Considerations when Recording Locomotion in Dairy Cattle

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Abstract

Several ways of recording feet and leg disorders for breeding purposes are briefly suggested. The emphasis is then put on locomotion scoring which can be regarded as a collective trait for this disease complex. Several scoring systems are introduced and first results presented. Finally, conclusions and recommendations for future work with this new trait are discussed.

1. Introduction

Over the last decade, selection of animals in dairy populations has shifted from purely production-based criteria to a more comprehensive system also including traits regarding the improvement of health traits, welfare, and longevity, and some indices have been developped accordingly (*e.g.* ITEM in Great Britain). Most of these new traits, *e.g.* health, are not as straight forward to measure and record as for example milk yield and a considerable amount of work has been put into the definition and development of these characteristics for recording. As being one of the major disease complexes in dairy cattle with substantial economic and welfare consequences, lameness or feet and leg problems have experienced much attention over the last two to three decades. It is a multifactorial disease complex comprising several disorders and caused by environmental and genetic factors.

The breeding goal can either be the improvement of locomotion as a whole or the avoidance of lameness which can also be characterised as 'negative locomotion'. Lameness in turn can be measured as an impaired walking ability or as the consequence of individual diseases. Moreover, other related auxiliary traits have been examined which are listed in Table 1.

To fulfill the requirements for traits in genetic studies, *i.e.* availability of thousands or even tens of thousands of records at reasonable costs, much research has been based on conformation traits as these are collected on a regular basis by breed societies for the evaluation of their sires. Foot angle and a trait for the position of the rear legs are among those traits scored in most countries and have thus been examined thoroughly. Other traits are recorded only nationally. A review is given by Boelling and Pollott (1997).

Some of the other possible measurements mentioned above were subjects of special research projects (Baumgartner *et al.,* 1990a,b; Distl *et al.,* 1982; Ral, 1990), but do not encourage an implementation in recording systems on a large scale, first and most of all due to high labour requirements and recording costs.

Another way of looking at the lameness problem is to record locomotion which summarises all possible factors impairing the ability to move into a single score independent of its origin. Contingent on the respective project, locomotion can be recorded from perfectness to the inability to walk or only the negative part of the scale, lameness, can be monitored.

Several schemes can be found that aim to qualify locomotion visually with a minimum of expense (Leaver & Webster, 1982; Manson, 1986; Manson & Leaver, 1988; Tranter & Morris, 1991; Wells *et al.*, 1993; Sprecher *et al.*, 1997). The original work was carried out by Leaver & Webster in 1982, Manson developed the idea further to a more sophisticated system with 9 instead of 5 levels by subdividing the original categories (see Table 2). The system is divided into two sections: the first part comprising categories one to four describes deteriorating locomotion, whereas the categories five to nine which make up the second part denote worsening clinical lameness. Originally, this system was designed to monitor clinical lameness caused by feeding, housing and general management. But due to the bisected strucure, this system can also be used to record lameness as a binary trait by recoding scores from 1 to 4 as non-lame and scores from 5 to 9 as lame. Moreover, by looking only at records classified in the first four categories, locomotion can be scrutinised thoroughly.

Wells *et al.* (1993) based their system on this work, but simplified it as the original system was thought to be too complicated under field conditions. The resulting “Clinical Lameness Scoring System” contains 5 levels. Both systems consider cows in the third category or higher (Manson & Leaver (1988a): © 3, Wells *et al.* (1993): © 2) as clinically lame. Tranter & Morris (1991) set up a system in New Zealand to monitor lameness in three herds there in a case study. Again, it is a scheme with 5 categories looking at the degree of sinking of the rear leg on the sound side, ab-/adduction of any limb, head movements, and shortening or lengthening of the stride. Finally, Sprecher *et al.* developped a system which emphasized the posture of the back beside the gait. A cow was already categorised as ‘mildly lame’ despite a normal gait when her back was arched while walking. The aim of that project was to examine the importance of lameness on the reproductive performance.

All the four systems have in common that the animals are being classified while walking on a firm surface, *e.g.* concrete, at their normal speed. They were designed to provide information about the prevalence and severity, and with repeated measurements, the incidence and duration of lameness.

2. First results from a large scale project

The Locomotion Scoring System developped by Manson and Leaver (1988) was applied in a large scale project which aimed to assess the genetics of locomotion and its correlation with body conformation traits which were regularly assessed in Great Britain (Boelling, 1996). This system was chosen as it was the most detailed at that time. Data were collected by the Holstein Friesian Society of Great Britain and Ireland (HFS). All dairy cows which were type classified by trained field-officers, were also locomotion scored. Altogether, 31768, 10845, 4379, 1601 records of cows in their 1., 2., 3., 4. lactation respectively, were exploited for the analyses. As the frequency of lameness scores (5 and higher) was less than 3 per cent and the emphasis in this study was mainly put on locomotion and not on lameness, the scores of 5 and higher, denoting lameness, were deleted from the data set for most of the genetic analyses.

Preliminary analyses revealed an impact of classifier and, due to different housing systems in Britain throughout the year, also of season of classification on the locomotion score (Boelling, 1996). An influence of age expressed in number of lactations could not be found for these data which contradicted results from a data set collected in more detail on a single farm. Due to the strong selection process of older cows for official classification, only the best animals were assessed and these did not exhibit impaired locomotion, whereas a decline with increasing age could be seen in non-selected cows (Table 3).

The heritability for locomotion was 0.10 " 0.03, 0.11 " 0.02, 0.06 " 0.03, 0.10 " 0.06 from 1^{st} to 4^{th} lactation, respectively. The correlation between rear leg side view (RLSV) and foot angle (FA) was highly negative for young cows and became even stronger with age (Table 4). Likewise, the correlation coefficients between RLSV and especially FA and locomotion grew closer to unity with increasing age, showing that either the connection between the traits became very close or that a sort of auto-correlation occurred among the classifiers, *i.e.* a cow with good feet and legs was automatically given a good locomotion score. Lameness as a binary trait exhibited the same relationship to other feet and leg traits as “bad” locomotion, *i.e.* more sickled legs and a shallow foot angle seemed to increase the risk of a lameness incidence.

Breeding values for locomotion were calculated for those 437 sires that were the fathers of the first lactation cows. They were normally distributed (Table 5), but showed a very high density around the mean. In fact, more than 80% of all values were found between +1 and -1 standard deviations around the mean which makes selection more difficult as the sires with a good value are more difficult to detect.

3. Discussion

The locomotion scoring system employed here is a linear system which rates locomotion from perfectness to a quasi-inability to walk. The degradation of locomotion is not a linear process in one direction only, but rather parallel in the categories 3 and 4 and it will not necessarily lead to lameness.

In the present scoring system, five categories were dedicated to lameness. Deterioration of the features characterising lameness, *e.g.* increasing difficulty in walking, rising and turning, can be seen as linear, but the expression of these does not necessarily reflect the degree or severity of the lesions causing this impaired movement (Loeffler, 1986; Daemmrich, 1987). Therefore, it is sufficient for a study where the interest is focussed on locomotion, as opposed to clinical lameness, to summarise all lameness categories into one single class.

The question remains whether there is any sense in improving locomotion when there is not inevitably an underlying linearity to lameness which is the trait that causes problems. Two answers were found.

Firstly, locomotion showed a deterioration with increasing age similar to some of the body conformation traits, like udder depth. This trend was only seen in the farm data. The mature cows assessed for the HFS records were very well selected animals which represented the ideal type of a dairy cow and where the selection became stronger and stronger with rising lactation number. The locomotion score for these cows stayed constant over time. This finding demonstrates that locomotion deteriorates for the average dairy cow, but that this deterioration can be kept at a minimum or does not occur at all, when the cows have a very good conformation and are well managed. Thus it is important to have a cow with a gait and conformation which are good as a heifer and which stay good throughout her productive life.

Secondly, although lameness is not linearly correlated with the severity of individual claw diseases, locomotion as a whole still helps to monitor any hoof problems. Subclinical diseases do not cause lameness at that stage, but may be reflected in a higher locomotion score. Therefore a close observation of changes in locomotion can aid in avoiding claw diseases. So locomotion as a linear trait describes the subclinical status, whereas lameness recorded as an all-or-none trait stands for the clinical status and both included in a recording system offer the possibility to improve this specific disease complex as a whole.

Summarising the findings and results of this study, the following items are suggested to consider for the implementation of locomotion as a new trait in a data recording system. Currently, sound locomotion is recorded on a scale from 1 to 4. This scale should be stretched out so that both linear conformation traits and locomotion are scored on the same scale. Additionally, lameness should be added as a miscellaneous trait so that lame cows receive two scores: a linear score for locomotion and a positive mark for being lame. This set up would also allow to establish correlations between locomotion and lameness. The statistical model for the analyses should contain an effect like 'herd-year-season' accounting for different housing systems, management and seasonal influences, and covariates 'age at inspection', 'stage of lactation' and possibly a factor describing different breed compositions. Additional specific factors having an impact on locomotion, *e.g.* hoof trimming, are difficult to account for in a mathematical way. Moreover, it is nearly impossible to record the data on a large scale and it is thus suggested to disregard them. The increase of the numbers of categories for locomotion may help to differentiate between the different grades of locomotion more exactly and to distinguish between the merit of sires regarding locomotion more distinctly. Although age in years has shown a strong impact in the data set collected on a single farm, no differences between differently aged cows in the HFS data set could be found due to the strong selection process. Therefore it does not seem recommendable to exploit these data genetically.

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Table 1. Different aspects of the inclusion of locomotory traits in an overall selection index

Breeding goal/ primary trait	Secondary trait	Method of recording	Data
	- locomotion	subjective scoring	categorical
	- lameness	subjective scoring	binary/ categorical
Good locomotion	- conformation traits	subjective scoring	categ./ continuous
	- individual diseases	positive cases	binary
No lameness	- hoof measurements	obj. measurements	continuous
	- pressure distribution	obj.measurements	continuous
Avoidance of	- histology	analysis of samples	continuous
claw diseases	- horn hardness	measurements	continuous
	- horn quality (quality of proteins)	analysis of samples	binary

Table 2. Different locomotion scoring systems

Manson (1986) **Manson and Leaver** (1988a)		**Tranter and Morris** (1991)		**Wells *et al.*** (1993)		**Sprecher *et al.*** (1997)	
1 1.5	Min. ab-/adduction, no uneveness or tenderness slight ab-/adduction, no uneveness or tenderness	0	No abnormality of gait	0	Gait abnormality not visible at walk, not reluctant to walk	1	Normal. Gait normal. Level-back posture while walking and standing.
2 2.5	Ab-/adduction present, uneven gait, maybe tender ab-/adduction present, uneven gait, tenderness	1	Lameness hardly noticable	1	Mild variation from normal gait at walk: intermittent asymmetry or mild bi- or quadrilateral restriction in free movement	2	Mildly lame. Gait normal. Level-back posture while standing, but back arched while walking.
3 3.5	Slight lameness, normal behaviour not affected lameness obvious, normal behaviour not affected, difficulty in turning	2	Slightly lame	2	Moderate and consistent asymmetry or symmetric gait abnormality, but able to walk without continuous stimulation	3	Moderately lame. Gait affected, short-striding. Back arched while standing and walking.
4 4.5	Lameness very obvious, affecting normal behaviour, difficulty in turning behaviour considerably affected, unwilling to rise	3	Markedly lame	3	Marked gait asymmetry or severe symmetric abnormality	4	Lame. Back always arched. Only one deliberate step at a time, one or more limbs favoured.
5	Severely lame, adverse effects on behaviour and condition, extreme difficulty in rising, difficulty in walking	4	Affected limb not weight bearing	4	Recumbent	5	Severely lame. Additionally, extreme reluctance to bear weight on or more limbs.

Table 3. Means and standard deviations of locomotion score per lactation number

Data source[1)]	Lactation number 1	2	3	4	5	6	7	8
HFS	2.45 "0.89	2.35 "0.82	2.39 "0.84	2.40 "0.86	2.41 "0.88	2.42 "0.92	2.50 "1.01	2.50 "0.87
Farm	2.61 "0.82	2.86 "0.91	3.04 "0.87	3.26 "1.07	3.49 "1.15	3.76 "1.25	3.64 "1.09	3.66 "1.09

1) HFS: Holstein Friesian Society of Great Britain and Ireland
FARM: all animals classified on one farm.

Table 4. Heritabilities of and correlations between rear leg side view (RLSV), foot angle (FA) and locomotion (LOC) or lameness

Trait	Trait RLSV	FA	LOC		RLSV	FA	Lameness
1st lactation							
RLSV	**0.19**	-0.37	0.22	RLSV		-0.39	0.11
FA	-0.59	**0.11**	-0.21	FA	-0.77		-0.09
LOC	0.33	-0.58	**0.10**	Lameness	0.42	-0.34	**0.016**
2nd lactation							
RLSV		-0.40	0.29				
FA	-0.68		-0.29				
LOC	0.72	-0.80					
3rd lactation							
RLSV		-0.43	0.34				
FA	-0.78		-0.31				
LOC	0.67	-0.75					
4th lactation							
RLSV		-0.46	0.30				
FA	-0.80		-0.33				
LOC	0.78	-0.96					

	h^2: on diagonal;	r_g: below diagonal	r_p: above diagonal
1st lactation:	s.e. (h^2):0.03 - 0.05	s.e. (r_g): 0.15 - 0.19	s.e. (r_p): 0.01
2nd lactation:		s.e. (r_g): 0.08 - 0.16	s.e. (r_p): 0.01
3rd lactation:		s.e. (r_g): 0.14 - 0.27	s.e. (r_p): 0.01 - 0.02
4th lactation:		s.e. (r_g): 0.03 - 0.47	s.e. (r_p): 0.02 - 0.03

Lameness: original score of 1 to 4 recoded as 0 (not lame),
original scores of 5 to 9 reincluded and recoded as 1 (lame)

Table 5. Distribution (%) of breeding values of 437 sires for locomotion

	Interval (in SD) <-2.5	-2.5-(-1.5)	-1.5-(-.5)	-.5-.5	-.5-1.5	1.5-2.5	>2.5
Proportion	0.23	5.72	29.29	27.46	31.12	5.49	0.69