Joint Genetic Evaluation for Fertility in Austria and Germany

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Abstract

Breeding values for male and female fertility will be estimated jointly for Austria and Germany starting in November 2002. The fertility trait used is non-return rate 90. About 13 million Simmental and 3 million Brown Swiss records from Germany and Austria are included in the evaluation. Breeding value estimation is performed with the computer program MiX99 for all breeds except Holstein. The fixed effects region*year*season, herd*year, inseminator*year, parity*age at first insemination*days open and the random effects permanent environment, service bull and inseminated cow are included. A slightly different model is used for Holstein. The joint evaluation increases accuracy through additional information and makes estimated breeding values of Germany and Austria completely comparable.

1. Introduction

Fertility can be described as the ability to produce a living offspring during an economically and physiologically approved period (Hyppänen & Juga, 1998). De Jong (1998) defined good cow fertility as an animal in lactation, which shows her heat in time and gets pregnant after the first insemination. From an economical point of view traits affecting the quantity and quality of milk are certainly the most important traits in dairy herds. However, functional traits affect the economic efficiency by reducing costs. In the economic total merit index in Austria, fertility has an economic weight of approximately 10% for Simmental and 12% for Brown Swiss (Miesenberger, 1997; Miesenberger *et al.*, 1998). Breeding values for fertility have been routinely estimated in Germany since 1994 and in Austria since 1995 for both countries separately. Currently, Germany and Austria are working on the implementation of a joint breeding value estimation for all traits and all breeds. Implementation should be finalised by November 2002. Austrian Holstein data will be included in the German evaluation which is performed by VIT Verden for all traits. Genetic evaluation for fertility for all other breeds, particularly Simmental and Brown Swiss, will be done by ZuchtData in Vienna, Austria. The objective of this paper is to present the joint routine genetic evaluation for fertility for Simmental and Brown Swiss in Austria and Germany.

2. Material and Methods

The current genetic evaluations for fertility are in both countries based on programs by Thaller *et al.* (1994). Only very minor differences exist between the two evaluation systems. The new joint evaluation is based on the program MiX99 (Lidauer *et al.*, 2000) and will be implemented in the routine evaluation in November 2002.

2.1 Data

All inseminations recorded since 1990 from dual-purpose Simmental (Fleckvieh) and Brown Swiss (Braunvieh) cattle are used in the joint genetic evaluation. The fertility trait considered is non-return rate 90 (NR90). NR90 is measured only after first insemination. Further inseminations are not used because high yielding cows may be inseminated more often. Records of cows with days open less than 20 or more than 200 days were excluded. Data of heifers inseminated at less than 360 or more than 960 days of age were also discarded. Data characteristics are shown in table 1. German data are approximately 4-5 times more than Austrian data. The genetic links between the two countries are good. 1168 and 431 service bulls are used in both countries for Simmental and Brown Swiss, respectively.

Table 1. Data characteristics.

	Simmental	Brown Swiss
No. of cows	4,894,866	1,080,948
No. of NR90	12,960,497	2,852,888
Percentage of Austrian data	21.2	23.3
Average NR90 (%)	61.8	60.9
No. of regions	27	26
No. of service bulls	17,225	7,642
No. of service bulls used in both countries	1,168	431
No. of herds	44,380	24,068
No. of inseminators	4,821	2,622

2.2 Model

The model for the separate genetic evaluations in Austria and Germany is (Thaller *et al.*, 1994; Druet, 2002):

$$\mathbf{y} = \mathbf{X_h}\,\mathbf{h} + \mathbf{X_m}\,\mathbf{m} + \mathbf{X_l}\,\mathbf{l} + \mathbf{Z_p}\,\mathbf{p} + \mathbf{Z_c}\,\mathbf{c} + \mathbf{Z_s}\,\mathbf{s} + \mathbf{e}$$

The new model for the joint evaluation is:

$$\mathbf{y} = \mathbf{X_r}\,\mathbf{r} + \mathbf{X_h}\,\mathbf{h} + \mathbf{X_i}\,\mathbf{i} + \mathbf{X_l}\,\mathbf{l} + \mathbf{Z_p}\,\mathbf{p} + \mathbf{Z_c}\,\mathbf{c} + \mathbf{Z_s}\,\mathbf{s} + \mathbf{e}$$

where **y** = vector of NR90; $\mathbf{X_h}$, $\mathbf{X_m}$, $\mathbf{X_l}$, $\mathbf{X_r}$ and $\mathbf{X_i}$ = known matrices relating NR90 to fixed effects; **h** = vector of herd by year of insemination fixed effects; **m** = vector of month of insemination fixed effects; **l** = vector of fixed effects defined for heifers as age at first insemination (16 groups), and for cows as lactation group number (7 groups, lactation 1 to 6 separately and seventh and later lactations grouped together) by days open (11 groups), giving a total of 93 levels; **r** = vector of region by year by month of insemination fixed effects; **i** = vector of inseminator by year of insemination fixed effects; $\mathbf{Z_p}$ = known matrix relating NR90 to permanent environment of the inseminated cow random effects; **p** = vector of permanent environment of the inseminated cow random effects; $\mathbf{Z_c}$ = known matrix relating NR90 to additive genetic female effects (inseminated cow); **c** = vector of genetic female effects (maternal genetic effect); $\mathbf{Z_s}$ = known matrix relating NR90 to additive genetic service bull effects; **s** = vector of additive genetic service bull effects (paternal genetic effect) and **e** = vector of residuals.

Both genetic evaluations are based on an animal model. Two major changes were applied for the joint genetic evaluation. A region effect, which accounts for differences due to different data recording systems and different climatic conditions, was included. This resulted in 8 regions for Austria and 19 for Germany. The inclusion of the region effect in an Austrian data set had almost no effect on the female fertility but considerable effect on the male fertility trait (correlations between EBVs = 0.996 and 0.97, respectively). The inclusion of the inseminator in the genetic evaluation led to very small changes in the EBVs (correlations >0.99 for male and female fertility). A slightly different model is used in the Holstein evaluation (Pasman & Reinhardt, 1998).

The heritabilities used in the routine evaluation are 0.02 for male and female fertility each. The repeatability is 0.03 and no correlation between male and female fertility is assumed. Heritabilities estimated on Austrian Simmental data were approximately 0.01 for male and female fertility (Druet, 2002).

2.3 Publication of estimated breeding values

The genetic evaluation for fertility for bulls and cows will be carried out at the same points in time as for milk. Breeding values for male and female fertility are published as relative EBVs with a mean of 100 and 12 points for one genetic standard deviation. The base population for the relative breeding values is rolling. Currently it consists of sires born between 1991 and 1993. The EBVs of the cows are only included in the total merit index and not published separately. The reliability is calculated approximately.

3. Results and Discussion

3.1 Fixed effects

The effect of the different regions on NR90 is shown in figure 1 for Simmental. Very large differences can be observed between the regions within country and across countries. The main reason for the marked differences are the different data collection systems. Some regional problems particularly exist in Austria, where the collection of the inseminations is not complete which is leading to higher NR90.

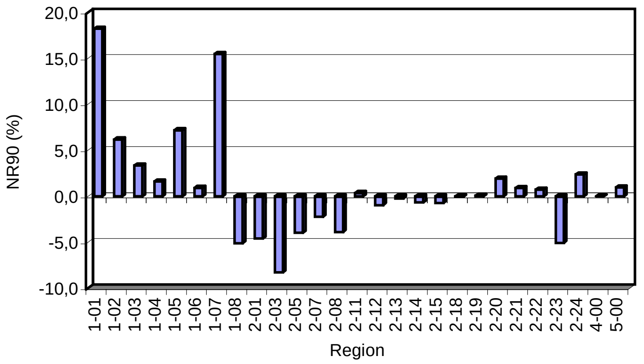

Fig. 1. Effect of region on NR90 (Simmental).

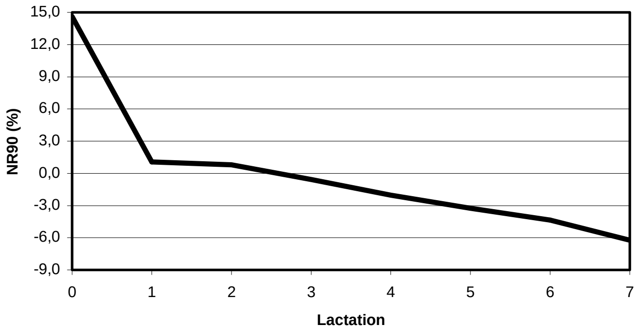

Fig. 2. Effect of parity on NR90 (Simmental).

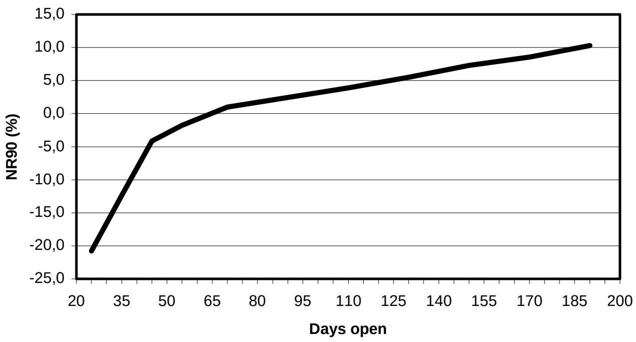

Fig. 3. Effect of days open on NR90 (Simmental).

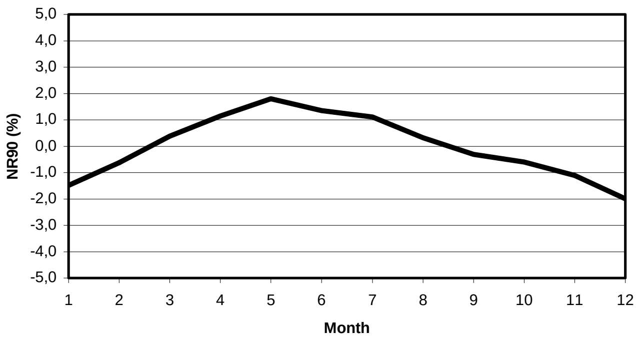

Fig. 4. Effect of month on NR90 (Simmental).

The effect of parity on NR90 is presented in figure 2. NR90 decreases with increasing parity. The effect of the inseminaton as heifer is approximately 15% above average. The decrease in higher parities is slow and might be caused by lactational stress or higher reproductive disturbances (Thaller *et al.,* 1994).

The length of days open is mainly determined by the farmer. To eliminate this management effect days open is included in the model. NR90 increases rapidly by increasing days open up to about 60 days (figure 3). The effect of month of insemination is much smaller and shows higher NR90 during the summer months (figure 4). The effects of the age at first insemination and of the inseminator are small (results not shown).

3.2 Genetic effects

The estimated genetic trends for the joint Austrian-German Simmental and Brown Swiss populations are shown in figures 5 and 6. The average breeding values per year are fluctuating slightly, showing no marked positive or negative trend over time.

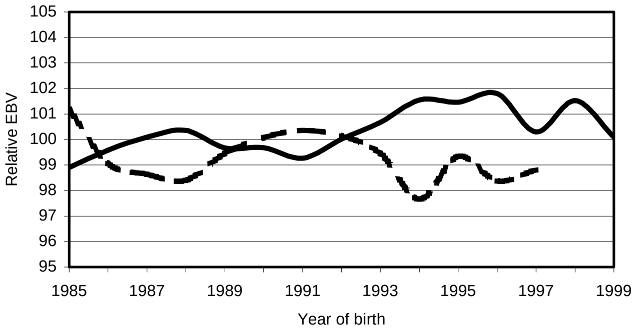

Fig. 5. Genetic trend for the bull population of Simmental (male fertility = solid line, female fertility = dashed line).

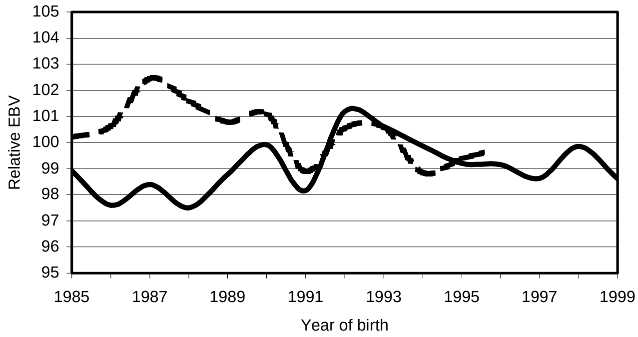

Fig. 6. Genetic trend for the bull population of Brown Swiss (male fertility = solid line, female fertility = dashed line).

4. Conclusions

Joint breeding value estimation for functional traits based on raw data is particularly important to improve accuracy. Austria and Germany are in the process of developing joint genetic evaluations for all traits. Evaluations for type traits and functional longevity (Fuerst & Egger-Danner, 2002) are already implemented in the routine evaluation. All further traits will be estimated jointly until November 2002. Finally a joint total merit index will be developed, which comprises milk, beef (depending on the breed) and fitness traits according to their economic importance. Model calculations show that without inclusion of functional traits in an index, most of them will deteriorate while small positive responses may be expected under selection for an index (Sölkner & Fuerst, 2002). The joint evaluation requires much computational effort but increases accuracy through additional information and makes estimated breeding values of Germany and Austria completely comparable.

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