LAMENESS IN DAIRY CATTLE BREEDING: PREVALENCE AND ETIOLOGICAL FACTORS – A REVIEW

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ABSTRACT

Lameness in dairy cows is among the most serious problems of modern cattle breeding. The prevalence of lameness among dairy cows varies on a worldwide scale. The factors important for lameness occurrence are: feeding regimen, genetic selection, the social hierarchy, overcrowding and herd size, the free walking space, environmental factors and climate, behaviour of cows in conditions of heat stress, the design of the pen and type of restraint device, the litter and hoof care practices.

The present review makes clear that lameness in dairy cows is widely distributed in various production systems. The incidence of lameness, according to literature data, ranges from 0 to 59%. The etiology of lameness in cows is multifactorial. Numerous factors have been investigated, as the nutrition and diet type, the social hierarchy in the herd, the walking area and overcrowding. Other important factors for lameness are the climate and behaviour of cows in conditions of heat stress related to rations and feeding habits. The type and comfort of bedding and neck rails also play a role with this regard. Regular hoof care and trimming are indisputable for prevention of lameness. The literature review confirmed that lameness is important and controversial issue. It could be concluded that more research is needed to outline their impact of production technologies on the prevalence and consequences of lameness in dairy cows.

Key words: *lameness, dairy cattle, lameness prevalence, etiological factors*

INTRODUCTION

Lameness in dairy cows is among the most serious problems of modern cattle breeding. It has been studied over many decades but still, there is not a uniform statement acknowledging all causes and means of control of this pathology in various production systems. Evidences regarding economical losses are indisputable and they are related to culling, production losses, weight loss, infertility, increased incidence of mastitis among cows with lameness and hoof problems.

The prevalence of lameness among dairy cows varies on a worldwide scale. According to Faye and Lescourret (1989) it is about 29.5%, whereas Greenough and Vermunt (1991) report an incidence of 15-37% that increases considerably in the immediate postparturient period. Arkins (1981) reports that the prevalence of cattle lameness in Ireland was between 6 and 44%. In Europe it varies mainly between 25 and 30%, and in Bulgaria – from 4.55% to 49.68% (Neichev et al., 1981; Dijkhuizen, 1987). In free-ranging cows in Australia, Harris et al. (1988) reported an average incidence of 7.5%, whereas in the USA according to Cook (2003), lameness ranged between 21.1% in summer and 23.9% in winter depending on the rearing technology and the litter. Lameness among cows, as reported by Broom (2001), varies from 35 to 56% in the USA and 59.5% in Great Britain. Todorov (2009) affirmed an incidence between 2 and 55%, most frequently between 6 and 10%. The lameness is a result of multiple factors influencing the health of cattle (Cook, 2003). It leads to disturbance in the normal life of cows, reduced appetite and ingested dietary dry matter,

poor body condition, reduced milk production, higher percentages of clinical mastitis in affected cows, reproductive disorders and a high culling rate in the herd.

The factors important for lameness occurrence are: feeding regimen, genetic selection, the social hierarchy, overcrowding and herd size, the free walking space, environmental factors and climate, behaviour of cows in conditions of heat stress, the design of the pen and type of restraint device, the litter and hoof care practices.

NUTRITION AS A FACTOR OF LAMENESS OCCURRENCE IN COWS

High production dairy cows spent 3 to 5 hours daily for feed intake (Grant and Albright, 2001). To achieve a high production of milk, they need to have a permanent access to feed although it could become a source of subacute ruminal acidosis. In numerous studies, ruminal acidosis is induced by decreased the long fibre content of the ration (Keunen et al., 2002). Todorov (2009) considers that the intake of more than 3-3.5 kg of concentrated feed at a time could induce acidosis, accompanied by release of histamine that is responsible for the development of aseptic total diffuse pododermatitis. According to Cook et al., (2004) factors such as overcrowding, inappropriate feeding places, social interactions of animals, inadequate feeding (insufficient dietary fibre content or excessive dietary dry matter) or changes in some of aforementioned factors increases substantially the risk of acidosis in cows. Another diet-related factor predisposing to lameness, is the deficiency or the improper ration between some trace elements (Zn, Cu, Se, S) and vitamins (A, D, E, biotin) (Bodurov et al., 1982; Denev, 2004).

A primary factor for development of acidosis, in the view of several researchers, is the space and time available for feeding cows i. e. the so-called manger width. The critical manger width (linear bunk space) according to Grant and Albright (1995) is 0.2 m per cow. It depends a lot upon the type of free stall barns. In 3-row free stall barns the manger width is 0.46 m, and in 2-row barns – 0.74 m provided that population rate was (Brouk et al., 2003). Even in 2-row free stall barns with 140% population rate, the manger width is > 0.46 m (Cook et al., 2004). It was therefore concluded that disputes about the need of a larger manger width for satisfying the needs of cows are inconsistent. In the view of authors, only cows from groups with incompletely built social relationships were affected. Olofsson (1999) believes that the number of feedings increased parallelly to increased competition, the time for feed intake shortens, the consumption rate increases as did the number of post fight traumas. Dominating cows were less affected than those of a lower rank, as determined by the social hierarchy in the herd. DeVries et al., (2004) provided evidence that cows fights doubled when the manger width was reduced from 1.0 to 0.5 m/cow. According to Munksgaard and Krohn (1990) the narrower the manger width, the lower the risk of injury of cows is. The various types of feed barriers mounted on feeding troughs could also have an effect upon herd traumatism in free-ranged cattle. Endres et al. (2005) and Huzzey et al. (2006) consider that headlock barriers were better than post-rail barriers in reducing the risk of injury. Also, the former barrier type was better for prevention of cows that were lower on the social hierarchy.

GENETIC FACTORS

Similarly to other health status parameters, lameness in cattle is relatively determined by genetic predisposition. Having investigating the parameters: leg and feet score, hoof angle, leg set, Perez-Cabal et al., (2006) have established an insignificant relationship with lameness. The authors showed that cows with high leg and feet scores and medium hoof angle and leg set scores tended to be more productive and had a longer service period. Boettcher et al. (1998) confirmed this tendency but also showed that female offspring of bulls with relatively higher body weight were more prone to lameness development. Betancourt and Diaz (1986) demonstrated that the increase of body weight of bulls from 750 to 1200 kg resulted in increased incidence of hoof diseases from 26 to 31%.

SOCIAL FACTORS

Cows have habits related to their daily activity and if disturbed, animals tended to preserve the duration of lying and rest episodes relatively constant (Cook et al. 2004). After first-time introduction in free-stall pens, heifers could spent lying less than 6.25 hours per day (Singh et al., 1993). The decreased pen usage after the parturition could explain the severe hoof lesions that are observed when heifers are moved from pasture in stalls (Bergsten and Frank, 1996).

Social factors, according to several researchers, determined the place where cows would lie down. Galindo and Broom (2000) established that cows at low ranks of the hierarchy spent considerably less time lying and resting and much more standing or spent less time in pens as compared to cows at the middle or high hierarchical levels. According to Gaworski et al. (2003) cubicles at the end of the row were less frequently used. Having investigated three-row stalls, the row with immediate access to the feeding path was used 41% more frequently by cows than cubicles at more remote rows (Cook et al., 2004). These cubicles, in the view of authors, were most probably occupied nu dominating cows that did not allow other cows to lie in that row. The fact that cows which spent more time standing is thought to pose a greater risk for interdigital space disease or heel erosions. It is acknowledged that if cows spent standing more than 45% of the day, the risk of hoof lesions and lameness increased considerably (Galindo and Broom, 2000). Galindo et al., (2000) proved that the time necessary for appearance of clinical signs of lameness in low-rank cows was significantly shorter than for those of higher ranks. Cook et al. (2004) believe that cows standing with only two front feet inside the stall and the hind feet on the alley (the so-called perching) are substantially prone to lameness.

OVERCROWDING

The limited space or overcrowding in the stalls has a two-side effect upon cattle welfare. The first effect is related to their physical needs for lying, standing, walking etc. Second, the limited space available alters the social interactions among cows in the herd. Both aspects are overlapping to influence the amount of manure per unit of stall area, body cleanliness, feeding, air quality and even the social hierarchy in the herd (EFSA, 2009).

Social problems could arise when the herd size is not uniform. Another problem is encountered when heavier cattle generations are reared in old stalls, the necessary comfort could be hardly achieved and this, the stall use coefficient is altered. Cows of a bigger size (withers height over 145 cm) rarely feel comfortable when their hind feet are stretched during lying compared to cows of smaller size (Keil et al., 2004). Investigations carried out by Wierenga and Hopster (1990) upon the stall use in three levels of overcrowding (125, 133.3 and 155%) vs normal density of 100%, showed that dominant cows were not affected by overcrowding unlike the others.

The optimal space for dairy cows is different for horny and hornless cows (Menke, 1996). Horns increase the space necessary for the head when lying, standing, increase the knocks in barriers or impede the entry and exit of animals in pens or feeding places. The necessary social space for a cow, in the view of Wilson (2000) increases as animals make constant attempts to gain more personal space in the stall. This space depends on dominant associations between cows and has an effect on time spent resting, especially for low-rank cows by increasing the time these cows spent lying on alleys or walking without rest (Winckler et al., 2003; Fregonesi et al., 2007a).

WALKING AREA

The space available to cows for walk is an important factor determining the aggression episodes. When raised on pasture, cows could easily avoid each other and rarely intrude into the personal space of leaders (EFSA, 2009). If the space is rather low, low-rank cows become more often locked in the stalls and the possibility to escape is very low. This, according to EFSA (2009) could occur with great probability when alleys are rather narrow, then the space allowance of cows is limited and the movement from the stall to another place in the stall could provoke aggression. In

free stall pens, the physical contact among cows is significantly increased as compared to cows reared on pastures especially when feeding and lying space is limited (Miller and Wood-Gush, 1991). A higher rate of conscious physical contacts among cows have been observed in loose housing compared to pasture rearing, together with increased risk of trunk and feet injuries (Menke et al., 1999; Fregonesi and Leaver, 2002). Henneberg et al., (1986) discovered that aggression episodes are more frequent when the width of alleys is decreased from 2.0 to 1.2 m, whereas alleys without an exit result are related in general to a high risk and impossibility to avoid conflicts among cows. The aggression was also believed to be related to the width and length of pens, feeding places, feeding place per animal ratio and the availability or not of an outdoor yard. The reduction only of the size of feeding places or the feeding places per cow ratio sharply increased the levels of aggression (DeVries et al., 2004; Huzzey et al., 2006).

EFFECT OF WEATHER FACTORS AND CLIMATE ON LAMENESS IN COWS

Many studies were carried out to establish the effect of climate on hoof health and lameness in cows. According to Todorov (2009) the incidence of lameness among cows increases in months with intensive rainfall and high ambient humidity (March-April and October-November). The places in stalls with high humidity around feeders and watering troughs in the yard increase the susceptibility to lameness. Williams et al. (1986) reported that lameness was most intensive during the winter and the autumn (from November to March) that, in the view of authors, was related to rainfall amounts and soil moisture. Russell et al., (1982) and Rowlands et al., (1985) believe that there was a relationship between soil humidity and lameness but its effect was lower as compared to the influence of other factors. According to Bodurov et al. (1982) the high floor humidity caused softening of hoof horn and solid floors presented a substantial risk for hoof diseases. Betancourt and Diaz (1986) established higher incidence of hoof disorders in bull breeders in Cuba from May to July, i.e. during the rain season in Cuba. According to Clarkson et al., (1996) the incidence of winter lameness was 25%, vs 18.6% during the summer. Faye and Lescourret (1979) did not observed a significant difference in lameness prevalence during these two years. During the first year, there were no seasonal differences in lameness among cows but during the second, lame cows were more numerous during the winter period. Wells et al., (1993) demonstrated an insignificant difference in lameness incidence during summer (13.7%) and spring (16.7%). Cook (2003) observed relatively more lame cows during the winter than in summer, in free-stall rearing on organic litter, but not on sand surface. Cows reared in tie-stall barns did not exhibit any considerable seasonal differences. The lameness among cows in free stalls with sand stall surface was similar in winter and spring. It was found out that in tie-stalls, lameness was less pronounced compared to free stalls, but there was no significant difference between sand and organic stall surfaces between seasons, as observed for other flooring types.

HEAT STRESS AND BEHAVIOUR

Heat and the stress it provokes could significantly increase the risk for laminitis and hoof lesions. The number of lying cows reared in free stalls on sand floor is considerably reduced when ambient daily temperature increases (Overton et al. 2002). Cows are standing in airy shady places near to the feeding path to improve their heat exchange. Having investigated the behaviour of cows during the hot summer days, Scharko (1998) discovered that cows panted and exhibited enhanced salivation. This, in the view of the author, contributed to development of respiratory alkalosis and enhanced excretion of bicarbonates with urine that on its turn could play a role for development of subacute ruminal acidosis. In order to preserve the amount of dry matter intake and the high milk production during heat stress, the dietary protein content of rations is increased (Scharko, 1998; Todorov, 2009). During hot days, cows eat rarely but ingest larger amounts that, combined with respiratory alkalosis (Scharko, 1998) pose a risk for acidosis and laminitis. Feeding a complete

ration could limit or reduce the development of laminitis, if it contains high-quality hay and silage with maximum fibre length and supplemented with bicarbonates for acidosis control.

NECK-RAIL POSITION

The position of the neck-rail and its height from the pen floor could have a substantial effect on time cows spent resting in beds (Tucker et al., 2005). According to some researchers, cows are standing in pens as there are no other comfortable places in stalls available. Tucker et al. (2006) believes that even when the floor in stalls (outside pens) was of poor quality (i.e. a wet concrete floor), the neck rail position could make cows spending more time standing on the stall floor and consequently, to increase the risk of lameness. Mülleder and Waiblinger (2004) found out that if the diagonal between the nail rail and the rear border of the bed was over 1.95 m, the incidence of lameness was lower. The multiple hits when cows lie down in narrow cubicles, horselike rising and sitting with hind feet flexed could have a negative impact and lead to injury, pain and fear. The usage of stalls could be also influenced by the position of the brisket board (Tucker et al., 2006). Thus, the flexible neck-rail could reduce the injuries, pain and fear in animals.

EFFECT OF BEDDING AND FLOOR TYPE

The floor and the bedding for dairy cows must conform to specific requirements in order to procure the necessary thermal comfort, space for lying, standing and duration of rest for 12-14 hours a day. The floor should allow maintaining the cows clean and in good health with minimum efforts (Chaplin et al., 2000). Solid floors, concrete or brick, are not considered appropriate for dairy cows (Bodurov and Ivanov, 1979; Stoyantchev and Uzunova, 1999; Iliev et al., 2008). Numerous authors report that cows prefer to lie down on a deep straw bedding than on mats and rubber mattresses, but others believe that rubber mattresses are better with regard to comfort of cows (Manninen et al., 2002). The preference towards a specific type of floor does not necessarily mean that the less preferred type of floor is not appropriate for cows (Cook et al., 2004). In several studies, cows preferred sawdust bedding than rubber mats or sand (Tucker et al., 2003). The ambient temperature could influence the preference towards mats as compared to sand (Wagner-Storch et al., 2003). It is reported that cows felt more confident on soft rubber beddings than on solid concrete floor and that the stride length and movement speed were similar to those observed on pastures (Jungbluth et al., 2003). According to Cook (2003) lameness is more often seen in farms using rubber mats that in those with sand bedding. The "climbing" posture was more often observed on rubber mats than on sand and correlated positively with lameness in cows (Cook, 2002).

Hernandez-Mendo et al. (2007) have reported that the gait and hoof health of cows improved when they were reared on pasture and body weight was regularly distributed among feet. The authors assumed that the type of diet could also have an impact. The solid, dry straw bedding with permanent quality is similar to conditions on pastures (Zdanowicz et al., 2004; Fregonesi et al., 2007b). This type of bedding ensured a thermal comfort, and conditions for optimal rest without risk of slipping. Straw bedding could contribute for development of mastitis in cows when the management practices are poor (Zdanowicz et al., 2004). According to Endres and Barberg (2007), composted manure could be also good bedding in stalls. Other investigations pointed out the time spent resting as the most important parameter of bedding quality (Tucker and Weary 2001). Rushen et al., (2007) stated that softer beddings reduced considerably the risk for carpal joint swelling as cows place the centre of weight to carpal joints when getting up or lying down.

HOOF TRIMMING

Hoof trimming is an essential part of hoof care. It helps distributing the body weight between hooves and protects the sole corium from trauma and hoof lesions (Manske, 2002; Mason and Offer 2007). The five point plan for lameness prevention created by Logue and Bergsten (2006) puts the

good quality of the hoof corn and regular trimming on the second place. Hoof trimming has a marked positive effect with regard to non-infectious hoof pathology. It is concluded that hooves of cows should be trimmed at least twice yearly (autumn and spring). This way, the body weight is properly distributed between lateral and medial hooves and all lesions are discovered at an earlier stage. Neichev et al. (1980) reported that trimming of overgrown hooves increased the daily milk production by 1.5-2 litres/cow in the 7^{th}-8^{th} lactation month, whereas Diaz and Bodurov (1986) the daily milk production decreased by about 3.3 l/day in cows with overgrown hooves and by 4.5 l/day in hoof diseases. от крава Cow hooves, especially the hind lateral one, exhibit an excessive growth with time (Mason and Offer, 2007) that leads to overload of the corium in the frog area and poses a high risk of sole ulcer development. One of trimming benefits is that recently trimmed cows are significantly less prone to slipping (Phillips et al., 2000). The change in the coefficient of cohesion with ground is attributed to the altered angle between hoof wall tubules and the ground, the larger sole surface and the altered traits of the new hoof horn. The loss of sole shape 50 days after lactation begins, in the view of Tranter and Morris (1991), is indicating the necessity of more frequent hoof trimming. Corrective trimming is not advised when there a risk of severe injury, between the 61^{st} and 150^{th} lactation days (Manske 2002). The ideal time for hoof trimming is between the 100^{th} and 150^{th} days of lactation (Scharko, 1998). Another appropriate period is the beginning of the dry period (Scharko, 1998; Manske 2002).

Trimming could have a negative impact and be a factor for lameness. In the book „Cattle Footcare and Claw Trimming" (1985) Toussaint Raven states that "if there are no lameness problems, trimming could create them". Having performed numerous studies, the author concluded that lameness could be provoked by improper trimming. Another predisposing factor could be the locomotion on rough abrasive surfaces, with subsequent severe erosion of the hoof horn and development of severe hoof lesions.

CONCLUSION

The present review makes clear that lameness in dairy cows is widely distributed in various production systems. The incidence of lameness, according to literature data, ranges from 0 to 59%. The etiology of lameness in cows is multifactorial. Numerous factors have been investigated, as the nutrition and diet type, the social hierarchy in the herd, the walking area and overcrowding. Other important factors for lameness are the climate and behaviour of cows in conditions of heat stress related to rations and feeding habits. The type and comfort of bedding and neck rails also play a role with this regard. Regular hoof care and trimming are indisputable for prevention of lameness. The literature review confirmed that lameness is important and controversial issue. It could be concluded that more research is needed to outline their impact of production technologies on the prevalence and consequences of lameness in dairy cows.

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