Calculation of Persistency Proofs from the German Multi-Lactation Model for Production Traits

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Introduction

In Germany a Multiple Trait Individual Animal Model was introduced in June 1991 to estimate uniformly breeding values for all dairy cattle. The breeding values are estimated separately for milk-, fat-, and protein-kg. Records from 1st, 2nd, and 3rd lactation are used, with first lactation being subdivided into three parts of 100-days each. These three 100 day parts from first lactation, the second lactation and the third lactation are considered as 5 genetically different traits in a multitrait model. Definition of 100 day periods allows for early genetic evaluation of young animals without projection of lactations in progress and also avoids extension of terminated lactations. The main reason for application of a multitrait model instead of a repeatability model was, that no transformation of first and second lactation records to mature equivalent was necessary. Without proper adjustment factors for parity many repeatability models showed problems with genetic trend estimates (e.g. Bonaiti et al., 1993), whereas no problems with biased genetic trend could be found in the German genetic evaluation system.

Due to the multi-trait approach each animal receives 5 EBVs with a proper weight on the included information (own performance or relatives' performance). Additional information about performance in different part lactations can be exploited either by putting different economic weights on the various part-lactation proofs or by calculating persistency measures from part lactation proofs, e.g. EBV part-lactation 3 to EBV part-lactation 1. Different weighting of part-lactation proofs is used for the index for milk production on Simmental cattle, with a 7% higher weight on part-lactations 2 and 3 compared to first 100 days. First, second, and third lactation have weights of .328, .297, and .375, respectively (Graser and Averdunk, 1991). On a study on Holstein cattle (Reents, 1992) only very small rank shifts could be observed using these weights, compared to an equal weighting of all part lactation EBVs as it is practiced in the Holstein breed. Therefore in the present study for the Holstein breed some persistency measures were examined and also compared to directly evaluated persistency traits.

Material and Methods

The statistical model for the official genetic evaluation for production traits in Germany is:

$$y_{ijm} = HYS_{im} + a_{jm} + e_{ijm}$$

where y_{ijm} is the yield of cow j in part-lactation m, HYS_{im} is herd x year of calving x season of calving i (fixed), a_{jm} is animal additive genetic effect(random), and e_{ijm} is a random residual. Yields are precorrected for age of calving, calving interval and standardized for within herd x year variation. Table 1 displays genetic parameters used for evaluation of milk yield.

Genetic evaluation for four persistency traits as proposed by Sölkner and Fuchs (1987) were carried out using first lactation data on Holstein cows calving from 1990 to 1995. Definition of persistency was:

Tomax2 = Maximum Milk yield in first 200 days / Mean milk yield in first 200 days

Tomax3 = Maximum Milk yield in 305 days / Mean milk yield in 305 days

SD2 = Standard deviation of milk yield in first 200 days

SD3 = Standard deviation of milk yield in 305 days

The statistical model of analysis was:

$$y_{ijkl} = HYS_i + Age_j + a_k + e_{ijkl}$$

where y_{ijkl} is persistency measure of cow j, HYS_i is herd x year of calving x season of calving (fixed), Age_j is age of calving (in months, fixed), a_j is animal additive genetic effect (random), and e_{ijkl} is a random residual. Heritabilities used were as reported by Sölkner and Fuchs (1987). Similar estimates were reported from Swalve (1994) on German Holstein data.

Tomax2/m, Tomax3/m, SD2/m, and SD3/m are the same persitency measures as defined before but with an additional effect of average milk yield of first lactation as class variable in the model. Table 2 displays statistics of the analysed persistency traits. Ratio of EBV_1/EBV_{23} is defined $EBV_{1\text{-}100}$ / ($EBV_{101\text{-}200}$ + $EBV_{201\text{-}305}$) and was calculated from September 1995 official genetic evaluation. As opposed to other studies ratio of part- lactation was reversed because then high values indicate low persistency like the other investigated persistency traits (e.g. Tomax2, SD2 etc.). Other ratios like EBV1/EBV3 etc. were also examined but results are not shown because EBV_1/EBV_{23} had a very high correlation to the other ratios.

Cows with persistent lactation curves could have lower health problems and this might be reflected in lower disposals during first lactation or during lactations 2 or 3. Therefore effect of various persistency measures on number of disposals was also investigated.

Calculation of relative breeding values for part lactation traits

The multi lactation model provides breeding values for all part lactations. The easiest way of expressing the genetic level of the EBV along with the persistency of the lactation is to standardize all part lactation EBVs (with a mean of 100 and a standard deviation of 12 points). Table 3 displays an example for some bulls with their respective standardized values. Compared to direct measures of persistency these standardized values have the advantage, that they display level of EBV together with the persistency profile of an animal. Bulls D and E might be taken as examples for different production in the different part-lactations. Both bulls have the same combined EBV for lactations 1 to 3 but bull D transmits very persistent first lactation, whereas bull E expresses genetic superiority mainly in first 100 days. However, breeders payed only little attention to these values, because together with standardized values for second and third lactation and then also for fat yield and protein yield too many numbers have to be taken into consideration.

Relationship of part-lactation ratios with direct measures of persistency

Table 4 shows correlations between EBVs for different measures of persistency for 1088 AI bulls from western Germany (year of birth between 1985 and 1987 to allow for completed 3rd lactations of the daughters). Correction for milk yield changed EBVs for direct measures only slightly (e.g. SD2 to SD2/m), except for SD3 to SD3/m, where correlation was .87. Figure 1 displays effect of milk yield on persistency measure SD3. Increase of milk yield leads to an increase of SD3, which was already found by several studies (e.g. Sölkner and Fuchs, 1987, Swalve 1994).

Correlation of EBVs for persistency to disposals during first lactation was in a range of .05 (Tomax2/m) up to .17 for SD3/m. Correlation of SD3/m to percentage of cows surviving lactation 3 was .14. Due to the definition of the persistency traits and disposals positive correlations indicate that persistency can have an impact on survival after first lactation and also after lactation 3. This has to be confirmed using evaluations for functional herd life, but unfortunately these evaluations were not available for this study. Correlation of persistency measures to EBV for milk yield of lactations 1 to 3 was also examined. Correlation of EBV1 / EBV23 to EBV15, which is EBV for lactation 1 to 3, was -0.54, whereas correlation between EBVSD3/m and EBV15 was lower with a value of -0.4.

Conclusions

Results from the study of Sölkner and Fuchs (1987), who advocated the use of SD3/m as a suitable criterion for persistency could be confirmed. Ratios for part-lactation EBV from the official German genetic evaluation for production can be used as a persistency measure as well and might not justify to run a separate genetic evaluation for a direct persistency measure like SD3/m to obtain persistency proofs for dairy cattle. As an alternative to separate genetic evaluations for production and persistency, random regression test day models can be applied for genetic evaluation for production traits (Schaeffer and Dekkers, 1994; Jamrozik et. al, 1995). This model allows for individual animals deviation from typical lactation curves, thus as a by - product evaluations for persistency can be obtained by this model (Dekkers et al. 1996). Dekkers et al. (1996) additionally investigated economic aspects of persistency and concluded that economic value of persistency is influenced by costs for roughage and concentrates as well as by average calving interval. Therefore these factors have to be studied under German conditions to apply a proper weight to persistency proofs.

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Tables

Table 1: Genetic parameters for milk yield. Heritabilities on, genetic correlations above and phenotypic correlations below the diagonal

Definition	No	1	2	3	4	5
1. - 100.	1	**0,36**	0,93	0,78	0,82	0,82
101. - 200.	2	0,81	**0,39**	0,90	0,89	0,87
201. - 305.	3	0,57	0,71	**0,30**	0,82	0,82
2nd lactation	4	0,44	0,50	0,39	**0,32**	0,94
3rd lactation	5	0,42	0,47	0,42	0,49	**0,33**

TABLE 2. Statistics of the analysed persistency traits for first lactation cows from western Germany, for definition of traits see text. Milk200 and Milk305 is daily milk yield in the respective part.

	number	Mean	SD	Min	Max
SD2	926299	2,492	1,064	0,000	12,2
SD3	644671	3,312	1,279	0,000	13,0
Tomax2	926299	1,166	0,086	1,000	4,4
Tomax3	644671	1,253	0,115	1,000	2,8
Milk200	926299	21,62	4,080	4,000	46,0
Milk305	644671	19,97	4,041	5,000	46,0

TABLE 3. Standardised proofs for 6 bulls for milk yield, with EBV1 = EBV1-100, ..., and EBV1-5 is standardised EBV for sum of all 5 part-lactations EBVs (=lactation 1 to 3)

Bull	EBV1	EBV2	EBV3	EBV1-5
A	138	131	126	130
B	131	126	121	127
C	125	124	125	127
D	121	123	126	125
E	127	125	120	125
F	125	131	127	125

Table 4: Correlation between EBV for different measures of persistency (1088 AI bulls born between 1985 and 1987)

		1	2	3	4	5	6	7	8	9
1	EBV1/EBV23	-	0,70	0,60	0,73	0.70	0,53	0,64	0,51	0,70
2	EBV Tomax2		-	0,91	0,83	0.80	0,71	0,83	0,46	0,67
3	EBV Tomax2/m			-	0,75	0,79	0,88	0,91	0,60	0.62
4	EBV Tomax3				-	0,98	0,66	0,77	0,72	0,91
5	EBV Tomax3/m					-	0,73	0,80	0,80	0,91
6	EBV SD2		symmetric				-	0,97	0,74	0,64
7	EBV SD2/m							-	0,71	0,72
8	EBV SD3								-	0,87
9	EBV SD3/m									-

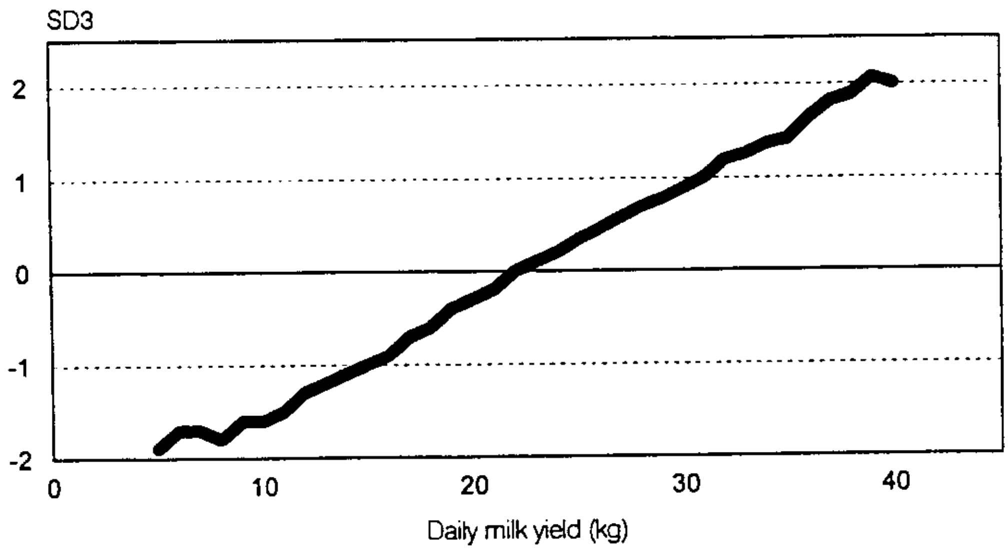

Figure 1: Solutions from MME for effect of average daily milk yield on persistency measure SD3.