Effect of True *vs* Approximate Variances on Selection for Yield Traits in Bulgarian Jersey-Type Rhodopa Cattle

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Summary

The effect of using accurate genetic parameters *vs* approximate ones on average EBVs for three proportions of selection of sires and bull-dams of Bulgarian Jersey-type Rhodopa cattle was studied by DFREML repeatability single trait animal model. Average EBVs slightly decrease when inaccurate heritabilities and repeatabilities were used. Percentage of missranked cows and bulls varied from 12% to 25.5% for milk and fat yields and from 22.3 to 44.0% for fat percentage. Discrepancies were higher for bull-dams and for more intensive selection. Although the effect of approximate genetic parameters on total selection merit resulted in underestimation of EBVs up to 0.082 genetic SD.

Introduction

Obtaining EBVs as a selection tool by an appropriate model is one of the possibilities for improving the breeding response. In most countries various genetic parameters are in use for the purpose of national evaluation of cows and bulls (Interbull bulletin, 1992). In Bulgaria the applied values for heritability and repeatability of yield traits are mostly taken from the literature and are not based upon population studies. Thus the effectiveness of selection may be influenced to some extent by the use of inaccurate values of corresponding genetic parameters.

Contemporary model for genetic assessment in Bulgaria is a repeatability animal model (AM) with constant genetic parameters across all breeds for the yield traits (Instruction of NSSR, 1993).

Having in mind the existing opportunities to meet the requirements of current standards in genetic evaluation and the possibility for comparison of methodology through the Interbull project this report was directed towards defining of the most appropriate model for the country purposes.

The objective of the study was to test the effect of using the model with correct variances vs currently accepted genetic parameters on average EBVs of selected bulls and bull-dams, as well as the change of their ranking when an approximate model was applied.

Material and Methods

Milk and fat yields and fat percentage records up to third lactation of Bulgarian Jersey-type Rhodopa cattle were obtained from the National Service for Selection and Reproduction (NSSR). Data comprises 5980 lactations, of which 2458 first, for the years of calving 1962-1994. The number of used bulls are 153 over cows spread in eight herds. Other characteristics of the data structure are given in Table 1.

Variance components and genetic parameters for the examined traits were obtained by a multivariate single trait REML repeatability AM, accounted for lactation number and herd-year-month as fixed effects, as well for animal additive and permanent

environmental random effects:

$$Y_{ijkn} = H_i + L_j + a_n + p_k + e_{ijkn} \quad [1]$$

where

H_i is the fixed effect of the i^{th} herd-year-month of calving
L_j is the fixed effect of the j^{th} lactation
a is the random individual animal effect and
p is the random effect of the k^{th} permanent environmental level and
e_{ijkn} is the residual effect.

The estimated variances were:

Var (a) = $\mathbf{A}^{-1}\sigma^2_a$ and Var (p) = $\mathbf{I}\sigma^2_p$.

Data was analyzed by MTDFREML set of programs (Boldman et al., 1993).

Numerator relationships were accounted for as described by Quaas (1976) including paternal grandsires. The first genetic evaluations for the EBV's were with variances at apparent conversion, e.g. V(-2*log*L) of 10^{-10} (**TEBV**), whilst the second evaluations corresponded to the genetic parameters currently accepted in the national system (**CEBV**) for predicting of breeding values. The average TEBVs and CEBVs were expressed as fraction of the genetic standard deviation - $(\Sigma_i^{nk} EBV/n_k)\ \sigma_a^{-1}$, where n is the number, and k is the proportion of selected animals: 1,2 and 10% cows and 5,10 and 20% bulls.

Compaired breeding values were expressed as difference of average TEBV and CEBV for k^{th} selected top portions. Additionally the effect of selection was represented by the number of cows and bulls that dropped out from selection, when current model of evaluation was applied.

Results and discussion

*1. **Summary of average characteristics.*** Table 2 shows 2269.46 litres of milk yield, 109.81 kg fat yield and 4.83 percents of fat. Variation of the examined traits is highest for fat yield -31% and lowest for fat percentage -8.44, while for milk yield was 29.56. The minimal and maximal values are: 1000 and 5313 for milk, 41 and 250 for fat yield and 2.19 and 6.0 for fat percentage respectively.

*2. **Variances and genetic parameters.*** Table 3 lists estimates of the variance components for the additive (a), permanent environmental (p) and residual effects (e). There are given also the corresponding proportions of the total variance - heritability (h^2), repeatability (R) and the permanent environmental one (p^2).

The obtained heritabilities for milk yield are 0.16, for fat yield -0.13 and for fat percentage -0.25. These values are much lower than the currently accepted ones for national evaluation procedure. The estimates of permanent environmental proportions for milk and fat yields slightly exceed current proportions, while for the fat percentage p^2 is implicitly tending to zero (10^{-8}). The repeatability estimates are slightly lower than the accepted coefficients for the national evaluation system.

The results show that some differences may be expected due to lower heritabilities for milk and fat yields, while for fat percentage these reasons may be more complex, e.g. lower heritability and repeatability.

*3. **Average breeding values (TEBV) for selected cows and bulls.*** In Table 4 are presented the average TEBV expressed as fraction of the corresponding genetic standard deviation for each trait. For simulated proportions of selected cows (1, 2 and 10 percents) the TEBV's for milk yield are 1.57, 1.35 and 0.89. For fat yield the same values are 1.50, 1.32 and 0.88. Similar figures are observed for the fat percentage -1.35, 1.17 and 0.80.

The same-way tested proportions but for 5, 10 and 20% for selected bulls give values of 1.31, 0.99 and 0.70 for milk yield, 1.25, 0.94 and 0.70 for fat yield and 0.91, 0.71 and 0.55 for fat percentage.

*4. **Differences between TEBV and CEBV due to applied h^2 and R.*** In Table 4 are also given the differences between average TEBV and CEBV for the same as above examined proportions of selected animals - 1, 2 and 10% for cows and 5, 10 and 20% for bulls. In all cases the differences between averages were positive,

which means that using the approximate values for heritability and repeatability leads to an underestimation of the best selected animals. For fat yield and fat percentage for cows there is a tendency for reduction of the difference with the decreasing of proportion of selection. For bulls the same tendency is observed for milk and fat percentage. The exceptions from these similarities are the differences for milk yield for cows and for fat yield for bulls. A general tendency for decreasing difference in EBVs with the augmentation of selected animals from alternative models was also found for yield traits in Holsteins (Dimov et al., 1996).

An unexpected result seemed to be the positive difference. In conditions, where estimated genetic parameters are lower than practically applied, corresponding breeding values TEBV should be smaller than CEBV. A study of individual differences may clear some of these discrepancies.

5. Percentage of cows and bulls excluded from selected groups

Results from the comparison of cow list (Table 4) evaluated using both sets of parameter values does not coincide to a certain extent. For milk yield the differences range from 12 to 27.5%, for fat yield - from 22.3 to 25.5% where for the fat percentage figures are higher giving differences from 22.3 to 44.0%.

For bulls these inconsistency tended to be lower and are in the scope of 10.0 - 14.3% for milk yield and fat percentage, and 14.3 to 23.3% for fat yield.

As the inconsistency of the genetic parameter estimates - applied and estimated was higher as the percentage of cows, wrongly included in the selected list increased. This percentage is relatively lower for milk and fat yields, while for fat percentage, where both parameters, for additive and permanent environmental effects differ (Table 3), wrongly selected bull-dams exceed 40%.

In spite of that discrepancy, the effect on the average EBV of selected group seemed to be small (Table 4). These results give an impression that genetic evaluation based even on approximate variances may ensure an appropriate criteria for selection.

Conclusion

The use of approximate vs accurate genetic parameters in genetic evaluations for yield traits may lead to an underestimation of the genetic level of selected animals, both cows and bulls. When a fixed number or proportion of selection is practiced the list of selected cows and bulls may differ, sometimes considerably, but it seems that the lost of merit is not as remarkable. Although the national standard evaluation methodology gives an acceptable basis for selection, there is a necessity for a further, extended research on genetic evaluation based upon estimated parameters as regards the entire dairy cattle population. Such work will throw more light on the changes in the accuracy of selection criteria.

References

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Table 1. Data structure

Number of bulls	153
Number of first lactations	2458
Number of lactations	5980
Number of herds	8
Year of calving interval	1962 - 1994
Rank of A^{-1}	3557
Herd-Year-Month levels	1352
Permanent Environment levels	2564
Rank of MME	7476

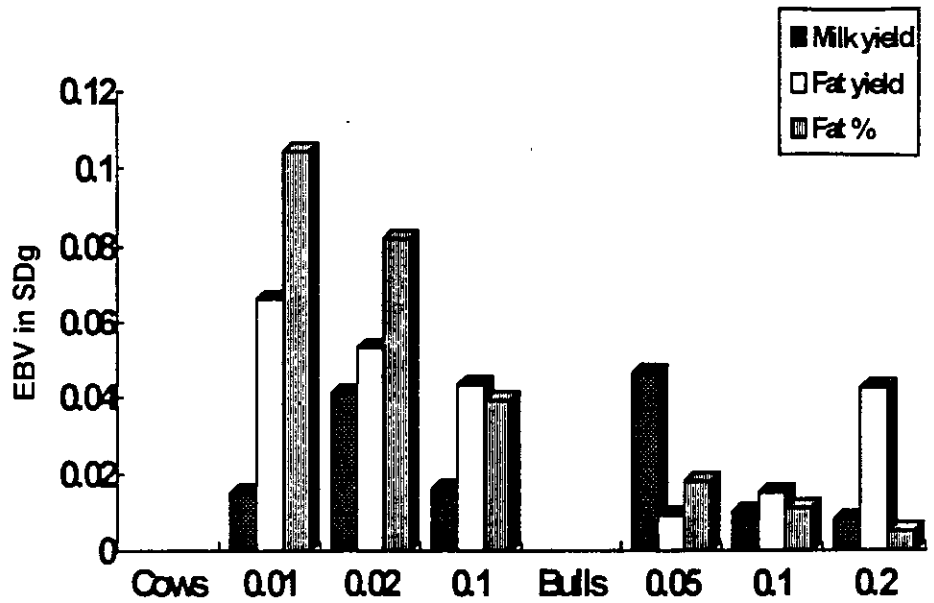
Table 2. Averages for yield traits of Jersey-type Rhodopa cattle

Characteristics	Milk yield	Fat yield	Fat %
Average	2269.46	109.816	4.83294
SD	670.887	34.0485	0.407908
CV	29.56	31.01	8.44
Min	1000.0	41.000	2.1900
Max	5313.0	250.00	6.0000

Table 3. Variances and genetic parameters for yield traits

Variances and genetic parameters	Milk yield	Fat yield	Fat %
		"True" values	
a	49169.35	95.43	0.03024
p	87987.78	213.89	0.00000
e	171515.99	432.37	0.09256
h^2	0.159	0.129	0.246
p^2	0.285	0.288	0.000
R	0.444	0.417	0.246
		Current for the National genetic evaluation	
h^2	0.30	0.30	0.50
R	0.50	0.50	0.60

Difference : TEBV - CEBV



% Missranked

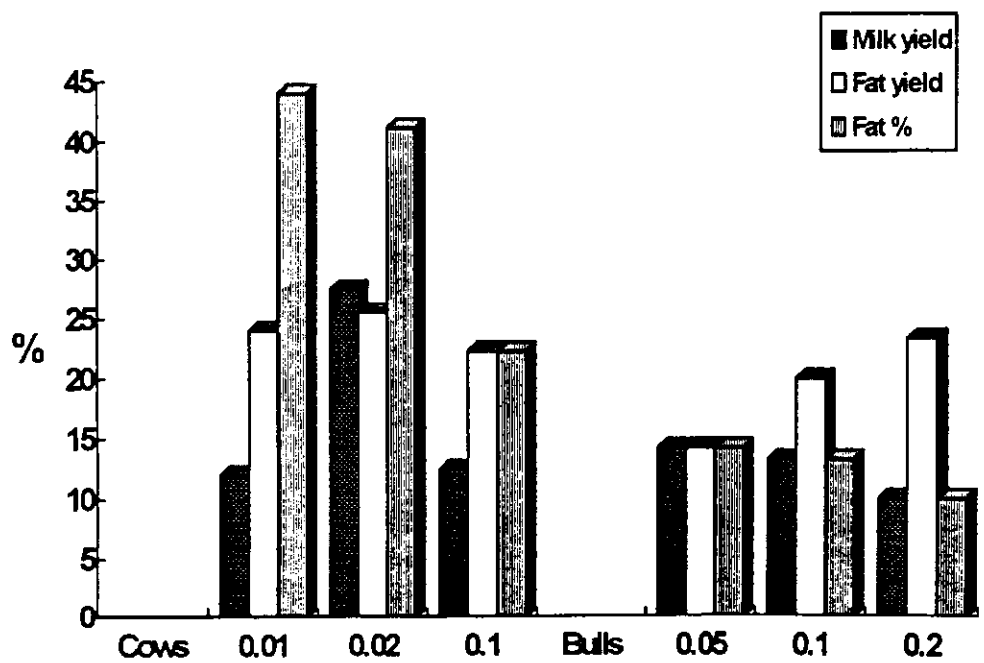


Table 4. Means of estimated EBV as fraction of genetic SD with estimated variances, average difference in EBVs and percentage of cows and bulls, that dropped out from selected groups

% selected by breeding category		Milk yield	Fat yield	Fat %
		Average TEBVs for selected cows and bulls		
Cows	1%	1.57	1.50	1.35
	2%	1.35	1.32	1.17
	10%	0.89	0.88	0.80
Bulls	5%	1.31	1.25	0.91
	10%	0.99	0.94	0.71
	20%	0.70	0.70	0.55
		Difference between "true" and current EBVs in genetic SD		
Cows	1%	0.015	0.066	0.104
	2%	0.041	0.053	0.082
	10%	0.016	0.043	0.039
Bulls	5%	0.046	0.009	0.018
	10%	0.010	0.015	0.011
	20%	0.008	0.042	0.005
		Percentages of cows and bulls that dropped out from the selected group when current vs actual parameters were used		
Cows	1%	12.0	24.0	44.0
	2%	27.5	25.5	41.2
	10%	12.5	22.3	22.3
Bulls	5%	14.3	14.3	14.3
	10%	13.3	20.0	13.3
	20%	10.0	23.3	10.0