ISSN 1330-7142
UDK = 636.234.1(497.4)

INBREEDING AND INBREEDING DEPRESSION IN SLOVENIAN HOLSTEIN POPULATION

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Original scientific paper

SUMMARY

Analysis of inbreeding and inbreeding depression was done on the data of routine breeding value estimation for milk production data on Holstein population in Slovenia. A pedigree file of 106 433 animals born from 1952 to 2005 was investigated for the occurrence of inbreeding. The maximum inbreeding was 37.5. However average inbreeding coefficients of inbred cows (1.3 %) and of all cows with test day records (0.989 %) were low. Daily milk, protein, and fat yield of first five lactation for 86 122 cows were analyzed. Inbreeding was included in the animal model as a linear covariate. The regression coefficients of milk, fat, and protein yield, multiplied with 305 days present inbreeding depression of lactation yields, were -22.17 kg, -0.601 kg and -0.387 kg respectively, for 1 % of inbreeding.

Key-words: inbreeding, milk production depression, holstein cattle

INTRODUCTION

The mating of related individuals is called inbreeding. The inbreeding coefficient of an animal is one half relationship coefficients between its parents. Inbred animal has inbreeding coefficient greater than 0 (Ločniškar, 1999).

At the end of 1980, relatively a lot of mating partners had the same ancestor(s), which caused the inbreeding of offsprings. The inbreeding increases faster in case of smaller population than in population that have very effective selection program which means they use small number of sires in comparison with cow population (Falconer and Mackay, 1996).

In the nineties average inbreeding coefficient in populations was increased in several populations (Miglior et al., 1992; Miglior et al., 1995; Smith et al., 1998; Thompson et al., 2000). At the same time the developed countries started to include attention on relationship coefficient between mating partners beside selection on production (total merit index) in selection programs.

A lot of cattle breeding organisations regularly calculated inbreeding coefficient (CDN, 2006) for all populations and computing inbreeding depression on production.

In Slovenia we started with calculating the inbreeding some years ago. Now we are showing the first results on estimation of inbreeding depression.

MATERIAL AND METHODS

The pedigree data of all holstein animals and for 86122 Holstein cows with test day records from central data base were collected for this research. Data set for test day records was the same as for January 2007 routine evaluation data of breeding values and included data for first five lactation of cows which calved form year 1997 in 3506 herds.

Software package PEDIG from Boichard (2002) was used for calculating inbreeding coefficients. This software used methodology from Meuwissen T.H.E. and Luo Z. (1992), which is an improved method of Quaas R. L (1976).

Depression of inbreeding is estimated as coverable in routine test day model for production trait for Holstein in Slovenia.

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The statistical model for routine breeding value estimation with repeatability single trait animal model included the following effects: Ali and Schaefer (1987) regression coefficients for description of lactation curve ($b_I - b_{IV}$), fixed effects: age at calving (T_i), lactation (L_j) and random effects: herd (h_k) permanent environment (p_{jl}) and animal (a_{ijkl}).

$$y_{ijklm} = \mu + b_I (d_{ijklm} / 305) + b_{II} (d_{ijklm} / 305)^2 + b_{III} (305 / d_{ijklm}) + b_{IV} (305 / d_{ijklm})^2 + T_i + L_j + h_k + p_{jl} + a_{ijkl} + e_{ijklm}$$

The model for calculating depression of inbreeding linear regression coefficient of inbreeding coefficient was included.
Relationship matrix was the same for both models and included animals with records their parents and grand parents except maternal grandmother of animal with record. Number of animals in relationship matrix was 106 433.
Statistical models in the matrix form were the same. In this case we see the structure of variances:

$$\mathbf{y} = \mathbf{Xb} + \mathbf{Z}_{\mathrm{h}}\mathbf{h} + \mathbf{Z}_{\mathrm{p}}\mathbf{p} + \mathbf{Z}_{\mathrm{a}}\mathbf{a} + \mathbf{e}$$

$\mathbf{y}$	- vector of test day milk yields
$\mathbf{X}$	- matrix for fixed part of model
$\mathbf{Z}_h$	- matrix for herd effect
$\mathbf{Z}_p$	- matrix for permanent environment
$\mathbf{Z}_a$	- matrix for additive genetic effect
$\mathbf{b}$	- solution vector of fixed effects
$\mathbf{h}$	- solution vector of herd effect
$\mathbf{p}$	- solution vector of permanent environment
$\mathbf{a}$	- solution vector of additive genetic effect (breeding values)
$\mathbf{e}$	- vector of residuals

MTJAAM (Gengler et al., (1997) software was used for variance components MTCAFS (Misztal et al., (1995) and for breeding value and other effects estimation. SAS package (2000) was used for the preparing of data and analyses of results of breeding value estimation.

RESULTS AND DISCUSSION

Comparison between inbreeding coefficient of the whole Holstein population in Slovenian data base (261 406 animals) and population included in routine breeding value estimation shows that animals being not included in breeding value estimation have on the average higher inbreeding coefficients (Figure 1). The average inbreeding coefficient for the whole Slovenian Holstein population is 1.11 % and for all animal included in breeding value estimation is 0.989 %.

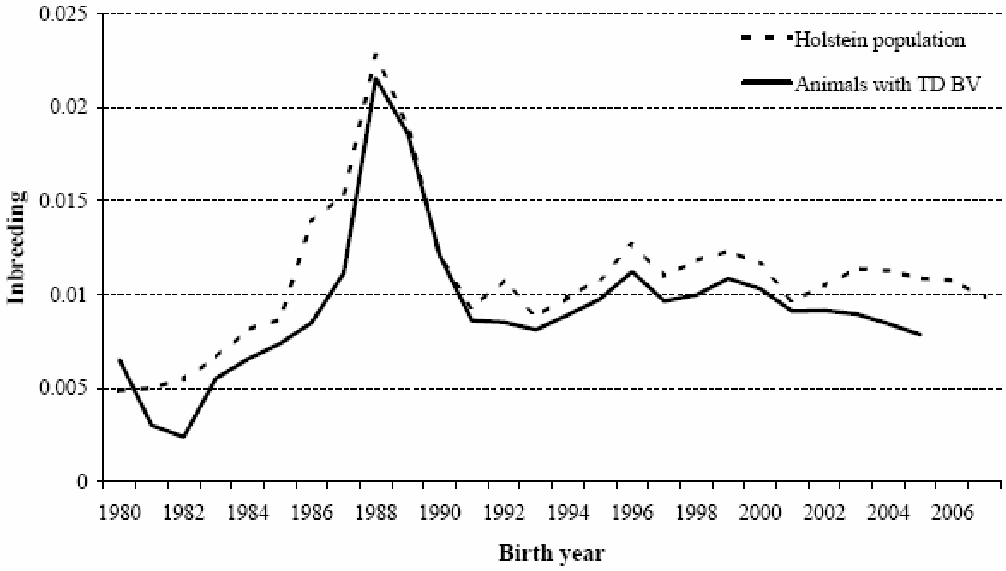

Figure 1. Distribution of average inbreeding coefficient for animals with breeding value estimates and for whole population per birth year

As shown in Figure 1 the average inbreeding coefficient increased from birth year 1980 to 1988 more then four times. In the last 15 years the average inbreeding coefficient has been stabile.

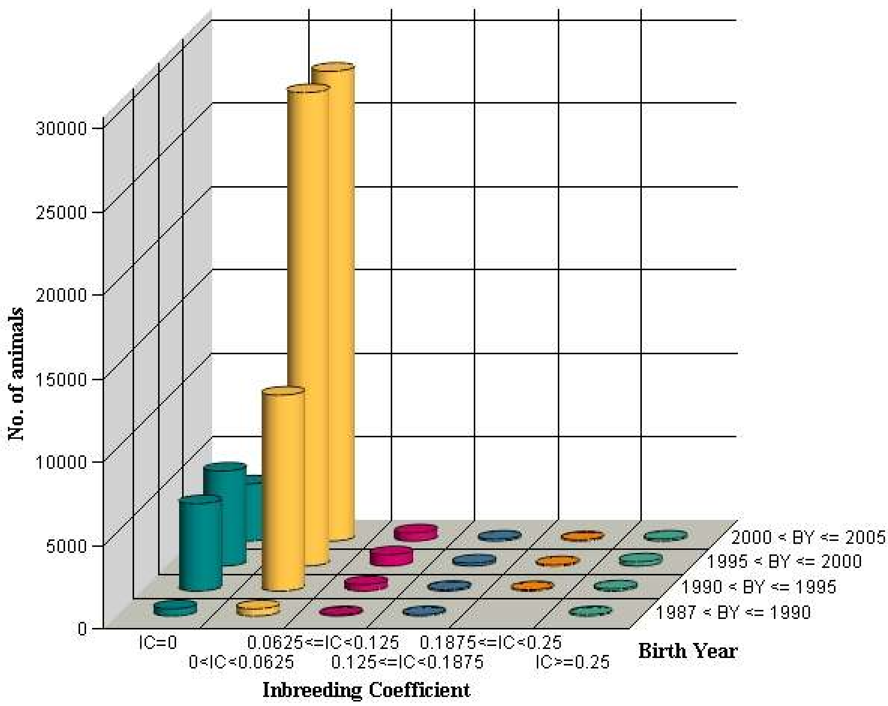

Figure 2. Breeding values for test day milk yield and linear regression on inbreeding coefficient

Cows with test day records were divided into six classes with regard to inbreeding coefficient (IC = 0; $0 < IC < 0.0625$; $0.0625 \leq IC < 0.125$; $0.125 \leq IC < 0.1875$; $0.1875 \leq IC < 0.25$. and $IC \geq 0.25$) and into four classes with regard to birth year ($1987 < BY \leq 1990$; $1990 < BY \leq 1995$; $1995 < BY \leq 2000$; $2000 < BY \leq 2005$). As shown in Figure 2 almost 80% of animals are in the second class of inbreeding ($0 < IC < 0.0625$).

The comparison between number of animals for the last two birth years groups shows that the last group was characterized by less frequency in all inbreeding coefficient class except second class. We can conclude that younger cows were more frequently inbred but had on the average lower inbreeding coefficient than older cows.

Linear regression on inbreeding coefficient in routine evaluation model was used for calculating of inbreeding depression. We started with estimation of dispersion parameters. No significant changes of the parameters of dispersion between the models were expected.
The model for calculating depression of inbreeding has practically the same parameters of dispersion as the model of routine breeding value estimation. The differences in dispersion parameters for milk yield were on the third digit and for protein and fat yield on the sixth digit. However the heritabilities were for all yields different on the forth digit. We could conclude that there are no differences in dispersion parameters estimates.
The correlation between breeding values estimated with routine and model with regression on inbreeding coefficient was very high 0.9990 for milk yield, 0.9995 for fat yield and 0.9996 for protein yield. The same are range correlations for this three traits.
The estimated linear regression coefficients of inbreeding coefficient were -0.0727 kg for milk yield, -0.00197 kg for fat and -0.00127 kg for protein yield. This linear regression coefficient presents inbreeding depression of test day yields for each percent of inbreeding. For easy presentation we multiplied these regression coefficients by 305 day. In this scale the regression coefficients present inbreeding depression of lactation yields. Lactation inbreeding depressions are -22.17 kg, -0.601 kg and -0.387 kg of milk, fat, and protein yield, respectively, for 1 % of inbreeding.

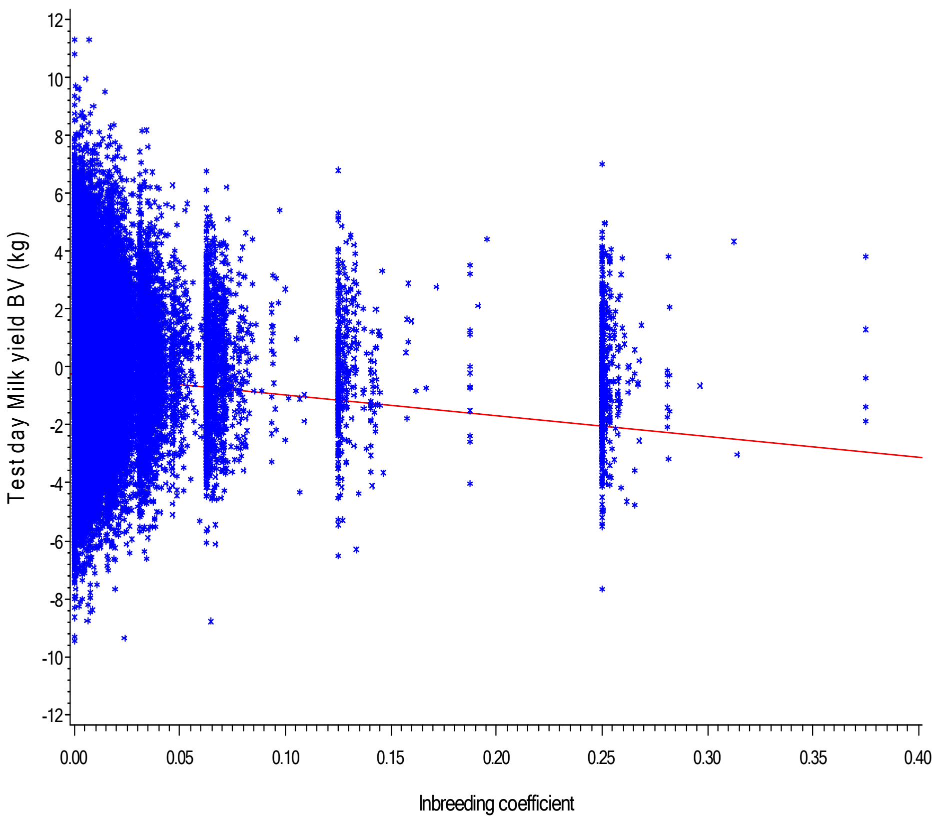

Figure 3. Breeding values for test day milk yield and linear regression on inbreeding coefficient

Figure 3 presents breeding value predictions for all animals dependent on inbreeding coefficient and estimated linear regression line for test day milk yield.

CONCLUSION

The whole population of Holstein cattle in Slovenian data base has on the average higher (1.11 %) coefficient of inbreeding as part of this population included in breeding value estimation (0.989 %). Younger cows were more frequently inbred but had on the average lower inbreeding coefficient than older cows.

Analysis of inbreeding and inbreeding depression was done on the data of routine breeding value estimation for milk production data on Holstein population in Slovenia. We included linear regression of inbreeding coefficient in the test day model for routine breeding value evaluation. There are no significant changes of the dispersion parameters estimates between both models.
We found quite a great linear regression coefficients of milk, fat, and protein yield which presented inbreeding depression. In lactation scale these coefficients are -22.17 kg, -0.601 kg and -0.387 kg for milk, fat and protein yield respectively, for 1 % of inbreeding.

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(Received on 9 May 2007; accepted on 4 June 2007)