

# Managing Lameness for Improved Cow Comfort and Performance

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## Introduction

Lameness is clearly one of the most important health and welfare issues on today's dairy farms. This is in part a consequence of the increase in size of herds, higher levels of feeding and management intensity, and a greater concern for the potential environmental impact of large scale dairy operations which has led to regulations for the containment of waste, and a gradual shift from pasture to confinement-type housing. While there are advantages, confinement housing can result in reduced cow comfort from increased exposure to hard flooring surfaces. Therefore, it should come as no surprise that the incidence of lameness continues to increase. The cow's foot was not designed for prolonged exposure on concrete and in housing conditions that subject claws to constant contact with wet manure slurry. Present-day housing and management practices common to intensive dairy production present tremendous challenges to foot health.

## Normal Gait in Cattle

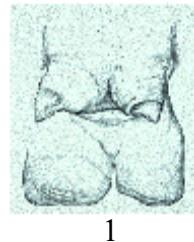
The cow's stride consists of the stance phase (standing position) and the swing phase (movement from, and back to, the standing position). The swing phase is divided into a retraction (contraction or shortening) and protraction (extension or lengthening) phase. The retraction phase of the stride starts with the cow in standing position. The cow begins her stride by shifting body weight to the sole of the weight-bearing surface of the claws which also provides traction as the cow enters the retraction phase of the stride. As the body moves forward and weight is applied to the soles of each claw, the foot is retracted (or lifted upward) toward the body, thus ending the retraction phase. Once the foot leaves the ground it is extended forward thus entering the protraction phase (forward swing and placement of the foot on the ground surface) of the stride. The heels strike the ground first with the soles resuming a normal weight-bearing position as the cow completes the protraction phase and reaches the standing position. In a sense, the rear legs propel the cow's body forward while the front legs act more like props or supports for the body weight.

Gait characteristics are altered by conditions which make the surfaces of floors more or less slippery. For example, on wet manure slurry covered concrete floors cows will alter their gait by lowering walking speeds, changing limb angles and reducing the length of their step, all in an effort to increase stability on the less secure surface. It is interesting to speculate on what effects, if any, this has on claw horn wear rates. In recent years the occurrence of thin soles from excessive claw horn wear has become a major problem in herds throughout the southeastern United States.

## The Dynamics of Weight-Bearing in Cattle: Anatomical and Biomechanical Factors

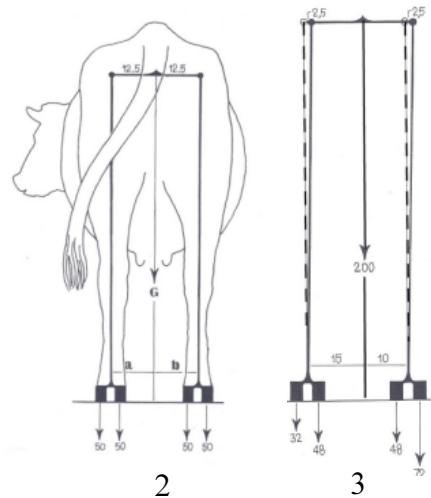
The anatomical and bio-mechanical characteristics of weight-bearing in cattle are well described in "Cattle Footcare and Claw Trimming" by the late Dr. E. Toussaint Raven from the Netherlands (Raven, 1989). Following years of study and observation, his insight on weight-bearing and the likely effect of housing conditions (hard floors) on foot problems has added much to our current understanding of lameness, particularly as it relates to claw disorders.

The sole of the inner claw of rear feet in cattle slopes toward the axial (inside) side of the claw (in other words, it slopes toward the interdigital space). This differs from the outer claw which tends to be flatter and more stable. As the cow steps forward and places her foot down, weight shifts (or rolls over) from the inside to the outside claw. The result is greater weight-bearing on the outside claw that over time (particularly on hard surfaces) leads to irritation of the corium and accelerated hoof horn formation on the outside claw (See Figure 1).

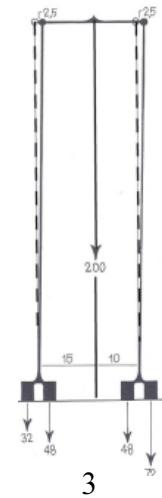


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At the hip the hind legs of the cow are connected to the pelvis through a ball-and-socket joint. This creates a fairly rigid skeletal structure for support of the rear quarters and legs of the cow. In an animal standing squarely on its feet, weight is distributed equally over all 4 claws of the rear feet (Figure 2, from Raven). However, during movement the distribution of weight within and between the claws changes displacing more weight to the outside claws. Despite movement, load-bearing on the inside claws is more even (more stable). Outside claws automatically and continuously correct for ever-changing weight load (Figure 3, from Raven). This circumstance of ever-changing weight distribution is believed to be a major reason for accelerated hoof growth and a higher incidence of claw disorders involving the outside claw.



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The situation for front feet differs in that both stability of the weight bearing surfaces and size of the claws is similar. Furthermore, there appears to be greater flexibility in the anatomical arrangement of the skeleton and soft tissues of the shoulder. Front legs are not connected to the upper body through a ball-and-socket joint. Instead, front legs are connected to the torso by tendons and ligaments that tend to cushion the effects of variable weight distribution between the claws. As a result the bio-mechanical forces associated with variable weight distribution are less pronounced in front feet and disorders leading to lameness less frequent. Despite similarities between each of the front claws, weight bearing is greater for inside claws. Consequently, when lesions do occur they are more commonly associated with the inside claw.

Confinement on concrete or other hard surfaces enhance the physical effects of load-bearing on feet, whereas housing on earthen surfaces tends to reduce these effects. The practical significance of which is the observation of cattle (especially heifers) moved from pasture to confinement that experience lameness due to a physical/mechanical form of laminitis. These physical effects are further complicated by the fact that the unyielding nature of hard-flooring surfaces tends to irritate the corium thereby increasing its blood flow and accelerating the growth of claw horn. Excessive hoof growth (particularly of the outside claw of rear feet) leads to overgrowth and eventually overloading of the affected claws. This causes the cow discomfort

which she attempts to alleviate by taking a base wide or cow-hocked posture (Figure 4, from Raven). Despite changing her posture she continues to bear excess weight on the outside claws. The end result is an increased risk of claw disease in these overgrown/overloaded claws.

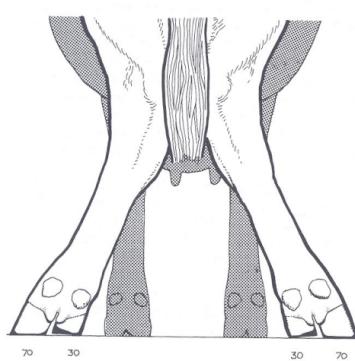


Figure 4

## Weight-Bearing Forces in Overgrown Claws

Most overgrowth occurs at the toe. When the toe is long the sole at the toe is thick. This forces the weight-bearing axis backward toward the heel often concentrating weight bearing forces over the sole and heel ulcer sites. By reducing length and sole thickness at the toe one is able to move the weight bearing axis forward and away from the sole and heel ulcer sites thereby decreasing the potential for ulcer development (See Figure 5, from Raven). Studies by Raven and others indicate that proper length of the front wall of the inside claw of the rear foot is approximately 3 inches in mature average sized Holstein cows. This front wall length corresponds to a sole thickness of about 1/4 of an inch which is believed to be the minimum sole thickness required to protect the corium. When front walls measure less than 3 inches, sole thickness at the toe is less than a 1/4 of an inch and potentially unable to support the weight of the cow on hard flooring surfaces.

Since horn of the wall is harder and grows faster than the sole, overgrowth of the abaxial (outside) walls is a natural occurrence in overgrown claws (See Figure 6, from Raven). Similar to that described earlier for overgrowth occurring at the toe, overgrowth of the abaxial walls shifts weight bearing forces onto the sole ulcer site. The combined effect of overgrowth of the abaxial wall and toe exaggerate weight bearing over this area and significantly increase the potential for a sole ulcer to occur. Correction of abaxial wall overgrowth displaces the weight bearing forces laterally thereby reducing the potential for sole ulcer development.

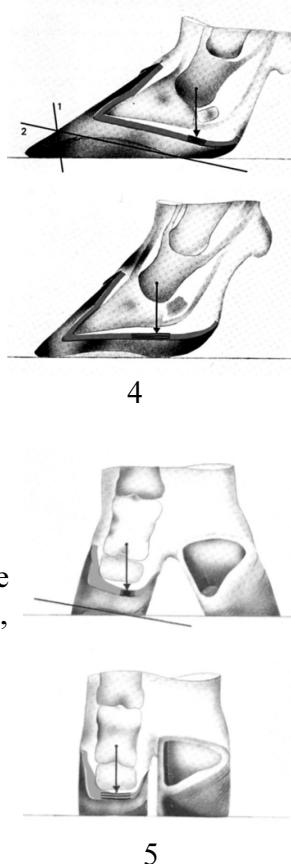
It is for these reasons (overgrowth, overburdening and altered weight bearing) that the claws of dairy cattle require regular evaluation and trimming. In some cases the rate of horn wear is in balance with the rate of horn growth despite the effects of weight bearing and trimming is not required. In other cases, horn growth exceeds the rate of wear and trimming is required to correct weight bearing disparities. In free stall housed dairy cattle, the rate wear often exceeds the rate of claw horn growth and trimming only exacerbates an already serious problem. Proper foot care and claw trimming requires an understanding of the anatomy of the foot and the dynamics of claw horn growth.

### Claw Trimming: 2 Approaches

*"If there is no lameness problem, trimming can produce it"*

from Cattle Footcare and Claw Trimming, by E. Toussaint. Raven

Although footcare and claw trimming have an important role in the management of lameness conditions, experience has shown that claw trimming can be a cause for lameness. The most common error in the US is over-trimming. It is important to remember that one of the primary purposes of the claw horn capsule is to protect the corium. When excess claw horn has been removed and the sole is no longer able to properly support the cow's body weight, the underlying corium becomes subject to damage from bruising. In herds with abrasive flooring surfaces cows may develop thin soles from excessive wear. Thin soles in dairy cattle represent one of the most difficult of foot problems to manage. The functional and corrective trimming method as described by Raven provides important guidelines for the maintenance of proper toe length and sole thickness. These guidelines are useful to prevent trimming-related lameness.



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**The Traditional Approach to Claw Trimming.** Traditional claw trimming techniques applied to cattle are based largely on procedures used by farriers and others trimming the hooves of horses whereby weight is transferred primarily to the hoof wall. Application of this same technique to the cow would consist of shortening the axial wall and sloping or “cupping out” the sole in order to place the majority of weight on the abaxial (outside) wall. This is problematic in that underdevelopment of the axial wall and sloping of the sole toward the axial (inside) wall are primary reasons for instability of the medial claw of the rear foot under natural conditions. Removal of the axial wall in both claws only exacerbates instability in the foot. Furthermore, transfer of weight-bearing to the abaxial walls naturally increases shearing forces on the walls. One might speculate that this could increase the risk of white line separation and thus white line disease. Based on the work of Raven, sloping of the soles in an axial direction may also encourage the development of sole ulcers by shifting weight-bearing within the claw onto the “typical site” for sole ulcers (See Figure 6, from Raven). Also, when the soles of claws are sloped axially, claws are encouraged to splay apart when weight is borne on the foot. This causes stretching and irritation of the interdigital skin and is believed by some to contribute to interdigital fibromas (corns) in cattle. Finally, traditional trimming techniques generally make little or no attempt to balance weight-bearing within or between the claws of each foot. Studies on the pathogenesis of sole ulcers and white line disease clearly show that claw overgrowth leads to disproportionate weight-bearing and eventually claw disease. Therefore, the re-establishment of appropriate weight-bearing within and between claws would seem to be an important objective in hoof trimming.

**Functional and Corrective Claw Trimming.** Functional claw trimming is the method described by Raven. Readers are advised to consult this book for a more in-depth review of this topic.

According to Raven the objectives of preventive hoof (claw) trimming are:

1. Correction of the relative overgrowth that leads to overburdening of the claw (overgrowth is most significant for the outside claw of rear feet and the inside claw of front feet).
2. Restoration of the appropriate weight-bearing surface within each claw.
3. Correction of claw lesions at an early stage.

The following describes a 4-step functional trimming procedure based on the Raven method. The trimming procedure and claw parameters described herein are intended for application on average sized Holstein-Friesian cows. They should be adjusted for larger framed cows or bulls. Although Raven's technique is described as 3-step procedure, the authors prefer the 4-step procedure as described below because it permits greater emphasis on heel balance (Step 4).

#### **Step-wise procedure for the trimming of rear feet:**

**Step 1.** Begin by making an assessment of the cow's size and length of her claws. The front wall of the medial claw should be a minimum of 3 inches (3 1/4 inches in a very large cow or bull) in length. The point of measurement is from just below the skin-horn junction where the hard horn starts to the tip of the toe. Three inches is accepted as the minimum front wall length for the average Holstein-Friesian cow. Minimum sole thickness should be 1/4 of an inch.

The bearing surface is “stabilized” on the inner hind claw sparing as much of the heel as possible. In other words, the bearing surface of the toe and wall is pared flat so that it will be at right angles to the long axis of the shin (cannon) bone in the standing position. This will ensure that the cow has a flat and stable supporting weight-bearing surface.

**Step 2.** Using the medial claw just trimmed as a guide, trim the toe of the outer claw (rear foot) to the same length. Next, pare the weight-bearing surface of the outside claw to the same level as that of the medial claw. When the front walls of each claw are held at the same level the weight bearing surfaces at the toe should be flat and level with each other.

**Step 3.** Shape and slope the sole so that the innermost back portion of the sole slopes toward the center of the claws. Care should be taken to avoid paring away important weight-bearing surface at the toe. Excessive cupping or sloping of the sole should be avoided because it reduces the weight-bearing surface area to the outside walls. Proper sloping of the sole in this region is designed to reduce pressure in the sole-ulcer site and open the interdigital space between the claws. Overgrowth of the sole which occludes the interdigital space causes dirt and manure to be entrapped between the claws. This increases the likelihood of interdigital disease.

**Step 4.** Balance the heels by laying the handle of the hoof knife across the heels and making the weight bearing surfaces perpendicular to the long axis of the leg. When trimming is complete the weight-bearing surfaces should be flat at the toes, along the walls, across the heels and perpendicular with the long axis of the leg. This assures an appropriate distribution of weight within and between the claws and completes the trimming process in feet where further corrective trimming procedures are unnecessary.

***Corrective Trimming:*** Steps 5 and 6 are characterized as “therapeutic and curative trimming procedures”. They are applied as needed.

**Step 5.** *Remove loose horn and trim away hard ridges.* In the presence of claw horn lesions, further corrective trimming is necessary. Remove all loose horn irrespective of how extensive it is (sole separation) and pare away hard ridges (heel horn erosion). Only healthy hoof horn should be left in place. Always slope horn away from the lesion. For example, carefully trim the loose necrotic horn around sole ulcers and slope the remaining horn axially (toward the inside). Likewise, remove the adjoining lateral wall when trimming out white line lesions. Trim carefully and DO NOT remove new healthy horn. Avoid damage to the corium (i.e. stop when trimming leads to bleeding of the corium).

**Step 6.** *Adjust weight bearing in damaged claws.* Pare the damaged claw lower toward the heel to increase weight-bearing on the healthy claw. In most cases the damaged claw will be the outside claw of rear and the medial claw of front feet. Specific indications for this trimming procedure would include conditions in which overgrowth has led to overloading (i.e. hemorrhage at the sole ulcer site) and pain resulting in postural or gait abnormalities. Lowering the damaged claw reduces weight-bearing and thereby permits recovery and eventual return to normal function and health. In some cases it is necessary to apply a foot block to the healthy claw in order to reduce weight-bearing in the damaged claw.

Part of fixing a foot is trimming a foot. In other words, unless the defect that created the problem is corrected the benefits from curative procedures are short-lived. The step-wise procedure as outlined above should be applied to the healthy as well as the lame foot in a lame cow. Quite often, similar problems can be found in the other foot. Cows that do not respond or get worse within a couple of days should be re-examined.

## **Claw Checking and Trimming as Needed**

Cows should have their claws checked at least twice per year for the presence of claw horn overgrowth and early lesions. Both abnormalities should be corrected as needed. However, in many situations today, cows are trimmed 2 or 3 times per year whether they need it or not. Trimming normal feet is costly and jeopardizes foot health, especially for cows on concrete where subsequent wear may create thin soles that could lead to serious problems. On the other hand, cows with corkscrew claws or laminitis would likely benefit from trimming as much as 3 or even 4 times per year because of the accelerated rates of claw horn growth that accompany these conditions.

## **Foot Blocks for Relief of Weight-Bearing in Diseased Claws**

The application of corrective trimming procedures as described in Step 6 above will often provide a sufficient difference in height between the two claws to relieve weight-bearing and promote recovery of claw lesions. However, when pain is severe or one is unable to create sufficient difference in height between the two claws, additional elevation of the diseased claw can be achieved by means of a block attached to the sound claw. Proper application of foot blocks requires attention to the following:

1. Start by properly trimming the claws according to the step-wise procedure outlined above. Before attaching a block to the healthy claw, the claw must be pared flat and in the proper plane. This will provide a bearing surface that is at right angles to the long axis of the cannon bone.
2. Prepare the claw with a rasp or grinder so that the adhesive will properly adhere to the wall and sole of the claw being fitted for the block.
3. Mix the adhesive to the proper consistency and apply to the block and claw as needed.
4. Apply the block and position it so that it lies flat on the sole and provides proper support of the heel. Failure to provide adequate heel support is one of the most common mistakes in applying blocks.
5. Be sure that adhesive is cleared away from the area between the block and the heel. Heel horn is very soft and can easily be damaged by the hard and sometimes very sharp edges of fully cured adhesive material.
6. Remove blocks after a period of 4-6 weeks. Blocks that cause discomfort prior to then should be removed sooner.
7. After removing a block, always re-trim the foot and adjust weight-bearing as needed.

## **Application of Bandages or Wraps to Lesions of the Claw Capsule**

Correction of horn lesions often results in small or moderate exposure of the corium. In general, most would agree that minor lesions or injuries to the corium are best left untreated and without a bandage. More severe lesions in which there may be large areas of the corium exposed may benefit from topical treatment with a mild disinfectant or antibiotic under a bandage with the proviso that it be removed within 3-5 days. The direct application of caustic or particularly irritating treatment materials on open lesions with exposed corium should be avoided. If it is the practice of the dairy to allow bandages to fall off on their own it is the opinion of these authors that they are better left without a bandage from the start. The environment of most cows is such that bandages become very contaminated within a couple of days. It is doubtful that they offer significant therapeutic benefit beyond this point. Indeed, results

from a Cornell study comparing cows with claw lesions with a wrap versus no wrap indicate no advantage to the application of a bandage.

On the other hand, a bandage is advised for hemostasis in cases where corrective trimming has led to there is severe hemorrhage of the corium or other tissues. Bandages are also advised for postoperative care of surgical cases such as claw amputation. As suggested above, these should be changed every 2 days depending upon the degree of environmental contamination. Every attempt possible should be made to house animals having had such procedures in a clean dry environment.

### **Training Employees in Foot Care and Claw Trimming Procedures**

It is the opinion of these authors that all dairies (regardless of size) should have appropriate handling and restraint facilities for the treatment of lame cows. Herds of 250 or more cows should have not only handling and restraint facilities (i.e. tilt table or stand-up trimming type chute), but in addition proper equipment (knives, sharpening devices, hoof nippers, and angle grinders) and trained personnel to examine and treat lame cows on a daily basis. Routine maintenance trimming may be left to the services of a commercial trimmer or conducted by on-farm employees at the discretion of the dairy.

Proper skills in foot care and claw trimming require supervised training and practice. Training programs such as that described below are advised. Estimated initial investment for dairies who choose to employ an on-farm trimmer (including chute, foot care equipment and training) may range from \$5000 to \$20,000 (in US dollars). Considering present-day replacement cow costs in the US (greater than \$2000/replacement), a foot care program that will reduce the loss of cows to irreversible lameness is easily justified.

**The Master Hoof Care Technician Program.** Training programs in foot care and claw trimming are available from various sources including those who market restraint systems. Some of those teach traditional methods of claw trimming. The Florida Master Hoof Care Program teaches the method of Toussaint Raven described in this paper. Part I of the course consists of 4 days (3 days of trimming on cadaver specimens and live cows) of intensive training on foot care and claw trimming. Part II consists of continued study and practice of the techniques learned in Part I of the course. After a period of 3 to 6 months of study and practice, the student is eligible to return to the University of Florida to take a written, oral, and laboratory practical examination. Successful completion of these examinations qualifies the candidate as a "Master Trimmer" in the Master Hoof Care Technician Program. This qualification is the employer's assurance that his employee is performing the task of foot care and claw trimming in accordance with accepted procedures.

The purpose of the Master Hoof Care Program is to provide training for health technicians responsible for foot care and claw trimming duties on dairy farms. The basis for the program comes from a strong belief that timely (i.e. daily) foot care and treatment of lame cows will reduce the number of cows lost from irreparable foot disease. Unfortunately, many dairies simply turn lame cows out into a lot where they remain until a commercial hoof trimmer or veterinarian can attend to them on their weekly or monthly visit. In these situations, cows go untreated for several days or weeks depending upon when the hoof trimmer or veterinarian is scheduled to visit the dairy. The time lag from original insult to examination and treatment permits treatable lameness conditions to progress to the point of irreparable damage that often results in premature culling of affected animals. This is costly and inhumane. Reducing losses in performance and involuntary culling from lameness has the potential to save the dairy industry millions of dollars to say nothing of the tremendous impact from improvements in animal welfare from providing prompt relief to suffering animals.

## **Treatment of Infectious Diseases of the Skin of the Foot**

Infectious claw disorders represent some of the most important causes of lameness in dairy cattle. However, unlike the lesion associated with a sole ulcer or white line disease which specifically affects the claw, these diseases affect the “skin” of the interdigital space, heel bulbs, and interdigital cleft (on the back of the foot above the interdigital space). Treatment consists of systemic therapy, footbaths, foot spraying or bandaging.

**Digital Dermatitis (Mortellaro's Disease).** Although digital dermatitis (DD) was first reported in the US around 1980, the disease was not a widespread problem until the early 1990s. Although the precise cause remains to be determined, the organisms observed in lesions most consistently are bacterial spirochetes belonging to the genus *Treponema* sp. Approaches to therapy include: 1) surgical excision, 2) footbaths 3) topical treatment with various disinfectants, and antibiotic solutions, 4) cryosurgery, and electrocautery, 5) topical treatment under a bandage, and 6) systemic antibiotic therapy. With the possible exception of cryosurgery and electrocautery, most of these treatments have a place in the management of this condition.

Topical spray-on treatment with antibiotic and some non-antibiotic preparations (Victory<sup>TM</sup> by Westfalia-Surge) have been shown to be very effective when used in a scheme of consistent daily treatment for a period of 8-10 days over a 2-week period. The major disadvantage to topical treatment is that lesions occurring in the interdigital space are missed. Topical antibiotic treatment under a bandage is particularly effective with most cows showing remarkable improvement within 24-48 hours. Furthermore, when properly applied this approach to treatment has the potential advantage of reaching lesions affecting the interdigital skin. Footbaths containing various compounds including 3-5% formalin, 5-10% copper sulfate, 20% zinc sulfate, oxytetracycline 1-4 g/l, lincomycin 1-4 g/l, or lincomycin/spectinomycin 1-4 g/l have been recommended. Results vary widely. Footbaths are discussed in greater detail below.

Response to topical antibiotic treatment (topical spray or bandage) is also influenced by the anatomic location of lesions. Lesions occurring on the plantar interdigital cleft were less likely to respond compared with lesions occurring on the heel bulbs or dewclaws. Limited evidence also suggests that response to therapy may be influenced by lesion maturity and possibly antibiotic resistance patterns of etiologic agents. These factors should be considered in evaluating treatment responses as well as the development of new treatment strategies.

**Interdigital dermatitis (Slurry Heel).** Interdigital dermatitis (ID) is an acute or chronic inflammation of the interdigital skin, extending to the dermis. It is extremely common in free-stall housing or other situations where the feet of cows are continuously exposed to wet manure slurry or muddy corral conditions. The disease is likely caused by a mixture of bacteria: *Fusobacterium necrophorum*, bacterial spirochetes, and possibly *Dichelobacter nodosus*. Unlike digital dermatitis because of their location in the interdigital space, most lesions of ID are not accessible to treatment by topical spray. Footbaths are the only practical treatment for ID in cows.

**Foot Rot (Interdigital Phlegmon) and Super Footrot.** Foot rot is an infectious disease of the interdigital skin characterized by the presence of an interdigital lesion, swelling, and moderate to severe lameness. Fever ranging from 103-105°F (occasionally higher) is a consistent finding during the acute stages. A recent study conducted at the University of Florida found that foot rot was associated with a 10% decrease in milk production in affected cows. This was greater than the milk loss observed for cows with claw disorders or digital dermatitis. Most cows developed the disease in early lactation as they were approaching peak milk yield which suggests that the occurrence of this disease in early lactation may inhibit a cow's ability to achieve peak milk yields.

In recent years, clinicians from the United Kingdom and the United States have observed a more extreme form of this disease referred to as "Super Footrot". It is characterized by acute onset of lameness and swelling of the foot that progresses rapidly to an ascending cellulitis. The interdigital lesion associated with "Super Footrot" is especially severe and successful treatment particularly challenging.

Footrot is responsive to most antibiotics in common use for cattle. In fact, it is the opinion of these authors that dose and duration of treatment are more important in most cases than antibiotic selection. The key to achievement of a successful therapeutic outcome is dependent upon prompt recognition and early implementation of treatment procedures. Systemic therapy plus topical treatment of the interdigital lesion have long been the preferred methods of treatment. In uncomplicated cases, improvement is noticeable within 24-48 hours with good recovery attainable in 3-4 days from the onset of treatment. Treatments of choice are Naxcel (Ceftiofur Sodium), Penicillin, Albon (Sulfadimethoxine), and tetracyclines (extra-label in dairy cattle). Some prefer to simultaneously treat the interdigital lesion as well. Various antiseptic-type products may be used as topical treatments. Bandaging of the foot is unnecessary. Regardless, the secret to success is early detection of the disease.

### **Footbaths and Environmental Considerations**

Most operations design facilities for placement of footbaths in parlor exit lanes, however, in some operations cows tend to loiter in lanes exiting the parlor. In general, it is best to locate footbaths in pathways or areas where cows tend to keep moving. Ideally, after traversing through the baths, cows should be kept in a clean dry area for approximately 30 minutes. This allows time for drainage of the excess fluid and for the medications to exert their antibacterial action. Contaminated footbath solutions are discharged into manure holding systems. Here they are diluted with other waste material from the dairy operation and eventually applied to crop fields. Until recently, most have considered the contribution of footbaths to chemical load in the environment to be insignificant and just a part of sound foot care management. However, a recent article in the July 2001 issue of Hoard's Dairymen demonstrated that the use of copper sulfate at the rate of 100 lbs per day equates to 18 tons per year. Considering the typical number of crop acres for an 800 cow dairy, that amounts to an application rate of 5 lbs per acre.

The article cites 2 important problems: 1) phytotoxicity, and 2) Environmental Protection Agency (EPA) guidelines on cumulative loading capacity of soils for heavy metals, including copper. Although copper is a potentially toxic for dairy cattle, the more significant problem relates to phytotoxicity. In high concentrations, copper damages the plant's root system. In some locations crop yields have been greatly reduced as a result of copper toxicity. At current rates of application many dairy operations will achieve the lifetime accumulative load within a period of 10-15 years. Clearly, all operations need to assess the amount of copper sulfate being applied per acre to determine if they are in danger of reaching lifetime accumulative loads. This assessment may be made by multiplying the pounds of copper sulfate purchased annually by .25 to determine the actual amount of copper; then divide this amount by the number of acres that are receiving manure applications.

### **Conclusions**

Claw disorders are the predominant causes of lameness in dairy cattle. They can only be managed by the establishment of a foot care program that addresses lameness on a daily basis. Appropriate claw health management requires proper foot care and claw trimming techniques. From an international perspective, the functional trimming method as described by Toussaint Raven is the most widely recognized and accepted claw trimming procedure. In the US, however, there are other approaches some which are based on trimming techniques applied to horses. The most common trimming error is

over-trimming. To learn proper foot care and claw trimming requires proper training in the “science” as well as the “art” of claw care and trimming. Infectious claw disorders are in large part a consequence of continual exposure to wet manure slurry. Treatment generally involves some form of topical treatment including topical spray, footbath, or topical treatment under a wrap. Foot rot generally requires systemic antibiotic therapy. The value of vaccination for control of infectious claw disorders is unknown at this time. Prompt treatment in combination with effective waste management are the best bets for keeping these diseases to a minimum.

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