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AUGUST 1999

## Animal Health

# Lameness and Hoof Health

Steven L. Berry, DVM, MPVM, Department of Animal Science, UCD

### Introduction

**B**ovine lameness is a continuing problem on dairies around the world. The 3 most common reasons for premature or involuntary culling of dairy cows are reproduction, mastitis, and lameness. The economic loss from lameness is due to premature culling, lost milk production, milk discard due to treatment with antibiotics, treatment costs, and reproductive inefficiencies. Research from New York calculated that the average case of lameness costs the producer about \$300. This equates to a loss of \$90/cow/lactation if we have a lactational incidence of 30% as reported in New York, \$150/cow/lactation if we have a 50% incidence as reported in Florida, or \$180/cow/lactation if the incidence is 60% as reported in UK and the Netherlands. The cost per case was found to be similar in various studies but the cost per herd is proportional to the lactational incidence.

**L**ameness is a multifactorial disease and is directly related to how cows are managed. Some of the contributing factors are nutrition, hygiene, cow comfort (freestall management), walking surfaces, time spent standing on concrete, hoof health, and claw trimming. Prevention is more economical than treatment, but close observation and prompt treatment of lame cows will decrease the duration and thus the cost of each case. If hoof trimming costs \$8-12/cow then it will pay if you can prevent some of the lameness problems. In Europe, it is commonly recommended that all cows be trimmed twice per year, once when the cow is dried off and once during mid lactation. A preliminary study from Sweden reported that cows had 30% more sole ulcers and 25% more severe sole hemorrhages when trimmed once instead of twice yearly. Many producers in the US do not trim cows on a regular basis because of the perceived cost of trimming. Functional hoof trimming is designed to balance the effects of wear and growth and will be explained more fully later in the paper.

### Incidence of Lameness

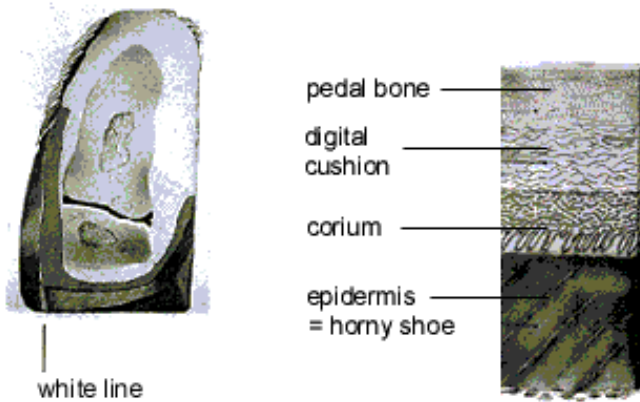
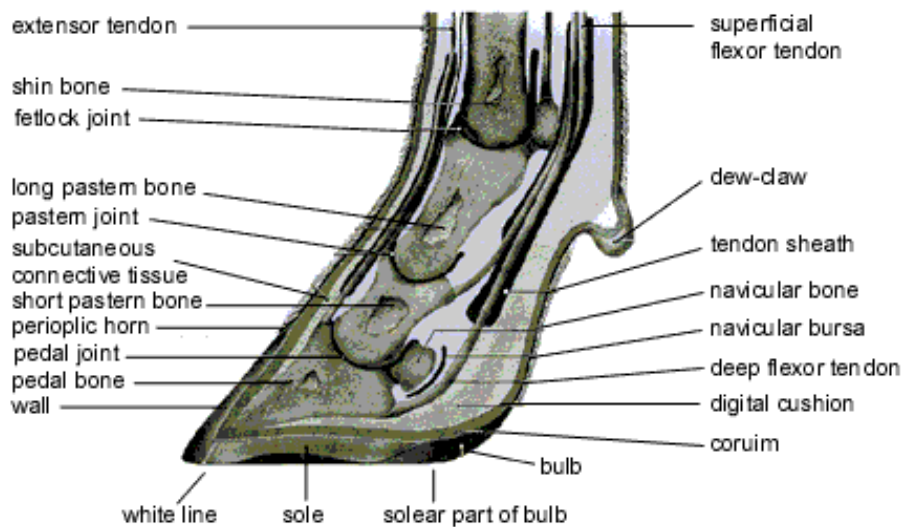
**A** lameness study in the UK observed a mean incidence of 60 cases of lameness per 100 cows per lactation. The incidence was higher during the winter than during the summer. As would be expected, there was large farm to farm variation, which indicates that management makes a big difference. Ninety-nine percent of the lesions causing lameness occurred in the feet with 92% occurring in the rear feet. Of the lesions in the rear feet, about 68% were on the lateral (outside) claw, 12% on the medial (inside) claw, and 20% on the skin. The most common lesions (58%) were sole ulcer and white line disease. These are the direct result of insult or injury to the corium and are lesions we generally attribute to "laminitis". Similar incidence figures have been reported from Florida but the summer incidence was higher than winter.

### Normal Anatomy and Function

**S**ince most bovine lameness occurs in the foot we will concentrate on the foot and how to keep it functional for the cow. Keep in mind that we have taken an animal whose natural environment is pasture (varied surface, often yielding) and put her on concrete for much of her life. By understanding the normal anatomy and function of the cow's foot we can keep the foot functional and prevent many of the lameness problems. Figure 1 shows the normal anatomy of the bovine foot. This and other pictures in this handout are from "Cattle Footcare and Claw Trimming" by E. Toussaint Raven by permission of the author.

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Figure 1. Normal Anatomy of the Bovine Foot



The foot is the part of the limb below the fetlock. This would correspond to human fingers and toes. The shinbones in cattle are the metacarpals on the front legs and the metatarsals on the rear legs. The foot is divided into two digits and the ends of the digits are called claws or hooves and are surrounded by horny capsules. Each digit of the foot, then, is comprised of four bones: the long pastern bone (proximal phalanx, P1), the short pastern bone (middle phalanx, P2), the pedal bone (distal phalanx, P3), and the navicular bone. The proximal and middle phalanges are outside of the claw and the distal phalanx and navicular bones are inside the claw. There are 2 joints in the foot the proximal phalangeal or fetlock joint and the distal phalangeal or pedal joint. The extensor and flexor tendons and the navicular bursa are also contained within the foot. A very important part of the foot is the digital cushion. The digital cushion lies below the pedal bone and has 2 functions: 1) to cushion the corium from the pedal bone and 2) to pump blood back up the leg when the cow walks. The two claws are divided by the interdigital space and connected by smooth, hairless skin. The interdigital space is narrow especially between the heels, which can trap manure and lead to interdigital dermatitis.

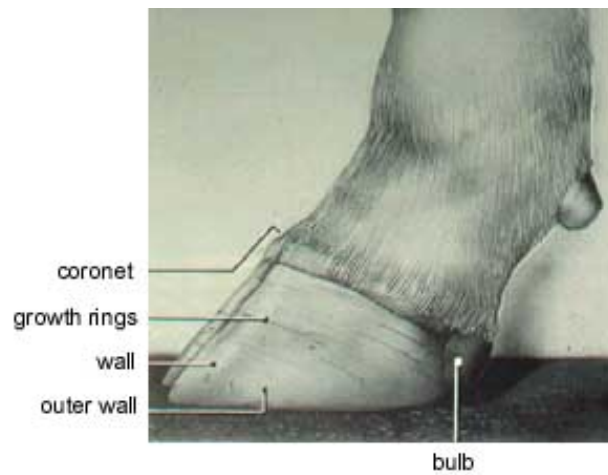


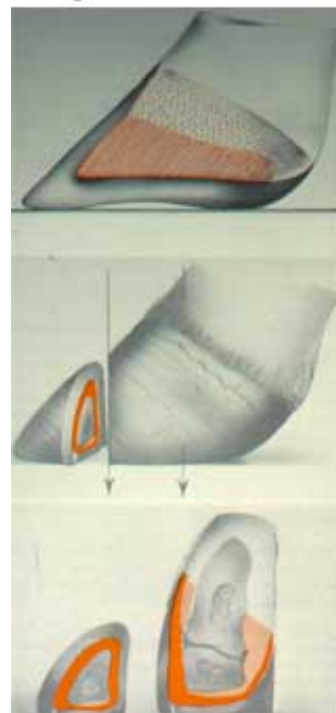
Figure 2. Abaxial View of the Normal Hoof

The horny capsule of the claw (hoof) is comprised of the wall, sole, heel, and white line. The wall consists of the toe or dorsal wall, the outside or abaxial wall, and the inside or axial wall (see Figure 2). The normal (non-laminitic) hoof wall has faint lines (rugae) or growth rings on it. These growth rings slope slightly toward the heel indicating that the heel wears faster than the toe. In fact the wall is the hardest horn, the sole is softer than the wall, and the heel is softer than the sole. The white line is the softest horn and forms the junction between the sole and the wall.

The cow's body is covered with the integument (skin and nails) which is the epidermis. In the claw the epidermis is the horny hoof. The dermis or corium contains the nerve and blood supply and is inside the epidermis of the claw. The corium produces the horny claw and if the corium is damaged it cannot produce healthy horn, thus lameness occurs. Healthy corium equals healthy horn and diseased corium equals diseased horn. The most common causes of lameness in cattle are from damage to the corium.

The dermis or corium (see Figure 1) produces hoof horn. The perioplic corium forms the perioplic horn, which is visible on the dorsum of the hoof wall at the toe and wraps around the hoof to merge with the heel (see Figure 2). So heel horn is formed by the perioplic corium. The coronary corium produces the wall of the hoof, which grows downward from the coronary band at about 5 mm (1/4 inch) per month. The laminar corium produces the laminar horn that attaches the abaxial, dorsal and a small part of the axial wall to the pedal bone (see Figure 3). Therefore, the pedal bone is firmly attached and suspended inside the toe of the normal hoof. The laminar corium also produces most of the white line. The solear corium produces the solear horn.

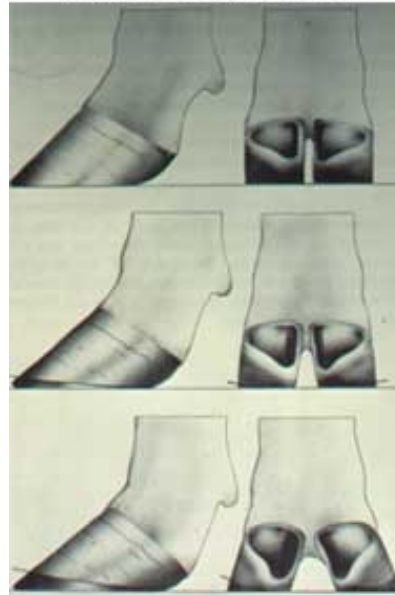
Figure 3 Laminar corium



## Biomechanics

If we look at the feet of beef cattle we find that the sole tends to be concave with the wall extending beyond the sole. Cattle on pasture will walk on varying surfaces, some hard and some yielding. When cattle are confined on cement then the hoof tends to wear differently. The sole and wall tend to wear flat due to the abrasive and shearing forces from walking on concrete. The toe and abaxial wall will grow faster and wear slower than the heel and axial wall (see Figures 4, 5 & 6). The cow becomes more cow hocked as she tries to relieve pressure on the rear, lateral claws. The claws also will splay because the abaxial wall is longer than the axial wall. This leads to uneven weight distribution and increased pressure on the corium especially near the rear of the pedal bone. If the pressure is great enough and prolonged enough then permanent damage is done. Damaged corium produces damaged horn, which sets up a vicious cycle.

Figure 4 Overgrown toe



## Functional Hoof Trimming

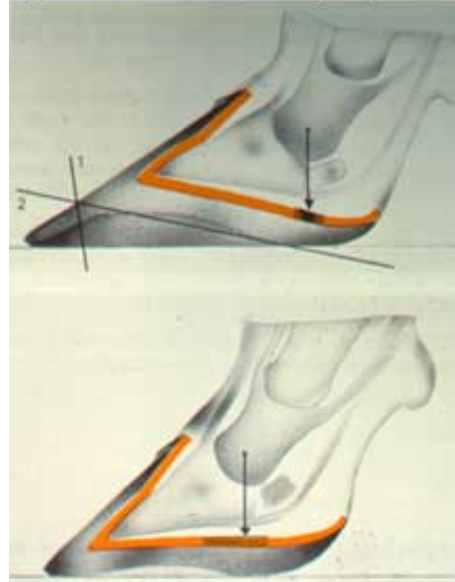
As mentioned above the hoof tends to grow at a rate of about 5 mm per month. The shape of the hoof is a result of a balance of growth and wear. The toe will tend to wear slower since it is harder and the heel will wear faster since the horn is softer. Overgrowth will generally result in a hoof that is too long and the toe (the toe angle is too shallow). The goals of functional trimming are to distribute the weight evenly between the 2 claws of the foot, to leave sufficient horn to protect the corium, and to trim the claws to their normal shape and proportion. We are basically trying to create a flat surface for the cow to walk on that will minimize trauma to the corium. By functional trimming we will establish appropriate weight bearing in the claws on all 4 feet.

Most cows will need to be trimmed 1-2 times per year. Cows with problems may need to be trimmed more often. Heifers should be trimmed about 2 months before calving to help shape the claws for the first lactation. Most producers on a regular hoof trimming program trim cows at dry off. Most cows could also use a mid-lactation trimming or at least an evaluation to determine if trimming is necessary.

The late Dr. Toussaint Raven from the Netherlands developed the method of functional trimming described below. The following procedure is described for the rear claws since they are most often the problem. Trimming the front claws would be done in the reverse order (lateral claw first) since when lameness occurs on the front feet it is more often the medial claw that is involved. Trimming occurs in 6 steps; the first 4 steps are corrective and the last 2 steps are therapeutic or curative:

1. Cut the medial claw to length with a pincers, 7.5 cm (3 inches) (see Figures 5 & 6). The measurement is made from the start of the hard horn just distal to the periople to the toe. The cuts are made perpendicular to the solear surface. This is the most crucial measurement and cut of the entire procedure. If the toe is cut too short then the corium of the toe will be exposed to trauma when the cow walks. It is better to cut slightly too long than too short. The pincers can be used to trim the wall along the abaxial side of the hoof. Pare the solear surface of the medial claw with the hoof knife, taking more of the sole off of the toe than the heel. The heel should be spared as much as possible and in many cases will not need to be trimmed at all. In cases where the heel has grown too long, it should be trimmed to the proper length and shape. Be sure to leave ample sole to protect the corium, 5-7 mm (about ¼"). The weight bearing surface should be flat and in the correct plane, i.e. 90° to the leg.

Figure 5 Functional trimming steps 1 & 2



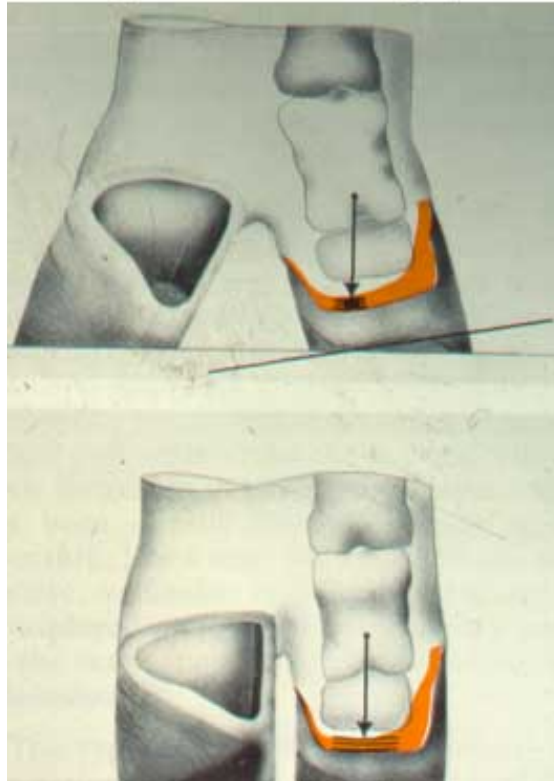
2. Using the medial claw as a guide, measure and trim the toe on the lateral claw to the same length. The front wall of the lateral claw may be slightly longer than the front wall of the medial claw. Pare the sole of the lateral claw to the correct thickness. The toes of the medial and lateral claws should be flat across the toes and flat from toe to heel.

3. Shape the axial sole so that the sole slopes toward the interdigital space. Do not reduce the weight bearing surface any more than is necessary. Trim less rather than more. Proper sloping of the sole will take pressure off of the typical site at the caudal part of the lateral sole and will open up the interdigital space so that manure and other debris are less likely to accumulate.

**Most cows will need to be trimmed 1-2 times per year. Cows with problems may need to be trimmed more often.**

4. Balance the heels. The weight bearing surfaces should be flat across the heels. On many Midwestern dairies, the cows do not have to walk very far and hoof trimmers may "rest" the lateral heel by trimming it about 1/8th of an inch lower than the medial heel. On most of our western dairies the cows walk greater distances and have more wear on the heels. "Resting" the heels if they are already thin is not advisable.

Figure 6 Functional trimming step 2



5. If the lateral claw is diseased then the heel will have to be trimmed lower than the sound, medial claw. Specific conditions that would warrant lowering the heel on the lateral claw would be sole ulcer, abscess, or white line disease. Allowing the lateral claw to rest will facilitate healing. Sometimes it will be necessary to apply an orthopedic block to the sound claw to get more weight off of the diseased claw.

6. Remove loose horn and pare away all the hard edges. Only healthy horn should be left. Be careful not to trim too much off of the lateral claw. Preserve the heels, especially the medial rear heel as much as possible.

**R**emember, the correctly trimmed, normal foot should have a flat weight-bearing surface (wall and sole) and should be flat across the toes and heels and flat front to back. The correctly trimmed, normal foot should also be perpendicular to the leg of the cow when viewed from the front or the rear.

### Pathological Conditions

**L**aminitis (which includes any damage to the corium) comprises most of the hoof disorders that can lead to lameness. Laminitis can be peracute (hours), acute (day to days), or chronic (weeks to months). The most common condition is chronic, subclinical laminitis. The most common hypothesis regarding the pathogenesis of laminitis is that endotoxins are produced in the gastrointestinal tract during subclinical or clinical rumen acidosis. These endotoxins are absorbed into the circulatory system and cause thrombi or small blood clots that can affect the peripheral circulation, especially in the feet. Circulatory disturbances of the laminar corium then result in poor attachment of the horn to the pedal bone and poor horn production. Chronic problems can even lead to dropping of the pedal bone and toe ulcers. The pressure of the bones on the corium cause hemorrhage and contusion and will become visible after about 2-4 months.

**T**he following are the most common hoof abnormalities that lead to lameness:

- **Sole and white line hemorrhages** originate from damage to corium with the blood being incorporated into the horn as it grows. These will become visible

several weeks after the insult depending on the thickness of the sole and rate of growth. A sole abscess or white line abscess can occur if the hemorrhage becomes infected.

- **Sole separation** results when the corium is damaged transiently, produces weak or damaged horn and then normal horn production resumes.
- **Sole ulcer** is a continuous opening in the sole horn that exposes the corium. The typical site is the rear middle part of the sole, which corresponds to the rear part of the pedal bone. The prognosis for sole ulcers depends on the damage to the horn producing tissue and the condition of the other claw.
- **Toe ulcer** occurs when the sole is worn too thin at the toe, or the toe drops inside the horn due to laminitis, or if the toe is accidentally trimmed too thin. Toe ulcers will always require an orthopedic block on the opposite claw.
- **White line disease** starts with fissures due to hemorrhage and poor quality horn formation. Rocks and gravel can become embedded in these and cause further problems. The problems with the stones or gravel are more likely the result of white line disease rather than the cause of the disease.
- **Heel horn erosion** is the formation of holes or fissures in the heel horn. Normal heel horn should be smooth. One hypothesis is that manure slurry contributes to heel horn erosion (the British refer to this condition as slurry heel). This generally does not cause lameness unless it is severe. This condition has also been association with interdigital dermatitis.
- **Papillomatous digital dermatitis (footwarts, heel warts, digital dermatitis, etc)** is a superficial dermatitis that occurs most often on the rear feet at the commissure of the interdigital space near the heels. It is thought to be a multifactorial disease with bacterial involvement. Response to topical antibiotics is good but recurrence is common.
- **Interdigital phlegmon (foul in the foot, footrot)** is a bacterial disease that is generally caused by a synergism between two bacteria. It has a very characteristic smell and causes necrosis in the interdigital skin. It can invade the deeper tissues if not treated early with antibiotics.

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