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Original scientific paper

THE EVALUATION OF GENETIC PARAMETERS OF THE TYPE OF CALVING IN THE POPULATION OF HOLSTEIN FRIESIAN COWS

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Genetic parameters (heritability coefficients and genetic correlations) of the type of calving, number of stillbirths and birth weight have been evaluated in the population of Holstein Friesian cattle breed. Data sets have been analysed by means of the Mixed Least Square Model (LSMLMW). Besides a random effect of bull-sires, the model has also included the fixed effects of farm, season, sex, the evaluation of viability of calves and types of birth.

Estimated heritability values and heritability errors for the type of calving (TC), number of stillbirths (SB) and birth weight (BWT) were low: 0.190 ± 0.062; 0.018 ± 0.006 and 0.149 ± 0.051, respectively. Heritabilities of the analysed traits were evaluated on the grounds of the calves` bull-sires additive value (direct heritability).
The values of the genetic correlation coefficients between examined traits ranged from -0.251 (correlation between the type of calving and number of stillbirths) to 0.340 (correlation between the number of stillbirths and birth weight).

Key words: type of calving, number of stillbirths, birth weight, genetic parameters, Holstein- Friesian breed

INTRODUCTION

In intensive milk production over a longer period of years the problem regarding the reproduction and diminished fertility in cows has been observed (ERIKSSON *et al.,* 2004; BOGDANOVIĆ *et al.,* 2005; ZABORSKI *et al.,* 2009; TRIFUNOVIĆ *et al.,* 2009; DJEDOVIĆ *et al.,* 2012). Contribution to improving the selection of traits that are of interest, is primarily related to

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the evaluation of breeding values of bulls and cows, as well as the alternative procedures in breeding (BOGDANOVIĆ 2012; PETROVIĆ *et al.,* 2012).

Today dairy cattle breeders in the whole world are facing increasing problems caused by calving difficulty which represents also a major cause of mortality in calves and greatest source of expenses of all veterinary interventions (MEYER *et al.,* 2001; STEINBOCK et al., *2003*)**.** Calving difficulty, along with increased calves mortality, is a considerable source of economic losses for cattle breeders what results in reduced fertility and reduced bovine production (LOMBARD *et al.,* 2006; MEE *et al.,* 2008; WIGGANS *et al.,* 2008; TIEZZI *et al.,* 2011).

By investigating the influence of genetic and non-genetic factors on the type of calving DJEDOVIĆ *et al.* (2005, 2010) says that the type of calving significantly highly ($P<0.001$) varies under the influence of bull–sires. The type of calving is also very highly significantly influenced by some non-genetic factors such as: farm, sex, grading and type of birth. Simultaneously, number of stillbirths did not statistically significantly ($P>0.05$) vary under the fixed effects of farm, season and type of birth. The effect of sex was significant ($P< 0.05$) on the number of stillbirths, while the grading of calves very highly significantly ($P<0,001$) affected the mentioned trait. In observed factors the type of birth and grading of calves caused the highest variations in birth weights.

Due to a significant effect of non-genetic factors on the variability of calving traits, heritability coefficients of given traits are low what impedes the improvement work, that is, genetic improvement of these traits and therefore a whole cattle production (TARRES *et al.,* 2010). The evaluated heritability values may differ depending on the raising conditions, models and methods applied for their evaluation, size of sample, method of breeding, as well as the structure of data used in calculation (GUERRA *et al.,* 2006; EAGLEN *et al.,* 2012). In literature, the values of heritability coefficients of the type of calving unbiased of the model used for their evaluation are within the limits of $h^2 = 0.063$ (GUERRA *et al.,* 2006) to $h^2 = 0.325$ (CERVANTES *et al.,* 2010). A number of authors (ERF *et al.,* 1990; MCGUIRK *et al.* 1998, LUO *et al.,*1999; MEYER *et al.,* 2001; STEINBOCK *et al.,* 2003; ERIKSSON *et al.,* 2004; DJEDOVIĆ *et al.,* 2005; JAMROZIK *et al.,* 2005; GUERRA *et al.,* 2006; COLE *et al.* 2007; CERVANTES *et al.* 2010) indicate that the estimated heritability for number of stillbirths is between 0.008 and 0.226. A high genetic correlation established between the calving traits confirms the possibility for conducting an indirect selection (LUO *et al.,* 1999; ERIKSSON *et al.,* 2004; MUJIBI and CREWS*,* 2009; CERVANTES *et al.,* 2010; EAGLEN *et al.,* 2012).

The objective of this study was to evaluate genetic parameters of the calving traits in the population of Holstein-Friesian cattle in order to make further selection work possible, primarily by estimating the breeding value of bull-sires which are going to be progeny tested and used in the programes of artificial insemination.

MATERIALS AND METHODS

Data

The research work on the heritability coefficients and correlation between the type of calving, number of stillbirths and birth weight was performed on the sample of 2664 calves, the descendants of 24 bull–sires, born on 2 farms of PIK Bečej, Serbia, in the course of 5 years. An average number of examined calves per bull-sire were 111. Basic information on data set and traits analyzed in this study are shown in Tables 1 and 2.

Table 1. Basic information on the data set

No. of animals	2664
No. of. sires	24
Average no. of progeny/sires	111
Means ± SD	
BWT (kg)	37,5±4,3

BWT= birth weight

Table 2. Frequency of type of calving per classes and rate of stillbirths and live-born calves

Trait n = 2664	Calving class	Number	(%)
	1	2159	81,0
TC	2	470	17,6
	3+4+5	35	1,4
SB		107	4,0
LBC		2557	96,0

TC= type of calving; SB= number of stillbirths; BWT= birth weight; LBC= live-born calves

The evaluation of live-born calves according to their vitality, typical characteristics, developing traits and presence of inborn anomalies, was performed by scoring in the following way:
(1) – calf born with inborn anomalies
(2) – poorly developed and avital calf
(3) – moderately developed and vital calf
(4-5) – well developed calf, vital and in type

As a type of birth is meant the number of calves born per one parturition, that is, whether the result of calving were singles, twins or threes.

Table 3 shows distribution of data per level of fixed factors used in model for evaluation of genetic parameters of examined traits.

Trait definitions

Type of calving in heifers and cows was registered and classified on the grounds of observation and degree of assistance offered during calving into 5 classes: (1)-normal parturition; (2)- applying the extra strength in drawing out the foetus; (3)- correcting the irregular position of foetus; (4)-fetotomy; (5)-caesarean section.

Due to a low recurring frequency in relation to other categories, the classes 3, 4 and 5 of the type of bovine calving were grouped into one unique class.

By **stillbirth** is meant each case of dying of calves in the period from calving to 48 hours postparturition. In data sets live-born calves are designated by the number 1, and stillbirths with number 2.

Birth weight represents the calves`weight measured during the first 24 hours post-parturition.

Table 3. Distribution of data per level of fixed factors used in model

Fixed factor	n
Farm	
1	1411
2	1253
Calving season	
I	628
II	517
III	898
IV	621
Sex calf	
Male	1414
Female	1250
Score for calves vitality	
1	2
2	6
3	22
4	111
5	2552
Birth type	
1	2476
2	182
3	6

Model

The evaluation of genetic parameters of examined traits was performed by means of a following mixed model of the Least Square method *LSMLMW,* (HARVEY,1990).

$$Y_{ijklmno} = \mu + O_i + F_j + S_k + P_l + V_m + R_n + e_{ijklmno}$$

where:

$Y_{ijklmno}$ – is the manifestation of the trait of o-individual, i-sire, j- farm, k- season, l- sex, m-evaluation of vitality, n-type of birth,

μ – general mean of the population for given trait,

O_i – random effect of i-sire (i= 1,...,24),

F_j – fixed effect of j- farm (j= 1,2),

S_k – fixed effect of k- season (k=1,....4)

P_l – fixed effect of l- sex (l= 1,2),

V_m– fixed effect of m- vitality evaluation (m= 1,….5)
R_n – fixed effect of n- type of birth (n= 1,..3)
$e_{ijklmno}$ – random error with characteristics N (0, σ^2).

The mean values for birth weight, as well as frequency of the type of calving per classes and percentage of stillbirths and live-born calves were determined by the use of a statistical programme SAS (2007) Version 9.1.3.

RESULTS AND DISCUSSION

The evaluated heritability values and their errors are shown in Table 4.

Table 4. Heritability (h^2) and heritability errors (Sh^2) of the type of calving, number of stillbirths and birth weights

Traits n = 2664	h^2	Sh^2
TC	0,190	0,062
SB	0,018	0,006
BWT	0,149	0,051

TC= type of calving; SB= number of stillbirths; BWT= birth weight

Heritability coefficient of the type of calving determined by the method of intra-class sire correlation was 0.19±0.062. This value shows that the manifestation of the type of calving is in a considerably higher degree influenced by the environmental factors than by a bull-sire factor.

By comparing the results obtained with the results of some other authors who studied this problem we can see that approximate values for direct heritability of the type of calving were obtained also by STEINBOCK *et al.* (2003) and GUTIERREZ *et al.* (2007). In calculating the heritability of the type of calving these authors have used the models very similar to the model mentioned in this analysis, what accounts for a high compatibility of the results obtained. A considerably lower values regarding the aforementioned parameter in their research were obtained by LUO *et al.* (1999); CANAVESI *et al.* (2003); ERIKSSON *et al.* (2004); GUERRA *et al.* (2006); MUJIBI and CREWS (2009) and TARRES *et al.* (2010). Higher heritability coefficient values for type of calving, in relation to shown results, have reported BENNETT and GREGORY (2001) and CERVANTES *et al.* (2010).

The number of stillbirths varied under the influence of hereditary base in the range of 1.8%, (h^2= 0.018±0.006) what also points to the dominant effect of the environmental factor on the manifestation of a given trait.

Similar values regarding the additive variation of the number of stillbirths were obtained also by MEYER *et al.* (2001). Lower genetic value was confirmed by ERF *et al.* (1990), MCGUIRK (1998) and ERIKSSON *et al.,* (2004). Higher values of heritability coefficients for the number of stillbirths were confirmed by LUO *et al.* (1999); STEINBOCK *et al.* (2003); GUERRA *et al.* (2006); COLE *et al.* (2007) and CERVANTES *et al.* (2010).

Heritability coefficients of birth weight were approximately 0.15. A confirmed heritability coefficients of birth weight in this study are lower than the results reported by LAZAREVIĆ (1982); ERIKSSON *et al.* (2004); GUTIERREZ *et al.* (2007) and MUJIBI and CREWS (2009).

Significant differences in evaluated heritability values, reported by different authors may be explained by the size and structure of sample, as well as the models applied, and not by a real heritability in populations observed. Therefore it is important, when investigating the heritability, to use a great number of animals produced by a greater number of bull-sires, by which it may be possible, in overall variability, to decrease the share of variability caused by external factors, and to increase the variability caused by genetic effect, what altogether leads to a more precise evaluation of heritability. Even besides the fact that examined traits display low genetic variability, it is highly important to include all known information on heritability of calving parameters in the evaluation of breeding performance of bull-sires because in this way a long term increase in the effects of applied selection in examined population of cattle could be realized.

Between the calving ease and number of stillbirths (Table 5) a negative and low genetic correlation was confirmed (r_P=-0.251±0.018).

Table 5. Coefficients of genetic correlations (r_g) and errors (Sr_g) of examined calving traits

Traits		r_g	Sr_g
TC	SB	-0,251**	0,018
TC	BWT	0,232**	0,018
SB	BWT	0,340**	0,019

TC= type of calving; SB= number of stillbirths; BWT= birth weight
NS – (P>0,05) * - (P<0,05) ** - (P<0,01)

` The values of other coefficients of genetic correlations calculated were 0.232±0.018 *(correlation of calving type and birth weight) and 0.340*±0.019 *(correlation of number of stillbirths and birth weight).*

LUO *et al.* (1999) who also examined a correlation between calving "ease" and number of stillbirths determined that there is a low, negative phenotypic correlation between these two traits. However, majority of authors (MCGUIRK *et al.,* 1998; ERIKSSON *et al.,* 2004; GUTIERREZ *et al.* 2007; MUJIBI and CREWS 2009; MATURANA *et al.* 2009) observed genetic correlation between calving "difficulty" and number of stillbirths and birth weight and established that there is a strong, or very strong, and positive correlation between them.

Confirmed values of genetic correlation, regardless of their strength, may serve to point to the choice of the method of genetic improvement for examined traits by use of indirect selection. Direct selection on the number of stillbirths is more difficult due to low heritability value although by understanding the correlations between calving traits this kind of selection becomes more effective. Birth weight is more easily measured and controlled in relation to the number of stillbirths so that by direct selection on calves` body weight the number of stillbirths can be reduced indirectly.

CONCLUSION

Results obtained during the investigations confirmed the hypothesis that fertility traits monitored during progeny testing of dairy bulls have low heritability. Assessed values for heritability and genetic correlations can be used to calculate breeding values for bulls for monitored traits. The use of bulls with known breeding values will contribute to faster genetic progress.

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GENETSKI PARAMETARI OSOBINA TELJENJA U POPULACIJI HOLŠTAJN FRIZIJSKIH KRAVA

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Izvod

Genetski parametri (koeficijent heritabiliteta i genetske korelacije) tipa teljenja, broja mrtvorođene teladi i telesne mase pri rođenju ocenjeni su u populaciji krava holštajn frizijske rase. Setovi podataka analizirani su putem mešovitog modela najmanjih kvadrata (LSMLMW). Model je pored slučajnog uticaja bikova–očeva obuhvatao fiksne uticaje farme, sezone, pola, ocene vitalnosti teladi i tipa rođenja.

Ocenjeni heritabiliteti i njihove greške za tip teljenja, broj mrtvorođene teladi i telesnu masu pri rođenju bili su niski i iznosili su: 0,190 ± 0,062; 0,018 ± 0,006 i 0,149 ± 0,051, odgovarajuće. Heritabiliteti analiziranih osobina ocenjeni su na osnovu aditivne vrednosti očeva teladi (direktan heritabilitet). Koeficijenti genetskih korelacija između ispitivanih osobina imali su vrednosti od -0,251 (povezanost tipa teljenja i broja mrtvorođene teladi) do 0,340 (povezanost broja mrtvorođene teladi i telesne mase pri rođenju).

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