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RISK FACTORS OF LAMENESS IN DAIRY CATTLE AND ITS INTERACTION WITH THE GRAZING ECOSYSTEM OF MILK PRODUCTION

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Introduction

Lameness in dairy cattle is a growing problem in milk production under grazing conditions. The risk factors that predispose to these pathologies have increased significantly due to technological changes during the last decades in the milk sector. Outbreaks of lameness, difficulty to walk and lack of comfort is a growing preoccupation of the farmers and is a challenge for technicians to resolve. Lameness is probable the most important animal welfare issue today in dairy herds; public perception of the dairy production is becoming increasingly important, and lame cows do not portray a good image of the industry (Oetzel 2003). Lameness has been identified by dairy farmers in Australia as one of the most important health problems of dairy cattle. A cost of 200 U$ per lame cow is estimated taking into account productive losses, reproductive inefficiencies, treatment costs and culling (Malmo and Vermut 1998). The average lactation length of lame cows was shorter due mostly to premature culling of some cows because of their poorer production and reproductive performance. These differences in production were valued at $NZ 94.40 per lame cow (Tranter 1992). We did not find reports regarding the economic impact of lameness in milk production systems of South America.

In this paper, the how and why of the main foot diseases on milk production on pasture will be discussed. Emphasis will be placed on the risk factors that predispose to these diseases. Especially in lameness, Preventive Medicine is needed to minimize its impact and to maximize the profit of the dairy farm.

Incidence of lameness under grazing conditions

In studies on lameness done under grazing conditions (New Zealand), incidences from 2% to 38% are reported depending on the herds (Tranter and Morris 1991). In Australia, a survey on 73 dairy farms reports that lameness occurred in 88% herds and the most affected herd had an incidence of 31% (Harris et al. 1998). In Uruguay, Freire and Ramos (2005) mentioned an annual incidence from 1.4% to 2.1% of the total cows in milk, with great seasonal and yearly variation. On the other hand, dramatic cases of laminitis with a milk reduction of 70 % and a culling-rate of almost 60 % of the animals in production have been reported (Ramos and Acuña 2004). Overall, these findings show that even if under grazing conditions the percentage of lame cows in the herd is usually less than under intensive conditions, high incidences and devastating cases of lameness of enormous negative impact on the productive system are observed.

In New Zealand, the two most common lesions causing lameness are: sole damage (bruising, worn soles, penetrations of the sole) and separation of the white-line with subsequent abscess formation under the wall ascending to the coronet (Chesterton 2004). The risk factors for these pathologies are the traumatic factors related to excessive walking on hard surfaces, wet and dirty underfoot conditions, a decline in horn quality of laminitic origin, management conditions and animal behavior (Vermunt 1992; Chesterton 2004). In Uruguay, the toe ulcer is the main pathology in primiparous cows (Acuña 2002); and the causes for this pathology under extensive production conditions, are anatomical, metabolic and traumatic factors (Gonzalez Sagues 2002). In Argentinean dairy farms, the prevalence of laminitis is higher in primiparous than multiparous cows, especially in autumn with serious clinical cases between 30 and 100 days of lactation (Corbellini 2000). From 2468 lame cows in New Zealand, 8.7% correspond to interdigital dermatitis (Chesterton 2004). In Uruguay, interdigital dermatitis was the main affection of a herd of 800 cows in production in the most humid years (Freire and Ramos 2005)

Risk factors

The grazing system of milk production determines a particular series of lameness risk factors. Environmental conditions, herd management, animal behaviour, nutrition, genetics and animal type, and the human factor have all an important impact on the occurrence of lameness. There are important differences in milk production systems which we need to understand, because the impact of each of the risk factors will vary accordingly.

Human factor

The human factor is of particular relevance on the incidence of lameness in the milk productive system in Uruguay; lameness in dairy cows is relatively new in our extensive conditions. In this sense, the lack of knowledge of the pathologies and their risk factors, the underestimation of the problem, a wrong clinical approach of the affected animal together with a lack of infrastructure for diagnosis and treatment, leads to poor

prevention and exposes the productive system to the negative impact of these affections.

The education of the stock-persons, farmers and technicians and the inclusion of lameness to the traditional sanitary programs are important factors in the control of these affections in Uruguay. The man and his decision in animal management are present in all risk factors of lameness and determine whether or not lameness will develop.

Environmental conditions

The physical stress that the cows are submitted to under extensive conditions determines that the environmental factors such as mud, high humidity, stones, associated with management factors such as the type of cow herding, long walks and animal behaviour have a mechanical/traumatic action of great importance as causes of lameness. It is not surprising that more than 75 % of lameness in New Zealand is of traumatic origin (Chesterton et al. 1989, Chesterton 2004; Tranter and Morris, 1991).

Clarkson and Ward (1991) in the United Kingdom reported a higher incidence of lameness in farms with less well maintained farm tracks and where the stockman was impatient when herding the cows. In New Zealand, the impatience of the farmer in handling the cows and the use of dogs are pointed out as risk factors of lameness, capable of modifying the social behavior of the cows favoring the crowding of the cows (the choice of foot placement is restricted) and herd dominance (Chesterton et al. 1989). Highly dominant animals tend to walk at the front of the herd and get milked first, whereas subordinate animals tend to walk at the back of the herd and get milked last. There is a relationship between the social position of the animal in the herd and the risk of lameness in dairy cows, but the strength of this relationship varied between herds (Sauter-Louis et al. 2004).

In my personal experience, a similar situation takes place in Uruguay, which is aggravated by the dramatic increase in the size of the herds, where a single person usually handles 200 to 300 cows or more. In this kind of herd, one of the problems is the maintenance of the farm tracks and gateways. Furthermore, the cows remain waiting on the concrete floor of the milking parlor for longer periods and walk long distances to pasture. These long walks are usually considered as inevitable by the farmer and should be evaluated with maximum precaution due to the great potential of trauma of the tissues of the claw.

Several studies have showed the effect of year and rainy season on the incidence of lameness. More lameness occurs in the rainy seasons, and high incidence of lameness usually follows periods of heavy rain (Australia: Jubb and Malmo 1991; United Kingdom: Eddy and Scott 1980). The onset of lameness has been associated with wet weather conditions (Tranter and Morris 1991). In our conditions, season and year affected the incidence of lameness as the highest number of lame cows occurred in the year with most rain-fall (Freire and Ramos 2005). The association between wet weather and the onset of lameness is associated with a decrease of the mechanical resistance of the hoof that predispose to a greater wear and an increased chance of sole penetration. On the other hand, the exposure of stones and other sharp materials in the tracks after abundant rains increases the risk of lameness. Besides, bad hygienic conditions favour bacterial growth and the onset of infectious diseases of the hoof (Vermunt 2004).

Nutrition and lameness

The connection between lactic acidosis/subacute ruminal acidosis and laminitis has been described extensively by several authors (Nocek 1997; Owens et al. 1997; Kleen et al. 2003; Oetzel 2003). Vasoactive substances secreted during the process of acidosis alter the vascular microcirculation at the corium of the claw, affecting the nutrition of the keratin-producing cells leading to bad quality of corneal tissue and causing secondary lesions of the hoof such as white line disease, wall abscess and sole ulcers (Vermunt 1992).

An excess of soluble carbohydrates and an inadequate level of protein, an inadequate fibre/concentrate ratio, deficiency of effective fibre, silages that go mouldy, rapid changes of the diet, lack of ruminal adaptation and excess of dominance of multiparous over primiparous cows are key points of the onset of the illness. On the other hand, aspects such as animal comfort and welfare should be considered: long walks, hard and excessively abrasive concrete floors, excess of moisture and mud predispose the animals to mechanical changes particularly important in the digits. Thus, laminitis is a multifactorial disorder.

Nutrition of the dairy herds under grazing conditions is based on the use of pastures composed of a wide variety of graminea and/or legume. The possibility of digestive disorders occurring in the rumen and laminitis in dairy cows fed only with forage of high quality particularly ryegrass with high contents of protein and soluble carbohydrates has been known for long (Nilsson 1963, Maclean 1965). In milk production systems under grazing conditions (New Zealand) rumen pH ranges between 5.6 and 6.7 (De Veth and Kolver, 2001). Similar data has been mentioned in dairy cows in Uruguay (Mattiauda et al. 2003; Reppeto and Cajaraville 2004). A rumen pH of 6.4 to 6.8 is considered desirable for optimum cow health and performance (Erdman, 1988).

Due to their specific physical-chemical and morphological properties, high quality pastures are unable to maintain an optimum rumen pH. Studies from New Zealand indicate that ryegrass/clover pastures in winter, autumn and early spring are high in water content, relatively low in fiber and high in protein compared to the summer period (Moller 1996; Kolver 1998; Kolver 2000; Westwood 2003). A similar situation is observed in South American dairy production systems. On the other hand, the chemical composition of the pastures in terms of soluble carbohydrates, crude protein and content of dry matter, is highly variable throughout the day (Orr et al. 1997; Van Vuuren et al. 1986; Chilibroste Et al. 1999). High intake of humid nutrients is associated with a reduction in saliva production per kg of dry matter intake (Meyer et al.1964).
The saliva produced during rumination is an essential mechanism of rumen pH maintenance (Erdman, 1988). As mentioned above,

the pastures usually have a high content of humidity that varies according to season and plant maturation, and time of day. The mechanisms decreasing the production of saliva are complex and are associated with high moisture and low eNDF percentage of the diet.

Studies in the dairy cow on the effects of moment of grazing during the day on ingestive behaviour determined that cows allowed to graze in the evening spent more time grazing, reducing time spent on rumination and rest (Chilibroste et al. 1999; Soca et al. 1999). Besides, these cows tend to produce milk with lower fat percentage. These changes in ingestive behaviour could have a negative impact on the ruminal environment. Adding long dry fibre to the diet has a positive effect of on production and milk fat content, showing the possible lack of effective fibre in the diet during autumn and winter in Uruguay (Chilibroste et al. 2001). Similarly, Kolver (1998) proposed an eNDF for high quality pasture between 40 to 50% of the total NDF. Under some conditions, the diet of New Zealand pasture-fed dairy cows may contain less than 20% eNDF and cows will be at greater risk of rumen acidosis.

The South American milk production systems present a high availability of grains and different compounds to feed the dairy cows. The supplementation of the traditional grazing system has increased the complexity of nutrition in the extensive dairy industry. The great variations in the availability of different types of grains and the instability of the prices conspire against an adequate nutrition plan of the dairy cows and expose the herd to sanitary risks. Rapid changes of the nutrients could be the cause of laminitis that causes great pain and damage to the animal and a decrease in milk yield.

The ingestive behaviour of the dairy cow during the early postpartum is not totally understood and this increases the complexity of the milk production system based on pasture. The depression of dry matter intake in cows that have recently calved has been mentioned by Nordlund (2003) under confined conditions. Under grazing systems, Chilibroste (personal communication) has determined low activity during the grazing session and very low biting rates. This behaviour suggest high levels of selectivity, e.g., even if there are high nutritional demands due to lactation requirements, the cows dedicate an important part of their grazing time to select the type of pastures that they will eat. Such selection could be orientated to young forage with high contents of soluble carbohydrates, crude protein, humidity and low effective fibre that could predispose to acidosis. This type of ingestive behaviour is specially important in primiparous cows (Chilibroste personal communication) and, when taking into account factors such as the worse adaptation to lactation when compared to multiparous cows and the dominance to which they are submitted, could explain the differential laminitis incidences according to category reported (100 % in primiparous vs 50 % in multiparous cows; Ramos and Acuña 2004).

On the other hand, in Uruguay, the incidence of the human factor in the diet composition and nutrition of the dairy cows is determinant in their health. In this sense, the underestimation of the acidotic capacity of the pasture, and the different fermentability of the carbohydrates in the supplements, the lack of a routine in the use of anti-acids as well as good monitoring of nutrition, and a poor communication among technicians, nutritionists, veterinarians and farmers determines that -in some cases- the feet of cows "explode". In some farms, milk production could be temporally high with diets excessively rich in starch that may cause acidosis and, in the long run, the economical consequences are dramatic.
In my experience, the impact of economic loss of an outbreak of laminitis under grazing conditions in Uruguay is devastating. Once the
illness occurs, the treatments are inefficient and the losses are inevitable. The prevention of laminitis is the only efficient measure. However, bouts of ruminal acidosis are always possible whenever grains or very high quality forage are consumed by dairy cows (Oetzel 2003).

Several studies have shown improved growth, milk yield, reproductive performance, lameness and/or immune response in ruminants fed diets containing organic trace minerals (Kropp, 1993; Manspeaker and Robl 1993; Spears 1996; Socha and Johnson 1998; Gunter et al. 1999; Nocek et al. 2000). The use of methionine supplements has been advocated to improve the integrity of hoof keratin (Greenough 1985); however, evidence of an association between methionine supplementation and hoof hardness is lacking (Clark and Rakes 1982). Biotin deficiency is associated with cracked and brittle hoof horn (Vermunt and Greenough 1995) increasing the incidence of lameness. Supplementation with biotin at 20 mg biotin/cow/day may improve hoof hardness and resistance to wear, however a prolonged period of biotin supplementation (more than 3 to 4 months) is required before beneficial effects are seen (Fitzgerald et al. 2000).

I personally consider that in the South American milk production systems the use of these comercial products that are reported to be beneficial for the health of the digit, has lead in several occasions to a general belief among farmers that the foot problems are under control. Due to the need to simplify the work by the farmer in the complex process of milk production there is a risk that these products may be considered as true magic powders that will solve the majority of the sanitary problems of the dairy herd. The use of these products without an integral program of foot health that includes the main risk factors mentioned above is destined to fail.

Breed and animal type

The massive use of imported genetics in the South American grazing systems of milk production should go hand in hand with intensive research of the productive and reproductive behaviour of these genetics under our conditions. Overall, the farmer bases his preventive strategy of lameness selecting bulls that improve limb and foot conformation. But, it should be taken into account that the heritability of these characters is very low, and the genetic progress in this aspect is slow and costly. Besides, it has been reported that the use of bulls that improve limb and foot conformation will hardly improve the

incidence of lameness that is associated with risk factors such as environment, animal management and nutrition (Gonzalez Sagües 1996). The selection of the adequate animal type and breed for each productive system is a primary and key point in the determination of the herd health and welfare, and will define the productive potential of the system.

The interactions among breed and pathology are described in several studies. In the United Kingdom, Pinsent (1981) mentioned that the hooves of Friesians were more prone to damage than were the small, hard and compact hooves of Jersey and Shorthorn cattle. Friesian herds had a higher incidence of lameness than a combination of Jersey/Friesian crossbreed herds (Harris et al. 1988). Under extensive production systems, Jubb (1991) observed that sole ulcers occurred predominantly in very large frame pure-bred Holstein-Friesian type cows, with an almost complete sparing of other breeds, strongly indicating a predisposition. In high lameness prevalence herds it is more likely that on average the feet of the cows were less pigmented (which is more common in Friesian type cattle and a percentage of Jersey type cattle) (Chesterton et al. 1989).
The use of dairy types selected for confined systems under extensive conditions has a risk of lack of adaptation of the animal and a limited expression of the individual genetic potential.
In a detailed review Laborde (2004) describes the importance of having adequate genetic selection objectives for specific production conditions. In this sense, one of the points to be analyzed is the "size of the cow" to be used in the grazing systems. From the perspective of the digit, the size and weight of the animal are characteristics that could end in a premature culling of the cows. In studies from New Zealand (Holmes et al. 1999) and United States (Hansen et al. 1998) that compared dairy types with similar productive potential but with differences in size and weight conclude that independently of the production systems heavier cows had a higher culling rate than lighter cows being the foot pathologies the main cause of culling. Besides, cows from the heavy line were less fertile. In agreement with this, Wells (1993) mentioned that every 100 kg increment of live weight, the incidence of lameness increases 1.9 times.

Take Home Messages

- The characteristics of the extensive grazing system determine that the traumatic factors have a great impact on foot health. In this sense, the development and inclusion of management guidelines that consider aspects of cow comfort is the base of a preventive program of these affections.

- The boundary between high milk production and laminitis is extremely thin. Aspects of nutrition, nutritional management, and ingestive behavior of the cows should be carefully and frequently analyzed.

- The technological changes during the last decades in the extensive dairy production significantly increased the risk factors that predispose to lameness, thus, the farmers should always have in mind that lameness is latent in all high producing dairy cattle. The underestimation of the problem and the lack of preventive programs expose the productive system to important economical losses.

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