Laminitis - More than How You Feed Your Cows

(Laminitis, Claw Disorders, and Infectious Foot Diseases)

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Introduction

Lameness is one of the most important health problems on today's dairy farms and certainly one of the more difficult to manage. Involvement by veterinarians varies from specific diagnosis and treatment of individual lameness conditions to consultation with the dairy owner and management team on procedures for treatment, control and prevention. There are several obstacles to timely examination and treatment of lameness by veterinarians, as well as herd owners or their employees. In many situations, farms lack appropriate restraint facilities for examining lame cows. Foot care under these circumstances becomes an arduous, if not dangerous task. It is often complicated still further by the condition of one's hoof care equipment. A sharp knife and a good set of nippers are essential in foot care. Beyond these one must understand the pathogenesis of lameness and the most appropriate trimming and treatment techniques to provide relief.

In large herds where restraint systems are often more readily available, direct involvement by veterinarians may be limited by the sheer number of lame cows encountered on a daily basis. As a consequence, throughout North America (in fact, much of the world) foot care and claw trimming is performed by either commercial trimmers or farm employees. Methods and technical expertise amongst trimmers varies significantly. This occurs in part because there are very few formal training programs for persons interested in foot care, and in most cases, no apprenticeship is required for a person to become established in the foot care business. As a result, the quality of foot care available to dairy farms in some areas is inconsistent and on occasion contributes to a greater amount of lameness.

The following is a brief review of some of the more common conditions including options for their treatment.

Laminitis (Clinical and Subclinical) and its Relationship to Claw Disease

The Classical Description. The pathogenesis of laminitis is believed to be associated with a disturbance in the micro-circulation of blood in the corium (the dermis or horn producing tissue of the claw) which leads to breakdown of the dermal-epidermal junction between the claw wall, and the bone with in the claw, otherwise known as the third phlanax (P_3). Rumen acidosis is considered to be a major predisposing cause of laminitis and presumably mediates its destructive effects through various vasoactive

substances that are released into the blood stream in coincidence with development of rumen acidosis. These vasoactive substances initiate a cascade of events in the vasculature (blood vessels) of the corium including increased blood flow, thrombosis (clotting), ischemia (restricted blood flow), hypoxia (lack of oxygen), and arterio-venous shunting (channels from arteries to veins that shunt blood away from the capillary bed). The end result is edema (swelling), hemorrhage (bleeding), and necrosis (death) of corium tissues.

The vascular disturbances associated with laminitis affect corium tissues at the cellular level. This is considered to be particularly important, since horn is formed by specialized epidermal cells known as keratinocytes that are dependent upon a good blood supply from the corium. These cells (keratinocytes) receive nutrients from the corium by diffusion across the basement membrane (a membrane that separates the corium from the epithelium containing the keratinocytes). Keratinization is the process by which keratinocytes produce keratin proteins that provide structural support to the cell and thus impart rigidity and strength to claw horn. As keratinocytes move toward the skin (or horn) surface they gradually reach a point at which they no longer receive sufficient nutrients by diffusion from the corium. This leads to cell death and cornification, the process whereby cells become hardened and cornified as horn.

The quality of claw horn is dependent upon keratinization which gives the horn cell structural rigidity and strength. In conditions resulting in vascular compromise such as laminitis, the keratinocyte may become injured or inflamed from being deprived of nutrients. The end result is the production of poorly keratinized (weak or inferior) quality horn. Thus, the term *claw horn disruption* has been proposed as possibly a more appropriate term for laminitis, and particularly subclinical laminitis.

By virtue of its anatomical location between the hoof shoe and P_3 the corium is particularly vulnerable to inflammatory insult. Any increase in size of the corium due to fluid accumulation will increase pressure, pain, and tissue damage. Bound on one side by the hoof wall and the other by the P_3, inflammation of corium tissues often leads to swelling at the coronary band.

Destruction of the dermal-epidermal junction has particular consequences in cattle as it permits weakening of the suspensory apparatus within the claw. As the suspensory apparatus weakens P_3 begins to "sink" or “rotate” within the claw. The result is compression of the corium and supporting tissues that lie between P_3 and the sole. This sets the stage for development of sole ulcers. In some cases this "P_3 sinking phenomenon" involves severe rotation of the toe portion of P_3 downward toward the sole. If compression of the corium by the toe is severe enough a toe ulcer may develop. If, on the other hand, sinking of the P_3 is such that the rear portion sinks furthest, compression and thus sole ulcer development will most likely develop in the area of the heel-sole junction (known by some as the "typical site" or the site most commonly associated with the development of sole ulcers). Sole ulcers are very common claw lesions in dairy cattle and constitute one of the most costly of lameness conditions. As a consequence, they justify further discussion.

Sole Ulcer

A sole ulcer is described as a circumscribed loss of the horny sole which exposes the corium. Sole ulcers tend to be one of the most debilitating of lameness conditions affecting dairy cattle. Early ulcers are often uncovered in the process of hoof trimming, particularly when paring away sole horn in the interdigital area over the "typical site" (the area described by Toussaint Raven where sole ulcers typically occur) for sole ulcers. Other indications include pain or hemorrhage in the "typical site". More mature or long-standing sole ulcers may be covered initially by rough, irregular horn tissue that when pared away exposes granulation tissue which bleeds freely if damaged.

As indicated previously, laminitis is thought to be a major predisposing cause of sole ulcers. The combination of excessive claw horn formation, displacement of P_3, and the accelerated growth of hoof horn on the anterior or dorsal (front) and abaxial (outside) hoof walls predispose the lateral claw to excessive loading, wear, and weight-bearing at the "typical site". The additional strain and pressure applied to the heel/sole region (or toe, in the case of toe ulcers) exacerbates dysfunction of the underlying corium and leads to development of the lesion. Treatment requires removal of the necrotic (dead or decaying) horn tissue followed by elevation of the affected claw with a claw block attached to the unaffected claw. It is important to avoid damage to the corium when removing loose and decaying horn tissue. Serious damage to the corium results in delayed healing and may increase potential for reoccurrence of the lesion. All healthy horn tissue should be left in place (See Steps 5 & 6 under Claw Trimming and Foot Care).

White Line Disease

Areas of hemorrhage are often most noticeable and severe in the white line region of the sole. This corresponds to a primary weight-bearing region of the claw. Because it is an active area of hoof formation it is also highly vascular, and a frequent site for hemorrhage during bouts of laminitis. These areas of hemorrhage are not visible during the acute stage of laminitis, but instead, gradually rise to the surface of the sole over a period of 6-8 weeks. At this point they become visible and useful as indicators of previous disease of the corium (subclinical laminitis).

Laminar necrosis results in the formation of subsolar abscesses (otherwise known as white line disease). There are a couple of reasons for this: 1) weakening or elongation of the dermal-epidermal segment and distorted claw growth often results in widening of the white line, and 2) horn of the white line formed by the diseased corium is softer, and thus more subject to wear, and penetration by foreign material from the environment. As a consequence, the incidence of white line disease often increases in herds suffering laminitis.

White line separation/disease resulting in abscess formation is treated by paring away all loose and damaged horn adjacent to the lesion (See Steps 5 & 6 under Claw Trimming and Foot Care). This usually requires removal of the wall adjacent to the separation until all loose horn is removed. When paring away of the lesion is complete, the area previously affected by the lesion should be sloped to the outside. In other words, avoid digging holes in the corium when trimming away white line lesions. This will prevent contamination and packing of environmental debris into the diseased site which prevents reoccurrence. A foot block should be applied to the unaffected claw to reduce weight-bearing and ease discomfort in cases where the white line separation has led to abscess formation. As with treatment of sole ulcers, there is no need to bandage the lesion unless it is required to control bleeding. The same is true for antibiotic therapy unless the infection extends to deeper tissues of the foot as evidenced by swelling and severe lameness.

Claw Trimming: 2 Approaches

In the preface of Toussaint Raven's book "Cattle Footcare and Claw Trimming", he gives a very important warning that *"If there is no lameness problem, trimming can produce it".* Although footcare and claw trimming have an important role in the management of lameness conditions, experience has shown that on occasion claw trimming can be a cause for lameness. One of the most common errors in claw trimming is over-trimming. Therefore, it is important to know what constitutes normal claw size and conformation.

The primary purpose of the claw 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 where abrasive flooring surfaces encourage rapid wear, cows may develop thin soles from excessive wearing away of solar horn. Thin soles in dairy cattle represent one of the most difficult foot problems to manage. The functional and corrective trimming method described by Raven provides important guidelines for the maintenance of proper toe length and sole thickness. Regardless of how one chooses to trim claws these guidelines are useful to prevent trimming-related lameness. But first, we take look at the traditional approach to trimming.

Traditional Approach to Claw Trimming. 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. Using this technique one would shorten the axial wall and slope or "cup out" the sole in order to place the majority of weight on the abaxial wall. This is problematic in that underdevelopment of the axial wall is a primary reason for the natural instability of the medial claw of the rear foot. Thus, removal of the axial wall in both claws only exacerbates total instability in the foot. Transfer of weight-bearing to the abaxial walls naturally increases shearing forces on the walls. Some believe that this may actually increase the risk of white line separation and white line disease by increasing shearing forces on the abaxial wall.

Sloping of the soles is also believed to encourage development of sole ulcers by shifting weight-bearing within the claw onto the "typical place" for sole ulcers to occur. When the soles are sloped axially the claws are encouraged to splay apart with each step that the cow takes. This causes stretching and irritation of the interdigital skin and is believed to contribute to interdigital fibromas (corns) in cattle.

In most traditional trimming systems, there is no attempt to balance weight-bearing within or between the claws. Studies on the pathogenesis of sole ulcers and white line disease indicate that claw overgrowth leads to disproportionate weight-bearing and eventually claw disease. Therefore, the reestablishment of appropriate weight-bearing within and between claws is an important objective in claw trimming and represents a major difference between the traditional and functional claw trimming techniques.

A common practice by many trimmers is to complete their job by grinding or chipping away wall horn near the weight-bearing surface. Cosmetically, the appearance may be more appealing, but in terms of function, the claw and its weight bearing surface are made weaker and potentially more vulnerable to disease. Furthermore, removing the wall in this fashion not only reduces surface area for weight-bearing, but also eliminates the hardest part of the weight-bearing surface. It requires the cow to bear weight on the white line, sole and heel only.

Functional and Corrective Claw Trimming. Functional claw trimming is the method described by Toussaint Raven. The following describes the basic objectives and trimming procedure.

The objectives of preventative hoof (claw) trimming are:

1. To correct 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). This permits one to balance weight bearing between the 2 claws.

2. To restore an appropriate weight-bearing surface within each claw.

3. To correct claw lesions at an early stage.

The following 6-Step work plan for trimming feet is recommended:

Step 1. With rear feet trimming begins with the inside claw. The front wall of the medial (inner) claw should be 3 inches long (from just below the coronary where the hard horn starts to the tip of the toe). This length of 3 inches (7.5 cm) is taken as the correct front wall length for the average Holstein-Friesian cow. Thickness of the sole should be a minimum of a 1/4 inch. The bearing surface (sole and wall but not the heel) is "stabilized" on the inner hind claw. 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.

The heel of the inner claw is not trimmed down unless overgrown. Furthermore, since claw lesions in the outer claw are the more frequent circumstance, preservation of the heel on the inner claw is desired in the event that it is necessary to provide rest to the outer claw by increasing weight-bearing on the inside claw heel.

A proper front wall length (at least 3 inches) will ensure adequate sole thickness particularly at the toe where sole thickness of at least a 1/4 of inch (5-7 mm) is required. The sole in this area should not "give" under pressure. If it does it may indicate that the sole has been trimmed too thin.

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 sole) of the outside claw to the same level as that of the medial claw. The outer claw is trimmed to the same level as the inner claw both at the toe and at the heel. When complete, the weight-bearing surfaces should be flat at the toe.

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 area 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. Weight-bearing surfaces should be flat at the toes, along the walls, and across the heels. 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.

Steps 5 and 6 are characterized as "therapeutic and curative trimming procedures". They are applied as needed.

Step 5. 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) or excessive weight-bearing on the claw. 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 claw block to the healthy claw in order to reduce weight-bearing in the damaged claw.

Step 6. In the presence of hoof horn lesions, further corrective trimming is necessary. Remove all loose and dead or decaying horn irrespective of how extensive it is (sole separation). It is also necessary to pare away hard ridges, such as observed in heel horn erosion. Only healthy hoof horn should be left in place.

As advised earlier, avoid digging holes in the sole. Always slope horn away from the lesion. For example, trim the area around sole ulcers and slope to the inside. Always remove the lateral wall and slope horn to the outside when trimming out white line lesions. Avoid damage to the corium (i.e. stop when trimming leads to bleeding of the corium).

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, if followed, forces one to observe and trim 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.

Foot Blocks for Relief of Weight-Bearing in Diseased Claws

The application of corrective trimming procedures as described in Step 5 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. This is one of the most common mistakes made 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 or reexamine blocks after a period of 4-6 weeks. Blocks that are no longer needed should be removed. When claw blocks show uneven wear, the lesion should be reevaluated and a new block applied if relief from weight bearing is needed. 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 experts 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 non-irritating antibiotic under a bandage with the proviso that it be removed within 3-5 days. The direct application of caustic or otherwise 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 may be better to avoid their use 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 bandage.

On the other hand, a bandage is advised for hemostasis in cases where 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.

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). Although there are some differences in the way these conditions develop and the way they appear, they all have at least one thing in common: they are believed to be caused by infectious agents capable of inducing inflammation and lameness.

Digital Dermatitis (Hairy Heel Warts or Footwarts) This disease occurred in near epidemic proportions throughout the United States in the early 1990s. Although not conclusively proven, it is the opinion of most that digital dermatitis (DD) is caused by 3,

or possibly 5, different bacterial spirochetes belonging to the genus *Treponema sp*. Although lameness caused by DD may be severe, it tends to be an inconsistent feature of this disease. Florida studies indicate that only about half of the animals affected exhibit lameness. Cows naturally avoid contact with the ground or flooring surface by walking on their toes. In fact, stubbed toes from excessive hoof wear are one indicator of a DD lesion in affected cows. Despite obvious indications of discomfort, research indicates that cows affected with DD are likely to suffer reduced reproductive performance and a tendency for lower milk production.

Lesions associated with this disease are typically round or oval and located on the back of the foot adjacent to the interdigital cleft. Some lesions are located on or above the heel bulbs and still others may be found adjacent to or near the dew claws. Early lesions are red, raw, and flat. They are extremely sensitive and cows react painfully to spraying with water or other direct contact. Even a mild disturbance of the inflamed tissue tends to result in mild to moderate bleeding. As lesions mature most will enlarge. Hairs at the skin margins remain long and erect serving as distant evidence of what might otherwise be an obscure lesion. On closer inspection one will observe a lesion with characteristics similar to the early lesion with a slightly more raised surface, characterized by some as granular or terrycloth-towel-like. These more mature lesions may be red, tan, or grey. Similar to the early lesion, they are very sensitive and tend to bleed easily if sufficiently disturbed.

Treatment of DD (Hairy Heel Warts, Footwarts) Approaches to therapy include: 1) surgical excision (removal), 2) footbaths 3) topical treatment with various disinfectants, caustic chemicals, and antibiotics, 4) cryosurgery (freezing), and electrocautery (burning), 5) topical treatment under a bandage, and 6) systemic antibiotic therapy. Most of these treatments have a place in the management of this condition; however the less invasive forms of treatment are preferred by these authors and highlighted in the following.

Topical spray-on treatment with antibiotic and some non-antibiotic preparations has 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 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 advantage of reaching interdigital lesions. Theoretically at least, the same is true for well-managed footbaths. Unfortunately, there are no published data on the effectiveness of footbaths for control of DD.

Interdigital dermatitis (Slurry Heel) Interdigital dermatitis (ID) is an acute or chronic inflammation of the interdigital skin, extending to the dermis (deeper layer of skin containing blood and nervous tissue). The disease is likely caused by a mixture of bacteria: *Fusobacterium necrophorum*, bacterial spirochetes, and possibly *Dichelobacter nodosus*. In the early stages, ID is characterized by superficial erosion of the interdigital skin that some are able to recognize by its distinctive foul odor. The

interdigital lesion is usually painful to the touch and followed by extension of the infection to the heel horn that results in heel erosion, the most readily visible feature of this disease. Early-on the eroded heel horn develops a pitted appearance. Eventually the roughened pitted heel horn is replaced by fissures (horizontal cracks) which may be sufficient to result in severe undermining of heel and solar horn. Coincident with this heel erosion is an acceleration of hoof horn formation. Excessive hoof formation leads to overgrowth and overloading of the affected claws. It's these effects of ID that are believed to make it an important predisposing cause of claw disease problems, particularly sole ulcers. Effects of ID on the interdigital skin are similar. Chronic inflammation causes the interdigital skin to thicken eventually resulting in the formation of an interdigital fibroma or "corn". The clinical diagnosis of ID is based on the presence of a thickened interdigital skin, pungent characteristic odor, pain to the touch, and the concurrent presence of heel horn erosion.

Treatment of ID Unlike DD, because of their location in the interdigital space, most lesions of ID are not accessible to treatment by topical spray. Furthermore, the specific treatment of heel horn erosion by topical spray has not been thoroughly studied. Instead, footbaths represent the most practical treatment option for interdigital lesions in cows.

Footrot and Super Footrot. Footrot 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^{o}F (occasionally higher) is a consistent finding during the acute stages. Although evidence is inconclusive, most believe that footrot develops following injury or abrasion of the interdigital skin. This interdigital injury is secondarily infected by *Fusobacterium necrophorum* alone, or in combination with *Bacteriodes melaninogenicus,* organisms which encourage progression to a more severe and necrotic-type of lesion. Failure to institute treatment early in the course of the disease may lead to complications involving surrounding soft tissues (tendons, tendon sheaths, joint capsules, and bone) ultimately resulting in deep digital sepsis. At this stage, response to medical therapy is quite often unrewarding, thus limiting one's options to either surgery, or possibly euthanasia, in particularly severe cases.

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 (a spreading infection). The interdigital lesion associated with this form of footrot tends to be especially severe and successful treatment particularly challenging. Readers are advised to contact their veterinarian for specific advice on treatment options if they suspect this form of the disease.

Treatment of Footrot. Footrot is responsive to most antibiotics in common use for cattle. In fact, dose and duration of treatment are likely more important 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

Although efficacy data are relatively non-existent, some recommend the use of a walk-through footbath containing 3-5% formalin, antibiotics, or 5% copper sulfate. To maximize effectiveness, it is suggested that a pre-bath of plain water be used ahead of the medicated footbath. Purpose of the pre-bath is to remove excess organic matter from the feet thereby reducing contamination of the medicated bath and extending its usefulness. 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. 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.

In addition to their germicidal effects, formalin and copper sulfate aid in hardening the claw horn and skin. In particular, readers are cautioned that formalin is dangerous to handle and can cause serious eye, skin, and respiratory injury. Formalin should not be used in concentrations exceeding 5% or for longer than three consecutive days.

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, an 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.

Conclusion

Lameness is a complex disease. In problem herds it is necessary to review the nutrition and feeding program, herd management, and cow comfort. The incidence of lameness is such that all herds should develop facilities for the safe and efficient handling of lame cows. Availability of good restraint facilities, foot care equipment, and proper training of personnel in foot care and claw trimming is essential particularly in larger herds. Infectious claw diseases are also important causes of lameness in dairy cattle. Footrot and "super footrot" represent conditions that cause severe inflamation and swelling of the foot. Closer examination will reveal a lesion in the interdigital skin as well. Prompt identification and antibiotic treatment are crucial to achievement of a successful therapeutic outcome with footrot. Interdigital and DD are similar conditions. Heel erosion, accelerated skin and hoof horn formation, lesions in the interdigital space, and the presence of bacterial spirochetes are consistent findings with both ID and DD. Although lameness is inconsistent, the lesions are painful and have a negative impact on overall performance. These diseases are most effectively treated and controlled by applying topical treatments either under a bandage, as a topical spray, and/or possibly in a well-managed footbath.

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Notes