Animal welfare, etológia és tartástechnológia

Animal welfare, ethology and housing systems

Volume 8 Issue 2

Gödöllő
2012

ASSOCIATIONS BETWEEN THE OCCURRENCE OF LAMENESS, NUMBER OF ORTHOPAEDIC BLOCKS USED BY HOOF TRIMMERS AND MANAGEMENT RISK FACTORS IN DAIRY COW HERDS

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Abstract

A 5-point locomotion scoring system was used to investigate risk factors for elevated locomotion scores and increased number of blocks used by trimmers among 11 422 dairy cows on 25 farms in Hungary. Each of the farms was visited twice between May and December 2010 and between May and December 2011. At each visit, all milking cows were scored for locomotion by a single observer. Farms were grouped according to their management (which sometimes changed in two years) and prevalence of lameness. Correlations, analysis of variance and chi-square tests were constructed to identify factors associated with elevated mean locomotion score (increased abnormality). Risk factors for increased locomotion score were: increased number of foot baths per week, decreased number of extra free stalls, decreased BCS, dirtier bedding, non-grooved feed yards, limited access to water, old-fashioned, square feeders and milking parlours with steps > 5 cm. Unrestricted rising was related to the presence of lunge areas and brisket boards. There were fewer hock and knee lesions in straw yards than in free stalls and rising was unrestricted on farms where stalls were provided with lunge areas and brisket boards. Risk factors for increased use of orthopaedic blocks by trimmers were: an increased number of foot baths per week, more frequent trimmings per year, decreased number of extra free stalls, narrower passageways, longer distances between barns and paddocks, lower placement of neck rails, increased percentage of cows perching and heifers with dirty hindlimbs, no access to paddocks, presence of free stalls, lack of lunge areas, poor quality surfaces in front of water troughs, non-grooved feed yards, stones on tracks, increased percentage of obviously ill cows, scraping passageways using tractors and the presence of grooved alleys in milking parlours. The results provide a framework for hypotheses for future investigations of risk factors for impaired locomotion.
Key words: dairy cattle, lameness, orthopaedic blocks, risk factor, lameness prevalence.

Introduction

Lameness has been recognized as a multifaceted condition (*Espejo and Endres*, 2007), severely-decreased animal welfare (*Webster*, 2001) and is an important constraint to the dairy industry (*Kossaibati and Esslemont*, 1997). Lameness is a major welfare problem of dairy cows (*Whay et al*., 2003) and because of its negative impact on milk production is one of the most important problems of dairy cattle (*Coulon et al*., 1996; *Warnick et al*., 2001). If antibiotics are administered, milk may have to be discarded (*Blowey*, 1993).

Technical and scientific knowledge about locomotion disorders in dairy cattle has grown partly due to activities of projects such "Sund Klov" (Healthy Claw) in Sweden and Denmark, (*DairyCo*, 2012), ''Lamecow", funded under the EU Sixth Framework (*Amory et al*., 2006) and applied behavioural studies in the USA (*Faull et al*., 1996). Nevertheless, lameness in dairy is still a problem, with for example data showing increase in prevalence in lameness in the UK from 18% in 1989-1990 and 35% reported in 2006–2007 (*FAWC*, 2009).

Improvements in mastitis and SCC in dairy cattle were possible due to different payments depending on milk quality. However, there have been few improvements in management of lameness in dairy cattle. Unlike milk quality there are no direct payments to reduce lameness. Management plans for decreasing lameness in dairy cattle are not developed to be fully effected because the research background is not strong enough to provide such a plan (*Amory et al*., 2006). It is obvious that there is a high prevalence of lameness and this is the evidence that recommendations are need to be provided to reduce locomotion disorders. The prevalence in Europe has been estimated at 1.2% in 34 zero-grazing herds in Holland (*Smits et al*., 1992), 5% on 101 farms in Sweden (*Manske et al*., 2002), 19% on 4 farms in Hungary (*Ozsvári et al*., 2007) and 22% on 53 farms in England (*Whay et al*., 2003). It is possible that differences in lameness variation in those countries occur because of different managements, scoring systems or observers.

Studies about lameness and its associations with dairy husbandry are still in progress. One of the methods of collecting knowledge about the diseases is observation of associations between prevalence of lameness and management risk factors. An increased occurrence of lameness was associated with concrete floors *Webster* (2002), slatted concrete floors (*Leach et al*., 1997) and rubber slats (*Hultgren et al*., 2004). More hoof lesions were found to be related to reduced time cows are lying (*Leonard et al*., 1996), presence of slopes and high steps (*Philipot et al*., 1993). High prevalence of lame cows was also associated with slippery surfaces and uncomfortable cubicles (*Faull et al*., 1996), free stalls in comparison to tie stalls (*Cook*, 2003) and lack of biotin as a supplement for milking cows (*O'Callaghan*, 2002). These studies comparing different management factors might be independently not sufficient enough for creating background for management program for decreasing lameness on Hungarian dairy farms. Different husbandry practices in different countries means that risk factors for lameness are likely to vary.

Extremely affected hooves can be given relief by shifting the weight-bearing surface off affected lesions to promote healing and recovering. There are two ways of doing that, either by leaving the unaffected hoof untrimmed higher than the affected hoof or by applying a wooden, plastic or rubber orthopaedic block to the healthy claw. One of those methods should be applied every time the corium is exposed. If possible, the cow with the orthopaedic block is best kept on concrete after trimming so the affected claw does not sink into mud, manure or dung. *Higginson et al*. (2011) asserted that orthopaedic blocks make no differences in lame cows with number of steps taken, in lying duration or bouts. However, the commonly used orthopaedic blocks lose the perpendicular placing, slope towards the axial cleft resulting in secondary hoof horn lesions when

cows walk intensively not allowing enough time for lesion recovery. For that reason larger angle-adjusted blocks maintained their original shape and position longer resulting in fewer secondary hoof horn lesions (*Burgi*, 2011). Blocks used are not direct indicators of overall prevalence of lameness in herds, but can give an idea how many cows are found with the most severe lesions. So far there was no publication found covering reasons for elevated use of orthopaedic blocks.

The aim of the study was to check associations between the prevalence of lameness, number of blocks used by hoof trimmers and management risk factors.

Material and Methods

25 Holstein-Friesian farms in eastern and south eastern Hungary were enrolled into a study of risk factors associated with high locomotion score and high use of blocks by trimmers. Farms were visited between May and December 2010 for the first time. During each visit all milking cows leaving milking parlour after morning milking were observed for occurrence of lameness. Cows were checked when walking on flat, clean concrete free of mud, muck and other contaminations which could make cows walking abnormally. For that reason locomotion scoring system developed by *Sprecher et al*. (1997) was used (*Table 1*). This method has understandable objective descriptions of posture and gait for scoring. It also includes subdivisions between sound with imperfect locomotion and clinically lame cows. The system contains 5 categories of increasing severity. The first describes a normal locomotion and only considers the back position (flat while walking and standing). Another one describes a mild abnormality visible only when the animal walks when the back is arched. The last 3 scores classify a bovine as lame and the animals are arching of the back while standing and walking with more visible gait abnormalities. Researchers consider lame cows to be the ones with scores 3-5 (*Clarkson et al*., 1996; *Sprecher et al*., 1997 and *Cook*, 2003).

***Table 1*. Locomotion score of dairy cattle**
(*Sprecher et al*., 1997)

Locomotion score 1 Normal	Stands and walks normally with a level back. Makes long confident strides.
Locomotion score 2 Mildly lame	Stands with flat back, but arches when walks. Gait is slightly abnormal.
Locomotion score 3 Moderately lame	Stands and walks with an arched back and short strides with one or more legs. Slight sinking of dew-claw in limb opposite to the affected limb may be evident.
Locomotion score 4 Lame	Arched back standing and walking. Favouring one or more limbs, but can still bear some weight on them. Sinking of the dew-claws is evident in the limb opposite to the affected limb.
Locomotion score 5 Severely lame	Pronounced arching of back. Reluctant to move, with almost complete weight transfer off the affected limb.

After locomotion scoring every single lameness preventive measure was recorded and discussed with farm manager. Farmers were given advices regarding the most neglected areas on the farms coming from scientific outputs and international journals dealing with dairy

management. The second visit was performed between May and December 2011. Again milking cows leaving milking parlour after morning milking were observed for occurrence of lameness and lameness preventive measures were recorded. Cooperation with leading professional trimming company helped to obtain information about number of blocks used during trimmings on 15 out of 25 farms in 2010 and 2011. Number of blocks was transformed to units of blocks/100 cows (lactating and dry). Then there was possibility to run a Spearman Rank Correlation test to determine strength of relationship between number of blocks used on farms, prevalence of lameness and environmental factors. Each farm was grouped to the category with particular measure and lameness score. Observations with lameness and 2 or more categories were analysed with analysis of variance. Percentages of lameness and percentages describing particular category were correlated and two measures described as categories were tested with Chi-square tests. Following measures were tested in the study to be theoretically associated with elevated prevalence of lameness: footbathing (no./week), trimming (no./year), method of trimming (no trimming, on-farm hoof trimmers, professional trimmers), records of lame cows, building type (freestall, straw yard), bedding material (corn, straw), scraping method (tractor, scraper), width of passageways between cubicles (cm), type of concrete between cubicles (grooved, non-grooved), surface quality (1 – relatively dry, no holes not slippery; 2 – wet or some holes or slippery; 3 – wet, some holes and slippery), width of passageways in front of feeders (cm), type of concrete in front of feeders (grooved, non-grooved), extra free stalls (no.), lunge area (present or not), brisket board (present or not), free stall length (cm), free stall width (cm), horizontal position of neck rail (cm), vertical position of neck rail (cm), water access (easy, limited), ventilation (present or not), steps in milking parlour >5 cm, type of concrete in milking parlours (grooved, non-grooved), access to paddocks, shade, distance between buildings and paddocks (m), width of track (m), track camber (present or not), stones on track (present or not) and stockman (1 – cows herded calmly, 2 – at least one worker expressing negative behaviour, 3 – more than half of workers expressing negative behaviours).

Results and Discussion

Relations between the occurrence of lameness, welfare measures and environmental factors

Among a long list of measures of potential risks for lameness only some of them were found to be correlated with an increased prevalence of locomotion disorders on the 25 Hungarian dairy farms measured (*Table 2*). There was a positive correlation between the number of foot baths per week and with a high number of lame cows. Less extra cubicles in barns were discovered to be correlated with more lameness. More dull, thin and obviously sick cows were found with compromised locomotion. Regarding performance data lower average milk yield, higher protein content, SCC and urea level were correlated to growth in prevalence of lameness. Finally, similarly to lactating cows, thin dry cows with soiled or wet bedding were found lamer.

***Table 2*. Correlations between occurrence of lameness, welfare measures and environmental factors observed on 25 dairy farms in Hungary**

Measures	No. of farms	Correlation coefficient (lameness)	Significance
Foot bathing (No./week)	50	+0.29	0.045
Extra free stalls (%)	50	-0.41	0.034
Milking cows – Obviously ill (%)	50	+0.29	0.40
Milking cows – BCS1 (%) *)	50	+0.36	0.010
Milking cows – BCS2 (%) *)	50	+0.40	0.004
Milking cows – BCS3 (%) *)	50	-0.52	0.001
Thin dry cows (%)	50	+0.43	0.002
Dry cows bedding cleanliness	50	-0.31	0.03

*) BCS – Body Condition Score; 5-point scale was used

The analysis of variance proved that more lame cows can be found on farms with limited access to water troughs compared to easy access to water, concrete square feeding troughs compared to feeder on flat surface and with steps higher than 5 cm in milking parlours compared to farms with no steps higher than 5 cm in milking parlours (*Table 3*).

Table 3. Analysis of variance between means of lameness in different environmental conditions

Measures	No. of farms	Mean of lameness	Std. dev.	Significance
Limited access to water Easy access to water	19 31	36.31 28.23	12.76 11.99	0.029
Feeder (flat surface) Feeder (concrete trough)	25 25	27.08 35.52	12.88 11.44	0.018
Feed yard non-grooved Feed yard grooved	31 19	35.97 23.68	12.03 10.25	0.001
Milking parlour with no steps Milking parlour steps >5cm	32 18	28.42 36.42	12.82 11.32	0.032

The investigation of resting areas for lactating cows shows that there is a very significant impact of a lack of lunge area and brisket boards on rising behaviour of cows (*Table 4*).

***Table 4*. Rising opportunities with different cubicle setups**

		Measures			
		No lunge area	**Lunge area present**	**No brisket board**	**Brisket board present**
Rising scores	1 - Unrestricted	0	12	0	12
	2 - Mildly restricted	9	3	6	6
	3 – Very restricted	4	0	3	1
No. of farms		28		23	
Df		2		2	
Chi-Square Tests - Value		18.96		10.87	
Asymp. Sig. (2-sided)		0.001		0.005	

Finally, a lower number of hock and knee lesions was found in straw yards in comparison to free stall barns (*Table* 5).

Table 5. Analysis of variance between mean occurrence of hock and knee lesions in straw yard and free stall barns

Measures	**No. of farms**	**Mean of hock and knee lesions**	**Std. dev.**	**Significance**
Straw yard	24	13.88	11.88	0.006
Free stall	26	26.85	18.92	

There is no agreement in literature with some of the measures how they affect lameness distributions; misinterpretation can have a place if advice are going to be given to Hungarian dairy farmers. There are different bedding materials used in free stalls and it is unclear which, if any, of the available surfaces are best for the health of legs and hooves (*Cook*, 2003; *Espejo et al*., 2006; *Faull et al*., 1996; *Wechsler et al*., 2000). There is no agreement which housing is better regarding lameness development (*Barker et al*., 2007; *Philipot et* al., 1993) and if overcrowding is really elevating the number of lame cows (*Espejo et al*., 2007; *Wierenga and Hopster*, 1990). For clarifying those and other issues this study gives good confirmation how scientific outcomes (similar or different) are found to affect lameness on Hungarian dairy farms. The estimated measures can give an idea what are potential risk areas which should be considered in applying lameness preventive solutions in Hungary. Locomotion scores provide an estimate of the prevalence of lameness in a herd. Scoring many cattle on many farms and correlating the scores with management practices can assist in understanding impaired locomotion and provide the opportunity to generate a hypotheses for improved locomotion, whatever the etihology of specific lesions.

Faye and Lescourret (1989) reported that the use of foot baths is beneficial in controlling digital dermatitis. However, benefits of foot bathing were not detectable on commercial farms in this study with more lame cows and more orthopaedic blocks used by hoof trimmers on farms

using more often foot baths. The same relations were found by *Amory et al.* (2008) in dairy cattle and by *Wassink et al*. (2003) in sheep. Foot bathing was probably positively correlated to an elevated prevalence of lameness due to a possible incorrect use of foot baths. This could include the chemical solution being too concentrated, too diluted, contaminated or not changed frequently enough. It is very likely that the reservoir with the solution became filled with faeces and cows had to walk through the slurry when leaving the milking parlour, possibly increasing the chance for the spreading of digital dermatitis (the conditions of foot baths were not measured in this study). The other explanation is that on farms with poor housing and management, foot bathing, alongside trimming, is thought to be the only possible effective routine solution, whatever the quality of action is taken. *Sumner and Davies* (1998) concluded that these are not the foot baths which make cows lamer, but farmers, seeing more lame cows, use foot baths more often. There are already commercially innovative approaches to foot bathing. Some foot baths separate the legs of the cows for proper cleaning, with special brushes or jets cleaning hooves from five sides. Additionally, pressurised water is sprayed when the cows vacate the bath; the equipment is sprayed down and the solution is changed with programmable repetitions. In other words what was until now a simple hole in the concrete became a thing of technology. Whichever method is used it should be used effectively.

A minimum 5-10% of extra stalls are recommended by different authors to be in the barn to provide enough space for all the cows (ESCE, 2012; *Tucker et al*. 2003; *Wagner-Storch et al.,* 2003). That solution gives every cow free access to a laying area. Animals will lie down longer if there is enough space to lie. *Bowell et al*. (2003) and *Leonard et al*. (1996) had shown that the ratio of cubicles to cows in his research was negatively correlated with the locomotion score and the same correlation was found in the present study. Moreover, the number of orthopaedic blocks used by hoof trimmers was also correlated with less extra stalls available for cattle.

Lower body condition scores (1 and 2) were found to be positively correlated to elevated lameness cases among 826 cows and the same relation was found on the 25 farms. *Ózsvári et al*. (2007) reported that the body weight of lame cows decreased by 6.6% (41.7 kg) compared to the indices of healthy cows. *Wells et al*. (1993) also found a strong correlation between poor body condition and clinical lameness. For a long time researchers believed that lameness was the result of sub-clinical rumen acidosis and body condition thought to be not a cause, but a consequence of lameness. A study at *Bicalho et al*. (2009) found that a thinner digital cushion was correlated to lower body conditions of cows. A weaker cushion has a lower capacity to protect the corium tissue from compression by the third phalanx which causes more incidences of impaired locomotion. The relation is likely to be true because a great part of the digital cushion is built up of adipose tissue. *Hassall et al*. (1993) and *Juarez et al*. (2003) claim that a lower body condition could be a consequence of reduced feeding times. *Juarez et al*. (2003) go further with conclusions that restriction of movement and not being able to arrive to the feeder as fast as healthy cows make lame cows unable to acquire larger portions of feed.

In the study, the farms where dry cows had compromised resting area cleanliness, there were more lame cows. *Borderas et al*. (2004), *Gregory* (2004) and *Somers et al*. (2005) associated contaminated surfaces and housing conditions with softer claw horns, increased hoof horn lesions and digital dermatitis. This relation is likely to be a reason for increased use of orthopaedic blocks by hoof trimmers on farms where an elevated percentage of heifers were found with dirty hindlimbs. When dry cows and heifers are moved from wet and dirty straw yard barns to milking groups they are experiencing a shock of contact with abrasive concrete passageways.

On farms with limited access to water more cows were reported with lameness and more blocks were used by claw trimmers. This is possible that on those farms the water troughs were positioned slightly higher and cows needed to walk on a concrete steps which increases the risk for slipping especially in winter. On some farms the water stations were placed at the end of passageways where the scraper arms were present when not in use. If the cows wanted to access the water trough, they needed to walk over the metal parts of the scraper. As a result safe and stable hoof position was compromised. In another situation, the cows drinking water were disturbed by the scraper when it started its movement. On some farms the water troughs were positioned along passageways on the way of the tractor scraping the manure. The area around the water troughs was not properly scraped and cows were walking in manure.

The cows kept in barns with flat feeding surfaces were observed with less locomotion problems. Modern feeders (flat surfaces) are build slightly higher than the level of the cows stand and feed is pushed few times a day closer to the cattle. In old fashioned troughs, which are usually relatively wide, food is most of the time spread to the farther end of the feeder. The cows that are trying to reach the farthest pieces of TMR are placing more weight on the front legs and placing more pressure on the hooves.

In the study the cows kept in barns with grooved feed yard passageways were less likely to be lame and more orthopaedic blocks were used by hoof trimmers in comparison to non-grooved yards. *Dembele et al*. (2006), *Faull et al*. (1996) and *Flower et al*. (2007) correlated slippery flooring with a higher prevalence of lameness and *Telezhenko and Bergsten* (2005) with alterations in gait. Abnormal gait on slippery surfaces causes altered weight bearing on the sole and white line disease. In comparison, *Barker et al*. (2007) claimed that the risk of white line disease increased with solid grooved concrete floors in housing and yards, compared with other floor surfaces.

Cows walking in the milking parlour are most of the time herded by stockmen. The cattle are in proximity to each other and if rushed, are not able to carefully observe where it steps. Cows which collide with an extra step must change their gait and either put more pressure on the hooves or lose equilibrium.

The stalls should have adequate lunge space in front to allow the cows to easily stand up and lie down. The comfort of cubicles was studied by *Dippel et al*. (2009) who concluded that cows were more often choosing stalls with a lunge area in comparison to stalls without that area. In the present study the same relations were found in addition to fewer blocks used by claw trimmers on farms providing their cows with lunge areas. It is possible, that in the barns with lunge areas, cows have longer lying times and do not affect their hooves so much.

The purpose of the brisket locator is to discourage forward movement when a cow is resting to preserve lunge space and minimize the change of hitting the stall structure when rising. It should allow the largest cow in the group to comfortably rest on the stall surface. It should also allow cows to extend their front leg(s) forward when resting, and step forward when rising. However, *Tucker et al*. (2006) and *Anderson* (2008) agreed that if given a choice, cows prefer stalls without brisket boards because they do not contribute to restlessness and brisket boards reduce the amount of time cows spend lying. A brisket board higher than 15 cm was estimated by *Espejo and Endres* (2007) to be associated with greater prevalence of lameness. In the present study there was no observation to estimate the preference for cubicles with and without boards, lying times and the height of brisket boards. However, considering rising easiness significantly more cows had unrestricted rising in cubicles with a brisket board present in comparison to stalls lacking that device.

Singh et al. (1994) estimated improved laying times in straw yards when compared with free stalls and *Singh and Ward* (1993) observed a relation between elevated sole lesion scores, growth in locomotion disorders and increased standing times. In the current study free stalls were confirmed to be more hazardous for dairy welfare than straw yards with a more average percentage of cows found with hock and knee lesions. There were also more orthopaedic blocks used by hoof trimmers on farms where cows were kept in free stalls. Unlike those studies, *Barker et al*. (2007) did not report any significant differences in mean herd locomotion scores between herds housed in straw yards and herds housed in free stalls.

Relations between the number of orthopaedic blocks used by hoof trimmers, welfare measures and environmental factors

On average 8.54 orthopaedic blocks were used by hoof trimmers per 100 cows with standard deviation of 5.73. The number of blocks used during trimming was reported to have a rather strong and positive correlation with an increased number of foot baths per week and a higher number of trimmings per year (*Table 6*). Similar to lameness, more orthopaedic blocks were used on farms with lower number of extra free stalls provided for milking cows. Narrower passageways in front of cubicles and feeders with longer distances to paddocks were strongly correlated to more lame cases. The neck rail positioned lower was negatively correlated to more lameness. Finally, more perching cows with dirty hindlimbs in heifers were positively correlated to increased occurrence of lameness.

The number of orthopaedic blocks was evaluated to differ significantly regarding the method of trimming with on-farm trimmers using 5-6 blocks per 100 cows and professional trimmers using 9-11 blocks per 100 cows (*Table 7*). In straw yards fewer orthopaedic blocks were used than in free stalls.

***Table 6*. Correlations between the number of orthopaedic blocks used by hoof trimmers, welfare measures and environmental factors observed on 25 dairy farms in Hungary**

Measures	No. of farms	Correlation coefficient (blocks)	Significance
Foot bathing (No./week)	24	+0.59	0.003
Hoof trimming per year	24	+0.41	0.049
Extra free stalls (%)	24	-0.85	0.002
Passageways – feeder (m)	24	-0.42	0.042
Building – paddock (m)	10	+0.82	0.007
Passageways – cubicles (m)	20	-0.60	0.005
Neck rail – vertical position	10	-0.73	0.016
Lactating cows perching (%)	20	+0.51	0.02
Heifers dirty hindlimbs (%)	20	+0.45	0.02

***Table 7*. Analysis of variance between mean the number of orthopaedic blocks used by hoof trimmers in different environmental conditions**

Measures	No. of farms	Mean blocks	Std. dev.	Significance
On-farm hoof trimming	10	5.63	3.85	0.044
Professional hoof trimming	14	10.65	5.64	
Straw yards	14	6.72	4.20	0.019
Free stalls	10	11.86	5.72	
Scraping – scraper	19	7.29	3.99	0.003
Scraping – tractor	5	14.83	6.45	
Lunge area present	5	7.42	3.76	0.004
Lunge area not present	5	16.31	3.16	
Water surface quality – good	16	7.36	4.35	0.039
Water surface quality – bad	8	11.87	6.38	
Feed yard surface grooved	13	6.39	3.41	0.012
Feed yard surface not grooved	11	11.79	6.03	
Parlour – smooth flooring	12	7.98	5.47	0.04
Parlour – rough flooring	8	12.34	4.82	
Parlour – rubber flooring	4	4.59	1.48	
No access to paddocks	10	12.75	4.40	0.001
Access to paddocks	14	6.09	4.34	
Track – no stones	6	3.84	1.59	0.047
Track – stones present	4	7.51	3.68	

In comparison, in barns where tractors were used for scraping manure a higher number of orthopaedic blocks was used. Interestingly, there were less cows with blocks in barns with grooved flooring in front of feeders in comparison to not grooved, however, there were more orthopaedic blocks used on farms where milking parlours were provided with grooved surfaces. Fewer numbers of blocks was found in milking parlours with non-grooved flooring and the least number of blocks was observed when cows walked on rubber. Increased provision of orthopaedic blocks was on farms without access to paddocks and stones on tracks.

The number of orthopaedic blocks used by hoof trimmers was not correlated to the prevalence of lameness. That means that a high prevalence of lameness does not require a a high number of blocks (for example, if digital dermatitis or only slightly-impaired locomotion takes place on a high scale in the herd). On the other hand, a high number of blocks used by claw trimmers does not mean that the level of lameness is very high if some cows need blocks to be used and the rest of cows have hooves in relatively good condition. Nevertheless, cows that need orthopaedic blocks are definitely the most affected by lameness.

The number of trimmings per year and its correlation with increased number of blocks can be explained by more care taken with lame cows. Herds which are more often trimmed are also more often monitored and the most severe cases can be treated which gives a greater chance for those cows to recover. The higher number of blocks used by professional trimming services in comparison to on-farm workers probably means that skilled hoof trimmers are more likely to find and estimate severe cases treatable with the use of orthopaedic blocks.

In a study by *Barker et al*. (2007) narrower passageways were correlated with a growth in the number of lame cows. In the present study, narrower aisles in front of feeders and cubicles were also correlated with a higher number of blocks used by claw trimmers. This is driven either by a higher level of slurry or more traffic and more wear of hooves in narrower passageways compared to wider areas.

The distance between barn and paddocks and between barn and milking parlour was found only to be investigated by *Espejo and Endres* (2007), but the relation in that study was found to be insignificant. In the current project, the cows on the farms with paddocks located farther from the barn were found with an increased number of orthopaedic blocks. The same relation was found in New Zealand and described to be a reason of excess exercise on hard surfaces causing mechanical stress on the hooves (*Vermunt*, 1992). It is not completely in agreement with *Harris et al*. (1988) who concluded that interdigital cracking and pain were more common when the distance to paddocks was shorter. An explanation for this was that in shorter tracks there is an increased crowding with more cows trying to pass the same place in the same time and with limited foot placement. On the 25 Hungarian dairy farms, farmers and hoof trimmers confirmed that more problems with white line disease and stones in the hooves were reported when cows were walking on concrete where small stones penetrated the hoof. Those situations happen when wheels of vehicles crossing routes of cattle bring small stones on a concrete during everyday activities or engineering works carried. As a confirmation in the present study more blocks were used on farms with stones found on tracks where cows were walking to milking parlours and to paddocks than on farms with tracks free of stones.

Neck rail position and its presence was found by scientists to have advantages and disadvantages. The neck rail often prevents cows from standing fully inside the stall in order to keep the bedding clean, but cows showed no clear preference for the position of the neck rail (*Tucker et al*., 2005). In the current study with the neck rail positioned lower was correlated with a higher number of orthopaedic blocks used. This finding agrees with *Fregonesi et al*. (2009) who observed that an aggressive neck rail placement contributes to the occurrence of lameness and when removed helps lame cows recover. Lower positioned neck rails did not affect lying times, but forced cows to perch, with only the two front feet inside the dry stall and hindlimbs usually in passageway in manure. *Bernardi et al*. (2009) found and described that as the stall-design paradox because neck rails improve udder and stall hygiene, but increase lameness. In the present study there was a link existing between a higher number of blocks, lower position of the neck rail and increased number of cows perching.

Barker et al. (2007) demonstrated that the use of automatic scrapers was associated with an increased risk of lameness. Although automatic scrapers can improve hygiene in the free-stall barn because of frequent scraping; they are thought to be associated with an increased percentage of lame cows because cows have dirtier hooves as the wave of slurry passes. Moreover, the movement of automatic scrapers is believed to result in the cows moving rapidly to avoid its path. *Stefanowska et al*. (2001) measured that 91% of locomotion incidents observed in barns with automatic scrapers occurred as a result of contact with the scrapers. During feeding, automatic scrapers can cause further disruption because cows lower in social rank may be displaced from their position at the feed barrier. Automatic scrapers in the present study were associated with fewer numbers of orthopaedic blocks used by hoof trimmers in comparison to tractor scraping. Number of blocks used by trimmers and mean occurrences of lameness were not correlated in this study but both measures are expressing compromised locomotion of dairy cows. The reason

for more blocks being used on farms with tractor scrapers could be that scrapers are used on flat, regular concrete surfaces. Tractors, however, are mostly used on poor-quality passageways where manure and dung is cumulating in holes and damaged areas. It is possible that the poor hygiene of feet and legs in dairy cows provides more favourable conditions for digital dermatitis.

Rough flooring in milking parlour alleys was associated with more blocks being used by hoof trimmers in comparison with smooth flooring which was associated with more blocks being used than on farms with rubber flooring. The surface where cows are milked is rarely maintained because is hard to reach with other machines. The concrete floors in the milking parlours are covered with manure and cleaned with chemicals and water many times a day which, with heavy traffic, makes it rougher because small particles are washed out, leaving sharper, bigger lumps. The destructive effect of rough, sharp, or eroded concrete is that these surfaces have higher frictional properties and results in an increased wear of the claw horn. As a result the white line is more prone to separation and the thin horn of the sole is at increased risk of penetration by foreign bodies. Smooth flooring is less abrasive and does not wear down hooves like rough concrete surfaces. It is documented, that the majority of cows prefer to stand and walk on soft rubber flooring, rather than on concrete floors (*Telezhenko et al*., 2004) because of its optimal softness (*Irps*, 1983) and friction (*Watson*, 2007). The present study confirms that softer flooring is related with fewer numbers of orthopaedic blocks used by hoof trimmers because rubber is not affecting hooves as concrete does.

Hernandez-Mendo et al. (2007) asserted that cows, when given access to pasture even for a few weeks, are able to improve locomotion and some attributions of gait (head bob, back arch, tracking up, and reluctance to bear weight evenly on all four hooves). Improved gait for cows in pasture was not because of increased lying times, but softer surfaces. This is probably the reason why in the current study fewer numbers of blocks used by hoof trimmers were on farms which provide cows with access to paddocks compared to those farms which did not have that opportunity. Paddocks are different to pastures mentioned earlier because there is no grass; yet, paddocks are considered to be friendlier to hooves than concrete.

Conclusions

The majority of relations between the occurrence of lameness, welfare measures and environmental factors on 25 farms were similar to those already reported in publications where elevated locomotion disorders were related to: increased number of foot baths per week, decreased number of extra free stalls, decreased BCS, dirtier bedding and non-grooved feed yards. Unrestricted rising was related to the presence of lunge areas and brisket boards. There were fewer hock and knee lesions in straw yards than in free stalls and rising was unrestricted on farms where stalls were provided with lunge areas and brisket boards. Associated with increased number of lame cows and not reported before were: limited access to water, old-fashioned, square feeders and milking parlours with steps > 5 cm. There were no contradictory findings to those already known related to the growth of locomotion disorders.

Orthopaedic blocks used by hoof trimmers on hooves with the most severe lesions were not studied before. In the present study, an elevated number of blocks was associated and related to an increased number of foot baths per week, more frequent trimmings per year, decreased number of extra free stalls, narrower passageways, longer distances between barns and paddocks, lower placement of neck rails, increased percentage of cows perching and heifers with dirty hindlimbs, no access to paddocks, presence of free stalls, lack of lunge areas, poor quality

surfaces in front of water troughs, non-grooved feed yards and stones on tracks. Those measures were already reported by scientists to be related to an increase occurrence of lameness. The increased percentage of obviously ill cows, scraping passageways using tractors and the presence of grooved alleys in milking parlours were three measures related to an increase in the average number of blocks. These three measures were not previously reported to be related to lameness.

Acknowledgments

We thank the 25 dairy producers who allowed us to visit their dairies and collect data. We also want to thank Dr. János Lehoczky, the owner of trimming company Leholand Kft., for help with arranging contact details of farmers and for his valuable comments. The work/publication is supported by the TÁMOP-4.2.2/B-10/1-2010-0024 project. The project is co-financed by the European Union and the European Social Fund.

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