young fit non-lame cows, but it is of great significance for older lame cows, since they do not have to shift position as much on sand.

Figure 1. Differences in lying behavior between cows on sand and cows on rubber crumb filled mattresses (from Gomez and Cook, 2010).

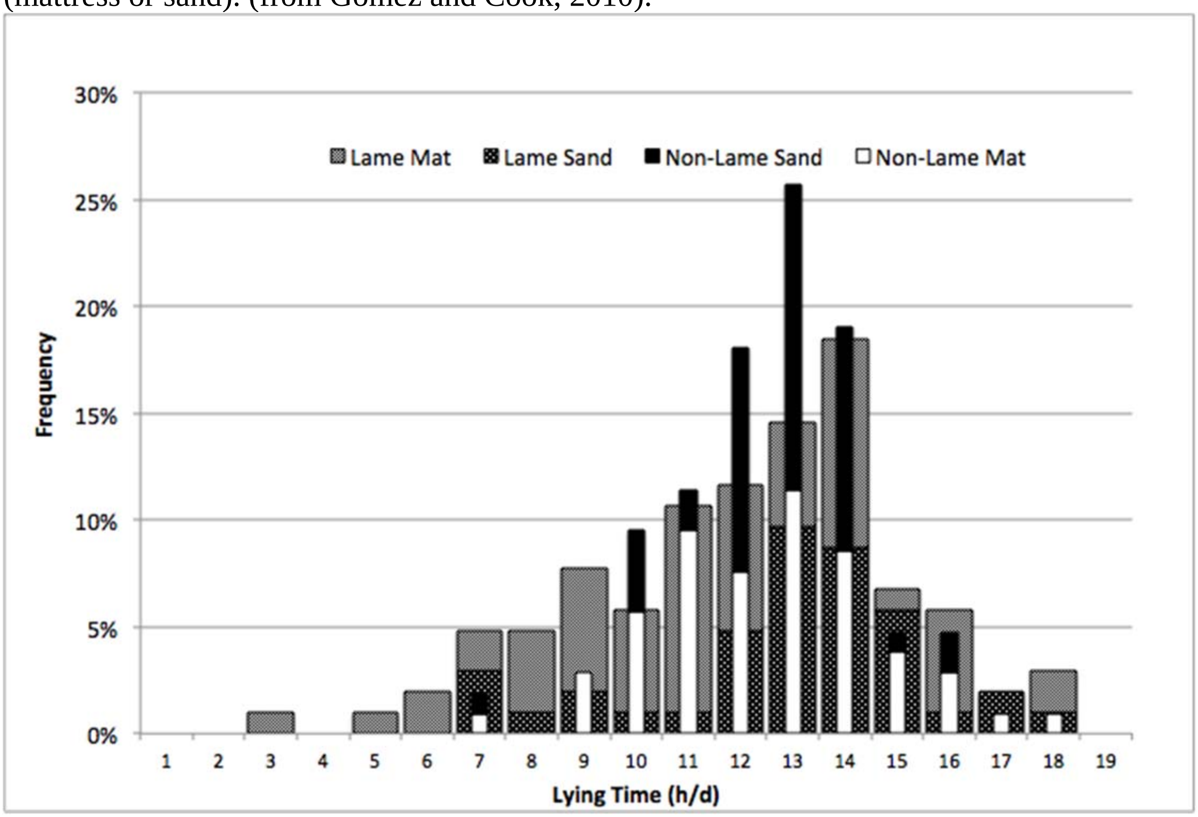


3. Improves the ability for lame cows to rise and lie down

The primary behavioral change observed in stall use by lame cows most consistently is an increase in the time standing in the stall - either perching or standing with all four feet on the platform, to between 4 and 6 h/d.

This change is indicative of a reluctance of the cow to rise and lie down in the stall and we have hypothesized that the painful forces at the claw stall surface interface are the reason for this change in lame cows. Ultimately, in stalls that do not provide the lame cow cushion, traction and support during rising and lying movements, resting behavior is further impacted. Lame cows get ‘stuck’ standing in the stall, reluctant to lie back down, or get ‘stuck’ lying down, reluctant to stand back up again. These challenges are magnified on firm mats or rubber crumb filled mattresses, because on this type of surface, resting is predicated by a greater need to rise and lie down more frequently. Figure 2 shows the difference in lying time frequency for lame and non-lame cows housed on mattress or sand stalls. Note that the distribution for lame cows is skewed toward both extremes, with a greater frequency of very short lying times and very long lying times observed, compared to non-lame cows. The effect of sand on lame cows is also obvious, there are many fewer lame cows with very short lying times than on mattresses, and there are more lame cows with longer lying times, suggesting that sand ‘normalizes’ lying behavior in lame cows. This normalization may have an impact on the ability for lame cows to rest and recuperate and improvements in hoof lesion score have been shown after 21 weeks of sand stall use compared to straw bedded freestalls.

Figure 2. Distribution of lying times (h/d) for 208 lame and non-lame cows by stall surface type (mattress or sand). (from Gomez and Cook, 2010).



Whether or not lame cows lie down more or less than non-lame cows is also likely affected by the time available for rest, which is also a critical issue for lameness prevention.

2. Time available for adequate rest

The time available for rest can be impacted by:

1. Stall design
2. Time milking
3. Time spent in lock-up
4. Overstocking
5. Heat stress

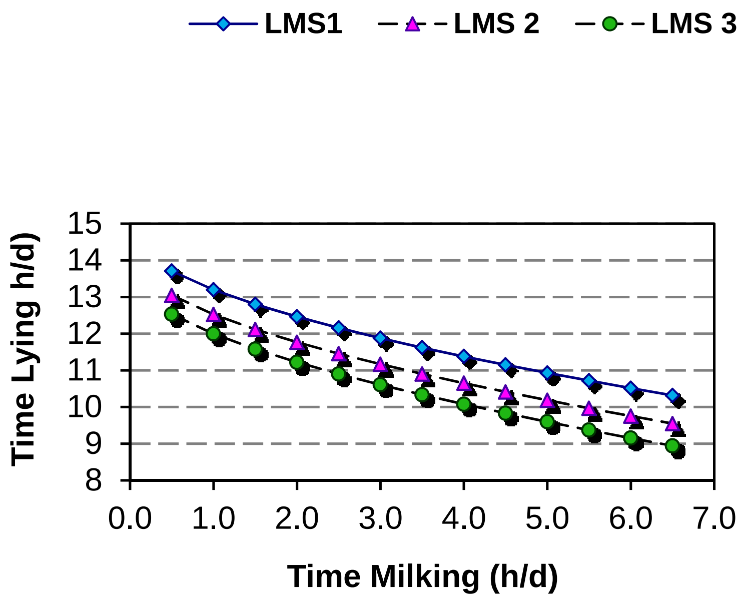
In confinement freestall facilities we target 12 h/d as a minimum target for lying time per day.

The effect of lameness and stall surface type has already been discussed, but other aspects of stall design may impact resting time, such as stall width, brisket locator presence and height, and lunge obstructions.

The time it takes to move the cow from the pen to the parlor for milking and back again has been associated with lameness. There are obvious impacts on the cow's time budget, but time spent in the holding area may also exacerbate the effects of heat stress during the summer. It is unlikely that a cow will be able to maintain a lying time target of 12 h/d if time spent milking each day exceeds 3 h/d. In our survey of 66 herds, mean time out of the pen milking was 90 minutes, suggesting that many herds are missing this goal, due to undersized parlors, poor parlor throughout, oversized pens, inefficient transfer lanes and too great a distance from the parlor to the pen of origin.

Time spent milking also impacts lame cows greater than non-lame cows, as they are often the last to return to the pen. Coupled with the resting behavior changes described, the impact of increased time milking can have a significant impact on the time available for rest. Figure 3 shows the relationship between time milking and time lying by locomotion score (1-3) for cows housed on rubber crumb filled mattresses. Note that only non-lame (LMS1) cows can be milked for 3 h/d and still maintain 12 h/d of lying time and that long milking times significantly impact the time available for rest for lame cows.

Figure 3. Impact of prolonged time spent milking (h/d) on time lying (h/d) by locomotion score (LMS1=sound, LMS2=slightly lame, LMS2=moderately lame) (from Gomez and Cook, 2010).



There has been no research on the time spent in lock-ups on the time budget of lame cows. However, since it has been shown that cows fail to recoup lost lying time when access to a place to rest is removed for more than 2-4 h/d, and since fresh cows are frequently locked up for prolonged periods on larger dairy herds, the impact of lock-up time on lameness should be considered. We have shown that lame cows appear to behave differently at calving time - with an increase in standing bouts on the day of calving (implying increased discomfort), and an increase in post-partum lying times, which was also associated with elevated BHBA levels (Calderon and Cook, 2011). Lame cows are high risk fresh cows with an increased risk for treatment or removal by 30DIM, so we recommend that they be managed appropriately. Lame cows benefit from housing on a bedded pack immediately post-partum and we advocate maintaining milking frequency at 2 times a day rather than 3 or more times a day milking, to ensure that these cows be given the time they need to rest and recover after calving.

Similarly, the effect of overstocking on lame cow behavior has not been examined. Since stocking at more cows than available stalls has been shown to reduce lying times, increased competition likely impacts lame cows disproportionately.

Finally, in order to thermal pant and dissipate heat, it has been shown that cows increase standing time per day under conditions of heat stress. Under conditions of moderate heat stress, standing time may increase 2-3 h/d, resulting in a proportionate drop in time available for rest.

3. Excellent hoof health management

Excellent hoof health management involves preventive routine hoof trimming and the early identification and treatment of lame cows.

Functional hoof trimming serves to balance the inner and outer claws of the rear feet, reducing the overload of the outer claw, and restores a more upright claw angle. These steps largely reduce the risk for sole hemorrhage and ulcer formation. The effects of trimming typically last ~ 4 months, before claw overgrowth returns balance to pre-trimming levels. Recommended trimming protocols suggest trimming for heifers prior to first calving, all cows at dry off and lactating cows around 80-150 DIM. However, this basic advice may need modification in larger herds, where hoof wear may be an issue.

Because cows with white line disease and sole ulceration have altered claw architecture and blood supply, I recommend that cows with pre-existing conditions are trimmed more frequently at around 90 day intervals. Trimming should be performed by a competent, well-trained professional working in a favorable environment with the right equipment.

While the detection of lame cows is relatively simple in smaller herds, it is more challenging when herds increase in size. I recommend that one or two trained caregivers have the responsibility of locomotion scoring cows each week by pen, as the cows are moved to the holding area for milking, in order to identify cows for treatment. Veterinarians should play a role in the detection of lame cows as they are released from lock-ups after post-partum checks and pregnancy checks and all cows at dry off should be locomotion scored, in order to identify lame cows that may have been missed.

The total trims required per year should be calculated based on historic lameness rates and the preventive program and the required trimmer visits per year determined. I would expect no more than 50 trims per trimmer/assistant per day if we are to give the trimmer enough time to do an excellent job for each cow, and the quality of the work needs to be monitored regularly.

4. An effective footbath program

An effective footbath program serves to assist in the control of infectious hoof disease, principally foot rot and digital dermatitis (DD or hairy heel warts). It is almost impossible to eradicate DD once it is present within the dairy herd and the goal is to find the 'manageable state of disease'. The two critical control points for the control of DD are:

1. The early identification of lesions and effective topical treatment
2. The use of a footbath program to reduce the risk for chronic DD lesions to recrudesce into active painful lesions

Note that the footbath is NOT used to treat active lesions. An antibacterial agent, with efficacy against Treponema species, should be applied to the feet as frequently as necessary to maintain control of the disease. A reasonable goal is to maintain the proportion of cows infected with DD to less than 5% at dry off trims. The median herd footbaths three times per week, but some herds may need more or less frequent bathing depending on the level of leg hygiene and the degree of the problem.

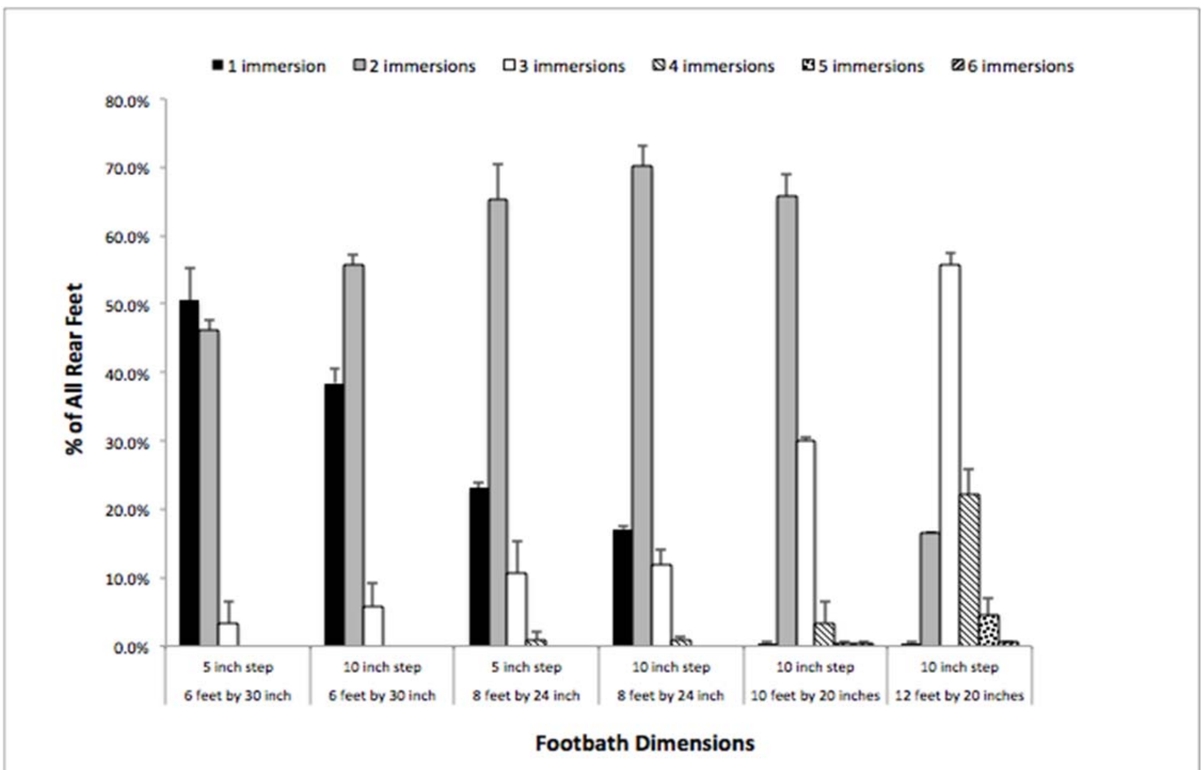
Two thirds of dairy herds use copper sulfate and one third use formalin as the antibacterial agent of choice. 42% of farms use more than one chemical and there are a wide range of commercial products that are available to address the chief concerns of the use of formalin, which is a potent carcinogen, and the disposal of copper on farmland, where plant toxicity is a potential risk.

The use of an acidifying agent to reduce the concentration of copper sulfate being used to 2-3% has become commonplace, with the goal of maintaining a bath pH of 4.0. Among the options are sodium bisulfate (pHMinus) added 1 oz at a time and a number of proprietary chemicals.

Recommendations on the need to replenish the solution so that it remains active are at best empirical. 200-300 cow passes are commonly used as a reasonable goal, but residual activity will depend on time of use, temperature and the degree of manure contamination, which may vary from farm to farm and day to day.

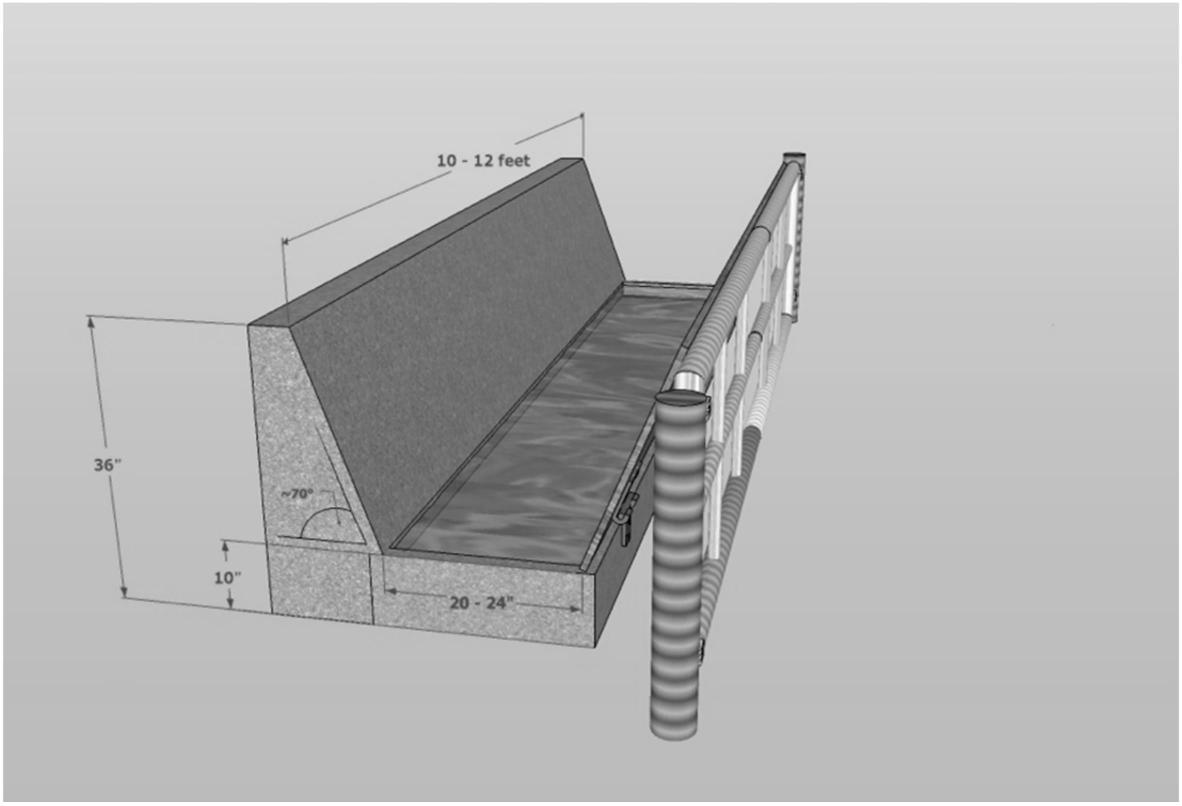
Whatever chemical agent is used, the delivery system must ensure that the feet are adequately exposed when the cow passes through the bath. Typically, farms install 50 gallon footbaths 6 feet in length and as wide as the transfer lane. We have shown that this design of bath does not optimize foot immersions per pass. Figure 4 shows that for an effective bath, where each rear foot receives at least 2 immersions per pass, the bath length must be 10 feet. Indeed, a recent study showed that a longer bath was three times as effective as a short bath with the same chemical.

Figure 4. Immersion profile for footbaths of different dimensions (from Cook et al, 2012).



We advocate footbath designs that are 10-12 feet in length with a 10 inch high step-in, as narrow as 24 inches, with sloped enclosed side walls (Figure 5). When filled to 4 inches in depth, this bath still maintains a final bath volume of around 50 gallons. We do not recommend the use of wash baths.

Figure 5. An ‘ideal’ footbath design.



5. Good flooring to avoid the risk of slipping, wear and trauma

In order to reduce the risk for wear and white line lesions and provide a comfortable surface when the cow is forced to stand idle, we advocate the use of rubber flooring in transfer lanes, holding areas, parlor return lanes and parlors. The type of rubber chosen is critical. On level floors firmer, less compressible recycled rubber products that tend to be cheaper may be used. However, on sloped floors and around the parlor a more compressible rubber with less recycled product in it with a heavy pattern to afford good traction is preferred. These products tend to be more expensive.

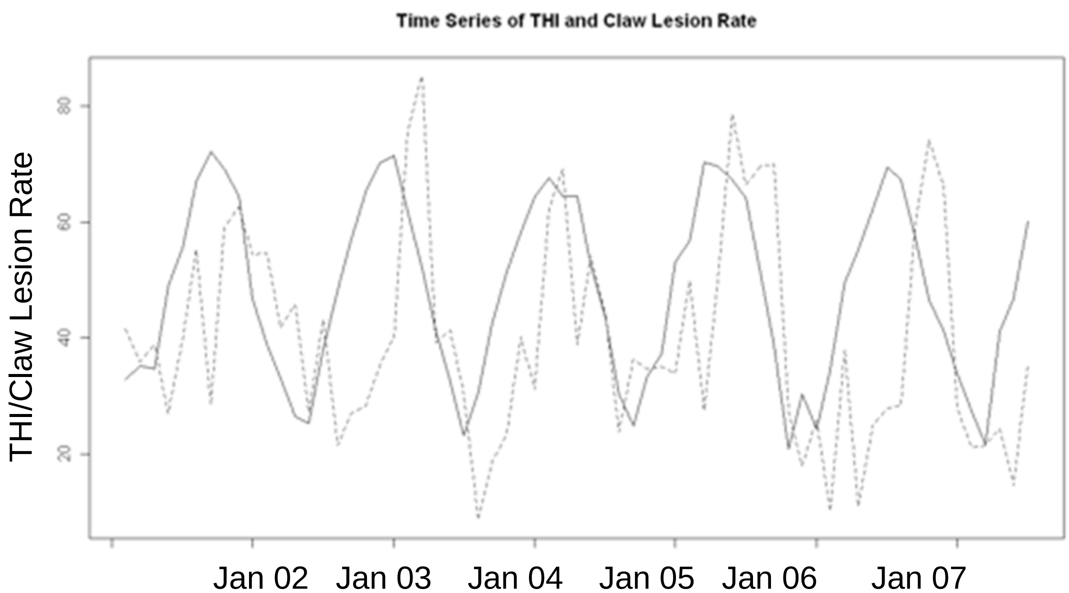
The use of rubber in freestall pens is not recommended for mattress herds and I do not believe it is needed for sand herds. In peer review two articles claim a lameness benefit for rubber in the alleys, two articles show that it makes lameness worse, and three were equivocal, with no clear effect. This may be due to the behavioral effect observed when rubber is used in the alleys in mattress stall pens, where cows choose to stand more on the rubber and lie down for less time in the stalls.

For concrete, we recommend a groove 3/4” wide, 1/2” deep, 3 1/4“ on center. This wider groove, located closer together ensures that when when a cow stands on the floor, each foot is always over a groove. The edge of the groove grips the claw and the groove allows for liquid manure to transfer from under the claw, improving contact with the concrete. In high risk areas for slipping, where cows have to make sharp turns, an additional groove 4” on center may be placed to create a diamond pattern.

6. Adequate heat abatement

As discussed earlier, when cows are heat stressed, they stand more and attempt to cool through the use of thermal panting. There are physiological changes that increase the likelihood of lameness associated with heat stress (such as SARA), but there are also behavioral changes that start at around 68 ^{o}F (Cook et al., 2007). Whatever the inciting cause, sole hemorrhage and ulcers peak ~ 2 months after the peak in heat - usually around September/October each year. Figure 6 shows the time series for a 450 cow dairy over a 5 year period, showing the relationship between monthly average ambient THI and claw lesion development. Note the two month lag each year between the peak in temperature (black solid line) and the peak in lesion development (red dotted line).

Figure 5. The relationship between average monthly ambient temperature humidity index (THI) (black solid line) and the rate of claw horn lesion development (red dotted line) for a 450 cow dairy in Wisconsin over a 5 year period (from Cook et al., 2006).



The primary goal of heat abatement is to reduce the risk for increased standing time in the alleys and around the milking center, by assisting cow cooling in high risk areas of the farm.

Therefore, I believe that the critical control points for heat abatement are:

1. Providing sufficient air movement in the holding area
2. Using effective soakers in the holding area
3. Providing adequate air movement in the resting area of the pens
4. Provide adequate access to water

We have developed a novel concept for holding area cooling using positive pressure ventilation systems that we hope will improve upon the current state of the art using recirculation fans, which struggle to provide the air speeds necessary to achieve optimal cooling and serve only to recirculate stale warm humid air from inside the barn. Similarly, in freestall pens we are searching for improved ways to supply fast moving cooled air over the lying area.

Currently, we recommend at least two waterers per pen for pens over 20 cows and a minimum of 3.5 inches of accessible perimeter per cow.

Conclusion

The development of large confinement housed freestall facilities for dairy cattle has been associated with an increase in the prevalence of lameness. However, it does not have to be this way and we can maintain very low levels of lameness in high producing dairy herds if we apply the 6-steps outlined in this article. Welfare concerns will only increase in the coming years and the dairy industry must act now to reduce the impact of this costly problem.

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