Genetic Evaluation for NR90 of Holstein Cattle in Germany

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Abstract

In Germany, non-return 90 days after first insemination (NR90) is considered to be the most suitable fertility parameter for genetic evaluation. Computer programs for evaluation of breeding values of NR90 were developed at BLT in Grub. Herd-year, season, parity, age at first heifer insemination, interval from calving to first insemination, maternal and paternal genetic effects, and permanent environmental effects were considered in the model. Genetic evaluation of NR90 is carried out separately for the HF populations in East and West Germany because of large differences in herd management and data recording systems in these regions. Genetic trends estimated in the data of East and Western Germany in 1996 are shown. In two subsequent evaluations (1995, 1996) on the basis of data from East Germany, averages of estimated breeding values for paternal effects of the youngest sires were considerably lower than those of older sires. The effects of the additionally included interaction of (status of sire * AI-station of sire * region of insemination) on sire breeding values in East Germany are discussed. Trends in breeding values estimated with the modified model show paternal effects of the youngest sires to be on average within the range of birthyear averages of older sires. Changes in estimates for other effects due to the additional effect were negligible. The estimated paternal breeding values of young sires out of the expanded model are plausible and are better accepted by breeders. The improved model was used for the routine evaluation in August 1997.

1. Introduction

In Germany, all inseminations performed and recorded since 1986 are available for genetic evaluation. Currently, genetic evaluations for fertility are carried out once a year separately for East Germany (the area of the former German Democratic Republic) and West Germany because of major differences in average herd size, herd management systems and data recording systems.

The fertility trait considered is Non-Return 90 days after first insemination (NR90). Data of further inseminations are not used because high yielding cows may be inseminated more often after a return than low producing cows. Also, the farmer may wait longer with the first insemination for high yielding cows. This holds for individual cows within herds as well as for increasing herd production levels (Coleman et al., 1985). Furthermore NR90 is observed earlier than calving interval (Averdunk, 1994).

From the insemination data pool, 12.9 million 1st inseminations from 7.6 million cows in East Germany and 12.6 million records from 7.5 million cows in West Germany were available. Records of cows with lactation number greater than 20 or with an interval from calving to first insemination of less than 20 or more than 200 days were excluded. Records of heifers inseminated at less than 390 or more than 810 days of age also were excluded.

In this paper, the effects of the addition of the interaction (status of sire * AI-station of sire * region of insemination) into the model are shown and discussed. The model was expanded by this effect in order to adjust for extreme and not plausible paternal sire effects in the youngest sire groups.

2. Initial model

Theory and estimation programs were developed by Thaller et al. (1994). The initial model used since 1994 is:

$$NR90 = h*y + s + 1*a/r + a_p + a_m + u_p + e$$

The fixed effects in the model are:
- the interaction of herd (h) * year of insemination (y)
- month of insemination (s)
the interaction of parity (l) * age of first insemination for heifers (a) or parity (l) * interval from calving to first insemination for cows (r)

Random effects included in the model are:
- paternal genetic effect of the sire used for insemination (ap)
- maternal genetic effect of the inseminated animal (am)
- permanent environmental effect of the inseminated animal (up)
- error (e)

The numbers of non-return observations, herd-years, sires, animals and permanent environmental effects in the evaluation system are shown in table 1, separately for the populations in East and West Germany.

3. Results from the initial model

Seasonal effects were larger in the data of West Germany than in East Germany, although patterns were similar. Effects of age at first heifer insemination were more pronounced in East Germany but smallest for medium aged heifers. Effects of interval from calving to first insemination had similar patterns but were larger in East Germany both in first and in second lactation. Differences between the effects of interval from calving to first insemination of the two regions were larger for the first than for the second lactation.

Correlations between the estimated breeding values in East and West Germany were 0.58 for paternal effects and 0.48 for maternal effects (minimum reliability 60 %). In West Germany, the maternal effects on NR90 of the sires born since 1975 were relatively constant whereas the paternal effects on NR90 were gradually decreasing. The paternal genetic effects on fertility of bulls born in 1994 were approximately 2% lower than those of bulls born in 1975. In East Germany, the maternal effects of sires increased for sires born from 1982 onwards, with exception of the birthyears 1988 and 1989. The maternal genetic effects of sires born in 1992 were on average approximately 4% higher than those of sires born in 1982. Paternal sire effects show a slightly favourable trend up to 1992. The sires born in 1993 and especially in 1994 had on average much lower paternal genetic effects.

In order to find out whether the extremely low average paternal effects of bulls born in 1993/94 would still be present after inclusion of more recent data, a test run was made with the same model using data from East Germany up to 1997 (one additional year of data). In figure 1, the average paternal sire effects according to birthyear are presented for the 1997 and the 1996 run. In both evaluations, a similar decline in the sire EBV averages for the last two birthyear groups under evaluation was found. In the 1996 evaluation, especially EBVs of sires born in 1994 and 1993 were affected. In the 1997 test-run, similar effects were found for sires born one year later. Thus, the hypothesis of sires born in 1993 to 1995 having considerably worse paternal effects on NR90 than other bulls could not be supported.

4. Changed model

The drop in average sire EBVs for the youngest sires is in agreement with average EBVs for paternal effects on NR90 of test sires being consistently lower over the last two years than those of proven sires in some regions in East Germany. In the same regions, there were also too many sires with extremely low proofs. In West Germany, similar problems were not observed. Although regional differences were present, it was not clear whether these differences were due to the AI-station of the sire or due to the region of insemination influences. Therefore, inclusion of the interaction among status of the sire (test, proven, non-AI), AI-station of sire and region of the herd was considered to adjust for the not explainable low solutions for paternal effects of the youngest sires. In the first instance, the evaluation for NR90 in East Germany was repeated with the expanded model.

5. Results from the changed model

Differences of fixed effects of month of insemination, age at first heifer insemination, and the interval of calving to first insemination within first and second lactation estimated with the initial model with those estimated with the expanded model generally were negligible. Only the effects of age at first heifer insemination were slightly smaller in the evaluation with the expanded model.
Standard deviations of solutions for herd-year and random effects estimated on the data for the 1997 evaluation with both the initial and the adapted model, and the correlation of estimates for those effects in both models are shown in Table 2. Standard deviations were similar in both models. Correlations between the estimates for herd-year, maternal genetic, and permanent environmental effects were close to 1. This strongly suggests that the influence of the change of the model on effects other than the paternal genetic effect is negligible. The correlation between the estimates for the paternal genetic effects resulting from the two models is still high (0.88) but substantially smaller than 1.

Birthyear averages for paternal effects of sires born before 1991 were, with exception of 1985, similar for both models. The averages within the birthyears from 1991 onwards were all about -0.01.

Correlations between the EBVs in East and West Germany were 0.47 for paternal effects and 0.62 for maternal effects (minimum reliability 60 %) . Trends in the EBVs for maternal effects were similar in both evaluations. Birthyear averages of paternal effects in West Germany remained relatively constant from 1978 up to 1994.

Correlations between estimated breeding values for maternal effects from the 1996 and 1997 evaluations were 0.89 in West Germany and 0.90 in East Germany, for paternal effects 0.75 in West Germany and 0.77 in East Germany.

6. Discussion

Breeding values were estimated for the HF populations in East and West Germany separately because of large differences in herd structure in East Germany and West Germany. As a consequence, the fertility management and recording system in these regions differ. For instance, artificial insemination by the farmer occurs more often in larger herds. Therefore, it is not surprising that fixed effects estimated in the data of East and West Germany show some differences. Correlations between breeding values estimated in both populations are relatively low. The genetic trends are also different.

The effects parity, age at first heifer insemination, and interval from calving to first inseminations are recoded and included in the model as an interaction effect. The advantage of considering the interaction between these effects is that adjustment can be made for parity-related differences in particular stages of the lactation which may be different from the overall parity effect.

The decrease of the proofs for paternal effects of the youngest sires in East Germany estimated with the initial model was not expected based on phenotypic non-return rates calculated by the AI-stations. This drop, however, is not a negative genetic trend since it can not be observed for the same group of sires in the subsequent evaluation. This indicates that the most recent information about inseminations and non return rates may not be complete or the initial model was not optimal.

Therefore an additional fixed effect was included into the model. The additional effect accounts for the status of the sire (test bull, proven sire or non-AI bull), AI-station of the sire (preparation of semen) and region of insemination. Status of the sire was considered since generally semen of proven sires is more expensive. Thus, more care might be taken at the insemination of a cow with semen of a proven sire. The price difference is, however, dependent on the AI-station of the sire. Sires from other regions or from abroad are more expensive than sires from the own AI-station. Furthermore, there might be laboratory related differences in semen quality. The third possible influence not accounted for in the initial model is the region of insemination. Underlying reasons for this effect are possible regional differences in the education of the inseminators or the handling of the semen by the inseminators. This may on its turn depend on where the straws were made. Effects of transport and storage on semen quality may differ among regions too. Because the three effects described appear to be interconnected, the interaction of status of sire, AI-station of sire and region of the herd was added to the model.

Effects of age of first heifer insemination and interval of calving to first insemination * parity in East Germany were similar in the 1996 and 1997 evaluations. Furthermore, solutions for herd year, permanent environmental, and, most important,
maternal genetic effects of all animals in East Germany were not affected by the choice of models (Table 2). Although the correlation between paternal genetic effects estimated with the two models was relatively high, a major change of the average paternal effects of the youngest sires in East Germany can be noticed. In East Germany the youngest sires are now more competitive to older sires considering their paternal effects (figure 2).

Comparison of the estimated trends of paternal breeding values showed that the decline of paternal effects found in the 1996 evaluation did not appear in the 1997 evaluation. Whether this is due to the change in the model or to the additional data is not obvious. However, correlations between estimated sire breeding values were similar for East and West Germany. Thus, the lack of trend in paternal sire breeding values in the 1997 evaluation may be due to the change of the model.

Region of the herd appears to be the minor factor of the interaction in comparison to the other two factors. The interaction of status of sire and AI-station of sire explained 92.5% of the variation caused by the complete interaction.

The results of this study show that the inclusion of the interaction among status of sire, AI-station of sire, and region of the herd in the genetic evaluation model for NR90 results in more plausible paternal proofs of the youngest sire group without considerable influence on estimates of other effects. Because of these results, the modified model was chosen for routine evaluation starting in August 1997.

References


Table 1. Size of the evaluation model for NR90 in West and East Germany

<table>
<thead>
<tr>
<th></th>
<th>Western-Germany</th>
<th>Eastern-Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. observations</td>
<td>11.616.150</td>
<td>12.468.278</td>
</tr>
<tr>
<td>No. herd-yeard</td>
<td>553.793</td>
<td>55.087</td>
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<tr>
<td>No. sires</td>
<td>94.943</td>
<td>46.517</td>
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<tr>
<td>No. genetic effects</td>
<td>9.911.872</td>
<td>7.787.965</td>
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<tr>
<td>(No. animals)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. permanent environmental effects</td>
<td>5.649.842</td>
<td>5.153.942</td>
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</table>
Table 2. Standard deviations of herd-year and random effects under the initial and the expanded model and correlations of the estimates out of the two models

<table>
<thead>
<tr>
<th>effect</th>
<th>standard deviation in the initial model</th>
<th>standard deviation in the test model</th>
<th>correlation</th>
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<tbody>
<tr>
<td>herd-year</td>
<td>0.194</td>
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<td>0.9955</td>
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<td>paternal genetic</td>
<td>0.012</td>
<td>0.011</td>
<td>0.8803</td>
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<tr>
<td>maternal genetic</td>
<td>0.018</td>
<td>0.019</td>
<td>0.9987</td>
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<tr>
<td>permanent environmental</td>
<td>0.028</td>
<td>0.028</td>
<td>0.9997</td>
</tr>
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</table>

Fig. 1: Trend in estimated sire breeding values for paternal effects for NR90 in two consecutive evaluations with the initial model for Eastern-Germany

Fig 2: Trend in estimated sire breeding values for paternal effects for NR90 in with the initial and with the expanded model for Eastern-Germany