Genetic Evaluation for Feet Traits Collected from Young German Holstein Bulls

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Abstract

In general the importance of functional traits is increasing in all dairy cattle populations over the last decade. Beside udder and fertility problems claw and foot disorders are main involuntary culling reasons. Linear description of feet and leg traits in the frame of conformation scoring didn't reduce claw and leg problems as expected. Therefore new ways of data recording should be established in order to get more reliable information in this trait complex. In Germany claw and leg traits were measured and scored from 4000 young AI test bull candidates after rearing them in test stations. After estimation of genetic parameters a routine genetic evaluation based on this data is implemented by VIT for test bull candidates of four breeding organisations. Procedures and results from estimation of variance components and from genetic evaluation are reported as well as a first attempts to derive a significant index of traits to predict feet and leg quality and functional longevity of future daughters.

Introduction

Functional traits became more important in all dairy cattle breeding programs during the last decade. Caused by increasing involuntary culling length of productive life of cows decreased and costs of rearing more replacement heifers lowered net income in milk production. Besides udder diseases and fertility problems, feet and leg disorders are the most frequent culling reasons in dairy herds. Therefore these traits are getting relatively more attention by dairy farmers compared to production traits. Since real information (disposal) about the overall functional trait "longevity" is available too late for selection purposes, more data for single functional traits, measured or scored in an earlier stage of life and genetically related to longevity is needed. Unfortunately precise information about feet and leg diseases or objective measurements of claw traits are not recorded in most countries. Claw and leg quality of young Simmental bulls was shown to have influence on functional longevity of their daughters (Distl, 1999). In 1996 a joint research project of German Holstein organizations and the veterinary university of Hanover was initiated to collect feet and leg traits from young AI test bull candidates after rearing them in test stations. Four breeding organisations continued data recording up to now. That data is used for genetic evaluation as proposed by Hamann and Distl (2002) and carried out routinely by VIT since 2004.

The objective of this paper is to present the evaluation method and to show how to use the proofs of young bulls as predictors for future longevity of their daughters.

Materials and Methods

Data

Data of young AI test bull candidates has been collected after rearing them in five different test stations since 1996 onwards. Records of almost 4000 bulls are available up to now. Age at recording ranges from 11 to 15 month.

At present 91 bulls born before 1996 with reliable proofs in claw traits (own performance test), feet and leg traits (daughter conformation) and daughter longevity are available for an approximate estimation of genetic correlations between feet and leg traits and functional longevity and for the derivation of a useful set of auxiliary traits to predict longevity.

Measured and scored traits

The traits recorded can be grouped into four categories. Traits measured at front and rear legs describing the claw size (1) and claw hardness (2), as well as traits based on a scoring system (scale 1 – 9) describing claw (3) and leg (4) conformation.

(1) Claw size measures
- Length of dorsal border (LDB)
- Angle of dorsal wall (ADW)
- Heel height (HH)
- Heel length (HL)
- Diagonal length (DL)

(2) Claw hardness measures
- At top of dorsal wall (HTDW)
- At middle of dorsal wall (HMDW)

(3) Claw conformation scores
- Interdigital space (IS)
- Interdigital Hyperplasia (IH)
- Angle of side wall (ASW)
- Straightness of dorsal wall (SDW)
- Arrangement of the digits (AD)

(4) Leg conformation scores
- Front legs front view (FLFV)
- Rear legs side view (RLSV)
- Rear legs rear view (RLRV)
- Hock angle at rear legs (RLHA)

As long as data is limited (number of bulls with own performance test and reliable proofs based on daughter information) and additional investigations are needed, the whole set of traits is recorded further on. Having found a more reliable significant trait combination to predict feet and leg disorders and functional longevity of future daughters the set of traits may be reduced to the most important ones.

Genetic evaluation model

Data were analysed using a linear animal model considering "test station x year x season" and "age of bull" as fixed environmental effects. The same multi trait animal model was used for estimation of variance components and for genetic evaluation:

$$\mathbf{y} = \boldsymbol{\mu} + \mathbf{X}\boldsymbol{\beta} + \mathbf{Z}\mathbf{a} + \mathbf{e} \qquad [1]$$

where $\mathbf{y}$ is a vector of scored or measured feet traits of a young bull, $\boldsymbol{\mu}$ is a vector of general means, $\boldsymbol{\beta}$ is the vector of fixed effects and $\mathbf{a}$ the genetic value of an animal. Genetic evaluation is carried out within three groups of traits, measured traits, scored traits at front leg and scored traits at rear leg.

Proofs are published on a standardized relative scale with mean = 100 and genetic standard deviation of 12 units. Genetically favourable proofs are higher than 100.

The best combination of claw and leg traits for the prediction of functional longevity was estimated using the SAS procedure RSQUARE. Each single trait was tested as linear and as quadratic regression variable to consider traits with an intermediate genetic optimum correctly.

Results and Discussion

In general, measured traits show a higher variation than scored traits. The expected standard deviation of 1.33 for a recording scale of 1 – 9 was not realized in most traits, indicating that classifiers still are not experienced enough to give extreme scores. On the other hand the candidate bulls are highly selected and kept in optimum environmental conditions causing low disease incidence.

Heritabilities

Heritabilties of all traits are given in table 1. Generally these estimates based on 3450 bulls with own performance are lower than the heritabilities estimated with a smaller data set by Hamann *et al.* (2002). In tendency, heritabilities of the same traits at the front leg are higher than at the rear leg. Correlations between the same traits measured at front and rear leg are high. Contrary to expectation, heritability estimates for scored traits are higher than for measured traits.

Table 1. Heritabilities of claw and leg traits, n=3348 own performance tested bulls.

Trait category	Trait	h^2 Front leg	h^2 Rear leg
Claw size	LDB	0.19	
	ADH	0.13	
	HH	0.15	0.18
	HL	0.10	
	DL	0.20	
Claw hardness	HTDW	0.09	0.12
	HMDW	0.02	0.07
Claw conformation	IS	0.38	0.31
	IH	0.27	0.32
	ASW	0.22	0.16
	SDW	0.38	0.20
	AD	0.13	
Leg conformation	FLFV	0.10	
	RLSV		0.23
	RLRV		0.11
	RLHA		0.17

Correlations with feet and leg score and functional longevity of daughters

The aim of the own performance test for claw and leg traits and the consecutive genetic evaluation is to find traits which are significantly correlated with daughters' feet and leg score and functional longevity. Correlations were estimated on the basis of 91 bulls having reliabilities of proofs above 0.75 in all traits (own performance and progeny test). All these bulls already have at least 10 performance tested sons. Significant correlations ($p<0.05$) with longevity were found for claw hardness at top of the dorsal wall (HTDW, front and rear) and interdigital hyperplasia (IH, rear). The deviation from an intermediate optimum is significantly correlated with longevity for the following traits: length of dorsal border (LDB, front), angle of side wall (ASW, rear) and the leg conformation score of hock angle at rear leg (RLHA).

It must be mentioned that these are pure correlations between proofs which are not weighted by reliabilities and transformed to an approximate genetic correlation by the method of CALO.

Longevity is an overall trait summarizing many functional traits. High correlations (>.40) between longevity and single functional traits can not be expected. The more single traits influencing longevity the lower we can expect these correlations.

When selecting two groups of sires with high and low proofs for longevity together with (or probably caused by) high and low proofs for daughter total feet and leg score, differences in average claw and leg traits become distinct. Based on the same selected sample a preliminary prediction formula for longevity including a combination of six claw and leg traits can be derived with an accuracy of $r^2 = 0.60$.

Future plan

In the next two years more bulls with more reliable proofs for feet and leg traits and functional longevity will be available to derive prediction indices with higher accuracy. The so called "claw & leg" index will then be considered in the selection of AI test bull candidates.

Conclusions

Breeding organizations have to be aware of the increasing importance of functional traits in dairy cattle. In order to satisfy the demand for AI bulls inheriting functional and healthy daughters with a long productive life breeding organizations have to provide breeders with reliable information about these functional traits. Therefore new ways of data collection and performance tests for feet and leg traits have to be organized and implemented as data basis for genetic evaluation.

Own performance test of young AI test bull candidates is one possibility to get reliable information in an early stage of life without high extra costs.

Field data collected by professional hoof trimmers at their regular visits may be an additional information basis to improve feet and leg quality of dairy cows by selection (Swalve *et al.,* 2005). Recording of claw disorders by certified hoof trimmers started in Germany last year. Results of two pilot projects indicated significant genetic variation in many claw disorders and expected genetic correlation with conformation traits and longevity (Swalve and König, 2004). Therefore routine recording and evaluation of claw data will be a new chance to improve feet and leg health and consequently functional longevity in dairy cattle populations.

References

Distl, O. 1999. Zucht auf ein gesundes Fundament beim Milchrind. *Züchtungskunde 71,* 446-458.

Hamann, H. & Distl, O. 2002. Prediction of functional longevity for dairy cows using foot quality traits in German Holstein bulls. *7th WCGALP, Montpellier.*

Swalve, H. & König, S. 2004. Klauenschnittbefunde für die Zucht nutzen. *Milchrind, 3/2004*.

Swalve H. *et al.* 2005. Analysis of genetic and environmental effects on claw disorders diagnosed at hoof trimming. *Poster 56th EAAP,* Uppsala.

Table 2. Correlations between proofs of claw and leg traits (own performance test of bulls) and functional longevity and feet and leg score (progeny test), n=91 AI bulls (reliability of all proofs > 0.70).

		Correlation with productive life		Correlation with feet and leg score	
Trait category	Traits	Front legs	Rear legs	Front legs	Rear legs
Claw size	LDB*	-0,03	-	**-0,22**	-
	HH	-0,03	-0,01	-0,19	-0,16
	DL	-0,17	-	**-0,29**	-
Claw hardness	HTDW	**0,22**	0,17	**0,31**	**0,35**
	HMDW	0,05	-0,09	0,03	0,11
Claw conformation	IS	-0,11	-0,13	-0,11	0,13
	IH	-0,07	**-0,20**	**0,24**	0,14
	ASW*	-0,08	**0,21**	-0,10	0,06
Leg conformation	RLSV	-	0,13	-	0,18
	RLHA*	-	**0,32**	-	0,17

*) Correlation of deviation from intermediate optimum
**) Bold correlations ($p<0.05$)