Developments in Prediction of Breeding Values in Slovenia

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Abstract

In Slovenia the animal model for lactation milk traits and the sire model for other traits for all dairy breeds (Black and White, Brown and Simmental) were used till the end of the year 2000. In the spring of 2001 the animal model was also introduced to conformation traits, fertility traits, and the animal test day model for all milk traits. Data for all traits and for all three breeds were obtained from national data base, which is owned by Cattle Breeding Service of Slovenia. For all milk traits the repeatability animal model was used, and the animal model for all other presented traits. Heritabilities and all other variance components are acceptable. As expected, the genetic trend is the greatest for milk, fat and protein yields. From the point of view of national selection it is important that results on breeding value prediction are available also to farmers. Each farmer can become our member and browse through our data warehouse. On the basis of this data a farmer can make a decision which animal to select for breeding.

Keywords: Cattle selection; Dairy breeds; Animal model; Slovenia

1 Introduction

In Slovenia the animal model for lactation milk traits and the sire model for other traits for all dairy breeds (Black and White, Brown and Simmental) were used till the end of the year 2000. In the spring of 2001 the animal model for conformation traits, fertility traits and the animal test day model for all milk traits were introduced. All results are presented at home page of Centre for Expert Work (www.bfro.uni-lj.si/zoo/org/centre/eng/index.htm)

2 Material and methods

Data were processed by SAS software package. We estimated variance components with VCE 4 (Groeneveld, 1998), while breeding values were predicted with our own software by J. Krsnik (Potočnik et al., 2001). For each trait, breeding values were predicted with the same procedure of data collection, statistical model, and result presentation for all Slovenian dairy breeds (Black and White, Brown and Simmental).

2.1 Material

Data for all traits and for all three breeds were obtained from national data base, which is owned by Cattle Breeding Service of Slovenia.

2.1.1 Standard lactation

For all three breeds breeding values for five traits: milk, fat and protein yield, fat and protein content were predicted. After prediction of breeding values, IPF (index breeding values for protein and fat yield) was calculated.

Data on first five lactation, year of calving from 1990 and days in milk from 201 to 650 were used.

2.1.2 Test day

Breeding values were predicted for the same traits as in standard lactation.

Test day records of first five lactation, year of calving from 1990 and days in milk from 6 to 305 were used.

2.1.3 Conformation traits, milking speed and temperament

Breeding values were predicted for 33 conformation traits, milking speed and temperament.

Conformation traits were divided into four parts: body capacity (height of wither (cm), height of rump (cm), body length (cm), chest girth (cm) and scores for body length, size, body capacity overall, body width, body depth); udder (fore udder, rear udder height, rear udder width, udder depth, suspensory ligament, teat thickness, teat length, teat placement, udder overall); type (shoulder, back, rump angle, rump length, rear leg, foot angle, hoof height, hoof form, type overall), and muscularity.

For conformation traits indices for four economic situations were computed (Table 1).

Table 1. Relative weights for conformation indices for each economic situation

	Economic situation			
Traits complex	Milk	Milk - Meat	Meat - Milk	Meat
Body capacity	0.2	0.2	0.2	0.3
Udder	0.5	0.4	0.3	0.1
Type	0.3	0.3	0.3	0.2
Muscularity	-	0.1	0.2	0.4

For traits that were classified by linear scoring system a homogenisation on classifier and year of classification before prediction of breeding values was done.

2.1.4 Fertility traits

Breeding values were predicted for calving interval and age at first calving.

Data were reduced for birth year 1968 and calving year 1971.

2.2 Method

The repeatability animal model was used for all milk traits, and the animal model for all other presented traits. In all cases relationship matrix was prepared in the same way. For animals with records sire, dam, paternal sire and dam and maternal sire were put in a relationship matrix (Potočnik and Krsnik, 2001).

2.2.1 Standard lactation

The statistical model (1) includes the following fixed effects for each of five milk traits: birth season (R_i), calving season (T_j) and concatenated effects days in milk and parity (ML_k) and random effects: herd (h_l), permanent environment (p_m), additive genetic effect (a_{ijklm}) and a residual (e_{ijklmn}).

$$y_{ijklmn} = R_i + T_j + ML_k + h_l + p_m + a_{ijklm} + e_{ijklmn}$$

Model 1: Statistical model for milk traits of standard lactation

2.2.2 Test day

The statistical model (2) includes the following fixed effects for each of five milk traits: days in milk (D_i) and parity (L_j) and random effects: concatenated effects calving season and herd (hs_k), permanent environment (p_{jl}), additive genetic effect (a_{ijkl}) and a residual (e_{ijklm}).

$$y_{ijklm} = D_i + L_j + hs_k + p_{jl} + a_{ijkl} + e_{ijklm}$$

Model 2: Statistical model for milk traits of test day records

2.2.3 Conformation traits, milking speed and temperament

The statistical model (3) includes the following fixed effects for each of 35 traits: concatenated effects of the classifier and classified year (OL_i), calving season (T_j) and concatenated effects age and period from birth to classifying (SD_k) and random effects: herd (h_l), additive genetic effect (a_{ijkl}) and a residual (e_{ijkl}).

$$y_{ijkl} = OL_i + T_j + SD_k + h_l + a_{ijkl} + e_{ijkl}$$

Model 3: Statistical model for type traits, milking speed and temperament

2.2.4 Calving interval and age at first calving

The statistical model for calving interval (4) includes the following fixed effects: calving season (T_i) and concatenated effects class for milk yield and parity (LM_j). The statistical model for age at first calving (5) includes the following fixed effects: calving season (T_i) and birth year (R_j). Both statistical models include the same random effects: herd (h_k), additive genetic effect (a_{ijkl}) and a residual (e_{ijklm} – model 4 and e_{ijkl} – model 5).

$$y_{ijklm} = T_i + LM_j + h_k + a_{ijkl} + e_{ijklm}$$

Model 4: Statistical model for type traits, milking speed and temperament

$$y_{ijkl} = T_i + R_j + h_k + a_{ijkl} + e_{ijkl}$$

Model 5: Statistical model for type traits, milking speed and temperament

3 Results

In this chapter we present estimates of variances, descriptive statistic for breeding values and genetic trends.

3.1 Variances

In all cases heritabilities and ratios for other random effects and residual were presented.

Heritabilities were quite high especially for content traits (Table 2). Permanent environment has slightly greater variance in Brown and Simmental population. A very important effect is herd especially for yield traits (Table 2).

Table 2. Variance components for milk traits in standard lactation

Breed	Trait	h^2	PE	Herd	e
HOL	Kg	.20-.25	.11-.12	.44-.51	.30-.36
HOL	%	.49-.50	.07-.13	.13-.18	.37-.38
BSW	Kg	.23-.28	.13-.14	.41-.48	.30-.36
BSW	%	.32-.42	.10-.11	.19-.27	.37-.48
SIM	Kg	.22-.28	.12-.13	.43-.50	.30-.35
SIM	%	.32-.34	.08-.10	.16-.22	.46-.50

HOL - Black and White, BSW - Brown, SIM – Simmental; kg – (milk, fat and protein yield), % – (fat and protein content), h^2 – heritability, PE – permanent environment, e – residual.

In the case of test day model, heritabilities are much higher than in the case of yield traits and a little lower in the case of contents (Table 3). The variance for permanent environment is lower in the test day model in comparison with lactation model. The herd also has much smaller effect (Table 3).

Table 3. Variance components for milk traits on test day records

Breed	Trait	h^2	PE	Herd	e
HOL	Kg	.37-.51	.13-.19	.11-.15	.34 -.46
HOL	%	.31-.36	.02-.07	.06-.07	.55-.64
BSW	Kg	.52-.64	.08-.12	.08-.09	.29-.40
BSW	%	.25-.41	. 01-.04	.06-.07	.53-.70
SIM	Kg	.51-.64	.09-.12	.08-.09	.29-.40
SIM	%	.25-.34	.01-.04	.05-.07	.59-.71

Explanation of abbreviations - see Table 2.

For conformation traits heritabilities are high for body measures, others are quite low. The herd effect has a low variance for most traits. In general, Black and White population has lower residual variances than other two populations (Table 4).

Table 4. Variance components for conformation traits

Breed	Trait	h^2	Herd	e
HOL	Body capacity	.16-.47	.10-.20	.45-.75
HOL	Udder	.08-.25	.02-.10	.72-.90
HOL	Type	.06-.22	.03-.09	.75-.90
BSW	Body capacity	.08-.46	.11-.25	.45-.79
BSW	Udder	.05-.21	.02-.16	.74-.93
BSW	Type	.02-.12	.03-.09	.84-.94
SIM	Body capacity	.13-.49	.10-.26	.44-.74
SIM	Udder	.03-.13	.14-.17	.75-.93
SIM	Type	.03-.08	.03-.12	.82-.93

Explanation of abbreviations - see Table 2.

Between populations there is a small difference between heritabilities for calving interval (CI) and age at first calving (Table 5). The herd effect for both presented traits has quite high variance (Table 5).

Table 5. Variance components for calving interval (CI) and age at first calving

Breed	Trait	h^2	Herd	e
HOL	CI	.10	.16	.77
HOL	Age	.22	.14	.67
BSW	CI	.09	.10	.82
BSW	Age	.20	.18	.66
SIM	CI	.10	.11	.81
SIM	Age	.22	.18	.64

Explanation of abbreviations - see Table 2.

3.2 Breeding values

Breeding values were predicted for more than 750,000 animals of all three breeds.

Breeding values were normally distributed for most of traits. The exception was calving interval where distribution was left asymmetric. This was the result of similar distribution of raw data.

For all traits in all three breeds the genetic base was formed for cows born in 1995. Also the total merit index for four economic situations was computed. In computation of total merit indices presented traits were included. In case of bulls beside presented traits also calving ease, paternal and maternal and in Brown and Simmental also daily gain and daily net gain were included.

The calving ease was computed for bulls as a deviation of mean of population and was standardised on scale where the mean was 100 and the standard deviation 12. The same standardisation was made for all presented traits.

3.3 Genetic trends

The main selection direction used to be milk production in all three breeds in Slovenia. In economic situation milk, the economic weight for IPF was 0.55. Therefore the highest genetic progress was made in milk fat and protein yield. In unit of genetic standard deviation in all three breeds the genetic progress was similar within each trait. In yields the genetic progress was in the past 20 years approximately 0.75 to 1 of genetic standard deviation, and greater progress was made in the past 10 years. In fat contents just a slight progress was made in the past 10 years, but in protein contents no genetic progress was perceived. The genetic progress for milk traits was similar to lactation and test day model.

No genetic progress was found for most of conformation traits. A slight genetic progress was made in height of wither and height of rump. Also the genetic progress for more than half of genetic standard deviation in the last ten years was found in udder overall and fore udder.

Also a slight genetic progress was found in age at first calving. In the past ten years even younger heifers calved.

3.4 Presentation of results

Last year a lot of work was put in presentation of national genetic estimation results. Now breeding values for all animals are available on Internet. Also a lot of other information could be found at our web address.

Each user has to fill a registration form first to have an access to on-line browsing through data warehouse. He gets a user name and a password and also a priority for browsing through data warehouse. Selectors from national cattle breeding service could browse through all data without restrictions. Breeders have some restrictions for browsing. They could see data of all bulls but just of own cows. Breeders could also get milk recordings, linear scoring and other data on their own cows.

4 Discussion

In Slovenia the animal model is used for prediction of breeding values for most of traits now. Thus new possibilities for better selection also within female population were obtained.

We can see that a great genetic progress has been made in milk production traits and specially in yield traits.

Genetic estimation methods were significantly developed in the past 10 years. These methods have provided a lot of quality data in short time. Therefore in selection data should be used by selectors as well as by breeders. This was the main reason to put the data warehouse available on Internet.

5 Conclusion

Last year genetic estimation methods were very improved. Most of traits used to be estimated with the sire model. Now most of traits are estimated by animal model. The test day model for milk traits has been developed since this spring.

Heritabilities and all other variance components are acceptable.

The genetic trend is the greatest for milk, fat and protein yields as expected.

From the point of view of national selection it is important that results on breeding value prediction are also available to breeders.

6 References

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