JOINT GENETIC EVALUATION FOR FUNCTIONAL LONGEVITY IN AUSTRIA AND GERMANY

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INTRODUCTION

After lactation yield, length of productive life is the second most important trait in dairy production (Allaire and Gibson, 1992). A long productive life of a cow helps to reduce replacement costs, and the full milking potential is only attained in later lactations (Essl, 1982). Ducrocq (1987) distinguishes between culling caused by poor lactation production and culling that is due to fitness problems. In cattle breeding the functional length of productive life (fLPL) is of interest. The fLPL is independent of production and other effects having a systematic influence on length of productive life.

In Austria breeding values for fLPL have been routinely estimated for bulls and cows since 1995 (Fuerst and Sölkner, 1997) using survival analysis.

Currently Germany and Austria are working on the implementation of a joint breeding value estimation for all traits. Implementation should be finalised by November 2002. Breeding values for longevity have been estimated jointly since November 2001. Compared to the former Austrian evaluation the model for survival analysis was changed from the Cox model to the Weibull model, which allows inclusion of time-dependent effects. The objective of this paper is to present the joint routine genetic evaluation using survival analysis for Simmental in Austria and Germany.

MATERIAL AND METHODS

The current and the former breeding value estimation for fLPL are based on models of survival analysis, which allow the inclusion of censored records.

Data. Data consist of all dual-purpose Simmental cows in Germany and Austria with first calving from 1979 onwards. Length of productive life is defined as the time from first calving to culling. Cows still present in the herd or sold for dairy purposes are included as right-censored. 20.4 % of all records are right-censored.

Table 1. Number of cows from the different regions

	Cows
Bavaria	4,245,178
Baden-Württemberg	660,248
Germany (other regions including Luxemburg)	58,552
Austria	1,099,847
Total	**6,063,825**

Current model. Breeding value estimation is performed with the computer program Survival Kit (Ducrocq and Sölkner, 1998a and 1998b). A Weibull hazard function is assumed for the baseline hazard function, which allows the inclusion of time-dependent effects. Instead of assuming one class of an effect to hold for the entire longevity period of a cow, an effect can change over time.

The hazard function is modelled as:

$$\lambda(t, z(t)) = \lambda_0(t) * \exp(z(t)'\beta)$$

where $\lambda(t, z(t))$ is the hazard function of an individual depending on time t, $\lambda_0(t)$ is the baseline hazard function assumed to follow a Weibull distribution, and $z(t)$ is a vector of (possibly time dependent) fixed and random effects with corresponding parameter vector ß.

The following effects are included in the model:

Region x year x season: This time-dependent year-season effect assumes that there are systematic differences between the 92 production regions.

Herd x year x season: A time-dependent year-season effect with changes on April 1 and October 1 should account for different culling policies due to the milk quota system.

Age at first calving: is the time-independent age at first calving with classes between 20 and 40 months.

Parity x stage of lactation: A time-dependent combined effect of lactation number and stage of lactation (1d-60d, 60d-180d, >180d) is also included as a fixed time-dependent effect.

Relative milk yield: This time-dependent effect is calculated by dividing the milk production (adjusted for parity) of a cow by the mean of the milk yields (adjusted for parity) of her herdmates for all lactations.

Relative fat- and protein content: The same procedure is applied as for relative milk yield.

Change of herd size: Major changes in the herd size due to changes in the management policy have a major impact on the risk of culling. This effect was not considered for herds with less than 8 cows. Otherwise 5 levels of change in herd size were defined (≤-50%, -49% to -16%, -15% to +15%, +16% to +49%, ≥ +50%).

Alpine grazing: In Austria alpine grazing is (in some regions) of major importance and is therefore included as a fixed time-dependent effect.

Genetic effect: A sire-maternal grandsire model is used instead of an animal model because of restrictions in computing capacity. EBVs for longevity of cows are calculated in an approximate two step procedure with the application of a sire-maternal grandsire frailty model and the estimation of the component of the animal's own additive genetic value (Ducrocq, 2001). Parameters needed for the survival analysis for longevity records to predict breeding values were estimated on data of Austrian Simmental using the formula of Yazdi *et al*. (2002):

$$h^2 = 4\sigma_s^2 / (\sigma_s^2 + 1)$$

The parameter estimation resulted in a heritability for fLPL of 0.12.

Former model. From June 1995 till August 2001 breeding value estimation for fLPL was carried out in Austria with a Cox model (Egger-Danner, 1993; Egger-Danner and Sölkner, 1994) on basis of an animal model. The model accounted for a strata effect describing the herd x year x season, age at first calving, the relative milk yield and relative fat and protein content. It was not possible to include time-dependent effects, so that the last two effects were calculated as averages over the lifetime of a cow.

Publication of estimated breeding values and reliabilities. The genetic evaluation for fLPL for bulls and cows is carried out every three months. The relative risk is transformed to breeding values with a mean of 100 points 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. Censored records are not used, but daughters, granddaughters, paternal half-sibs and nieces are included.

RESULTS AND DISCUSSION

The correlation between the EBVs of Austrian Simmental bulls from August 2001 and from Austrian bulls jointly estimated in November 2001 is 0.64.

By analysing the reasons for the low correlations between the former EBVs for fLPL and the current model a study was carried out on a reduced dataset of 178,238 records. The same cows and same information were available in the reference dataset. The model was extended stepwise by one effect and correlations between EBVs were calculated. The correlation between the current Weibull model with the time-dependent effects and the former Cox model was 0.79. The inclusion of the time-dependent parity x stage of lactation, the change from the stratification to a time-dependent herd x year*season effect and the change in the definition of the relative milk yield and relative fat and protein content led to a reduction of the correlation of approximately 0.05 each. Change from Cox to the Weibull model resulted in 0.02 difference of the correlation.

Genetic Trends. Figure 1 contains the genetic trends of functional longevity for Austrian and German Simmental bulls born between 1975 and 1995. In contrast to a slight decrease in average phenotypic longevity during the last years, the genetic level is rather constant so far.

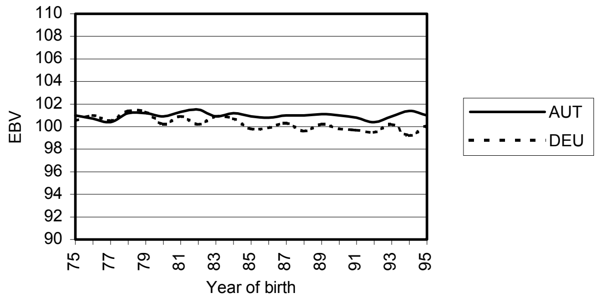

Figure 1. Genetic trend for functional longevity of Austrian and German Simmental bulls.

Effects. From figure 2 we may conclude that the relative milk yield as well as the relative fat and protein content have a large impact on the culling risk of a cow. The risk of a cow with a milk production one standard deviation below herd average is double compared to an average producing cow.

Figure 3 shows the different culling policies in the first and later lactations. The risk of culling is very high at the beginning of the first lactation and decreases over time. In the later lactations the risk of culling increases slightly within the lactation, but decreases with lactations.

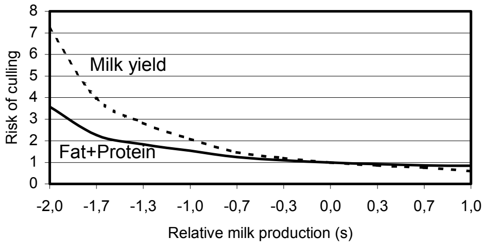

Figure 2. Effect of relative milk yield and fat+protein content within herd.

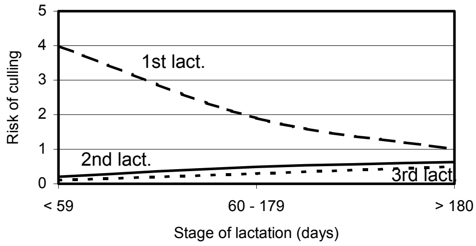

Figure 3. Effect of parity x stage of lactation.

The risk of culling is highly dependent on the change in herd size. If the number of cows is shrinking by 50%, the risk of culling of cows is 1.5 times higher than in a herd with stable herd size. For cows with alpine pasturing the risk of culling is reduced by 50%. The risk of culling increases slightly with higher age at first calving.

CONCLUSION

The joint evaluation of breeding values for fLPL with the clearly improved model and the additional information resulted in significant changes in the breeding values for functional longevity of bulls and cows. The joint evaluation requires much computational effort but increases accuracy through additional information and makes estimated breeding values of Germany and Austria completely comparable. A further improvement will be the inclusion of type traits as early predictors for fLPL in the future (Sölkner and Fuerst, 2002).

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