Do Your Cows Have Sore Feet? Tips For Hoof Health

Soreness, bruising, and inflammation of the feet are painful conditions for humans and cattle. But in the case of the dairy cow, a painful foot affects more than just her disposition.

Lameness results in lowered milk production, involuntary culling, discarded milk, medical expenses, and reproductive inefficiency. At a hoof trimming seminar sponsored by Hilmar Cheese Company on September 1, 1999, Steven Berry, DVM, University of California, Davis, reported recent Cornell research which estimates that a typical case of lameness costs producers nearly $300 in lost profits.

Many risk factors, including genetics, nutrition, housing, flooring, and hoof trimming determine the odds of a cow going lame. Each of these factors can be controlled to some extent through management.

Basic Anatomy of the Hoof

According to Kent Hoblet, DVM, The Ohio State University, lesions of the hoof are responsible for 75% to 90% of all cattle lamenesses. Familiarity with basic hoof structure can aid in the identification of such cases as well as the evaluation of management strategies that affect hoof health.

The bovine foot is divided into two digits, or claws, comparable to the middle and ring fingers of the human hand. The claws are responsible for protecting sensitive internal tissues of the foot and for supporting the weight of the cow. Between the claws is a hairless strip of tissue known as the interdigital skin.

Each hoof is further separated into four regions: the periople, wall, sole, and heel (Figure 1). The latter three components constitute the hoof horn and are formed of keratin, the same material found in human hair and fingernails. Keratin is a modified type of epidermis, or skin covering, containing minerals, water, and fat. Beneath this external layer is the corium, a region containing all the blood vessels and nerves of the claw.

Horn forms at the coronary band and grows downward to form the hoof wall at a rate of approximately 5 mm per month (Blowey, 1993), with the fastest rate of growth occurring in the spring and summer and the slowest rate of growth in the winter. It has been shown that rear hooves grow faster than the front hooves and generally require the most corrective trimming (Kasari, 1991).

The hoof wall is made of tubular and intertubular horn. Cattle are born with a set number of these tubules which expand to facilitate hoof growth. As the wall grows downward from the coronary band, it slides across a series of grooves, or folds, called laminae which connect the hoof wall to the internal structures of the foot. Look along the inner wall of a hollowed out hoof (those sold as chew toys for dogs make excellent models), and you'll see hundreds of these tiny structures.

Separating the wall from the skin of the fetlock is the periople, a soft and shiny hairless band, usually pink in color. The periople overlies the coronary band, retains moisture in the foot, and secretes a waxy, protective coating over the hoof.

The sole is made from the same tubular horn as the hoof wall, but is much softer than the wall and is less than 1 cm thick (Kasari, 1991). Between the hoof wall and the sole is the white line, the softest, most flexible area of the foot. Naturally weaker than the wall and the sole, the white line is susceptible to gravel, manure, and other debris which can lead to a claw infection and lameness.

The foot also contains four bones: the long pastern bone (P1), the short pastern bone (P2), the pedal bone (P3), and the navicular bone (Figure 2). Both pastern bones are located above the horn, while the pedal bone and navicular bone are positioned inside the hoof capsule. The digital cushion, a fatty layer of tissue beneath the pedal bone, pumps blood up the leg as the animal walks and acts as a shock absorber, protecting the corium from the surrounding bone. Running along the front of the leg from the top of the pedal bone to the fetlock is the extensor tendon which allows the animal to extend her feet forward. A parallel flexor tendon runs along the back of the leg, and lets the cow kick backward.

By understanding this basic structure and function of the hoof, you can identify

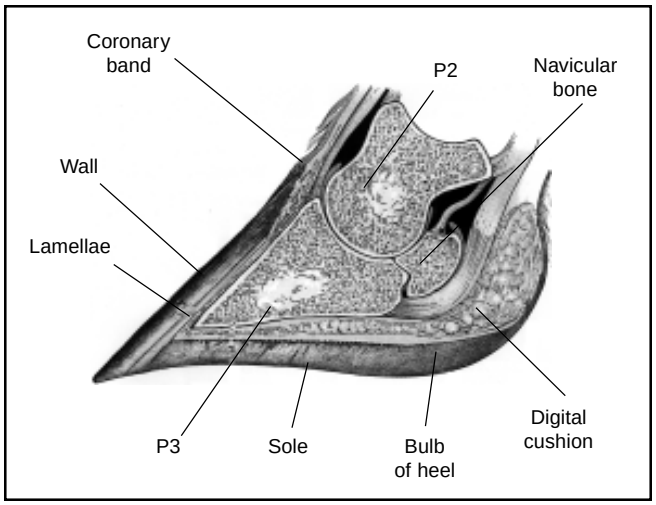


Figure 1. Cross section of the bovine claw. (Reprinted with permission from *Illustrated Handbook on Cattle Lameness*, Zinpro Corporation.)

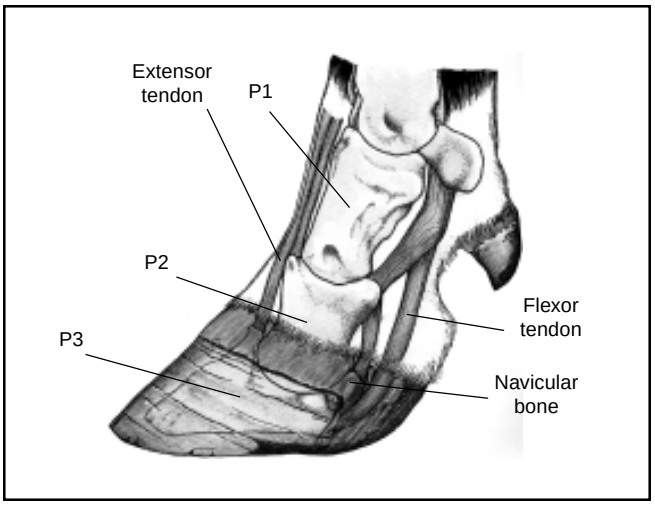


Figure 2. Bones and tendons of the bovine claw. (Reprinted with permission from *Illustrated Handbook on Cattle Lameness*.)

problem feet and make necessary corrections. You can also improve your herd's resistance to lameness by using genetic information to select service sires that transmit functional improvement in feet and legs.

Jersey Genetics and Linear Type Appraisal

Prior to the adoption of a linear scoring system in 1980, the American Jersey Cattle Association (AJCA) classified cows by rating them against the prevailing idea of an "ideal" cow. This subjective method of type evaluation included a general feet and legs category. However, like all other traits classified, there was little, if any, scientific information to show the trait's relationship to longevity and productive life.

To move type evaluation to a more scientific basis, the National Association of Animal Breeders (NAAB) and the breed associations began a program in October of 1977 to assess each organization's program. The outcome of that review was a proposed Uniform Functional Type Traits Appraisal, which was based on seven principles:

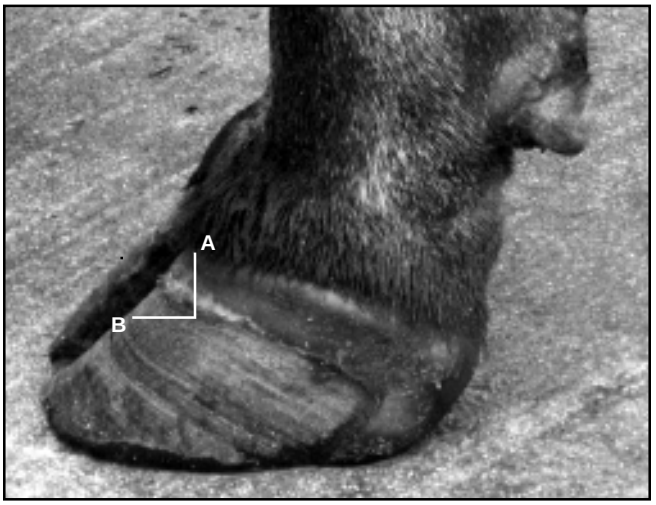
- Evaluation of specific biological traits;
- Use of numerical scores from one biological extreme to the other;
- Scoring of all similar age contemporaries;
- Evaluation of cows while they are still young;
- Evaluation of both registered and unregistered cows;
- Scoring of cows without knowledge of sire or the previous scores; and
- Analysis by Best Linear Unbiased Prediction (BLUP) procedures.

The United States Department of Agriculture (USDA), NAAB, and several universities endorsed the program, and the AJCA implemented this linear appraisal procedure on January 1, 1980.

Often compared to measuring a cow with a yardstick, the linear system is based on a 50-point scale, 1-50. Unlike its predecessor, classification, linear appraisal takes into account biological extremes. For example, a cow with very posty legs would fall at the lower end of the scale, 1, while an extremely sickle-hocked cow would be placed at the high end, 50.

When evaluating the feet and legs of Jersey cows, the appraiser scores two specific traits: (a) foot angle and (b) rear leg set, side view.

Foot angle, one of the most difficult traits to measure, is evaluated by estimating the steepness of the angle of the rear foot from the hairline to one inch below the hairline. Because hoof trimming does not alter foot angle as much as it does heel depth, measurement of the front angle provides the most accurate information upon which to base genetic evaluations.



The linear score for foot angle indicates the angle of the rear foot. It is measured by assessing the angle between two points: one at the hairline (A), and the other 1" below the hairline (B).

On the linear scale, a 45° foot angle is given as a linear score of 40. Every five degrees plus or minus from 45° adds or subtracts five points from the linear score. For example, a 40° foot angle is scored 35.

According to Michael Hurst, Director of Appraisal for the American Jersey Cattle Association, studies show that the linear score associated with maximum lifetime profitability of Jersey cows is 42 (approximately 47°).

For rear leg set, appraisers assign a score of 25 for moderate curvature in the leg above the hock. Lower scores indicate great set, and higher scores, less set (posty legs).

"Leg set is a mobility trait in which you want to stay away from both extremes," Hurst comments.

Heritability estimates describe what fraction of the differences in observed traits are due to transmittable genetic factors. In the case of foot angle, approximately 10% of the differences in foot angle scores can be attributed to genetics. The same is true for rear leg set.

Though their heritabilities are low, the genetic estimates for both feet and legs have economic importance and thus have a critical place in the calculation of the Functional Trait Index (FTI).

Introduced in 1992, FTI estimates the impact of different type traits upon lifetime relative net income, holding milk and fat constant. The larger the weight for a given trait, the more influence that trait exerts in the calculation of FTI. Similarly, the lower the weight, the less influence.

When FTI was first calculated, foot angle was weighted 0.30 in the formula. When the weights were updated in 1998, foot angle was weighted more heavily, at 1.97. The PTA for rear legs also figures more significantly in today's FTI than it did in 1992.

"That's where foot angle stands out from a genetic standpoint," said Hurst. "Foot angle has as much impact as any of those type traits on lifetime profitability when you hold production constant."

FTI is one of four factors used in calculating the AJCA Production Type Index (PTI). PTI ranks bulls on overall merit with PTA protein, PTA fat, the FTI and PTA somatic cell score combined in a ratio of 10:4:3:-1.

"Because of the heavy emphasis on foot angle in FTI," Hurst explains, "our PTI will sort those bulls with the most correct feet and legs to the top so that you can make your selection on one criterion, the PTI."

Management and Lameness

A young cow with a functionally correct foot angle and rear leg set cannot reach her productive potential if management conditions are unfavorable. Housing, flooring, ration formulation and hoof trimming all play important roles.

According to research conducted in the late 1970s and early 1980s by Ben T. McDaniel and John C. Wilk, professors of Animal Science at North Carolina State University, herd management and genetic selection for feet and legs is well worth the economic return.

After laboriously measuring the foot angle and toe length on hundreds of dairy cattle across the country, they reported a

number of important relationships between these traits and production, reproductive efficiency, lameness, and longevity. "Lameness in Dairy Cattle," a 1989 paper co-authored by McDaniel and Wilk, summarizes these correlations:

- Short toe length in first lactation and increased milk production in second lactation;
- Steep toe angle in first lactation and increased milk production in second lactation;
- Short, steep claws and fewer days open;
- Long claws, low angles and lower survival rates;
- Long claws and high incidence of interdigital dermatitis (foot rot); and
- Deep heels and more sole ulcers.

Based upon their work and other studies, Wilk and McDaniel offer these management recommendations.

The first thing to do is to evaluate where your cows are walking. "Floor or ground surfaces that increase rates of lameness are those that are too rough, too smooth, too soft, or too wet." Reduce the abrasiveness of new concrete flooring, and roughen or groove older concrete, which often becomes smooth and slippery over time.

Removing cattle from concrete flooring to a dirt lot or pasture for several hours a day is also conducive to the maintenance of clean, dry feet.

In addition to placing cows on proper flooring, free stall beds should be kept as smooth and dry as possible to promote cow comfort and to encourage cattle to lie down. Viral diseases of the foot can be prevented by maintaining a dry bed and providing a clean foot bath containing copper sulfate or formalin.

To prevent nutrionally induced lameness, all cows should be fed a ration correctly balanced for nutrients and fiber. Wilk and McDaniel warn against feeding a ration that is too fine, cut too short, or highly acidic, as such rations are purported to increase the risk of laminitis. To neutralize the effects of an acidic ration or high levels of concentrate, buffers should be added to the feed. Likewise, a source of long fiber should supplement feed that is finely ground.

Wilk and McDaniel suggest that heifers be introduced to concrete and free stalls at breeding age as well as when they are springing. Because first-time calvers are prone to laminitis during the first 60 days post-calving, special care should be taken in their diet. Make a gradual change from a low- to high-energy ration. By allowing heifers time to adapt, you may be able to prevent future cases of lameness.

Dr. Steven Berry of the School of Veterinary Medicine, University of California, Davis, demonstrates the correct technique for regular inspection of a cow's foot during a seminar at the Jer-Z-Boyz Ranch in Pixley, Calif.

To complete this lameness prevention plan, a trained hoof trimmer should inspect the feet of every cow at least twice a year.

To properly inspect the feet, the trimmer must look at the bottom of the hoof. Many hooves that appear healthy from the top reveal lesions or excess wear when picked up for inspection. Lame cows or those with problem feet should be checked, treated, and trimmed as necessary at the first sign of warning. The same procedure should be followed at dry-off.

A High Cost–Benefit Ratio

Paying attention to hoof health has a high cost-benefit ratio. "The easier it is for a cow to walk to the food and water sources, the more money she's going to make for you," notes Michael Hurst.

By implementing these management strategies and using genetic information in the selection of service sires, you can establish an effective protocol to reduce lameness and maintain a profitable herd.

For More Information About Cattle Lameness

The hoof diagrams on page 69 were reprinted with permission from the Zinpro Corporation's *Illustrated Handbook on Cattle Lameness*, written by Paul R. Greenough, F.R.C.V.S., Professor Emeritus of Veterinary Surgery at the Western College of Veterinary Medicine, University of Saskatchewan; LaVerne M. Schugel, D.V.M., vice-president of Research and Development (retired) for Zinpro Corporation; and A. Bruce Johnson, Ph.D., director of Nutritional Services for Zinpro Corporation, Eden Prairie, Minn.

The *Handbook* is a 30-page booklet written to aid livestock producers in the identification of cattle lameness. Copies are available. For further information about the *Handbook* or to download an order form, log onto Zinpro Corporation's web site at http://www.zinpro.com/home/library/cattlelame.htm.

The World Wide Web also offers technical information and guides on hoof health and management practices. Visit the University of Florida website at http://edis.ifas.ufl.edu/BODY_DS-092.

Michigan State University offers a lameness scoring system on its website at http://www.canr.msu.edu/dept/ans/extens.html. Click on Dairy Extension Programs, then go to the August, 1997 of the Michigan Dairy Review. Click on "Lameness and Reproduction."

References

Blowey, Roger. (1993) *Cattle Lameness and Hoof Care: An Illustrated Guide*. Ipswich, UK: Farming Press.

Kasari, Thomas R. (1991) The principles of trimming the bovine hoof. *Veterinary Medicine*, 1218-1226.

McDaniel, Ben T., Hahn, Martin V., & Wilk, John C. (n.d..) Floor surfaces and effect upon feet and leg soundness. Raleigh: North Carolina State University.

McDaniel, Ben T., & Wilk, John C. (1989, November) Lameness in dairy cattle. Raleigh: North Carolina State University.