Genetic evaluation for direct and maternal livability in The Netherlands

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Abstract

A new breeding value estimation for livability has been implemented in the Dutch/Flemish genetic evaluation in April 2011. Breeding values are estimated with a multiple trait animal model with correlated direct and maternal effects. Benefits of the new model are that the maternal effect is modelled more correctly and observations from heifers and cows are treated as different traits. The phenotypic trend for live-born calves from heifers is negative and for cows stable. Therefore the breeding goal has changed towards breeding for more live-born calves from heifers, whereas previous breeding for more live-born calves from heifers and cows was the breeding goal. Genetic trends in the last decade remained stable or slightly increased. Interbull correlations with other countries increased in case of breeding values based on heifer observations and a comparable evaluation model. Trait and model harmonisation amongst countries is preferable to get higher correlations.

1. Introduction

In April 2011 the Dutch/Flemish breeding value estimation for livability has changed. Until the evaluation of December 2010 livability was evaluated with a single trait sire model with a sire of calf effect for the direct effect and a sire of cow effect for the cow effect on livability. The cow effect is a combination of the sire of calf effect and the sire of cow effect. Heifers and cows were analysed separately. In the new breeding value estimation the data is analysed with a multiple trait animal model with correlated direct and maternal effects. A major benefit of the animal model with correlated direct and maternal effects is that the maternal effect or the effect of the cow on the calving process is more correctly modelled, as the dam is in the model instead of the maternal grandsire. Therefore the direct and maternal effect are completely separated, where previously the maternal grandsire effect was a combination of both effects. Another benefit is that the observations of heifers and cows can be treated as different traits.

The aim of this paper is to report the results of the implementation of the new national breeding value estimation of livability in The Netherlands.

2. Material and Methods

2.1 Data for breeding value estimation

A stillborn calf is defined as a calf that dies before, during or within 24 hours after birth. Farmers in the Netherlands have to report their stillborn calves but they do not have to eartag them with a lifetime number. As a consequence stillborn calves do not enter the national database. Therefore a stillborn calf was identified as the offspring of a dam with a calving but without any offspring born on that day. The sire of these animals was determined through the inseminations of the dam 9 months prior to the calving date. Due to the indirect determination of a stillborn calf the sex of the animal is unknown and cannot be used as a fixed effect in the breeding value estimation.

Data of animals born since July 1993 are used in the breeding value estimation for livability. Records from calves, born alive or dead as previously described, with a gestation length between 260 and 300 days are used for the breeding value estimation. Calves born from embryo transfer are discarded. The age at first calving has to be between 640 and 1075 days and only single births are included.

2.2 Statistical model

The breeding values for livability are estimated for heifers and cows with a multiple trait animal model with correlated direct and maternal effects. The statistical models used, are:

For heifers:

$$Y_{ijklmnopqr} = H_i + YM_j + A_k + Hcow_l + Rcow_m + Hcalf_n + Rcalf_o + cow_p + calf_q + e_{ijklmnopqr}$$

For multiparous cows:

$$Y_{ijklmnopqrs} = H_i + YM_j + P_k + Hcow_l + Rcow_m + Hcalf_n + Rcalf_o + cow_p + calf_q + perm_r + e_{ijklmnopqrs}$$

where

Y	livability of calf born from a heifer or cow (0 = dead, 1 = alive)
H	herd or management group (fixed); for heifers 20 consecutive calvings form a management group, for cows 30 calvings form a management group
YM	year x month of birth of the calf
A	age at calving for heifers (fixed)
P	parity for cows (fixed)
Hcow	heterosis of the cow (covariable)
Rcow	recombination of the cow (covariable)
Hcalf	heterosis of the calf (covariable)
Rcalf	recombination of the calf (covariable)
cow	additive genetic effect of the cow or maternal effect (random)
calf	additive genetic effect of the calf or direct effect (random)
perm	permanent environment for cows (random)
e	residual (random)

Pedigree data of all cows with a calving record were included. Breeding values were expressed on a relative scale with mean 100 and standard deviation of 4 points, where breeding values above 100 mean higher livability.

Data from the national evaluation of August 2011 was used and comprised 17,287,110 records of which 4,723,758 calves were born from heifers and 12,563,352 calves were born from multiparous cows.

2.3 Genetic parameters

Table 1 shows the heritabilities, genetic correlations and genetic standard deviations used in the breeding value estimation for livability since April 2011 (Van Pelt & De Jong, 2011).

The heritabilities for the heifer traits increased with the change from a sire model to an animal model. For direct livability for heifers the heritability increased from 0.030 to 0.038 and for maternal livability for heifers the heritability increased from 0.050 to 0.085. The heritability of the livability traits for cow decreased slightly from 0.010 to 0.005. The repeatability for the cow livability is 0.033.
Genetic correlations between heifers and cows are 0.570 for the direct livability and 0.524 for maternal livability. Therefore livability for heifers and cows are treated as different traits. In the old system genetic correlations were not used as livability was analysed in a single trait setting.

Table 1. Heritabilities (bold on diagonal), genetic correlations (off-diagonal) and genetic standard deviations for direct and maternal livability within and between parities (heifers *vs.* multiparous cows)

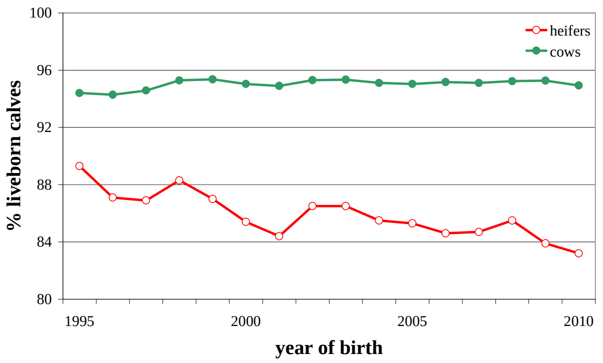
	Mat.liv 1	Mat.liv 2+	Dir.liv 1	Dir.liv 2+	Gen.sd (%)
Mat.liv 1	**0.085**				10.79
Mat.liv 2+	0.524	**0.005**			1.53
Dir.liv 1	-0.156	0.214	**0.038**		7.20
Dir.liv 2+	0.090	0.358	0.570	**0.005**	1.48

3. Results and Discussion

3.1 Phenotypic trends

The phenotypic trends for livability are shown in figure 1 for black and white heifers and multiparous cows with at least 87.5% Holstein genes. The phenotypic trend for multiparous cows is constant at a level of 95 percent live-born calves. However, the phenotypic trend for heifers shows a decline of five percent live-born calves during fifteen years. In 1995 one out of nine calves died within 24 hours after birth, whereas in 2010 one out of six calves died. The decline of the phenotypic trend in Holstein is also shown in other studies (Philipsson *et al.*,1997; Meyer *et al.*, 2001; Steinbock *et al.*, 2003; Hansen *et al.*, 2004; Cole *et al.*, 2007).

Figure 1. Phenotypic trend of livability for heifers



and multiparous cows in Holstein

3.2 Genetic trends

Genetic trends for direct and maternal livability for black and white Holstein are shown in figures 2, 3, 4 and 5 for bulls and cows. Only bulls with a

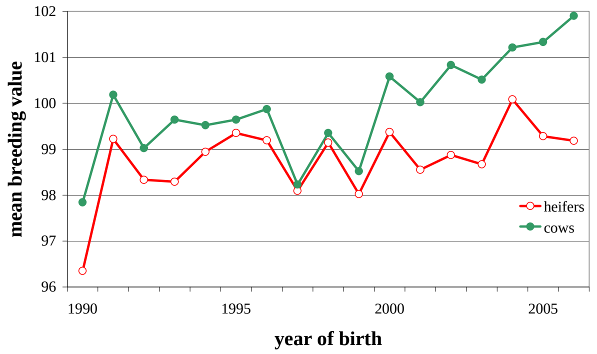


Figure 2. Annual genetic trend for direct livability by birth year for Holstein bulls

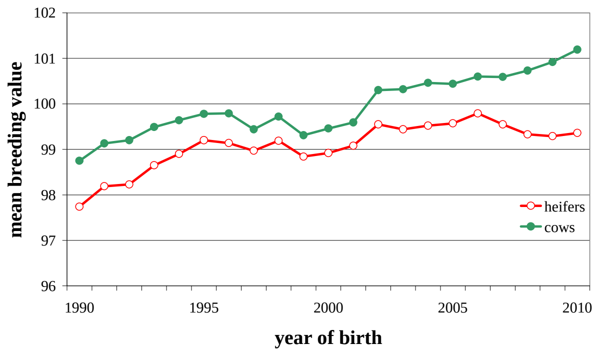


Figure 3. Annual genetic trend for direct livability by birth year for Holstein cows

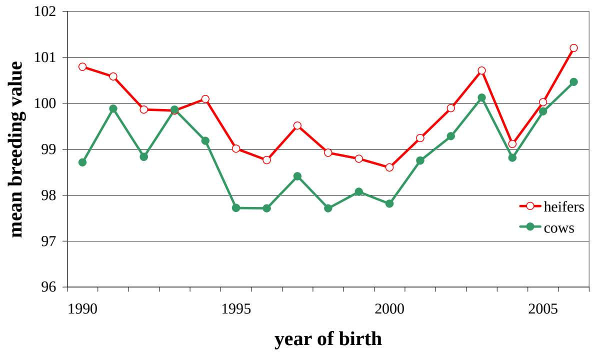


Figure 4. Annual genetic trend for maternal livability by birth year for Holstein bulls

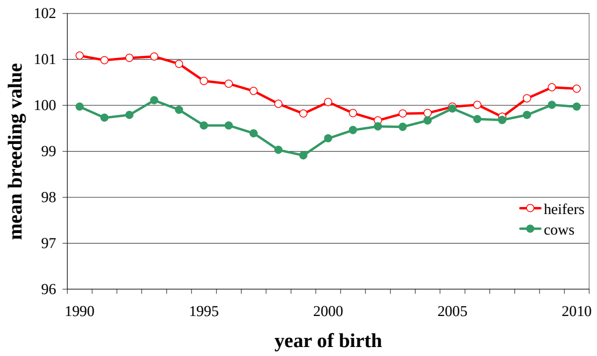


Figure 5. Annual genetic trend for maternal livability by birth year for Holstein cows

reliability of at least 50% for direct livability were used for the genetic trend of bulls.

For direct livability genetic trends for bulls and cows are positive (figure 2 and 3). Bulls born since 1997 show an upward trend for heifer and cow direct livability. For cow direct livability the bull trend is more pronounced by an increase of one genetic standard deviation. For cows the genetic trend is similar with a delay of two years. For heifers the trend stabilised. Note that heifer and cow livability diverge in more recent years.

The genetic trend for maternal livability shows a turning point around 1999 (figure 4 and 5). Since 1999 the trends increased on bull level by half a genetic standard deviation. On cow level the trend for cow maternal livability increased as well but heifer livability remained stable.

3.3 Breeding values

Reliabilities of bulls increased for the heifer traits compared to the old system. This is mainly caused by increased heritabilities. The multiple trait setting also contributes to the reliability. The reliabilities increased by 10% and 20% for direct and maternal heifer livability respectively. The reliabilities of bulls for the cow traits remained the same.

Correlations of breeding values with the old sire model and the new animal model were higher than 0.92 for all traits and for heifers traits even higher than 0.98.

With the breeding value estimation based on a sire model the breeding goal was to increase the percentage of live-born calves for heifers and multiparous cows. The phenotypic and genetic trends show that there is a slight improvement for multiparous cows, but a deterioration especially for the phenotypic trend for heifers. The response for cows is much smaller than for heifers. Therefore, it was decided to change the breeding goal for livability towards breeding for more live-born calves from heifers. The main reason is to turn the negative phenotypic trend into a positive one and breed for more animal welfare. This was also recommended by Philipson & Steinbock (2003).

Because of the change in breeding goal, correlations between the old and new index for direct livability is 0.88 and for maternal livability 0.84. This resulted in some reranking of bulls.

The effect in heifers of 100% heterosis is 0.6% more liveborn calves for direct livability and 0.9% more liveborn calves for maternal livability. The effect of heterosis in cows is negligible.

Using bulls, which differ two genetic standard deviations, on average animals, will result in a difference of 6.44% live-born calves (direct livability) and 9.66% live-born calves from heifers (maternal effect).

3.4 Interbull evaluation

The Interbull correlations for stillbirth between the Netherlands and other countries (Table 2; Interbull, 2011) changed because of the shift in the breeding goal, but only for the countries sending the same kind of traits to Interbull. In the international evaluation for stillbirth, Canada, the Scandanavian countries Denmark, Finland and Sweden, and Israel also send breeding values based on heifer data only. Those correlations increased on average by 0.14 to a level of 0.80 for direct livability and increased by 0.11 to a level of 0.88 for maternal livability. Correlations with the other countries remained the same and are at a lower level. Possible causes for the lower correlations are the parities on which the breeding value is based and whether the same additive genetic effect is used as breeding value for maternal livability. The maternal grandsire effect in a sire model is not the same as the dam effect in an animal model. Harmonisation in trait definition is necessary to obtain high correlations between countries.

Table 2. Interbull correlations for livability for the Netherlands with other countries in April 2011 and difference with December 2010

	Direct livability		Maternal livability		
country	corr.	diff.	corr.	diff.	parity*
CAN	0.83	0.16	0.95	0.14	1
DFS	0.81	0.14	0.96	0.12	1
ISR	0.75	0.12	0.72	0.08	1
FRA	0.69	-0.01	0.84	0.04	1-9
USA	0.65	-0.02	0.81	0.02	all
CHR	0.62	0.01	0.82	0.06	all
ITA	0.47	0.02	0.40	-0.01	?
CHE	0.46	0.00	0.54	-0.02	all
HUN	0.46	0.00	0.41	0.00	?
AUS	0.38	0.02	-	-	2+
average	0.61	0.04	0.72	0.05	

* parities included in breeding value sent to Interbull

4. Conclusions

A multiple trait animal model with correlated direct and maternal effect was successfully implemented in the breeding value estimation for livability traits in the Netherlands:

- This resulted in a better estimation of the maternal effect. because of the use of a full relationship matrix.
- Reliabilities increase. especially for the heifer traits. because of increased heritabilities and the multiple trait setting.
- The breeding goal has changed towards breeding for more live-born calves from heifers to change the negative phenotypic trend.
- Interbull correlations with some countries increased.

5. References

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