Understanding Herd Lameness

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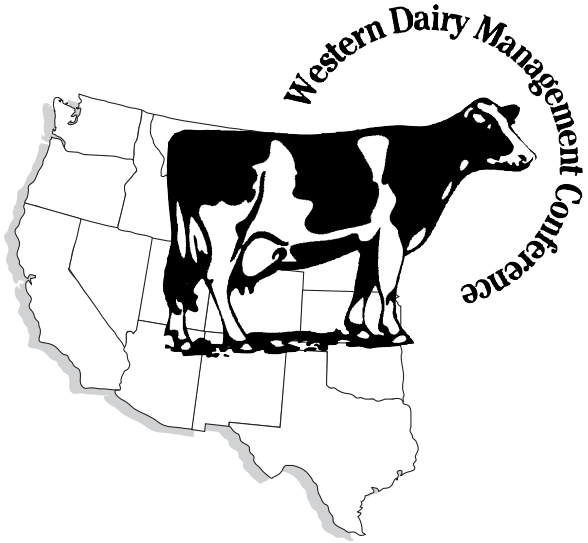

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With the exception of a few diseases of the nervous system, lameness in cattle is caused by an animal adjusting its movements or way of standing in order to avoid pain. The pain resulting from the various diseases that cause lameness is the most severe form of discomfort suffered by animals. For this reason, lameness has attracted the attention of European animal-rights activists. The economic importance of lameness has been well documented. Financial losses occur as the result of reduced milk production, loss of body condition, reduced fertility, culling, veterinary costs and medication, as well as time devoted to nursing an animal by the dairyman. It has been estimated (Esslemont, 1990) that a single case of sole ulcer could cost $US 260-360 and one case of interdigital disease might cost $US 100-200. In a later study (Esslemont and Spincer, 1993), the average cost of an incident of lameness was placed at $US 150. Earlier estimates indicate that financial annual losses from lameness may amount to $US 2,000 per 100 cows (Whitaker et al., 1983) and the loss to the dairy industry of the UK could be $US 30 million each year.

Reduced fertility makes up a significant proportion of these losses (Collick et al., 1989). Lame cows were found in this study to take 14 days longer to conceive than did normal animals. Among animals affected with sole ulcers, conception might be delayed for 40 days. Lame cows have been shown to contract other diseases more frequently (usually indirectly), such as mastitis.

Lameness has been the subject of a number of surveys. The annual incidence of lameness has been estimated by a number of workers as 5-30% (Politiek, et al., 1986) and 21% (Reurink and Van Arendonk, 1987). Philipot et al. (1990) found the incidence of lameness to be 8.2%, but 25% of the animals examined had claw lesions. The incidence of lameness from non-infectious causes has increased considerably in recent years. Figures from milk-recording organizations in Germany indicate that culling due to claw and leg problems nearly doubled from about 4-5% to 7-9% over a ten-year period starting in 1983 (Distl, 1994). The increase is probably associated with the introduction of more and more intensive nutrition and complex management systems. These, in turn, have led to an increased awareness of the importance of a phenomenon referred to as 'sub-clinical laminitis' which was first described by Peterse in 1979 who considered it to be the underlying cause of diseases such as sole ulcer, white line disease, toe ulcer, etc. The infectious diseases causing lameness will not be discussed in this paper.

Sub-Clinical Laminitis

The term 'sub-clinical' is used because the signs of the disease are not obvious. To the eye of the keen observer, an affected animal will walk more carefully than normal. Sometimes the skin around the coronary band and dew claws will be pink and puffy. Very often the only reason for suspecting that sub-clinical laminitis is causing problems is because there is an increase in the occurrence of diseases such as sole ulcer, white line disease, double sole and possibly heel erosion. Hemorrhage of the sole is considered to be a very significant characteristic sign of sub-clinical laminitis and is used by many workers to evaluate the severity of laminitis in a herd or group of cattle.

The disease process involves damage to the blood vessels supplying the horn-producing tissues. As a result, subtle changes in the quality of the sole horn occur. The texture of the horn softens and becomes vulnerable to infection, wear and damage. For many years nutritional mismanagement was considered to be the cause of this condition. The disease is essentially one of intensive management of animals in high-production herds so, in 1982, Mortensen and Hesselholt introduced the idea that sub-clinical laminitis was more likely to occur if factors other than nutrition were stressing the herd. In this paper the 'risk factors' (predisposing causes, Vermunt 1994b) associated with this disease will be discussed.

Nutrition

Carbohydrate

Sudden increases in carbohydrate intake or the continued intake of high levels of carbohydrate cause changes in the microbe population of the rumen (Peterse et al., 1986) and the rumen becomes very acidic. The operative word here is 'sudden'. The sudden introduction to free choice total mixed ration is likely to result in a problem. Increasing the post-calving ration too rapidly can cause a problem. If the cattle are component fed, it is preferable to feed the concentrate four times a day to high-yielding cows rather than just twice a day.

Several authors (Nilsson, 1963; McLean, 1966, 1970; Weaver, 1971; Little and Kay, 1979) associate feeding barley with an increase in the incidence of laminitis. It is probably wise to avoid including more than 40% barley in dairy cow rations because it is highly digestible. Finely ground or moist grains are also highly digestible.

Fibre

Fibre has two important functions, firstly it counteracts the acid produced by the rapid digestion of carbohydrate, and secondly, the hard stems of the forage stimulate rumen movement and rumination. Therefore, forage should not be chopped too fine (25% of particles of hay should be greater than 2" in length). Some long hay should always be fed to provide stimulation to the rumen. Ideally, forage should not fall below 40% of the dry matter intake.

Heavy manuring of pasture or the generous use of nitrate fertilizers can sometimes cause problems. Nitrate is converted to nitrite in the rumen. Nitrite can reach toxic levels in grass, pasture crops and silage. Nitrate may contribute to laminitis (Vermunt, 1990). About ten days after a spell when the weather is warm and wet, pasture will have grown rapidly and nitrate in the vegetation will be at its highest level. High levels of nitrate are also present during the period immediately prior to the plant developing its seed.

Lead Feeding

At the end of the dry period, the dry matter intake of a cow may be reduced by as much as 30%. Heavy concentrate feeding prior to calving can increase an animal's predisposition to laminitis. It is recommended that the pre-calving feeding program should be based upon the animal's body condition. The safest method of managing the pre-calving feed management is with a total mixed ration. However, in the case of component feeding, it must be remembered that a cow will take concentrate before she will consume forage. Therefore, in the case of component feeding, the concentrate offered each day should be limited to 0.75% of the animal's body weight.

After-calving Rations

After calving, the cow must be introduced gradually to a ration if it is formulated to be high in energy. Peterse (1982) recommended that until the concentrate offered reaches 8 kg per day the daily offering should not be increased by more than 1 kg per day. Once the cow is consuming 8 kg of concentrate per day, further daily increases should be limited to 0.5 kg per day.

Buffers

A buffer is a component of a ration that can neutralize acid. Fibre is a natural buffer. Some producers add sodium bicarbonate to the ration at 1% of the dry matter. Including more buffer may reduce the palatability of the ration. Although not a buffer, providing rock salt licks will increase salivation in cows and the saliva increases the rumen pH.

Protein

The literature is controversial on the role of protein in the pathogenesis of laminitis. In some cases, feeding protein at levels in excess of 18% is associated with laminitis (Manson and Leaver, 1988; Bargai et al, 1992). In other instances no such relationship could be established (Greenough et al., 1990). There is no evidence that any particular source of protein is more dangerous than any other. However, protein-rich grass has been associated with the occurrence of laminitis (Vermunt, 1992). It is unclear to what extent allergic reactions to protein exist. It should also be borne in mind that grass growing extremely rapidly tends to be low in fibre.

Heritability of Lameness

Russell, Bloor and Davies (1986) demonstrated that the daughters of some bulls were more likely to suffer from lameness of digital origin than those of other sires. Heritability estimates for a 'single eye-scored claw angle' average about 0.10 (McDaniel, 1994). McDaniel also indicates that animals with steep claw angles (50-60() have greater longevity. The most common claw traits were discussed by the EAAP Working Group "Claw Quality in Cattle" (Politiek et al., 1986; Distl et al., 1990). These traits consisted of an evaluation of the claw shape, the quality of claw horn and features of the inner structure of the claw. Several studies demonstrated that these traits had sufficiently high additive genetic variation to achieve genetic improvement. Claw measurements are significantly correlated genetically and phenotypically to

the prevalence of claw disease, longevity and lifetime performance (Nielsen and Smedegaard, 1984; Reurink and Van Arendonk, 1987; Rogers and McDaniel, 1989; Rogers et al., 1989; Baumgartner and Distl, 1990).

Because the angle of the joints of the limb are difficult to measure, their significance has been studied less intensively than have been the characteristics of the claw. Variations in posture contribute to the difficulty of making accurate evaluations. Scores or even actual measurements of individual cows often show large changes when they are observed after the cow moves a few steps (Te Plate and McDaniel, 1990). Since the advent of photogrammetric methods for measuring hock angle (Greenough, 1987), more precise measurements have been possible. In one study, Vermunt (1994a) found that the range of the hock angle was from 154.3-177.4(and that there is a decrease in the angle with age. McDaniel (1994) states that the 'mildly straight leg' can be associated with survivability. However, it must be appreciated that the very straight limb is correlated to a high incidence of joint disorders (Bailey, 1985). McDaniel (1994) also points out that 'rear leg rear view' scoring is extremely valuable in assessing overall limb conformation.

Strategies for improving leg and claw quality are being developed. Distl (1994) states:

> *"Important parameters for claw and leg quality can only be identified when traits used in breeding work are closely related to claw health, longevity, life-time performance and functional efficiency of the animal. This definition implies that claw and leg quality cannot be recorded by just one trait. The traits necessary seem to be more complex and may be of different importance in dependence of the exposure to environmental effects. Particularly, claw shape is a result of the interaction between individual factors and environment. Genetic components may respond differently to specific environments and in each specific environment other genetic components may play the prominent role."*

In the late seventies the Nordic countries introduced a system whereby claw and leg traits were given an economic rating which was included when the total merit index was being calculated. Research during the past decade has established a rationale for contributing to the control of lameness through improving claw and limb quality. Still further work is needed to establish claw and limb traits as useful parameters for the epidemiologic investigation of herd lameness.

Management

The study on lameness in dairy cows conducted by the University of Liverpool considered the role of management in foot lameness in UK dairy cattle (Ward, 1994a). How important is the farmer as a cause? They found that the amount of lameness was closely related to his/her knowledge, training and awareness. The necessity of providing short courses for dairy farmers and dairymen is obvious. However, as a corollary to this problem, the education of the veterinarian should also be taken into account. In some countries the knowledge of the veterinarian is limited to the treatment of foot rot and some simple semi-surgical procedures. In other countries (Italy and Spain) veterinary practices specializing in digital disorders exist.

Functional Hoof Trimming

The term 'functional hoof trimming' implies that the 'Dutch method' of hoof care, which was originated by Toussaint-Raven (1989), is being applied. Correctly performed hoof trimming is considered to be beneficial (Manson and Leaver, 1988). However, undue stress can be counterproductive to milk production (Stanek et al., 1994) as can poor trimming technique. The use of a tipping table and older type of equipment can cause the trimming period to be extended to as much as 30 minutes. The modern Danish or Dutch claw-trimming crushes, combined with contemporary hydraulic hoof cutters and metal bladed, electric angle grinders, can permit the procedure to be completed in as little as seven minutes with minimum distress to the cow. The conclusion reached by the Liverpool workers seems to be highly appropriate (Clarkson et al.,1993). It is believed by some producers that regular claw trimming can add one lactation to the average life of a herd. "Foot-trimming can be beneficial, but not always. It would seem that correct training in the correct technique is essential."

Cow Comfort (ecopathology of lameness)

Significant improvement in milk production per cow has taken place during the past ten years. During the same period there has been a tendency for size of the herd to increase, concrete to take the place of pasture,

and cubicles to be favoured over straw yards or tie stalls. The economics of contemporary dairy farming demand intensive management. In some cases this demand creates stresses in the cow, caused by a conflict between its normal behaviour and the environment in which it must exist.

Several factors link housing/behaviour to the incidence of lameness. Maximum lying time increases the period of rumination. Saliva generated during rumination increases the alkalinity of the environment of the rumen, thereby counteracting acidosis which is a major factor in the etiology of laminitis. Furthermore, when a cow is lying down almost twice as much blood perfuses the udder than is the case when she is standing. It may be assumed that increasing blood perfusion of the udder may cause increased milk production. Cermák (1990) hypothesizes that if cows lie longer in cubicles their exposure to slurry deposited in passageways will be subsequently shorter. This, in turn, would reduce the environmental challenge to the foot as well as reduce the likelihood of falls on slippery concrete surfaces.

Cermák (1990) goes on to point out that there is a forward space demand (0.7 to 1.1 metres for a 600 kg Holstein dairy cow) as she lunges forward to rise. The cubicle partition should be of 'space-sharing' design and provide three zones of free space for the head, rib cage and pelvic area. The bottom division rail should be set at from 34-40 cm and the top rail at from 111-117 cm from the floor. The width of the cubicle should be from 115-122 cm. The base and the bedding of the cubicle have a profound effect on the lying time of the cow. The more resilient and soft the lying surface, the longer the cow will rest. Cows will lie for as many as 14 hours in the most comfortable cubicles. A sand bed seems to be the most acceptable to cows, but sand bedding requires modifications to the drainage system. However, experimentation is taking place with a variety of bedding systems that may use automobile tires, chopped rubber and canvas mattresses.

The design of the loose-housing system is important. Potter and Broom (1987; 1990) point out that space is used very competitively between rows of cubicles, around drinking troughs in milking collecting yards and at entries and exits. Space available in these 'strategic sites' must be generous if a cow is to have sufficient personal space for flight to accommodate aggressive encounters between the various animals in the social hierarchy. It is desirable that the width of alleyways behind the cubicles should be 3 to 3.5 metres. 2.5 to 3.0 metres should be added if feed bunks face the cubicles. The loafing or exercise area should be calculated at not less than 3.3 m2 per cow (Sainsbury and Sainsbury, 1979; Zeeb, 1987). If computerized feeding devices are used, enough of them should be provided to prevent cows spending prolonged periods waiting for access to the equipment.

The floor surfaces over which cows walk have also received a great deal of attention. New (green) concrete often causes an increase in the prevalence of lameness for up to nine months after it has been laid. Anecdotally, some producers recommend dragging a heavy weight over the fresh concrete before it has finally set.

Slurry contains a mixture of organisms and chemicals, many of which can attack the horn of the claw or the skin between the claws. Good hygiene is essential to reduce the incidence of infectious diseases. Excessive moisture in the environment softens the horn, which wears more rapidly and is more prone to mechanical damage.

There has been much study of the interaction between housing and behaviour. Housing that is conducive to 'social confrontation', (that is to say, there is a high risk of a dominant cow confronting a submissive one) will cause an increased stress in the herd. Mortensen and Hesselholt, (1986) demonstrated that changes in the blood vessels seen in laminitic claws are also seen in other organs of the body. If the incidence of lameness in a herd is high, it should be assumed that the environment is interacting adversely with the behaviour of the animals. Careful observation of the behaviour of the animals, vis-à-vis aggressive behaviour and/or amount of time spent resting, can provide a useful indicator of the importance of negative social interaction in the herd.

Footbaths

Footbaths provide a traditional technique aimed at reducing the reservoirs of organisms on the interdigital skin. In recent years the installation of permanent footbaths is being discontinued in favour of portable equipment, usually fabricated from fibreglass. Trials have been conducted to evaluate efficacy of different solutions. Formalin or formalin with copper sulphate is the most potent (Serieys, 1982). Other chemical agents such as iodides or cresols fail rapidly due to the high levels of organic matter present in the washing fluid. Formalin in a concentration of 5% is considered to be effective if the ambient temperature is more than 12°C. Formalin footbaths are effective in

reducing the incidence of interdigital dermatitis. Reports concerning the use of formalin for the control and treatment of digital dermatitis are extremely contradictory.It should be noted that formalin is poorly biodegradable and that there are reports of milk taint when the product is used.

Footbaths should always be placed at the exit of the milking parlour. Cleansing the digits by running the animals through a clear bath water prior to entering the parlour not only reduces the bacterial burden on the skin but extends the life of a medicated footbath by minimizing contamination of the bath with organic matter (Blowey, 1994).Since digital dermatitis has become a major problem, various antibiotic solutions have been used (oxytetracycline or tetracycline-HCL, <6 g/l; lincomycin, 0.15g/l). The antimicrobial activity and concentration of these products reduce significantly after a herd uses the bath possibly due to absorption in faeces and soil particles (Keulen et al., 1992). A minimal solution footbath is now marketed (Ward, 1994c) that has a soft foam base lying beneath a waterproof membrane. When a cow steps into the bath, the fluid moves to bathe her feet. The bath needs only 10-15 litres of fluid compared with 125-200 litres in a traditional footbath. Fluid is used at the rate of about 4 litres for every 25 cows (Ward, 1994b).

Management of Replacement Animals

The corium of the claws of cattle aged between 8 and 13 months is more susceptible to nutritional and management stress than is the case with older animals (Greenough et al., 1990; Greenough and Vermunt, 1991). Solar hemorrhages are a consistent finding in the claws of animals affected with sub-clinical laminitis. Beef steer calves fed high levels of energy have more hemorrhages in the soles of their claws than those fed lower-energy levels. Heifers that increased in weight at rates greater than 750 grams per day showed more hemorrhages in the soles of their claws than those that increased in weight less rapidly. However, there is yet no objective evidence that establishes a link between solar hemorrhage in the young animal and claw disease in later years. From a circumstantial perspective, in the dairy herds in which laminitis is recognized as a major problem, a significant number of heifers are found to have hemorrhages in the soles of their claws. The number of cubicles available per animal may be important, particularly for heifers (Leonard et al., 1994), some of which are sensitive to social confrontation when first introduced into the milking herd (Greenough and Vermunt, 1990). Heifers should be introduced into the milking herd in groups and care should be taken to ensure that each is properly trained to use a cubicle. Heifers that stand for long periods tend to have a greater preponderance of hemorrhages in the sole of their claws. Hemorrhages are both an indication of bruising and the presence of laminitic changes.

It has become more and more an accepted practice to calve heifers at 24 months of age or earlier. It is argued that a heifer will produce more milk between 22 months of age and 60 months of age. This is only true if the average age of the herd exceeds 60 months. Another perspective on this controversy is that the size of the claws of a heifer of 24 months of age is significantly less than a animal that is 30 months old, the weight-to-claw-size ratio is different. Added to this problem is the recommendation that heifers should be of a certain wither height and weight before they are bred. Frequently, small-framed heifers are unable to meet these standards unless they are force fed and this practice undoubtedly has negative side effects.

Exercise

Movement causes blood to circulate freely through the tiny blood vessels of the foot. Lack of movement allows blood to pool in the digit and the tissues have less opportunity to be oxygenated. Any change in management that reduces the opportunity for an animal to walk freely is detrimental. This situation can occur when young animals are taken from pasture and placed in relatively confined spaces. It can also occur if heifers stand for prolonged periods when they are introduced to the dry herd. Aggressive social interaction with dominant cows, together with unfamiliarity with the cubicle system, cause this to happen. In some cases, this may be the first time that the animal has walked on concrete, and it is also a time at which the diet changes. The cumulative effect may stress the animal.Over the past decade interest has focused on the finding that laminitis commonly affects dairy heifers (Peterse and Van Vuuren, 1984; Moser and Divers, 1987; Bradley, et al., 1989; Colam-Ainsworth et al., 1989; Vermunt, 1990; Greenough and Vermunt, 1991; Bargai et al.,1992; Frankena et al , 1992; Leonard, et al., 1992, 1994). The fact that so many workers have identified laminitis-like problems in young is probably the most significant finding of recent years. Too high a rate of growth during puberty, the stress of social interaction, sudden

changes in diet, reduced exercise and negative reaction to a new and hostile environment are all factors that cumulatively predispose heifers to the occurrence of laminitis. There is evidence that once damage to the small blood vessels of the foot has occurred the animal will become increasingly sensitive to future insults.

Discussion

Historically, the dairy industry has accepted lameness in cows as an accidental problem that is unavoidable. Contemporary information derived mainly from European sources now points out that lameness can be a herd problem. The dairy producer faced with a herd lameness problem must accept the fact that appropriate nutrition, combined with suitable management practices, can reduce the incidence of lameness without interfering with the productivity of the cows. New approaches to investigating herd lameness are being developed, (Greenough and Vermunt, 1994).

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