Effect of Flooring and/or Flooring Surfaces on Lameness Disorders in Dairy Cattle

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A study published in 1996 by the National Animal Health Monitoring System (NAHMS) indicated that 15% of cows culled from dairy herds in the United States were culled as a "direct effect" of lameness. This sounds reasonable until one considers that the "indirect effects" of lameness on production and reproduction are estimated to account for an additional 49.1% of culling in US herds. Although these data are now 10 years old, it is doubtful that the impact of lameness on culling has improved much since that time. The obvious question is why?

In countries such as the United States where economic incentives have encouraged producers to expand herd size, there has been a gradual change from pasture-based to confinement-type housing systems. Properly designed confinement systems offer the advantages of improved protection of animals from inclement weather conditions. For example, confinement conditions offer convenience for the implementation of cow cooling measures in hot weather and the provision of shelter and wind blocks in cold conditions. It also creates facilities for improved access to feed and water, and a comfortable place for the cow to lie down and rest.

On the down side, confinement conditions require cows to stand and walk on hard flooring surfaces. The unyielding nature of solid surfaces (like concrete) promotes claw horn overgrowth thereby creating unbalanced weight bearing within and between the claws of the foot. This predisposes to claw disorders, most notably ulcers and white line disease. In conditions where concrete floors are also abrasive, there is excessive wear on the claw's weight bearing surface. Excessive wear of the sole results in the development of thin soles and frequently, lesions in the toe. Confinement conditions also limit cows to a smaller area thereby increasing exposure of the cow's foot to manure slurry and moisture. This increases potential for the development of infectious skin disorders of the foot (particularly, digital and interdigital dermatitis) and heel horn erosion.

Indeed, growing evidence supports the contention that floors and flooring surfaces are predominant predisposing factors in lameness of dairy cattle. In the following, we provide some thoughts about lameness and the impact of floors and flooring surfaces. We begin with some general comments about cows, claws, concrete and confinement, follow that with a review of some of the recent literature and end with some personal observations from studies in the Midwest and Southeastern United States.

Cows, Claws, Concrete and Confinement

Cows are land animals. They prefer soft surfaces for walking and lying down. Hard flooring surfaces are less comfortable for cows and contribute to claw horn overgrowth and weight bearing disturbances that predispose to lameness. The unyielding nature of hard flooring surfaces in combination with concomitant diseases such as laminitis can lead to the development of claw disorders such as sole ulcer and white line disease.

Claw lesions are often indiscriminately referred to as sole abscesses. However, a sole abscess is more accurately described as a secondary condition frequently occurring secondary to a sole ulcer, white line disease, or traumatic puncture of the weight bearing surface of the sole or heel. The pathogenesis and underlying causes of each of these conditions is different. For that reason, it is useful to define these accordingly when recording claw lesions.

A sole ulcer is a circumscribed lesion of the sole that frequently exposes the underlying corium. These may occur on the weight bearing surface of the toe, heel-sole junction or on the heel and may result in profound lameness. Sinking and rotation of the third phalanx (P3), subsequent to laminitis or relaxation of the suspensory apparatus of P3, in combination with overgrowth and excess or disproportionate weight bearing are believed to be important causes of these lesions. The development of ulcers is exacerbated by exposure to hard flooring surfaces and housing conditions that predispose to poor cow comfort.

The white line is the softest horn within the claw and weight bearing surface. It joins the hard horn of the wall with the softer horn of the sole thereby making a flexible junction for the union of these structures. Unlike horn of the wall, heel and sole, horn of the white line is structurally weaker because it does not contain tubular horn. Its strength and resistance to physical forces is determined largely by the degree of keratinization occurring within the cells that make up the white line horn. Formation and accumulation of keratin within developing horn cells is dependent upon health of the corium. Laminitis for example, is a disease that affects the corium and greatly reduces the integrity of claw horn because it interferes with keratin formation and development of horn cells. Therefore, separation and disease of the white line is a common consequence of laminitis. In addition to laminitis, the white line is vulnerable to mechanical damage and concussive forces because of its location on the weight bearing surface.

Punctures of the sole leading to abscess formation are not uncommon. Such lesions are usually secondary to sharp stones or other extraneous debris that may be found in cow lanes and alleyways. Nails and screws often accompany recent construction and small bits of wire may be found in barns with worn rubber belting used on flooring surfaces. Keeping track of the various types of foreign bodies found in claws or feet is therefore important to sorting out the underlying causes of lameness due to traumatic lesions of the sole.

Concrete, depending upon formulation and how it's finished, is capable of creating an extremely abrasive surface for dairy cow's claws. New concrete is more abrasive than old, and wet concrete is up to 83% more abrasive than dry concrete (McDaniel, 1983). Where floors are abrasive claw horn may easily wear more than it grows during the first 2 months on concrete. Animals housed on wet concrete suffer doubly: first, because of the increased abrasiveness associated with wet concrete and secondly, because moisture softens the claw horn thereby permitting an increased rate of wear. Another important cause of accelerated claw wear occurs from poor handling procedures where crowding or rushing cattle results in increased wear from twisting and turning on rough abrasive flooring surfaces. Proper design of facilities incorporating ideas for easing cow movement and thus reducing rotational forces on claws are important housing considerations.

The manner in which concrete is finished has significant consequences for foot and leg health. Rough finishes increase the rate of claw horn wear and are associated with a higher incidence of lameness (Wells, et al., 1995). New concrete is particularly abrasive because of the sharp edges and protruding aggregate that naturally develop as it is cures. These may be removed by dragging heavy concrete blocks or a steel scraper over the flooring surface. They may also be removed mechanically by grinding or polishing of the surface. Generally speaking, concrete finished with a wood float provides one of the best surfaces for a cow's foot. A steel float finish tends to be too smooth and may be particularly slippery when covered by manure slurry. On the other hand, a brush or broom-type finish may result in a surface that is too abrasive.

Smooth concrete reduces wear and may contribute to claw horn overgrowth that may require more frequent trimming of claws. Smooth surfaces are also slippery and predispose to injury, usually of the upper leg from falling. A Dutch study determined that concrete floors normally do not provide sufficient friction to support normal locomotion of dairy cattle (van der Tol, et al, 2005). So, grooving the surface of smooth concrete floors is necessary to improve traction and reduce injuries from falling. Most recommend grooving a parallel or diamond pattern in the floor to maximize traction. Grooves running in a parallel direction should be 3/8 to ½ inch wide and 3/8 to 1/2 inch deep and spaced approximately 3 to 4 inches on center. When grooves are wider than 2 inch, the floor is less comfortable because support at the weight bearing surface is less uniform. For the same reason, it is advised that the floor area between the grooves be kept flat also. Grooves on a diamond pattern may be slightly wider at 4 to 6 inches on center. The diamond pattern is considered to be particularly useful in high traffic areas. The orientation of grooves at right angles to the direction of the manure scraper travel should be avoided.

In recent years, there has been significant interest in ways to reduce the negatives of concrete by incorporating rubber belting along feed mangers and in alleys or walkways to and from the milking parlor. Observation of cow behavior indicates that cows prefer the softer surface offered by rubber belting. In fact, where stall design is poor, cows may find the rubber flooring more attractive for resting than the adjoining stall. When this happens cows may block access to the feed manger. Rubber belts can also be slippery walking surfaces when wet. Grooving belts as described above for concrete surfaces helps reduce slipping injuries. The use of belting that contains reinforcement wires should be avoided. As will be discussed later, these wires frequently become a source of trauma causing punctures of the sole.

The primary problems with rubber belting are related to manure handling issues and securing them to the underlying floor. For example, in flush barns where rubber may not be properly or completely secured, manure and other debris may become entrapped beneath the rubber. In barns that scrape manure, depending upon how the rubber is secured to the floor, scraping, or pivoting of the scraper itself, may result in displacement of the rubber. Rubber flooring must be secured in such a way as to make it resistant to dislocation by either the twisting or turning action of the wheels of the scraper. Despite these drawbacks, rubber belting is a floor surface modification that improves cow and foot comfort, but additional research is needed to confirm this observation and provide direction on how to optimize its use in dairy facilities. Rubber is not a substitute for a poorly designed stall. In herds where belting does not work well it may be due to other cow comfort issues (poor stall design, heat stress, etc.) that have not been properly addressed.

In some areas owners or managers are able to avoid the negatives of concrete by using feed barns with adjoining dirt lots. For example, in the western United States where outside lots are generally dry and groomed frequently, cows find real relief from hard flooring surfaces by exiting barns to rest during cooler periods of the day or night. The disadvantages of dirt lots in warm and humid climates are that they usually lack shade and quickly become mud wallows in wet weather. Further, while cows may be inclined to use these lots during the evening or overnight hours, feeding patterns and increased relative humidity during these same periods, increases the likelihood of hyperthermia and reduced performance. Cow cooling is a 24-hour-a-day process during periods of intense summer heat and humidity. Clearly, adjoining dirt or grass lots can reduce the mechanical impact of hard surfaces on feet and legs, but maximum benefit in some areas is seasonal.

Confinement exposes the feet of animals to greater amounts of manure slurry and moisture. Since claw horn absorbs moisture readily, feet of cows in free stall housing systems are softer. In housing systems where floors are abrasive, wetter and thus softer, claws wear more rapidly predisposing to thin sole problems. But, in addition to effects on horn hardness, at least one study indicates that the exposure of claws to manure slurry has very detrimental effects on the intercellular matrix of claw horn (Kempson, et al., 1998). In other words, the health and integrity of claw horn is reduced for cows with near constant exposure to manure slurry. Possibly the best example is heel horn erosion, a disorder observed almost exclusively in confinement housed animals. It is believed that manure slurry not only increases the susceptibility of heel horn to erosion, but also provides the ideal environment required to support the growth of organisms that actually breakdown and destroy the heel horn.

Effects of Rubberized Flooring

Canadian researchers studied the effects of roughness and compressibility of flooring surfaces on cow locomotion (Rushen and de Passille, 2006). Sixteen non-lactating cows were chosen to walk down specially constructed walkways with differing flooring materials through a series of 3 different experiments. Specifically, researchers evaluated the time it took to leave the start box to walk onto the flooring material, time to walk through the initial corner, time to traverse the gutter, time to arrive at the end of the walkway, total time to traverse the walkway and total number of steps taken for 1 defined foot of the cow.

Experiment 1 compared Animat (Animat, Saint-Elie d'Orford, Quebec City, Canada), a re-vulcanized rubber with burls to improve friction or traction, with concrete flooring. They tested both surfaces dry and then again with a 1 to 5 mm layer of manure slurry. Researchers observed that total passage time was shorter on Animat compared with concrete. Cows took fewer steps and slipped less often on the Animat as compared to concrete. When cows were observed on a dry concrete surface compared with the manure slurry covered floor, cows moved faster on the dryer surface.

In Experiment 2, researchers introduced a second type of flooring, a thinner, but high friction, slip resistant material used primarily on conveyor belts (#125, 2-ply, Cobelt Canada, Inc.). This material was compared against a normal concrete flooring surface. Results of this experiment did not show a difference between the two flooring surfaces although cows tended to move a little quicker on the slip resistant flooring surface. Researchers also observed that more cows slipped on the conveyor belting material as compared with the dry concrete, but differences between groups were less than those observed in Experiment 1.

The degree of friction (an indicator of traction) depends upon roughness of the floor surface and its compressibility. So, in Experiment 3, researchers examined the effect of the degree of compressibility independent of the degree of floor roughness. They tested 3 materials: concrete (degree of compressibility, 1), Animat (degree of compressibility, 2.05), felt (degree of compressibility, 5.23), and PastureMat (degree of compressibility, 10.11). The only significant effects observed were with PastureMat. Cows took fewer steps to traverse the walkway and total time to traverse the walkway was shorter indicating more confident footing on the PastureMat material.

Results of this study demonstrate some of the advantages of commercial rubber flooring systems over flat un-grooved concrete surfaces for improving locomotion of dairy cows. Rubber floors that offered greater amounts of friction and more compressibility reduced slipping and cows traversed the walkways faster. Another way of interpreting this is that cows were more confident walking on the rubberized surfaces. On the other hand, when walkways were covered with slurry, slipping increased and cows were less confident about their footing. They tended to walk slower, decrease the length of their stride and took longer to traverse the walkways. This points out that regardless of the flooring surface, when floors are slurry covered footing is less secure.

A recent California study evaluated the effects of rubber flooring on development of claw lesions, locomotion scores, clinical lameness, and rates of hoof growth and wear in multiparous cows (Vanegas, et al., 2006). Researchers studied 2 groups of cows housed in identical free stalls barns. One of the barns had rubber alley mats (Animat, Saint-Elie d'Orford, Quebec City, Canada) covering the entire floor surface of the pen, whereas cows in the other pen were housed on concrete. Cows were evaluated 3 times between 10 and 30, 74 and 94, and 110 and 130 days in milk. Researchers assessed the occurrence of claw lesions on rear feet and the occurrence of clinical lameness based upon locomotion score and rates of claw growth and wear.

Results suggested that the Animat rubber flooring system used in this study was beneficial to hoof health. Cows on concrete had greater odds of developing or exacerbating existing conditions of heel horn erosion than cows on rubber flooring. Odds of becoming lame, and the proportion of cows requiring therapeutic hoof trimming because of lameness, were greater for concrete-exposed cows. Cows on rubber flooring had decreased rates of claw growth and wear as compared with cows on concrete. Finally, irrespective of flooring surface, second lactation cows had greater wear rates than those in third or greater parities. This latter finding agrees with that found in an observational study reported by van Amstel of a herd suffering severe problems with thin soles due to excessive wear. Researchers suggested that the higher incidence of thin soles in 2nd lactation animals may have been a carry-over effect of excessive wear during the first lactation, and reduced claw horn growth and accelerated wear during the early stages of the second lactation (van Amstel, et al., 2006).

In another recent study…….Dutch researchers evaluated claw shape, horn hardness, and horn growth and wear on 12 dairy farms (Somers et al., 2005). They chose 20 cows from each farm and made their evaluations on the right rear outer claw of each cow. Their objective was to determine the effect of floor type and changes on claw characteristics over time. Herds were housed on a slatted floor, solid concrete floor, a grooved floor or on a straw yard. The researchers found the shallowest claw angles for cows housed on the straw yards and steepest claw angles for cows housed on the solid concrete floors. In other words, the toe overgrew in the cows on the softer straw yards, whereas the claws for cows exposed to concrete experienced a greater rate of wear. And so it is, when claws overgrow, toes become long and the sole at the toe becomes thicker. In conditions where there is greater wear at the toe, the toe remains shorter and the sole at the toe thinner.

These researchers also found less digital dermatitis in the cows housed on slatted floors with manure scrapers as compared with other floor types. Housing on slatted floor/manure scraper systems tends to reduce manure contamination on feet. The finding of fewer cases of digital dermatitis is corroborated by other researchers lending credence to observations of a close relationship between slurry contamination on feet and the infectious skin disorders: digital and interdigital dermatitis and heel erosion.

Thin Soles: A Problem Influenced by Parity, Days in Milk, Season and Housing Conditions

The claw capsule's purpose is to protect the underlying soft tissues of the corium. A sole thickness of 1/4 inch (7 mm) is required to withstand the mechanical pressures imposed by the hard surfaces encountered in confinement and semi-confinement conditions (Toussaint Raven, 1989). When conditions of overgrowth occur, the toe becomes longer (that is, the dorsal surface is more than 3 inches in length from midway down in the periople or cuticle to the tip of the toe) and the sole at the toe becomes thicker (greater than ¼ inch). Weight bearing is disproportionately distributed toward the heel and heel-sole junction. In contrast, when the conditions of excessive wear occur, the toe is short (less than 3 inches on the dorsal surface) and sole at the toe, thin (less than ¼ inch).

Sole horn growth rates are affected by age, diet and length of the daily photoperiod. Wear rates are influenced by the abrasiveness of flooring surfaces, cow comfort, horn quality, and claw horn moisture (van Amstel, et al. 2004). Therefore, the shape of the claw capsule is a product of growth and wear. In the following we share observations from 2 herds: a large Midwestern dairy (van Amstel, et al., 2006) and another in the southeastern United States (Shearer, et al., 2006). The purpose in both studies was designed to characterize the problem of thin soles in modern dairy operations.

Midwestern Herd Study Data were collected over a 12 month period to determine the effects of parity, days in milk and seasonal risk of thin soles and related lameness conditions. The study herd had an average of 3221 lactating cows housed in a free-stall barn with grooved concrete surfaces. Stalls were bedded with sand and cows were cooled during the summer months with fans and sprinklers. The diagnosis and treatment of thin soles were made by on-farm trimmers who were trained through the Master Hoof Care Program at the University of Florida. The diagnosis of thin soles was based on a short dorsal wall (less than 3 inches) and a soft flexible sole on finger pressure.

The study of this herd was prompted by a severe problem with lameness due to thin soles which was cited as the cause of lameness in 32.8% of cases presented to the trimmers. Only the rate of digital dermatitis was higher (37.4%). Among other measures employed to address the problem, a major change was the addition of rubber to the holding areas, exit lanes, alleyways and in the free stall barns along mangers. In order to assess the effects of this change, researchers monitored the frequency of thin soles in first lactation animals before and after the addition of rubber.

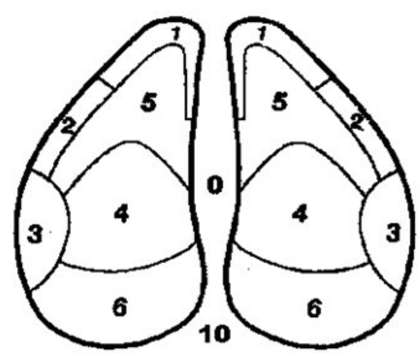
As indicated above, thin soles were the most common claw lesion observed. Further, the incidence of thin soles was significantly higher for 2nd lactation cows (13.3%) compared with 1st (11.4%) and 3rd or greater lactation animals (8.1%). Incidence of thin soles tended to be higher during mid-lactation as compared with 0-60 and 350+ days in milk (DIM). In terms of seasonal effects, the incidence of thin soles was highest during the months of August through December. Frequency for all lameness conditions in first lactation animals prior to the installation of rubber was 66.9% compared with 32.6% afterwards. Incidence of thin soles in first lactation animals was 21.8% prior to the installation of rubber and only 4% thereafter.

The Effects of Heat and Heat Stress Abatement Procedures on Claw Health. Lameness is a disorder that appears to be impacted detrimentally by heat stress as well as by the methods used to abate it. The potential for rumen acidosis (irrespective of ration considerations) increases during periods of hot and humid weather because of changes that occur with respect to the cow’s physiological adaptation responses, feeding behavior and rumen buffering capacity. Thus, laminitis associated with rumen acidosis is more likely to occur during hot and humid periods. As described earlier, laminitis contributes to a decrease in the structural integrity of claw horn as a consequence of the reduced keratinization rates in developing claw horn cells. The result is softer claw horn that wears faster.

Cooling cows in hot and humid conditions in the southeast requires shade, forced air movement (fans), and water in the form of sprinkling, misting or preferably, fogging. Air flow and water are necessary to increase the evaporative cooling of cows and air, but it also increases the amount of moisture on flooring surfaces and the abrasiveness of concrete flooring surfaces. Add to this the effects of a flooring surface that is already too abrasive (such as new concrete), or bedding materials such as sand, and the rates of claw horn wear may escalate rapidly. These conditions are often compounded in large operations by the layout of facilities that may require cows to walk long distances on abrasive flooring surfaces or management systems designed to milk cows 3 or more times per day (thus increasing the amount of time cows spend standing or walking on hard abrasive surfaces).

One approach to alleviating problems presented by abrasive flooring surfaces is the strategic application of rubber belting or mats to holding areas, walkways or along feed mangers. Rubber belting cushions the foot and seems to greatly reduce the abrasive properties of flooring surfaces, but it can also be very slippery and if not grooved lead to injuries from slipping or falling. Also, while conveyor belting is very attractive cost-wise, after it becomes worn reinforcement wires may eventually protrude through the surface and lead to puncture wounds of the sole.

The following is a report of preliminary findings from a southeastern dairy operation with a pattern of lameness that is typical for many large herds in this region.

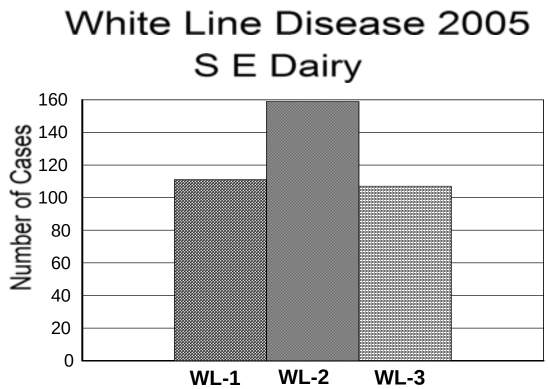


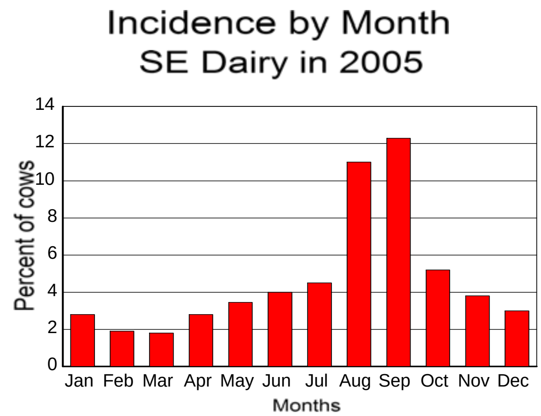
Southeastern Herd Study Observations on lameness disorders were monitored in a ~ 2,200 cow dairy herd in the southeastern United States (Shearer et al., 2006). Cows were housed in free-stalls with sand bedding. Some cows had access to dry lots during times of the year when weather would permit. All foot work was conducted by on-farm trimmers who keep records on both lesions and claw zones (See Claw Diagram) affected for cows presented to the trim chute for examination and treatment as necessary (Shearer, et al., 2004). Data was recorded chute-side in handwritten records which are transferred to an Excel file for the purposes of summarization and evaluation of monthly and annual lameness observations. As in the earlier study, foot care personnel (2 gentlemen) were experienced trimmers and previous recipients of a "Certificate of Successful Completion" from the Master Hoof Care Program (van Amstel and Shearer,1998; Shearer and van Amstel, et al., 2000).

Observations during the Period January 2005 through December 2005

Trimmers examined or treated 1,243 of 26,531 (4.7%) of lactating cows (at risk) during the 12-month period from January through December 2005 (range: low of 1.9% in February to a high of 12.2% September). The predominant causes of lameness were white line disease 377/1243

(30%); ulcers 341/1243 (27%); thin soles 144/1243 (12%); upper leg injuries 78/1243 (6%); and sole punctures 69/1243 (5.5%). All of these conditions were more likely to occur ($p < .05$) during the warm season (for seasonal analysis purposes warm season = March through September, and cool season = October through February, See Figure at right).





Ulcers occurring in zones 4 (sole) and 6 (heel) accounted for 96% (329/341) of all ulcers recorded. White line disease (WLD) in zones 1 and 2 accounted for 72% (270/377) of all WLD cases reported (See Figure at right). Preliminary analysis indicates that multiparous cows were more likely to develop ulcers than primiparous cows and that the odds for developing white line disease increased as days in milk (DIM) increased. Cows were more than twice as likely to develop thin soles during the warm season.

This herd has suffered problems with excessive wear and thin soles for several years. And, as in previous years, it has always seemed to follow a similar seasonal pattern. Lameness peaked during the months of August and September in the year studied. This coincides with the period of time in which heat stress is most severe in the southeastern region of the United States. We conclude that the management of lameness in regions with hot and humid weather conditions may be complicated, not only by heat stress itself, but also by efforts to attenuate it.

Despite the installation of rubber mats and conveyor belting in walkways, the herd has continued to struggle with excessive claw wear. While these data indicate that thin soles accounted for only 12% of claw lesions, toe abscesses associated with WLD in zones 1 and 2, accounted for nearly ¾ of the WLD recorded. Experience with this herd and others suggest that white line disease in the toe region is a common secondary problem in thin sole herds. In this herd, trimmers used a very precise definition for thin soles (i.e. dorsal wall less than 3 inches and a sole that was flexible to digital pressure). Cows that had toe abscesses from thin soles were not recorded as thin soles, but as WLD in zones 1 or 2.

On the other hand, in the study by van Amstel of the Midwestern herd, cows with the combination of thin soles and toe abscesses were often recorded as thin soles. Trimmers from this herd did not record lesions by claw zone affected. Thus, the rate of thin soles reported from this herd was nearly 3 times as great as that in the southeastern herd. Despite inconsistencies in the manner in which these data were recorded, the problems observed, and their interpretation as to underlying cause, is the same – thin soles and WLD in zones 1 and 2.

It is important to note, however that toe abscesses originating from WLD are sometimes incorrectly diagnosed as toe ulcers/abscesses. Although the distinction may seem trivial, ulcers have a different pathogenesis (manner in which they develop). A high incidence of toe ulcers may imply a serious problem with laminitis which would obviously be misleading information if the true underlying cause is thin soles and WLD. Therefore, we contend that an accurate diagnosis is important in trouble-shooting these conditions.

While white line disease was the predominant claw lesion over the 12 month period (30% of cases), the incidence of sole ulcers slightly exceeded the incidence of white line disease during the months of August and September. Thus, we suggest that thin soles may also be an important contributor to sole ulcers. When soles are thin, it is difficult, if not impossible to balance weight load between the claws. If soles are thin and weight bearing unbalanced, such that greater load is borne on the outside claw (in rear feet for example), tendency to develop an ulcer on the outside claw will be greater.

Data analysis also revealed that upper leg injuries and sole punctures occurred with greater frequency during the warm season. As indicated earlier, injuries from slipping or falling are more common when floors are wet, regardless if covered with rubber belting or not. Sole punctures also increased during the summer months. In some cases this was found to be a consequence of the protrusion of reinforcement wires from worn rubber belting. In others, small pieces of wire were actually found as foreign bodies in the sole. Stray nails from the previous construction of a new barn also found their way to the soles of some claws and resulted in subsolar abscess formation. We speculate that thin soft soles are more vulnerable to punctures.

Conclusions

There is little question that floors and flooring surfaces are significant contributors to lameness in dairy cattle. Sole ulcers, white line disease and thin soles are common claw disorders in dairy cattle and each are associated with housing and flooring conditions. Concrete is a necessary evil when herds expand and cow density increases. Rubberizing concrete flooring surfaces improves cow comfort and traction. However, rubberized or not, whenever floors are wet or covered with manure slurry many of the benefits of rubber are lost, or at least significantly reduced. Excessive wear rates are a growing problem in the US dairy industry. It contributes to thin soles and toe abscess problems arising from separation of the sole from the white line in zones 1 and 2. Proper diagnosis of these conditions is critical to the development of effective strategies for control. Observation suggests that claw lesions have a seasonal pattern of occurrence whereby incidence tends to peak during the hot and humid summer months. Evidence is accumulating that while the measures we use to maintain performance and health during periods of intense heat stress are beneficial for cows, they may not be good for feet.

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