Locomotion Scoring Your Cows: Use and Interpretation

P.H. Robinson and S.T. Juarez
Department of Animal Science
University of California, Davis, CA 95616-8521

Introduction

Lameness of dairy cattle is an economic and welfare issue. It is the third most important health related economic loss facing the dairy industry, following fertility and mastitis. Most economic loss due to lameness results from costs of premature culling, veterinary treatment, increased labor, discarded milk, prolonged calving interval, and reduced milk production (Kossaibati and Esslemont, 1997; Enting et al., 1997). Pain and discomfort (Whay et al., 1998), as well as the increased risk of culling due to reduced milk production (Warnick et al., 2001; Rajala-Schulz et al., 1999) and reduced reproductive efficiency (Sprecher et al., 1997; Collick et al., 1989), are also welfare concerns caused by clinical lameness in dairy cattle.

High producing mature dairy cows tend to be at high risk of lameness due to the metabolic stress of high milk yield (Barkema et al., 1994; Seegers et al., 1998; Warnick et al., 2001). In addition, a progressive decline in the quality of cows' hooves, due to deterioration in shape and/or softening of the horn and internal structures (Rowlands et al., 1985), occurs with increasing age, thereby increasing the probability of clinical lameness as cows' age (Eddy and Scott, 1980; Baggott and Russell, 1981).

Assessing behavior as a means to evaluate welfare can reveal how cows cope with their environment and physiological state. Lameness modifies normal dairy cattle behavior, presumably due to the pain caused by weightbearing. For example, Hassall et al. (1993) showed that lame cows entered the milking parlor later, lifted and kicked their feet more frequently, and shifted weight from one foot to another more often during milking compared to non-lame cows. Lame cows also lay down longer than non-lame cows, grazed for a shorter period of time, had a lower bite rate, and ruminated longer while lying. Singh et al. (1993) showed that lame cows lay longer and that their lying patterns were uniformly spread over the 24 h day, compared to non-lame cows, thereby revealing a disturbance of normal lying behavior in lame cows. Lame cows also stood longer in free stalls and had more abnormal lying and sitting positions than non-lame cows.

Locomotion scoring systems are useful in assessing the severity, duration, and prevalence of lameness. In the two most popular systems (Manson and Leaver, 1988: UK; Sprecher et al., 1997: USA), observer assigned locomotion scores (**LS**) range from 1 to 5 and increase as the severity of lameness is judged to increase. The locomotion scoring system developed by Sprecher et al. (1997) is most applicable to cows housed in free-stall barns since, unlike the system of Manson and Leaver (1988), it does not require cows to rise from a lying position as a part of the scoring assessment. However both systems utilize two key indicators, gait and back posture, to assess lameness; thereby guiding the scorer to assign the appropriate LS.

There are two key issues related to lameness. The first is to determine the extent of the problem, and assess its cost, and the second is to determine how to alleviate the problem, if it is deemed serious enough to be cost effective to do so. Locomotion scoring is a relatively new tool to address the first issue (i.e., to determine the extent of lameness) in order to determine if the problem is serious enough to justify attempts to alleviate it. This article will primarily address the use of locomotion scoring to determine the extent of a lameness problem, assess its economic cost, and evaluate the impact of interventions designed to reduce the extent of lameness.

What Is a Locomotion Score?

Locomotion Score is a qualitative index of a cows' ability to walk normally. Visually scored on a scale of 1 to 5 (Table 1), where a score of 1 reflects a cow that walks normally and a score of 5 reflects a cow that is three-legged lame, a LS is visually assessed in only a few seconds per cow. Generally LS of 2 and 3 are considered to represent sub-clinically lame cows; whereas LS of 4 and 5 represent those cows that are clinically lame. *A LS higher than 1 does not indicate why a cows' gait is affected, merely that she is showing some degree of gait abnormality (i.e., lameness)*. Scores higher than 1 may suggest intervention is advised, either of individual cows or of groups of cows, to determine the cause of the gait irregularity.

Table 1. Locomotion Scoring Guide

Score	Description	Back	Assessment
1	Normal	Flat	Cow stands and walks with a level back. Gait is normal.
2	Mildly lame	Flat or arch	Cow stands level backed, but develops an arched back to walk. Normal gait.
3	Moderately lame	Arch	Arched back is evident while standing and walking. Gait is short strided.
4	Lame	Arch	Arch back is always evident and gait is one deliberate step at a time. Cow favors one or more legs/feet
5	Severely	3-legged	Cow demonstrates an inability, or extreme reluctance to bear weight on one or more limbs/feet

Adapted from Sprecher et al., 1997.

Examples:

Level back standing, so LS is 2 or less.
If arch develops when walking, LS=2.

Arch back standing, so LS is 3 or higher.
No inability to bear weight so LS is 4 or lower.
If cow favors a foot/leg walking then LS=4.

What Is the Impact of High Locomotion Scores?

Locomotion scores can be used to assess the extent of the expected changes in behavior of cows and resulting reduction in dry matter (**DM**) intake and milk production due to lameness. Data developed from dairy cows on several commercial dairies in California in 1999 were used to estimate these reductions (Table 2). Since feed intake of individual cows cannot be estimated for commercial cows in group-fed corrals, the values for changes in feed intake due to increasing LS were estimated from measured milk energy outputs and the estimated energy density of the ration that was fed. Clearly this approach has difficulties, as weight losses by cows will lead to mis-estimates in their energy requirements and so underestimate, or overestimate, actual changes in DM intake.

Table 2. Estimated reductions in DM intake and milk yield related to LS.

	DM Intake	Milk Yield
LS	-- *% reduction vs. LS of 1* --	
2	2	1
3	5	3
4	17	7
5	36	16

The lower % reductions for milk yield than DM intake as LS increase, reflect the high priority need for energy to maintain body tissues; meaning that the full impact of reductions in DM intake are not seen in reduced milk production, at least initially, as cows mobilize body fat and protein to sustain milk production at levels higher than possible based on only the nutrients consumed in the diet. However as body reserves of individual cows are mobilized (i.e., their condition score declines) the milk production decline will increase and milk production will decline to levels that can be sustained by the actual level of nutrients consumed (i.e., mobilization of body nutrients becomes progressively limited because there is less to mobilize). While there is a negative correlation between LS and body condition score, with body condition scores decreasing as body LS increase, it is not a strong relationship since cows with higher LS are *in the process of getting thinner* due to their higher LS and may not, yet, be *showing* a lower condition score.

In order to assess the accuracy of the predicted changes in performance outlined in Table 2, a designed study was completed in which mature cows at the Rancho Teresita Dairy near Visalia, CA were used. Cows within each of four corrals were chosen for the experiment based upon their individual LS (Sprecher et al., 1997), which was assigned in their normal pen environment. A random group of cows in LS categories 1 to 3 was created within pen, from all cows scored in these groups within pen, for subsequent behavioral observation and productivity measurement; while all locomotion 4 cows were used, as their numbers never exceeded 8 per pen. These selected cows were subsequently identified, from their individual ear tag number, at the 4:30 am reproductive lock-up on day 2 and marked across their forehead and flank with one of four colored grease pens to indicate their assigned LS. No cows were scored 5 (i.e., unwilling to bear weight on one or more limbs) and so results relate to LS 1 to 4.

Results of this study (Table 3) show that behaviors of the cows were affected by LS, particularly for LS=4 cows that lay down more and dispersed a shorter distance into the corral after their return from the milking parlor. In addition, cows produced about 4.2 lbs/d less milk for each increase of 1 LS unit. These data suggested that the previously determined milk production declines (Table 2) may have underestimated the impact of increasing LS for LS=2 cows (1% previously predicted vs. 2.3% measured reduction), for LS=3 cows (3 vs. 7.5%), and for LS=4 cows (7 vs. 11.8%).

Table 3. Impact of increasing LS on behavior and milk production (Expt 1).

	LS					*P*	
	1	2	3	4	SEM	Linear	Quad
Behavior							
% cows lying	17.5	18.9	16.8	25.2	.02	.02	.07
Distance[1] (ft)	62.2	67.5	65.8	56.1	9.7	.16	.02
Return time[2] (min)	25.3	25.3	33.0	34.0	1.9	.07	.88
Production (lb/d)							
Milk	103.1	100.7	95.4	91.0	12.6	.02	.77
Fat	3.7	3.6	3.5	1.3	.6	.19	.81
True protein	2.9	2.9	2.7	2.5	.3	<.01	.29

[1] - distance that the cows dispersed into the corral.
[2] - average time of return from the milking parlor.

During the period that this research was being completed, some people suggested that if lame cows were forced to walk less (i.e., kept in corrals closer to the milking parlor) that this might be beneficial by having a lesser impact on cow behavior, feed intake, and milk production; as the cows would be less likely to lay down in the corrals. In order to assess this possibility, a second study using mature Holstein cows at the Castelanelli Brothers Dairy near Lodi, CA were used. Cows in each of three corrals, selected based upon their distance from the milking parlor (i.e., 94, 178 and 261 ft from the milking parlor), were used. Cows were locomotion scored, selected, and grease pen color code marked as described for Experiment 1. As in Experiment 1, all identified LS 4 cows were used from each corral and no LS 5 were identified.

Results of this study (Table 4) show that, while some behaviors of the cows were influenced by the distance of the corral from the milking parlor, milk production was not affected. In addition, the interaction of LS by corral distance from the milking parlor was never statistically significant, meaning that the impact of corral distance from the milking parlor was not different among cows of different LS groups, thus *not* supporting suggestions that moving cows with higher LS to corrals nearer the milking parlor is beneficial to behavior or milk production.

Table 4. Increasing distance from the milking parlor and behavior and milk production (Expt 2).

	Distance from Parlor				*P*		
	94	178	261	SEM	Linear	Quad	LS*D
Behavior							
% cows lying	52.8	46.0	56.5	.02	.22	<.01	.30
Distance[1] (ft)	237.5	224.4	179.2	15.6	<.01	<.01	.67
Return time[2] (min)	64.6	54.3	46.5	2.3	<.01	.69	.14
Production (lb/d)							
Milk	89.3	89.5	87.1	13.4	.54	.70	.62
Fat	3.3	3.3	3.3	.6	.87	.88	.47
True protein	2.6	2.6	2.5	.4	.45	.54	.67

[1] - distance that the cows dispersed into the corral.
[2] - average time of return from the milking parlor.

Table 5. Impact of increasing LS on behavior and milk production (Expt 2).

	LS				*P*		
	1	2	3	4	SEM	Linear	Quad
Behavior							
% cows lying	46.0	49.5	52.4	59.2	.02	<.01	.52
Distance[1] (ft)	235.3	222.5	190.3	215.3	15.6	<.01	<.01
Return time[2] (min)	53.7	52.2	51.5	63.2	2.3	.07	.05
Production (lb/d)							
Milk	92.3	87.7	90.6	84.0	13.4	.22	.78
Fat	3.4	3.4	3.3	3.2	.6	.50	.81
True protein	2.7	2.6	2.7	2.5	.4	.20	.56

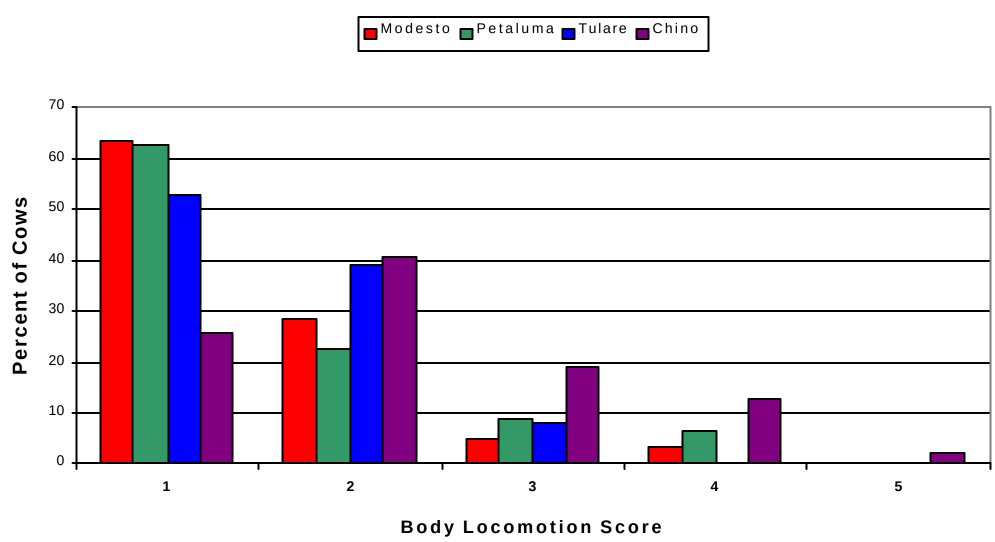
1 - distance that the cows dispersed into the corral.
2 - average time of return from the milking parlor.

Results of this second study can also be expressed to assess the impact of increasing LS (as for experiment 1 in Table 3). On this second dairy (Table 5), results were similar to those of dairy 1, with the greatest behavioral and production impacts occurring with cows scored as LS 4. Combined with results from dairy 1, the % milk production declines for LS cows 2, 3, and 4 cows are 2.5%, 4.7%, and 10.5%; which are somewhat higher than those of 1%, 3%, and 7% determined in the initial California evaluation (Table 2).

What Is a Good Locomotion Score Profile?

It is realistically impossible to achieve no lameness in a herd, if any cow locomotion scoring over 1 is considered to be expressing some degree of lameness. Nevertheless, the LS profiles shown in Figure 1, for high production groups on four commercial herds in California indicate, that it is possible to eliminate clinical lameness (i.e., LS of 4 and 5), as that was the case in the Tulare herd. A reasonable goal might be to have greater than 65% of cows scoring 1 with less than 3% scoring 4. Cows with LS of 5 should be immediately removed to hospital corrals, if for no other reason than their welfare.

Figure 1. High group locomotion profiles for four commercial California dairies.

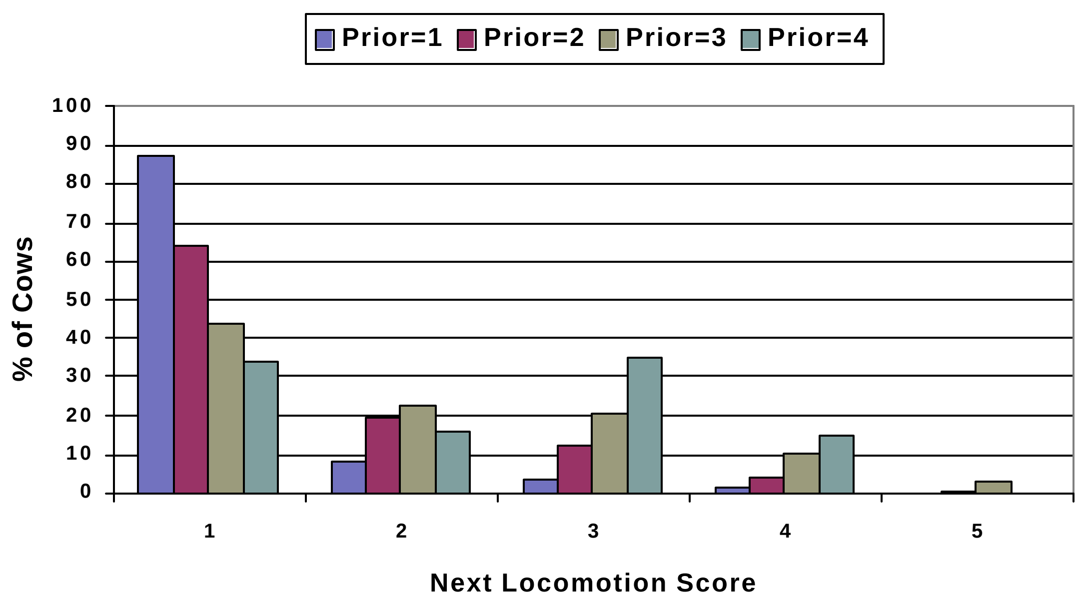


Do Cows Progress Up the Locomotion Scoring Scale with Time?

It might be reasonable to assume that individual cows would become progressively more lame with time, as assessed by LS, until they are eventually treated and recover or are culled from the herd. In a study with over 1000 cows scored monthly throughout their lactations (over 12,000 individual scores), there is some support for that theory, although it is not strong. On the commercial dairy on which this study was completed, cows scoring 4 and 5 would have been identified by staff, assessed for the cause of the high LS, and action initiated. However, cows scoring 3 or less would not have been examined. Figure 2 shows that of cows scored 3 on any particular month (Prior 3), fully $^{2}/_{3}$ of them showed less lameness the next month, about 20% the same amount and only about 15% became worse (i.e., scored 4 or 5). Expressed differently, only 3% of cows scored as 1 on any month (Prior 1) were scored 4 or 5 the next month, while 6% of cows scored 2 any month (Prior 2) scored 4 or 5 next month, and 15% of cows scored 3 any month (Prior 3) scored 4 or 5 the next month. And all of this without intervention to correct the reason for the LS!

So how does a cow spontaneously become less lame? The answer is in the nature of the locomotion scoring system. This system, by its name and nature, does not actually assess lameness in favor of scoring back posture and stride. While these factors are clearly associated with lameness, *they do not identify why a cow is lame*. Physical injury, heel warts, sole abscess, a stone in the hoof, even a sore belly (acidosis, displaced abomasum, hardware) will all affect back posture and stride. Clearly some of these conditions correct themselves and so cows become less lame, at least as assessed by LS. So in this sense, a high LS (certainly 3 or higher) is reason to examine the cow to determine the reason for the lameness and, if necessary, take action to correct it. Keeping in mind that the reason for the high LS may not be found in the legs or hooves.

Figure 2. Probability of cows scoring higher or lower the month after any LS.



What Is the Cost of Locomotion Scores Greater Than 1?

It is certainly well accepted that lameness costs dairy producers milk revenue. But how much? Based upon the milk losses measured on California dairies, and discussed above, milk revenue losses can be estimated based upon the body LS profile of any group of cows. A simple 'Excel' spreadsheet to do this can be downloaded from the author's web address at:

http://animalscience.ucdavis.edu/faculty/robinson

Example printouts for a herd with a good (Modesto from Figure 3) and poor (Chino from Figure 3) LS profile (Table 6) shows the impact of two very different LS profiles on milk revenue losses. Such numbers can be used to assess the relative milk revenue cost of lameness and thus decide whether intervention strategies would be expected to be cost effective.

The 'Modesto' LS profile would not generally be considered to represent a herd with serious lameness (i.e., only 7% clinically lame), yet the 200 cow group milk revenue losses would be $752/mo. Such a cost would likely be judged to be sufficiently high to justify general group management and/or nutritional interventions, as well as specific interventions in LS 3 cows, to prevent them from developing into LS 4 or 5 or cull cows. The 'Chino' profile suggests bankruptcy court may beckon.

Table 6. Predicted milk revenue losses due to a good LS profile (Modesto from Fig. 3).

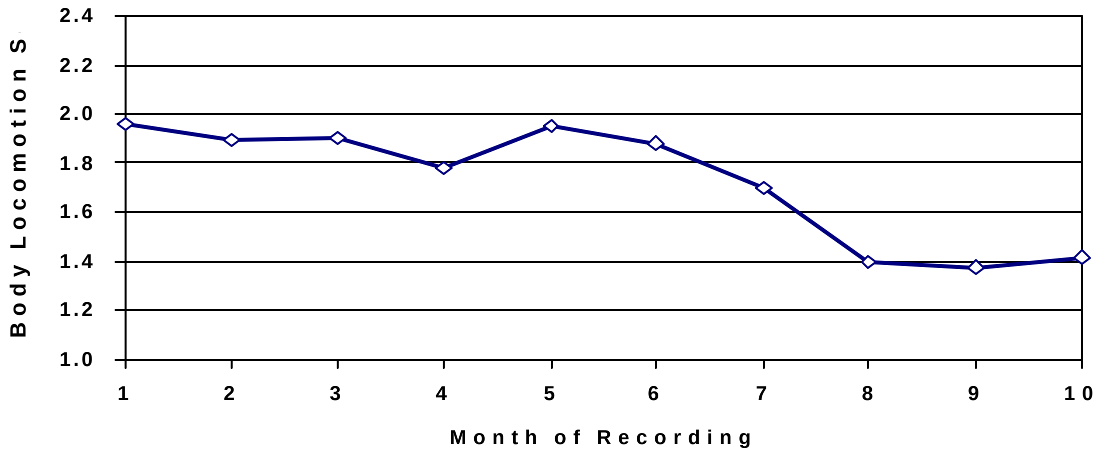
Animal Inputs			**Predicted Outputs**		
Group milk average	**99.0**	lb/d	Avg. LS	1.46	LS units
Group size	**200**	total cows			
Milk price	**$12.25**	$/100 lbs	Losses		
LS			Milk	1.02	lb/cow/d
1	**64**	% of cows		205	lb/group/d
2	**29**	% of cows			
3	**4**	% of cows	Fiscal	$0.13	$/cow/d
4	**3**	% of cows		$25	$/group/d
5	**0**	% of cows		$752	$/group/mo

Predicted milk revenue losses due to a poor LS profile (Chino from Fig. 3).

Animal Inputs			**Predicted Outputs**		
Group milk average	**99.0**	lb/d	Avg. LS	2.23	LS units
Group size	**200**	total cows			
Milk price	**$12.25**	$/100 lbs	Losses		
LS (LS)			Milk	3.08	lb/cow/d
1	**26**	% of cows		616	lb/group/d
2	**41**	% of cows			
3	**19**	% of cows	Fiscal	$0.38	$/cow/d
4	**12**	% of cows		$76	$/group/d
5	**2**	% of cows		$2,265	$/group/mo

Note: Bolded cells are input and non-bolded cells are predicted outputs.

Figure 4. Monthly changes in a high group string LS as a result of a general change after month 4.



Assessing the Locomotion Score Impact of a Change

Locomotion scores of individual cows can be used to select cows for hoof examination in order to assess the reason for the higher LS. But what if you take more general action to improve hoof, feet, or leg health? How can you make an assessment of whether your intervention, such as installing rubber mats or adding a supplement to the ration, has made a difference? Who can remember how bad your herd lameness was 6 months ago?

One way to assess the impact of interventions, or raise a flag if lameness is getting worse, is to assess all cows in all groups on a regular basis and track average LS over time. Tracking average scores on a regular (i.e., monthly) basis provides a running index of the extent of lameness on a dairy, or in a group of cows within a dairy, as well as providing a criteria to assess when to intervene, and to assess the impact of any intervention that was implemented to alleviate lameness. Figure 3 shows the impact of one intervention on one dairy. The intervention was made after month 4 and, in spite of a further LS increase in month 5 (it is best to be patient with lameness), the average LS of these high groups progressively declined over the subsequent 3 months to a more desirable value in the area of 1.4.

Conclusions

Locomotion scoring is a relatively quick and simple qualitative assessment of the ability of cows to walk normally. LS, if collected regularly (e.g., monthly), can be used to identify specific cows at risk of becoming clinically lame for examination of the cause of the lameness. Group profile LS can also be used to determine expected milk revenue losses of a dairy, or of a group of cows within a dairy, and that loss can be used as a criteria to determine if general interventions, of either a management or nutritional nature, are warranted. Finally, LS profiles collected regularly within a dairy can provide a running index of the extent of lameness as well as being an index of the impact of interventions designed to alleviate lameness.

Acknowledgements

The authors thank the owners and employees of the Rancho Teresita Dairy in Visalia, CA and the Castelanelli Brothers Dairy in Lodi, CA for their patience in allowing collection of data on their dairies.

Literature Cited

Baggott, D. G., and A. M. Russell. 1981. Lameness in cattle. Brit. Vet. J. 137:113-132.

Barkema, H. W., J. D. Westrik ., K. A. S. van Weluen, Y. H. Schukken, and A. Brand. 1994. The effect on reproductive performance, milk production and culling in Dutch dairy farms. Prev.Vet. Med. 20:249-259.

Collick, D. W., W. R. Ward, and H. Dobson. 1989. Association between types of lameness and fertility. Vet. Rec. 125:103-106.

Eddy, R. G., and C. P. Scott. 1980. Some observations of the incidence of lameness in dairy cattle in Somerset. Vet. Rec. 106:140-144.

Enting, H., D. Kooij, A. A. Dijkhiuzen, R. B. M. Huirne, and E. N. Noordhuizen-Stassen. 1997. Economic losses due to clinical lameness in dairy cattle. Livestock Prod. Sci. 49:259-267.

Hassall, S. A., W. R. Ward, and R. D. Murray. 1993. Effects of lameness on the behaviour of cows during the summer. Vet. Rec. 132:578-580.

Kossaibati, M. A., and R. J. Esslemont. 1997. The cost of production diseases in dairy herds in England. Vet. J. 154:41-51.

Manson, J. F., and J. D. Leaver. 1988. The influence of concentrate amount on locomotion and clinical lameness in dairy cattle. Brit. Soc. Anim. Prod. 47:185-190.

Rajala-Schultz, P. J., Y. T. Gröhn and C. E. McCulloch. 1999. Effect of milk fever, ketosis and lameness on milk yield in dairy cows. J. Dairy Sci. 82:288-294.

Rowlands, G. J., A. M. Russell, and L. A. Williams. 1985. Effects of stage of lactation, month, age, origin, and heart girth on lameness in dairy cattle. Vet. Rec. 117:576-580.

Seegers, H., F. Beaudeau, C. Fourichon, and N. Bareille. 1998. Reasons for culling in French Holstein cows. Prev. Vet. Med. 36:257-271.

Singh, S. S., W. R. Ward, K. Lautenbach, and R. D. Murray. 1993. Behaviour of lame and normal dairy cows in cubicles and in a straw yard. Vet. Rec. 133:204-208.

Sprecher, D. J., D. E. Hostetler, and J. B. Kanneene. 1997. A lameness scoring system that uses posture and gait to predict dairy cattle reproductive performance. Theriogenology 47:1179-1187.

Warnick, L. D., D. Janssen, C. L. Guard, and Y. T. Gröhn. 2001. The effect of lameness on milk production in dairy cattle. J. Dairy Sci. 84:1988-1997.

Whay, H. R., A. E. Waterman, A. J. F. Webster, and J. K. O'Brian. 1998. The influence of lesion type on the duration of hyperalgesia associated with hindlimb lameness in dairy cattle. Vet. J. 156:23-29.