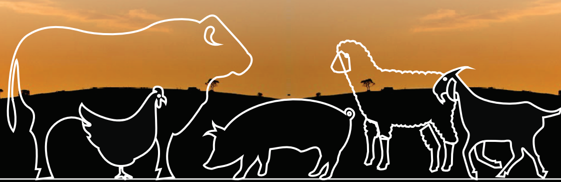
ISBN

4th INTERNATIONAL CONGRESS

PROCEEDINGS

NEW PERSPECTIVES AND CHALLENGES OF SUSTAINABLE LIVESTOCK PRODUCTION



Belgrade, Serbia 7th - 9th October 2015

ISBN

INSTITUTE FOR ANIMAL HUSBANDRY
BELGRADE - SERBIA

4th INTERNATIONAL CONGRESS

PROCEEDINGS

NEW PERSPECTIVES AND CHALLENGES OF SUSTAINABLE LIVESTOCK PRODUCTION

Belgrade, Serbia 7th - 9th October 2015
www.istocar.bg.ac.rs

Number of copies - 200 electronic copies

PATRON

Ministry of Education, Science and Technological Development of the Republic of Serbia

ORGANIZER

Institute for Animal Husbandry
Autoput 16, P. Box. 23, 11080, Belgrade-Zemun, Serbia
Tel: +381 11 2691 611; +381 11 2670 121; +381 11 2670 541;
Fax: + 381 11 2670 164;
biotechnology.izs@gmail.com
www.istocar.bg.ac.rs

EDITOR INSTITUTE FOR ANIMAL HUSBANDRY
For Editor Milan M. PETROVIĆ, Ph.D
Editor in Chief Zdenka ŠKRBIĆ, Ph.D

INTERNATIONAL SCIENTIFIC COMMITTEE

ORGANIZING COMMITTEE

CHAIRMAN	Dr. Milan M. Petrović
SECRETARY	Dr. Dušica Ostojić Andrić
MEMBERS	Dr. Čedomir Radović
	Dr. Violeta Caro Petrović
	Dr. Zorica Bijelić
	Dr. Violeta Mandić
	Dr. Aleksandar Stanojković
	Dr. Nikola Stanišić
	Dr. Nevena Maksimović
	Dr. Veselin Petričević
	Prof. Dr. Slavča Hristov
	Prof. Dr. Mirjana Đukić-Stojčić
	Prof. Dr. Zoran Ilić
	Dr. Dobrila Jakić-Dimić
	Doc. Dr. Predrag Perišić
	Doc. Dr. Aleksandar Simić
	Dr. Slobodan Lilić
	Dr. Tanja Vasić
	Doc. Dr. Tanja Petrović

CONGRESS SECRETARIAT

CHAIRMAN	Dušica Ostojić Andrić
MEMBERS	Nikola Delić Dragan Nikšić Marina Lazarević Marija Gogić Maja Petričević Nenad Mićić Olga Devečerski Stanislav Marinkov Slavko Maletić

CONTENTS

INVITED PAPERS

ORALLY PRESENTED PAPERS

POSTER SECTION I

POSTER SECTION II

POSTER SECTION III

Proceedings of the 4th International Congress
New Perspectives and Challenges of Sustainable Livestock Production
October 7 – 9, 2015

HERITABILITY AND REPEATABILITY OF FERTILITY TRAITS OF HOLSTEIN-FRIESIAN BULLS MONITORED IN PROGENY TESTING

M. Lazarević[1], D. Nikšić[1], D. Ostojić Andrić[1], V. Pantelić[1], N. Maksimović[1], N. Stanišić[1], D. Stanojević[2], N. Mićić[1]

[1]Institute for Animal Husbandry, Belgrade-Zemun, 11080 Zemun
[2]University of Belgrade, Faculty of Agriculture, Nemanjina 6, Belgrade-Zemun, 11080 Zemun
Corresponding author: M. Lazarević, e-mail: marinaplazarevic@gmail.com
Original scientific paper

Abstract: To test the variability of fertility traits of Holstein-Friesian bulls monitored in progeny test, reproduction data of 342 cows, daughters of 15 bulls were used. Cows have been in production in seven farms of Agricultural Corporation "Belgrade" in the period from 2004 to 2012. The study included the following fertility traits: the average calving age, service period and calving interval. To analyze the influence of genetic and non-genetic sources of variability a mixed model with random effect of bull - sire, the fixed effects of farm, year, season and order of calving was used. The sire is present in variability of all the observed fertility traits (p <0.01), whereas the fixed factors manifested their influence at different levels of statistical significance. The heritability of fertility traits was low: the average calving age – 0.224, service period – 0.087, calving interval – 0.085. Repeatability of mentioned traits was 0.258, 0.111, 0.102, respectively.

Keywords: Holstein-Friesian breed, bulls, fertility traits, heritability, repeatability.

Introduction

Holstein cattle in Europe are grown mainly in the lower regions. In the Republic of Serbia around 100.000 cows and heifers of Holstein - Friesian breed are reared. The most of the animals are grown in Vojvodina and a smaller part in Central Serbia. With the exception of cows that are bred in the vicinity of Belgrade in a very intensive organized production at several large farms (PKB Padinska Skela, PIK Zemun, BD Agro Dobanovci, etc.), number of cattle grown on small farms in Central Serbia is small and amounts to a few thousand (*Lazarević et al., 2013).* The current selection of cattle Holstein - Friesian is mainly focused on improving the

milk traits. Long-term selection of animals for high milk yields has seriously impaired reproductive performance.
Fertility is a feature that is not characterized by yield but is of high economic importance in dairy cattle. Reduced fertility leads to a prolonged calving interval and culling due to reproductive problems (*Jansen, 1985*).

Generally, there is an opinion that a large number of fertility traits is characterized by low heritability (less than 10%), but a large genetic variability. Taking this into account and also the economic importance of fertility traits, certain reproductive traits should be included in the selection criteria (secondary traits) of breeding programs (*Menendez Buxadera and Dempfle, 1997*). According to *Bogdanović et al. (2012)* in a population of Austrian Simmental cattle, relative economic importance of milk production traits, meat production and functional traits is 37:18:45, respectively, while in the population of the Brown cattle breed, relationship between milk production traits and functional traits is 45:55. Reproductive traits that are considered as the functional, such as age at first calving, service period, calving ease and incidence of stillbirth should be emphasized. Breeding for high yields in dairy cattle has led to disruption of fertility traits due to unfavorable genetic correlation between milk yield and fertility (*Pryce et al., 2004)*.
In order to improve fertility traits, or to prevent their disruption,it is necessary to put special emphasis on the selection of these traits. Contribution of selection is primarily associated with the estimation of breeding values. Progeny testing, and in particular progeny testing of bulls, and use of the positive bulls, is of great importance. Given that fertility traits are characterized by low heritability, aim of this study was to determine the effect of non-genetic factors and the contribution of bull - sires to the variability of fertility traits.

Material and Methods

To test the variability of fertility traits of Holstein-Friesian bulls monitored in progeny test, reproduction data of 342 cows were used, which were in production on seven farms of Agricultural Corporation "Belgrade" in the period from 2004 to 2012 (Tables 1 and 2).

Table 1. Distribution of calving by year of calving

Calving year	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
Calving number	7	33	40	138	182	261	211	134	20	1026

Table 2. Distribution of calving by farms

Distribution of calving by farms							Total
1	2	3	4	5	6	7	
390	273	69	129	6	102	57	1026

The cows were daughters of 15 bulls and analysis included the first three calvings (Table 3).

Table 3. Distribution of daughters and calvings by bull-sires

Number	Bull-sire	Number of calvings	Number of daughters
1	1276	60	20
2	1355	111	37
3	1356	93	31
4	1381	36	12
5	1382	63	21
6	1383	30	10
7	1384	123	41
8	1421	51	17
9	1433	75	25
10	1437	36	12
11	1439	54	18
12	1484	105	35
13	1498	117	39
14	1502	33	11
15	1509	39	13
total		1026	342

Within each year the four seasons were observed:

1. Winter: includes cows calved during December, January and February (288 calvings);
2. Spring: includes cows calved during March, April and May (217 calvings);
3. Summer: includes cows calved during June, July and August (272 calvings);
4. Autumn: includes cows calved during September, October and November (249 calvings).

The database contained the following elements: identification number of animals, identification number of the sire, date of birth, dates of the first, second, third and fourth calving and duration of service period. Based on the available data for each cow, age at the first, second and third calving was calculated and then the duration of calving interval. The analysis included three repetitions for each trait.

The study included the following fertility traits:

- Average age at calving (days);
- Service period (days);
- Calving interval (days).

Statistical analysis of data obtained during the progeny testing of Holstein-Friesian bulls was divided into three parts.

The first part of the analysis included the determination of the basic variation-statistical parameters. Descriptive statistics analysis was performed using the statistical program *StatSoft.Inc (2004), Statistica for Windows version 7*.

The second part of the data processing included the identification of the different impacts on the variability of traits in progeny test. The variability of fertility traits was assessed by the method of least squares *LSMLMW*. To analyze the influence of genetic and non-genetic sources of variability a mixed model was used with random effect of bull-sire, fixed effects of farm, year, season and the order of calving.

Mixed model for analyzing the impact of genetic and non-genetic sources of variability on fertility traits in progeny test:

$$Y_{ijklmn} = \mu + O_i + F_j + G_k + S_l + R_m + e_{ijklmn}$$

where:

- Y_{ijklmn}: studied trait,
- μ: population average for observed trait,
- O_i: random effect of i-th sire (i=1,…,15),
- F_j: fixed effect of j-th farm (j=1,…,7),
- G_k: fixed effect of k-th calving year (k=1,…,9),
- S_l: fixed effect of l-th calving season (l=1,2,3,4),
- R_m: fixed effect of m-th order of calving (m=1,2,3),
- e_{ijklmn}: random error with N characteristics$(0,\sigma^2)$.

In the third part of the analysis, components of variance, heritability, repeatability and correlation of fertility traits were calculated. Components of variance were

calculated by the method REML (Restricted Maximum Likelihood) within VARCOMP procedures (SAS 9.3, 2012).
For the calculation of heritability (h^2) and repeatability (r) coefficients, the following formulas were used:

$$h^2 = \frac{\delta^2{}_a}{\delta^2 p} \qquad\qquad r = \frac{\delta^2 a + \delta^2 pe}{\delta^2 p}$$

where:

$\delta^2 a$ - additive genetic variance;

$\delta^2 pe$ - variance of permanent/fixed environmental factors;

$\delta^2 p$ - Total (phenotypic) variance, consisting of additive variance, dominance variance, variance of interactions (epistasis), the variance of permanent/fixed effect of environmental factors and the error variance
($\delta^2 p = \delta^2 a + \delta^2 d + \delta^2 i + \delta^2 ep + \delta^2 pe + \delta^2 e$).

Results and Discussion

Table 4 presents the descriptive statistical indicators and variability of fertility traits monitored in progeny test of the Holstein-Friesian bulls. Average duration of calving interval was 411.69 days with a coefficient of variation of 18.78%. *M'hamdi et al. (2010)* report a slightly higher duration of calving interval (444.2), while *Ghiasi et al. (2011)* in their research obtain lower values 393.85 and similar results are reported by *Hoekstra et al. (1994).* Minimum calving interval of 237 days indicates early/premature partus or pregnancy ending in abortion, because the normal duration of gestation in cows of the Holstein – Friesian breedas reported in the research of *Petrović (1993),* is 275.37 days. Maximum duration of calving interval is 758 days, which is, from the economic and technological aspect, extremely unfavorable because one calving is lost and lactation postponed.
The duration of the calving interval is directly affected by the duration of service period. Average service period is 134.51 days and is characterized by high variability (57.33%). *Petrović (1993)* states a shorter service period, in first calving heifers 105.9 days whereas in cows service period lasted 119.6 days. *M'hamdi et al. (2010)* in their investigation state the average service period of Holstein - Friesian cows in Tunisia of 150.9 days.

Table 4. Mean values and variability of fertility traits in progeny test of Holstein-Friesian bulls

Trait	N	μ	Min	Max	Sd	Cv (%)
Calving interval, days	1026	411.69	237	758	77.32	18.78
Service period, days	1026	134.51	29	474	77.12	57.33
Average calving age, days	1026	1182.51	634	2008	350.30	29.62
Average age at first calving, days	342	770.34	634	1175	50.66	6.58
Average age at second calving, days	342	1182.84	1024	1571	92.55	7.82
Average age at third calving, days	342	1594.34	1347	2008	131.27	8.23

The maximum duration of service period is 474 days. There are a number of reasons for this prolonged service period: long-term selection for high milk yield, poor farm management, poor conception, silent estrus and malnutrition.
Age at first insemination is one of the significant traits from a biological and economic point of view. Premature bred heifers are lagging behind in growth, giving small and undeveloped calves and their milk yield deteriorates. However, intensive rearing in the period of growth enables early breeding of heifers. The two main criteria for the breeding time are: age, or the age and development of heifers, which are considered to be physically developed for fertilization when they reach ⅔ to ¾ of body weight of cows *(Petrović, 1993).*

The cows calved for the first time at the age of 770.34 days, the same results are stated by *Petrović (1993).* The average age at the first, second and third calving is characterized by less variability than other fertility traits, with the variability increasing from the first to the third calving.
Bull-sire is present in variability of all observed fertility traits ($p < 0.01$), while the farm at a high level ($p < 0.01$) exerted influence only on calving interval and duration of service period (Table 5). The effect of season was present in the variability of the calving interval and service period, without significant effect on the average age at calving. Seasonal variations in temperature and humidity, the quality and quantity of food available caused a significant variation of reproductive performance. Order of calving did not influence the variation of calving interval and service period ($p > 0.05$), while the statistically significant effect ($p < 0.01$) was recorded on the average age at calving. *M'hamdi et al. (2010)* report a statistically significant effect ($p < 0.01$) of farm, year and order of calving on calving interval

and duration of service period. The effect of the year is present in variability of all observed reproductive traits but on a different level of statistical significance.

Table 5: Influence of genetic and non-genetic factors on the variability of fertility traits in progeny testing of Holstein-Friesian bulls, F value

Trait	F values of studied effects				
	Bull-sire	Farm	Year	Season	Order of calving
	df_1=14	df_1=6	df_1=8	df_1=3	df_1=2
	df_2=992	df_2=992	df_2=992	df_2=992	df_2=992
Calving interval, days	4,69**	2,41**	1,87*	5,08**	$0{,}94^{nz}$
Service period, days	4,67**	2,41**	1,75*	5,25**	$1{,}24^{nz}$
Average calving age, days	9,64**	$1{,}58^{nz}$	4,64**	$1{,}12^{nz}$	2580,39**

$p>0{,}05^{nz}$, $p<0{,}05^{*}$, $p<0{,}01^{**}$

Table 6 shows the components of variance, heritability and repeatability of reproductive traits.
According to the literature data, heritability of fertility traits is low, below 0.1 (*Ghiasi et al., 2011).* The obtained heritability of fertility traits ranged from 0.085 (calving interval) to 0.224 (average age at calving). Slightly lower values are reported by *M'hamdi et al. (2010). Ghiasi et al. (2011)* in the population of Iranian Holstein received slightly lower values of heritability, 0.074 for calving interval and 0.076 for service period. *Hoekstra et al. (1994)* report heritability of 0.03 for calving interval.
Repeatability of fertility traits is characterized by somewhat higher values than heritability coefficients, Table 6. Repeatability coefficient is used to calculate the potential production of the animal on the basis of the first production results (*Stanojević et al, 2013*). Repeatability ranged from 0.102 (calving interval) to 0.258 (average age at calving). *M'hamdi et al. (2010)* report slightly higher values: 0.152 for calving interval and 0.135 service period.

Table 6. Components of variance, heritability and repeatability of fertility traits monitored in progeny testing of Holstein-Friesian bulls

Trait	σ_a	σ_{pe}	σ_p	h^2	r
Calving interval	511,750	99,750	5987,917	0,085	0,102
Service period	524,865	146,306	6034,996	0,087	0,111
Average calving age	2423,000	369,700	10804,941	0,224	0,258

There is a strong genetic correlation between fertility traits, Table 7. There is a complete genetic correlation between calving interval and service period, 0.999. *Ghiasi et al. (2011)* report the same values of genetic correlations. This is a strong association between fertility traits originating from the fact that certain traits are calculated directly from the others.

Table 7. Genetic correlations of fertility traits

Trait	Calving interval	Service period	Average calving age
Calving interval	1,000	0,999	0,908
Service period	–	1,000	0,895
Average calving age	–	–	1,000

In order to improve, or at least stop the negative trend of fertility traits, it is necessary to place special emphasis on these traits in the selection. Finally, there are great expectations in the use of genomic selection in order to improve reproductive traits *(M'hamdi et al., 2010).*

Conclusion

Based on the results of the analysis of fertility traits of Holstein-Friesian bulls monitored in progeny testing, the following can be concluded: the average duration of calving interval was 411.69 days with a coefficient of variation of 18.78%, while the average duration of service period was 134.51 days and characterized by high variability (57.33%). The cows calved for the first time at the age of 770.34 days. Bull-sire is present in variability of all observed of fertility traits (p <0.01), while the fixed factors (farm, year, season and order of calving) showed their influence at the different level of statistical significance. The heritability of fertility traits was low: the average age at calving, 0.224, service period 0.087 and calving interval 0.085. Repeatability of mentioned traits was 0.258, 0.111 and 0.102, respectively. There was a strong positive correlation between the studied fertility traits.

Looking at the obtained results it is evident that it takes a lot of effort in the selection of fertility traits in herds of dairy cattle. Given that fertility traits are characterized by low heritability and high genetic variability, and significant share in the profitability of milk production, certain reproductive traits should be included as the selection criteria in breeding programs.

Acknowledgment

Research was financed by the Ministry of Education and Science, Republic of Serbia, project TR- 31053.

Heritabilitet i repitabilitet osobina plodnosti bikova holštajn frizijske rase praćenih u progenom testu

M. Lazarević, D. Nikšić, D. Ostojić Andrić, V. Pantelić, N. Maksimović, N. Stanišić, D. Stanojević, N.Mićić

Rezime

Za ispitivanje varijabilnosti osobina plodnosti holštajn-frizijskih bikova praćenih u progenom testu iskorišćeni su podaci o reprodukciji 342 krave, kćeri 15 bikova. Krave su proizvodile na sedam farmi Poljoprivredne Korporacije "Beograd" u periodu od 2004 do 2012 godine. Istraživanje je obuhvatilo sledeće osobine plodnosti: prosečan uzrast pri teljenju, trajanje servis perioda i međutelidbeng intervala. Za analizu uticaja genetskih i negenetskih izvora varijabilnosti upotrebljen je mešoviti model sa slučajnim uticajem bika - oca, fiksnim uticajem farme, godine, sezone i rednog broja teljenja. Bik – otac prisutan je u varijabilnosti svih posmatranih osobina plodnosti ($p<0,01$) dok su fiksni faktori svoj uticaj ispoljili na različitom nivou statističke značajnosti. Heritabilitet osobina plodnosti je nizak: prosečan uzrast pri teljenju, 0,224, trajanje servis perioda 0,087, međutelidbeni interval 0,085. Repitabilitet navedenih osobina je 0,258, 0,111, 0,102, odgovarajuće.

Literature

BOGDANOVIĆ V., ĐEDOVIĆ R., PERIŠIĆ P., STANOJEVIĆ D., BESKOROVAJNI R., PETROVIĆ M. D. (2012): Longevity as functional traits of dairy cows. Zbornik naučnih radova Instituta PKB Agroekonomik, 18, 3-4, 23-33.

GHIASI, H., PAKDEL, A., NEJATI-JAVAREMI, A., MEHRABANI-YEGANEH, H., HONARVAR M., GONZALEZ-RECIO O., CARABAÑO M.J., ALENDA R. (2011): Genetic variance components for female fertility in Iranian Holstein cows. Livestock Science, 139, 277–280

HOEKSTRA J., VAN DER LUGT A.W., VAN DER WERF J.H.J., OUWELTJES W. (1994): Genetic and phenotypic parameters for milk production and fertility traits in upgraded dairy cattle. Livestock Production Science, 40, 225-232

JANSEN, J. (1985): Genetic aspects of fertility in dairy cattle based on analysis of A.I. data - a review with emphasis on areas for further research. Livestock Production Science, 12 1 - 12 1 Elsevier Science Publishers B.V., Amsterdam - Printed in The Netherlands

LAZAREVIĆ M., PETROVIĆ M.M., PANTELIĆ V.,RUŽIĆ-MUSLIĆ D., BOGDANOVIĆ V., ĐEDOVIĆ R., PETROVIĆ M. D. (2013): Study of the variability of milk traits in the population of Holstein Friesian cattle in Central Serbia. Proceedings of the 10th International Symposium Modern Trends in Livestock Production, October 2-4

M'HAMDI, N., ALOULOU, R.,. BRAR, S. K., BOUALLEGUE, M., BEN HAMOUDA M. (2010): Phenotypic and genetic parameters of reproductive traits in Tunisian Holstein cows. Biotechnology in Animal Husbandry, 26, 5-6, 297-307

MENENDEZ BUXADERA, A., DEMPFLE, L. (1997): Genetic and environmental factors affecting some reproductive traits of Holstein cows in Cuba. Genetics Selection Evolution, 29, 469 - 482

PETROVIĆ M.M. (1993):Uticaj genotipa na razvoj priplodnog podmlatka, dužinu iskorišćavanja i životnu proizvodnju krava u populaciji crno belih goveda. Doktorska disertacija

PRYCE J. E., ROYAL, M. D., GARNSWORTHY, P. C., MAO, I. L. (2004): Fertility in high-producing dairy cow. Livestock Production Science, 86,125- 135.

STANOJEVIĆ D., ĐEDOVIĆ, R., BOGDANOVIĆ V., BESKOROVAJNI R., PERIŠIĆ P., POPOVAC M., POPOVIĆ N. (2013): Heritability and repetability estimation of milk yield traits of black and white cows. Proceedings of the 10th International Symposium. Modern Trends in Livestock Production, October 2-4