From Functional to Productive Longevity in the Netherlands

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Abstract

The breeding value for functional longevity in the Netherlands will be replaced by a breeding value for productive longevity from January 2008 onwards. The breeding value for productive longevity will be expressed in days, the genetic standard deviation is 270 days. The heritability of productive longevity is 0.12. The genetic trend for productive longevity is higher than for functional longevity. For protein, udder depth and interval calving to first insemination the difference in correlation with functional and productive longevity was quite large. Productive longevity will replace functional longevity in the Dutch total merit index from January 2008 onwards. The total weight of production in the Dutch total merit index will stay the same after the introduction of productive longevity. The correlations of productive longevity with longevity traits in other countries decreased on average –0.18 based on results of the Interbull test evaluation of March 2007.

1. Introduction

From August 1999 onwards, breeding values (EBVs) for longevity are published in the Netherlands. The genetic evaluation for longevity in the Netherlands is carried out using the "Survival Kit", version 5.1 (SK, Ducrocq and Sölkner, 1998, Ducrocq, 2002). Many other (European) countries use the SK for the genetic evaluation of longevity. They all have in common that the model contains an effect including level of milk production of the cow. Level of production is added to the model to distinguish voluntary and involuntary culling. In case of voluntary culling, the farmer decides the moment that the cow is culled. In case of involuntary culling, the cow determines the moment of culling. By including production level as an effect in the model, longevity is adjusted for voluntary culling and the EBVs for longevity only include involuntary culling. In this paper longevity adjusted for voluntary culling will be called functional longevity and longevity not adjusted for voluntary culling will be called productive longevity.

Main arguments for the choice of including adjustment for production level in the model were that this would enable to select more effective on involuntary culling, the longevity trait would gather all the information on functionality of the cow and longevity would be independent of production.

During the past few years some discussion came up in the Netherlands about the trait definition and the expression of the breeding value of longevity. Main discussion points were that the distinction between voluntary and involuntary culling was not clear to farmers in practice. EBVs for longevity of bulls with high or low EBVs for production were experienced as hard to explain based on phenotypic data in practice.

Therefore, the Dutch Cattle Improvement Organisation (NVO) decided to exclude milk production as an effect from the model of the genetic evaluation of longevity from January 2008 onwards.

The aim of this paper is to give an overview of the results and consequences of the change from functional longevity to productive longevity. The results of evaluations for functional and productive longevity including the same data will be compared.

2. Material and methods

2.1. Data

The data of the August 2006 evaluation for longevity was used for the evaluations of functional and productive longevity. The data included 8.224.924 cow-herd combinations. All daughters of bulls with at least 15 daughters or granddaughters were included in the genetic evaluation. In total 24.612 bulls were included in the pedigree file.

2.2. Methods

The model used for the genetic evaluation for functional longevity is described in Van der Linde and de Jong, 2004. The model for the genetic evaluation for productive longevity was the same as for functional longevity except the exclusion of the effect of intra-herd lactation value of the current and the previous lactation in the model for productive longevity. The lactation value is an economic value combining the profit of kg milk, fat and protein.

Genetic parameters for productive longevity were estimated and used for the estimation of EBVs. The heritability (h^2) of longevity on the original scale was calculated as:

$$h^2_{orig} = \frac{4 \cdot \sigma^2_{sire}}{\left(\sigma^2_{sire} + \sigma^2_{hys} + 1\right)}$$

[1]

where σ^2_{sire} is the sire variance and σ^2_{hys} is the herd-year-season variance.

EBVs for functional and productive longevity were compared in several ways. The correlation between both longevity traits was estimated based on EBVs of bulls with at least 15 daughters. The genetic trend was estimated by calculating the average EBVs per year of birth of the bulls. Birth years with at least 300 bulls with at least 15 daughters in the genetic evaluation and a breeding value with a reliability of at least 35% were included. This group of bulls was also divided into three equal groups based on their ranking for kg of protein within year of birth. Therefore, an additional edit for bulls was a known breeding value for kg of protein. Per group the difference in the average standardised (to genetic standard deviations) EBVs between functional and productive longevity were calculated.

The correlations between phenotypic longevity of the daughters and the breeding value of the bull were calculated for both functional and productive longevity to examine whether this relationship had improved from functional to productive longevity or not. For phenotypic longevity was taken the average number of days alive for bulls with at least 15 daughters that could have reached the age of 60 months after the first calving.

Correlations of functional and productive longevity with other traits for Holstein bulls were estimated. Correlations were estimated to use other traits as predictor for the longevity breeding value of young bulls and to know the differences between the correlations of a trait with functional and productive longevity.

Genetic correlations between countries of the Interbull routine evaluation of February 2007 and the test evaluation of March 2007 were analysed to compare correlations of functional and productive longevity with longevity traits of other countries.

2.3. Expression of breeding value longevity

The breeding value for functional longevity was expressed as a relative breeding value with an average of 100 and a genetic standard deviation of 4.5 point. The breeding value for productive longevity was expressed in days. The argument for changing from a relative to an absolute expression of the EBVs for longevity was that a EBV in days clearly shows the effect of a bull on the longevity of his daughters.

3. Results and discussion

3.1. Parameters

Variance components of functional and productive longevity are in Table 1. The heritability of productive longevity is slightly higher than for functional longevity (0.12 vs. 0.10). The estimated ρ parameters of the Weibull distribution per stage of lactation for parity 1 to 3 were very similar for functional and productive longevity. The maximum difference was 0.06.

Table 1. Variance components of functional (FUN) and productive (PRO) longevity.

Parameter	FUN	PRO
Sire variance	0.030	0.037
Gamma	4.85	4.95
HYS-variance	0.229	0.224
Heritability (original scale)	0.096	0.119

3.2. Comparing breeding values

The correlation between productive and functional longevity was estimated on 0.80 based on EBVs of bulls. The estimated genetic trend for Holstein bulls is presented in Figure 1. The estimated genetic standard deviation of productive longevity is 270 days. Figure 1 shows that the genetic trend for productive longevity is higher than for functional longevity. The regression coefficients of the breeding value of all bulls in Figure 1 on the year of birth is –0.006 (–0.1 % of the genetic standard deviation) for functional longevity and 13.5 (5.0 % of the genetic standard deviation) for productive longevity.

Figure 2 shows the differences in breeding value for functional (FUN) and productive (PRO) longevity expressed in genetic standard deviations (PRO-FUN) for bulls per year of birth per class of breeding value for protein. The breeding value for productive longevity of the group of bulls with a high ranking on protein decreased in the oldest birth years and increased in the youngest birth years compared to functional longevity. The same pattern is visible for the group of bulls with a low ranking on protein but the breeding value for productive longevity of this group decreased for all birth years.

The correlations between the average number of days alive for daughters of a bull that could have reached the age of 60 months after the first calving was 0.629 for functional longevity and 0.774 for productive longevity. So, the relationship between the breeding value for longevity of the bull and phenotypic survival of the daughters has improved for productive longevity compared to functional longevity.

3.3. Correlations with other traits

Correlations of functional and productive longevity with other traits for Holstein bulls were estimated with MACE. Correlations of both longevity traits with some other traits are given in Table 2.

Table 2. Genetic correlations of functional (FUN) and productive longevity (PRO) with other traits.

Trait	FUN	PRO
Protein	-0.13	0.41
Somatic cell count	0.43	0.44
Body depth	-0.38	-0.28
Feet and Legs	0.31	0.23
Udder depth	0.49	0.22
Interval calving-1st insemination	0.27	-0.08

For protein, udder depth and interval calving to first insemination the difference in correlation with functional and productive longevity was quite large. This is as expected because these are production traits or traits with high correlations with production traits. The correlation of somatic cell count with functional and productive longevity is very similar.

3.4. Results Interbull test evaluation March 2007

Genetic correlations for longevity between the Netherlands and other countries were compared between the Interbull test evaluation of March 2007 and the routine evaluation of February 2007 (Interbull, 2007). Results in Table 3 show major changes in the longevity correlations. Average Holstein correlations decreased from 0.79 in February 2007 to 0.61 in the March 2007 test evaluation. The reason is the change in the model from functional longevity (measuring involuntary culling only) to productive life (measuring all culling). Correlations with all countries decreased even with countries that currently have productive life evaluations (Great Britain and United States). Reason for this might have to do with differences in culling strategies. An example is the correlation of productive life with fertility.

Table 3. Genetic correlations between the Netherlands and other countries for functional (FUN) and productive longevity (PRO) for Holstein.

Country	FUN[1]	PRO[2]	PRO-FUN
ALL	0.79	0.61	-0.18
FRA	0.81	0.62	-0.19
DNK	0.89	0.73	-0.16
GBR	0.73	0.64	-0.09
CAN	0.84	0.58	-0.26
ESP	0.72	0.52	-0.20
USA	0.81	0.74	-0.07
DEU	0.82	0.66	-0.16
ITA	0.72	0.40	-0.32

[1] Interbull routine evaluation February 2007
[2] Interbull test evaluation March 2007

In the USA this correlation is 0.51. In NLD this correlation is –0.08. The NLD correlation of fertility with functional longevity is 0.27. Protein correlations are 0.10 in the USA and 0.41 for NLD productive life and –0.13 for NLD functional longevity. Productive life in the USA might be more similar to functional longevity in NLD. Correlations with countries that have functional longevity decreased much more compared to countries that have productive life.

4. Discussion

Including productive longevity into the current Dutch total merit index (NVI) would lead to a higher selection response of production and a lower selection response of the other traits included in the NVI. Therefore the weights in the NVI on production and productive longevity will be adapted in that way that the selection emphasis on production plus longevity and on the other traits in the NVI is the same as in the current NVI. The new weights are not available yet.

5. Conclusions

The heritability of productive longevity is higher than for functional longevity (0.12 vs. 0.10).

The genetic trend of productive longevity is higher than for functional longevity (5.0 % vs. –0.1 % of the genetic standard deviation per year of birth).

Correlations between functional or productive longevity and other traits changed the most for protein (+), udder depth (-) and interval calving to first insemination (-).

MACE correlations between productive longevity and longevity traits of other countries were on average 0.18 lower than for functional longevity.

6. Acknowledgements

Vincent Ducrocq (INRA, France) is acknowledged for providing the software package “Survival Kit”.

7. References

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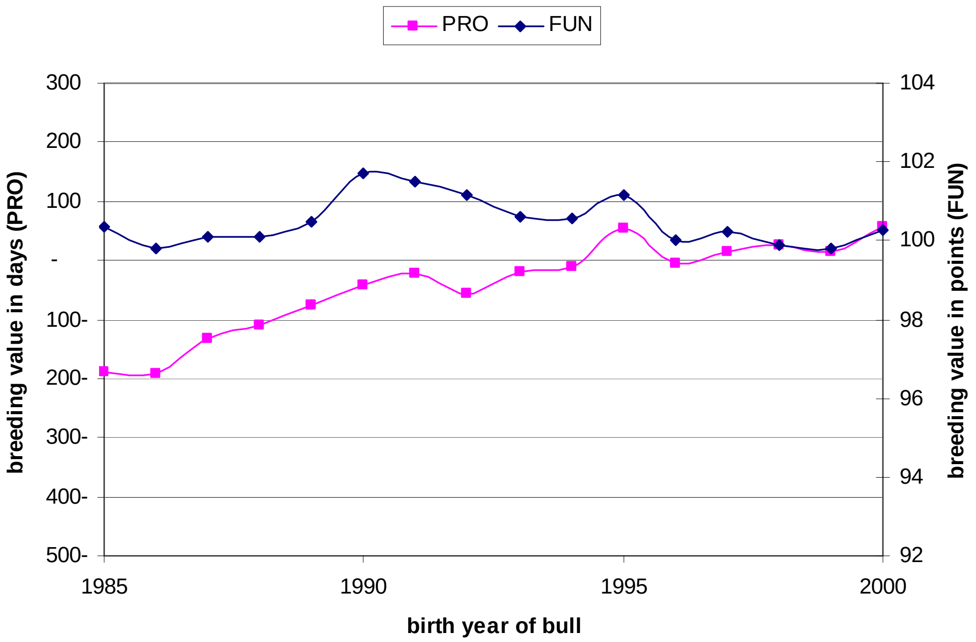

Figure 1. Genetic trend for functional (FUN) and productive (PRO) longevity for bulls per year of birth.

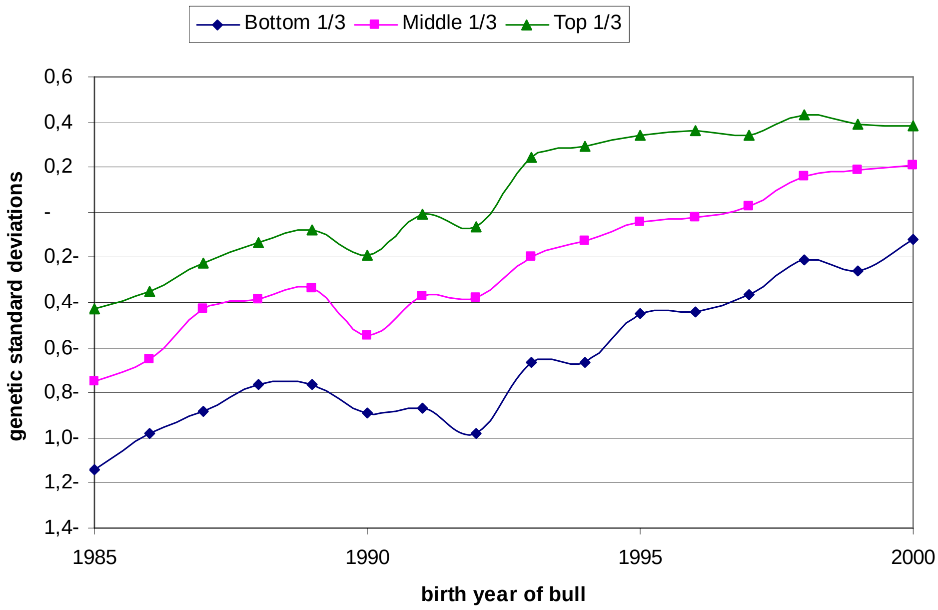

Figure 2. Differences in breeding value for functional (FUN) and productive (PRO) longevity expressed in genetic standard deviations (PRO-FUN) for bulls per year of birth per class of breeding value for protein.