EFFECT OF LAMENESS ON MILK PRODUCTION IN HOLSTEIN-FRIESIAN FARMS IN HUNGARY

GUDAJ RICHARD – BRYDL ENDRE – POSTA JÁNOS – KOMLÓSI ISTVÁN

SUMMARY

This paper investigates associations between lameness, body condition score and milk yield in dairy cows. The dataset includes 7299 test-day milk yields from 826 cows on five farms in Hajdú-Bihar County in Hungary collected over 18 months from May 2010 to November 2011. The data were analyzed in a general linear model to account for the correlation of repeated measures observed during lactation. The total mean estimated reduction in milk yield per 305-d lactation of lame cows in comparison to never lame cows was 372 kg. Cows with lameness scores 1 and 2 had body condition scores and milk yields significantly higher than clinically lame cows with scores 3-5. BCS observed two months earlier than lameness reported was higher in non-lame cows in comparison to lame cows. This might suggest that lame cows are lame because they are thin and not thin because they are lame. This emphasises the importance of managing cows' body condition through proper nutrition, timely reproductive management and transition cow care. Factors affecting milk yield included: farm, parity, animal ID and whether a cow ever became lame or not during the study. Authors conclude that clinical lameness has a significant impact on milk production. This is important information for assessing the economic losses due to clinical lameness and decreased cow health what can be used in informing farmers about the impact of the disease.

ÖSSZEFOGLALÁS

Gudaj R. – Bydl E. – Posta J. – Komlósi I.: A SÁNTASÁG HATÁSA A TEJTERMELÉSRE MAGYARORSZÁGI HOLSTEIN-FRÍZ FARMOKON

A sántaság, a testkondíció pontszám és a tejhozam közötti kapcsolatot vizsgálták a tejelő tehenészetekben. Összesen 826 tehén adatait gyűjtötték be 5 hajdú-bihar megyei gazdaságból 2010 májusa és 2011 novembere között (18 hónap alatt) így összesen 7299 tejhozam adatot kaptak. Az adatokat általános lineáris modellben elemezték a laktáció alatt megfigyelt ismétlődő mérések közötti korreláció bemutatására. A 305 nap alatti teljes becsült tejhozam-csökkenés 372 kilogramm volt, összehasonlítva a sánta tehenek laktációját azokkal a tehenekével, amelyek soha nem voltak sánták. Az 1-es és 2-es sántasági pontszámú tehenek testkondíció száma és tejhozama jelentősen magasabb, mint a 3-5 közötti pontszámú, klinikailag sánta állatoké. A sántasági jelentések előtt két hónappal megfigyelt testkondíció számok magasabbak voltak a nem sánta teheneknél, mint a sántáknál. Úgy tűnik, hogy a sánta tehenek azért sánták, mert soványak és nem azért soványak, mert sánták. Ez kiemeli a tehenek testkondíció kezelésének fontosságát a helyes táplálás, az időszakos szaporodásirányítás és az átmeneti tehéngondozás segítségével. A tejhozamot befolyásolja a farm, a laktáció száma, az állat egyedi jellemzői és az, hogy vajon a tehén sánta volt-e vagy nem. Összefoglalva a klinikai sántaságnak nagy hatása van a tejtermelésre. Ezért fontos információ a klinikai sántaság és a romló egészségi állapot következtében fellépő gazdasági veszteségek felméréséhez, amit arra használhatunk, hogy tájékoztassuk a farmereket a betegség hatásairól.

INTRODUCTION

Lameness is an important disease in dairy cattle because it is reducing animal welfare and is among three the most expensive diseases in the dairy industry after mastitis and fertility problems (*Kossaibati and Esslemont*, 1997). Losses in milk yield, protein and fat content of the milk are among the main factors contributing to economic losses (*Enting et al*., 1997). Mastitis control has already received a substantial awareness in modern dairy industry (*Archer et al*., 2010), however, there are still no recognisable improvements with lameness. Dairy cow welfare is recognised to be an important part of media's and consumers' opinion about overall farm animal welfare (*Eurogroup for Animals,* 2011). Any progress with decreasing locomotion disease will be more effective if reliable data of its financial implications and possible ways of predicting are evaluated. *LeBlanc et al.* (2006) and *Leach et al.* (2010) reported that farmers are underestimating prevalence of lameness If there is tendency for incorrect defining whether or when a cow becomes lame; the impact of lameness on health, production, and, therefore, the consequential economic loss is likely to be underestimated as well. Factors affecting lameness are type of housing (*Dippel et al*., 2009), feeding (*Stone*, 2004), genetics (*Boettcher et al*., 1998) and management (*Blowey*, 1993).

Body condition and parity have been associated with prevalence of lameness. *Wells et al*. (1993) reported an increased risk of lameness with increased parity; and they also found a strong correlation between poor body condition and clinical lameness. However, the authors explained that loss of body weight might be the result of lameness and not a causative factor for lameness. There are confronting results when lame cows produce more milk and when never lame cows produce more milk. Regarding clinical lameness cows that were ever lame had higher mean test day yields (TDY) throughout lactation than those that were never lame (*Deluyker et al*., 1991; *Green et al*., 2002; *Bicalho et al*., 2008). The conclusions of those studies were that higher yielding milk cows are more prone to be lame, which is more likely observed in multiparous cows. High milk yield has been associated with lameness and claw lesions by *Alban et al*. (1996) and *Hultgren et al*. (2004) and with lameness and sole ulcer by *Barkema et al*. (1994). No difference in milk yield between lame and not lame cows was evaluated by *Cobo-Abreu et al*. (1979) and *Mohamadni et al*. (2008). Unlikely to that, *Hernandez et al*. (2005) reported that cows that were not lame produced 874kg more milk in comparison with cows with the most severe cases. Literature on the effect of lameness assessed by LS on milk yield is limited. A single farm of 2 showed a significant decrease in milk yield of 1.89 kg/d for each unit increase in LS (*Juarez et al*., 2003).

Ozsvári et al. (2007) estimated lameness to be affecting 19.2% of milking cows on 4 Hungarian farms with 19.7% of all culled cows being removed from farms for locomotion problems. Understanding associations between lameness and milk production might help to develop effective preventive tools against the diseases in the future. The aim of this study was to estimate factors affecting occurrence of lameness, losses of milk and possible ways for decreasing and predicting prevalence of the disease.

MATERIALS AND METHODS

The data came from 826 Holstein-Friesian dairy cows on five farms in Hajdú-Bihar County in Hungary. Herds were kept in zero grazing systems and fed a concentrate ration and conserved forage (grass or grass and maize silage). The 5 herds had year-round calving patterns with annual rolling mean herd sizes of 285 to 980 cows and mean herd 305 lactation day yield ranged from 8100 to 10300 kg/cow. Housing varied from modern free stalls bedded with straw to older style straw yards. Herd managers were made aware that the study was observational; no interventions were made and they were encouraged to continue with their existing management policies. The data set contained 7299 test-day milk checks (one test per cow per month in milk) from 826 cows over 18 months from May 2010 to November 2011. Production data were retrieved from the RISKA farm herd management software and contained: milk yield, percentage of fat and protein, somatic cell count and urea level. Production data were combined with lameness and body condition scores. Every month 5 cows from first lactation and 5 cows from second lactation were selected. 5-point scale locomotion score of dairy cattle was used (*Table 1*). The system developed by *Sprecher et al*. (1997) has understandable objective descriptions of posture and gait and was used for scoring lameness in cows. This also includes subdivisions between sound and clinically lame cows. Cows were provided relatively dry, free of obstacles, concrete surface on all farms. Cows which were found in the cubicles were given few minutes to recover after standing up, so impact of muscle crump would not affect

Table 1.

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

Locomotion score 1 Normal (1)	Stands with flat back, but arches when walks. Gait is slightly abnormal.
Locomotion score 2 Mildly lame (2)	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 3 Moderately lame (3)	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 4 Lame (4)	Pronounced arching of back. Reluctant to move, with almost complete weight transfer off the affected limb.
Locomotion score 5 Severely lame (5)	Stands with flat back, but arches when walks. Gait is slightly abnormal.

1. táblázat: A tejelő tehén mozgási pontszáma (Sprecher et al., 1997).
Mozgási pontszám 1 (Normális) - Az álló testtartás és a járás normális, egyenes háttal. Hosszú, biztos lépések (1); Mozgási pontszám 2 (Enyhén sánta) - Állás egyenes háttal, de járás közben a hát hajlott, a járásmód enyhén abnormális (2); Mozgási pontszám 3 (Közepesen sánta) - Állás és járás közben hajlott a hát és a lépéshossz megrövidül. A fűkörmök enyhén besüllyedtek lehetnek az érintett végtaggal ellentétes lábon (3); Mozgási pontszám 4 (Sánta) - Állás és járásközben a hát hajlott, egy vagy több végtagját kíméli járás közben, de még helyez rá súlyt. A fűkörmök besüllyedtek az érintett végtaggal ellentétes lábon (4); Mozgási pontszám 5 (Nagyon sánta) - A hát kifejezetten hajlott, nem szívesen mozog az állat, az érintett végtagra szinte nem helyezi a testsúlyát (5)

cows' locomotion. For evaluating body condition score 5-point scale condition score of dairy cattle published by *Rodenburg* (2000) was used.

The dataset contained farm id (1-5), cow id, parity (1-3), months of lactation, body condition score (1-5), lameness score (1-5), clinically lame and not lame (1=lame=lameness score 3-5; 0=not lame=lameness score 1-2), ever-never lame (1=lame at least once; 0=never lame during the observational period), lame for the first time (1=lame for the first time; 0= already lame or not lame in time of checking), milk yield. BCS, LS and milk yields were also coded with observations up to 5 months before and up to 5 months after observed lameness for each 3 parameters. The occurrence of first lameness by month in milk was plotted, and the mean lactation curve for cows that were never lame and cows that were clinically lame during a lactation (ever-lame) was compared visually in Excel for Microsoft.

Data was collected and transformed in Microsoft Office Excel application. Different models were used to evaluate the traits. The fixed effects of farm, number of lactation and ever lame as well as random effect of the cow were included in each model. For the analysis of milk production data, two models were used. Model I included five lameness effects from two months before up to two months after the milk production data. Model II included body condition score information as further fixed effects from the period two month before up to two month after the milk production data. The Model III was used to test the effect of lameness on body condition score (BCS). Additional fixed effects were lameness information from the period of two month before up to two month after the measuring BCS measuring time. The fixed effects for each model were analysed by least-square analysis using the GLM-procedure in SAS 8.2 statistical software (SAS, 1999).

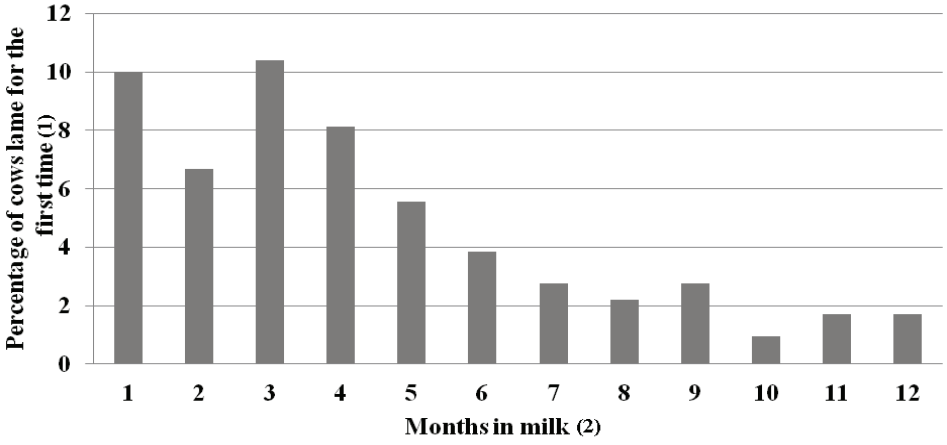
RESULTS AND DISCUSSION

48.2% of cows on 5 farms became lame at least once during the study. The incidence of first episode of lameness peaked 1 and 3 months after calving (*Figure 1.*). Factors affecting milk yield included: farm, parity, animal ID and whether a cow ever became lame or not during the study. Those factors were found to be similar to *Green et al*. (2002) and *Blowey* (1993). On 5 farms cows were lame for the first time mostly in the first 4-5 months. The high incidence of lameness cases after calving illustrates the need to focus on the transition period to prevent both infectious and metabolic diseases directly after calving, as well as lameness cases months after calving.

Never lame cows produced highly significantly more milk through lactation than cows that were at least once lame (32.12/day, std. dev. 8.81 vs. 30.90/day, std. dev. 9.45, respectively) (*Figure 2.*). As a consequence, never lame cows produced 1.22 kg more milk/d than cows that were lame at least once. This is a mean of 372.1 kg extra kilograms of milk over 305 days of lactation. Multiplying this with the current average milk price in Hungary (€0.3005, assessed 12 February 2012) (*Dairy Co.*, 2012) it gives €111.82 lost per one lactation due to the difference in milk yields only.

This analysis has identified a higher mean lactation yield in cows that were never lame during lactation versus those that were at least once lame during a lactation

***Figure 1**. Percentage of cows lame for the first time by month in milk observed on 5 farms.*



1. ábra: A sánta tehenek százalékos aránya a vizsgélati időszak elején 5 farmon
Az első alkalommal sánta tehenek százaléka (1); hónapok tejben (2).

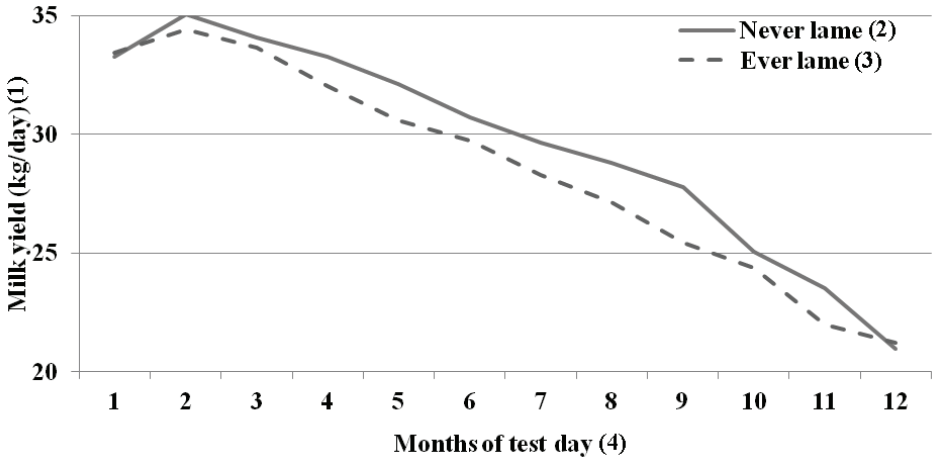
as postulated by *Hernandez et al*. (2005) and (*Lucey et al*., 1986). During 305 days lactations at least once lame cows were observed to produce 372.1 kg less milk that cows never being lame. *Ozsvári et al*. (2007) estimated in Hungary the average decrease owing to lameness for lactation of 579 kg. Drop in milk yield and increase in lameness score in the current study are not in agreement with *Archer et al*. (2010) and *Green et al*. (2002) where cows with higher lameness scores produced more milk. Higher milking cows were thought to be at greater risk of ketosis and other health disorders because their nutritional demands are not met.

Sprecher et al. (1997) has provided widely recognised nowadays a lameness scoring system that uses posture and gait to predict dairy cattle reproductive performance. A 5-point score system was by a few authors considered to describe clinically lame cows with scores from 3 to 5 (*Cook and Nordlund*, 2007; *Clarkson et al*., 1996; *Barker*, 2010). Very clear pattern with significant differences between not lame and clinically lame cows was observed in the study regarding average test day milk yields and average BCS (*Table 2*.). This information might be useful in explaining and helping to realize how lameness is affecting milk production and condition of cows for those farmers who underestimate impact of lameness on welfare of cattle.

Intrestingly, lameness scores (from 1 to 5) were negatively related to mean BCS but ever lame cows in comparison to never lame cows were observed with greater mean BCS. This might mean that exactly when lameness occurred drop in BCS was so great that cows with lower lameness scores (or not lame at all) were in that time in better conditions in comparison to ever lame cows. It is also very likely that ever lame cows were experiencing more extreme BCS scores in comparison to never lame cows.

The relationship between mastitis and lameness is unclear. Based on 10 dairy herds *Peeler et al*. (1994) associated the clinical lameness before first service

***Figure 2**. Mean lactation curves for cows that were ever-lame versus those that were never-lame*



X axis = repeated measures of test day yield, Y axis = kg of milk per day.

2. ábra: A sántaságon átesett, és a vizsgálatig egészséges tehenek laktációs-átlag görbéje. X tengely = a tejhozam a laktáció egyes hónapjaiban, Y tengely = napi tejmennyiség kilogrammban
tejhozam (kg/nap) (1); soha nem volt sánta (2); volt már sánta (3); a teszt hónapja (4).

with a 1.4-fold increase in the odds of clinical mastitis. However, cows with sole ulcers on 102 dairy herds did not have higher odds of mastitis or high SCC than did unaffected cows (*Hultgren et al*., 2004). In the current study ever lame cows were observed with significantly higher number of SCC. The most elevated SCC was found with LS5 reaching an average 1 086 000 SCC/ml (data not shown).

Table 2.

Differences in milk yields and BCS of particular lameness scores observed on 5 dairy farms

Lameness score (1)	Test day milk yield (mean) (2)	Standard Deviation (3)	BCS (mean) (4)	Standard Deviation (5)
1	32.96 a	8.75	2.75 a	0.58
2	32.07 a	9.43	2.64 b	0.54
3	30.86 b	9.87	2.48 c	0.53
4	29.84 b	8.45	2.41 c	0.58
5	28.56 b	8.61	2.31 c	0.98

a, b: Means with different letters differ at $p<0.05$.

2. táblázat: A tejhozam és kondíciópont különbségek a részleges sántaságot mutató egyedeknél 5 farmon történt megfigyelés alapján
sántaság pontszám (1); tejhozam tesztnap (középérték) (2); általános eltérés (3); testkondíció szám (középérték) (4); általános eltérés (5); az a, b és c az azonos sorokban $p<0,05$ szinten szignifikáns különbséget jelölnek

In the study cows that were lame at least once during the study had higher fat content in milk (mean 3.57% and standard deviation 0.82) in comparison to cows never lame during the study (mean 3.41% and standard deviation 0.89) (*Table 3.*). Lower fat content is known to be related to subacute ruminal acidosis (SARA) (*Oetzel*, 2007), however SARA is considered as one of the reasons of lameness causing decreased blood flow between tissue and corium (*Nordlund*, 2002). That means that SARA was probably not the main reason for higher prevalence of lameness on 5 farms. The digital cushion consisting of fat and loose connective tissue is an important support structure in the claw (*Shearer*, 2010). Recent studies suggest that body condition score mirrors size (i.e. fat content) of the digital cushion and may be very important to the integrity and health of claws. In study of *Bicalho et al*. (2008) body condition scores were positively associated with digital cushion thickness. These results give support to the concept that sole ulcers and white line abscesses are related to contusions within the claw horn capsule and such contusions are a consequence of the lower capacity of the digital cushion to dampen the pressure exerted by the third phalanx on the soft tissue beneath. That means that lame cows producing milk with higher fat content are actually partly loosing fat from the digital cushion in the claw. The highest prevalence of cows lame for the first time in the current study was observed to be in the first 4-5 months of lactation. Maintenance of good body condition throughout the first 100-150 days of lactation may prove to be a very important feeding objective. In contrast to milk fat content ever lame cows were in better conditions.

Literature is not providing many associations with lameness and milk protein content. Dippel et al (2009) found that cows with suboptimal milk protein content (<3.2% or >3.8%) were more likely to be lame. However, Tranter and Morris (1991) reported that lame cows had lower milk protein content. In the current study ever lame cows had higher milk protein content.

Table 3.

Comparison of never lame and at least once lame cows during the study

Parameter (1)	Never Lame / Ever Lame (6)	Mean (7)	Standard Deviation (8)
BCS (1-5) (2)	Never	2.51a	0.61
	Ever	2.56 b	0.73
SCC no.(*100)/ml (3)	Never	415 a	924
	Ever	530 b	1215
Fat (%) (4)	Never	3.41 a	0.82
	Ever	3.57 b	0.89
Protein (%) (5)	Never	3.19 a	0.44
	Ever	3.28 b	0.51

a, b: Means with different letters differ at $p<0.05$

3. táblázat: A sántaságon átesett és sántaságtól mentes tehenek összahasonlítása a tanulmány alatt
paraméter (1); testkondíció szám (1-5) (2); scc szint (3); zsír (4); fehérje (5); soha nem volt sánta/ már volt sánta (6); középérték (7); általános eltérés (8); az a és b az azonos sorokban $p<0,05$ szinten szignifikáns különbséget jelölnek

Mohamadni et al. (2008) found in Iran the average lameness to be higher in spring than in autumn (2.73 vs. 2.47, respectively). Relations between seasons and average lameness were thought to be linked with moisture, humidity and temperature in particular part of the year in the UK (*Williams et al*., 1986). *Gómez et al*. (2003) argued that high temperatures with high humidity are responsible for damaging factors which can lead to foot rot by easier bacteria development. *Cook and Nordlund* (2007) in the USA claimed that there were more lame cows in the summer than in winter what was thought also to be partly related to heat stress-associated ruminal acidosis responsible for elevated prevalence of lameness. In the present study significantly more lame cows were observed in winter than in the summer (*Table 4.*). Cold weather during winter may lead to manure handling problems in the alleys and reduced frequency of footbathing causing more lameness problems. This is also possible that warm and dry summers in Hungary are less harmful for cows than much colder and wetter winter, spring and autumn with more lame cows observed. There were significance differences in means of lame cows in different seasons.

Table 4.

Mean locomotion scores observed in 4 seasons on 5 dairy farms

Mean lameness score (1)	Season (2)	Standard Deviation (3)
1.74 a	Summer	0.86
1.87 b	Autumn	0.92
1.99 c	Spring	0.97
2.28 d	Winter	1.08

a, b, c, d: Means with different letters differ at $p<0.05$

4. táblázat: Megfigyelt mozgási pontszámok átlaga 4 évszakban, a vizsgált 5 farmon
középértékű sántaság pontszám (1); időszak (2); általános eltérés (3); az a, b, c és d az azonos sorokban $p<0.05$ szinten szignifikáns különbséget jelölnek

There were several studies aiming to predict prevalence of lameness using logistic regression model (*Bicalho et al*., 2007), the Fuzzy Set Theory (*Cruz et al*., 2001) or observation of cows' movement (*Song et al*., 2008), but none of them are developed on such a level to provide satisfactory repeatability of prediction. In the current study BCS was significantly higher in non-lame cows in comparison to lame cows two months before TDY and lameness were observed (*Table 5*.). Regarding milk yields, the highest milk yields were observed in those cows that had the lowest lameness score observed two months earlier (*Table 6*.). However, that information is not robust enough to be used in predicting cases of lameness.

Table 5.

Associations between current LS and BCS observed 2 months earlier

Lameness score (of current TDY) (1)	Mean BCS (2 months earlier) (2)	Standard Deviation (3)
1	2.68 a	0.54
2	2.59 b	0.61
3	2.56 b c	0.53
4	2.50 b c	0.57
5	2.33 b c	0.85

a, b,c: Means with different letters differ at $p<0.05$.

5. táblázat: Kapcsolat a jelenlegi LS és a 2 hónappal korábban megfigyelt testkondíció szám között
sántaság pontszám (1); középértékű testkondíció szám (2 hónappal korábban) (2); általános eltérés (3); az a, b és c az azonos sorokban $p<0,05$ szinten szignifikáns különbséget jelölnek.

Table 6.

Associations between lameness scores and test day milk yield observed 2 months earlier

Lameness score (2 months earlier) (1)	Mean of milk yield (of current TDY) (2)	Standard Deviation (3)
1	32.39 a	9.86
2	32.07 a	8.21
3	30.85 b	8.55
4	29.83 b	7.23
5	28.60 b	11.06

a, b: Means with different letters differ at $p<0.05$

6. táblázat: Kapcsolat a 2 hónappal korábban megfigyelt sántaság pontszám és a tejhozam tesztnap között
sántaság pontszám (2 hónappal korábban) (1); tejhozam középértéke (2); általános eltérés (3); az a és b az azonos sorokban $p<0,05$ szinten szignifikáns különbséget jelölnek.

CONCLUSIONS

With 19.7% reasons for culling being lameness on 5 dairy farms in the present study there is need for taking immediate actions for decreasing prevalence of the disease. Findings about impact of lameness on milk production on 5 Hungarian dairy farms can be used for providing farmers with more accurate information on impact of lameness on production and welfare of cattle. There was a higher fat content observed in cows lame at least once during the study in comparison to those which were never lame what emphasises limited fat resources available for undisturbed claw functioning. Ever lame cows experienced more extreme changes of BCS what could have possible impact on thickness of digital cushion

in claws and making them lame. This study proves that more care should be taken in the first 4-5 months of lactation to protect cows against elevated prevalence of lameness. Winter seems to be more harmful for dairy locomotion in Hungary than summer.

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Szerzők címe: *Gudaj R. – Posta J. – Komlósi I.*
Debreceni Egyetem Agrár- és Gazdálkodástudományok Centruma
Centre for Agricultural and Applied Economics Science;
Authors' address: University of Debrecen; 138 Böszörményi street; 4032 Debrecen;
tel: +36- (52) 508-444; fax: +36 52 413-385
rgudaj@agr.unideb.hu; postaj@agr.unideb.hu; komlosi@agr.unideb.hu

Brydl E.
Szent István Egyetem, Állatorvositudományi Kar
Szent István University Faculty of Veterinary Science
H-1078 Budapest; István u. 2; Hungary;
tel: +361 478-4239; fax: +361 478-4243
brydl.endre@aotk.szie.hu