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PROCEEDINGS

11th - 13th October 2017 - Belgrade, Serbia

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BELGRADE - SERBIA

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Proceedings of the 11th International Symposium
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VARIABILITY OF MILK TRAITS IN PROGENY TESTING OF THE SIMMENTAL BULLS

Marina Lazarević[1], Vlada Pantelić[1], Dragan Nikšić[1], Nevena Maksimović[1], Miloš Marinković[1], Nenad Mićić[1], Dragan Stanojević[2]

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Original scientific paper

Abstract: The data of the Institute for Animal Husbandry, Belgrade-Zemun have been used to investigate the variability of the properties that are observed in the progeny testing of Simmental bulls. The analysis is based on a sample of 7,845 first-calving heifers in the period 2007-2010. The tests included the following milk properties in the standard first lactation (305 days): milk yield (kg), milk fat content (%) and milk fat yield (kg). An analysis of the production traits of the first-calving heifers under control showed that their average milk yield was 4346.49 kg milk with 3.93% milk fat and yield of 171.11 kg of milk fat. Sires, years and calving season exhibited a highly significant impact ($p<0.01$) on all the milk properties observed in the progeny testing. Based on the BLUP solution, the rank of bulls for each trait was formed, and then the correlation coefficients of the rank, ranging from 0.402 (relationship between the yield of milk and milk fat content) to 0.989 (the relationship between the yield of milk and the yield of milk fat) were established.

Key words: Simmental breed, first – calving heifers, milk properties, variability of traits, progeny test.

Introduction

The Simental breed in Serbia represents the dominant population of cattle. In the total stock of cattle it makes more than 85%, i.e. cattle of the Simmental type, with the majority of the most represented local Simmental cattle, and to a lesser extent, animals imported from West European countries (Germany, Austria, Switzerland). As a breed of combined abilities, Simmental cattle enable the production of milk and meat, however, it is mainly selected to improve milk quality traits. The improvement of milk quality traits has so far been the most

important selection route in the Simmental breeding program. One of the important preconditions for long-term provision of high-yielding populations is the systematic work on genetic improvement and rearing of heifers, which will be used as the first generation of dairy herds.

From the aspect of the genetic potential of dairy cows, the most important measure for increasing the yield of milk is the implementation of systematic breeding and selection work in the registered population. The genetic advancement of each herd equally depends on the breeding values of the male and female animals. The choice of parental pairs of future generations of dairy herds, selection criteria for heifers and their proper breeding in terms of nutrition and conditions of keeping should be given a primary importance. The choice of bull sires should be given the highest attention when it comes to the results of the progeny testing on milk performance and body development. The selection based on the results of the progeny testing is of particular importance for the features that are gender specific-limiting, such as milk performance and fertility, i.e. features that are only expressed in female animals.

The results of the study of the reproductive and production properties of Simmental cows, the heritability values and values of phenotypic and genetic correlations of these characteristics, are presented in the studies of *Pantelić, (2006), Pantelić et al., (2007), Petrović et al., (1999, 2006, 2009), Perišić et al. (1999a, 1999b), Miščević et al., (1995), Đurđević and Vidović, (1994), Romčević et al, (1992).* According to the results of previous studies, it can be concluded that the Simmental breed of cattle in Serbia is characterized by a marked variation in terms of production and reproductive characteristics.

The aim of this paper is to determine the average manifestation of milk properties, their variation and determine the influence of certain genetic and non-genetic factors on milk performance traits and determine the breeding value of bulls-sires.

Material and Methods

The data of the Institute for Animal Husbandry, Belgrade-Zemun have been used to investigate the variability of milk performance properties that are controlled in the progeny testing of Simmental bulls. The analysis is based on a sample of 7,845 first-calving heifers in the period 2007-2010. The study included the following milk performance properties in standard first lactation (305 days):

- Milk yield (kg);
- Milk fat content (%);
- Milk fat yield (kg).

In each year, two seasons were observed:

1. Summer: it included heifers calving for the first-time in May, June, July, August, September and October (3819 lactations),
2. Winter: it included heifers calving for the first-time in November, December, January, February, March and April (4026 lactations).

The first-calving heifers under control originated from 81 bull-sires, with the smallest number of daughters in the bull test being 40 and the maximum of 435. Distribution of the first-calving heifers to bull-sires is shown in Table 1.

Most of them originally came from family farms and fewer from commercial farms in Central Serbia. Milk control was performed using the reference A4 method and calculation of lactation Test interval method (*ICAR, 2009).*

Table 1: Distribution of first-calving heifers to bull-sires

Sire's HB	Number of daughters	Sire's HB	Number of daughters	Sire's HB	Number of daughters
B20	82	1224	69	1410	124
B21	89	1227	74	1416	57
B54	43	1230	79	1419	77
B121	70	1243	40	1423	49
B137	63	1261	56	1424	74
788	113	1264	47	1437	89
800	75	1267	109	1438	66
859	302	1279	53	1440	435
923	95	1280	58	1442	73
925	85	1286	217	1445	248
969	53	1287	81	1447	204
977	92	1294	60	1450	54
1012	78	1298	124	1452	84
1019	50	1302	44	1453	149
1029	70	1318	46	1457	83
1031	94	1319	48	1464	100
1036	112	1329	238	1465	66
1084	86	1347	111	1479	80
1091	51	1364	60	1491	55
1102	103	1376	97	1492	189
1109	55	1377	66	1499	63
1124	50	1380	55	1501	56
1171	67	1382	42	1506	155
1185	60	1383	111	1509	128
1187	58	1388	121	1512	189
1197	97	1390	40	B138	59
1206	266	1394	192	V028	42

In order to determine the influence of certain genetic and non-genetic factors on the investigated milk performance properties of the first calving heifers of Simmental breed, a fixed model of the least squares of *LSMLMW* was used (*Harvey, 1987*). The non-genetic factors included in the study were the fixed impact of the year and the calving season, while the genetic factor included in the examination was the fixed impact of the bull-sire.
A fixed model for analyzing different impacts on variability of traits in progeny testing:

$Y_{ijkl} = \mu + O_i + G_j + S_k + e_{ijkl}$
where:

- Y_{ijkl}: observed trait,
- μ: population average for given trait,
- O_i: fixed effect of i sire (i=1,…,81),
- G_j: fixed effect of j calving year (j=1, 2, 3, 4),
- S_k: fixed effect of k calving season (k=1, 2),
- e_{ijkl}: random error with characteristics N $(0,\sigma^2)$.

A mixed model of the least squares of L*SMLMW* adapted by *Harvey (1990)* for application in the process of breeding of farm animals was used to estimate the breeding value of bull-sires in the progeny test. The model used is identical to the model already mentioned, but in this case the bull-sire is seen as a random factor.

Results and Discussion

Table 2 presents descriptive statistical indicators and the variability of milk performance traits in the progeny testing of Simmental bulls.

Tabele 2. Descriptive statistical indicators of milk performance traits in the first standard lactation

Trait	*X*	*Min*	*Max*	*SD*	*CV (%)*
Milk yield, kg	4346.49	1675	8303	658.21	15.14
Milk fat content, %	3.93	3.29	4.65	0.10	2.51
Milk fat yield, kg	171.11	64	320	27.16	15.87

In the period from 2007 to 2010, in the standard lactation, they achieved the average milk yield of 4346.49 kg with a pronounced variation interval of 1675 and 8303 kg, with a standard deviation of 658.21 kg.
Majority of other authors *(Romčević et al., 1992, Đurđević and Vidović, 1994, Perišić, 1998*) emphasize the lower milk yield of controlled cattle of the Simental breed. Thus, *Petrović (2000)* in his research states that cows in standard lactations have an average milk yield of 4282 kg, varying from 1786 to 7721 kg and a standard deviation of 1121.68 kg. According to the data of the *Institute for Animal Husbandry (2008)*, the milk yield of registered cows in the Simmental population in the period from 2003 to 2007 ranged from 3986 to 4440 kg.
Comparing their results with the results shown, it is obvious that the milk performance of the first-calving heifers of Simmental breed in Serbia has a positive trend. The variability of milk performance traits in the progeny test by years of calving is shown in Table 3.

Observing the average milk yield of the first-calving heifers of Simmental breed in standard lactation in the four-year period, there is a positive trend except in 2009 when the drop in the production of milk was recorded (4238.83kg). The highest milk production was achieved in 2010 (4420.34) with a pronounced coefficient of variation (17.20). However, according to data of *ICAR (2011)*, the Simmental population of the first-calving heifers in the developed countries (Germany, Austria) achieved significantly higher production (5000-6000 kg).

Table 3. Mean values and variability of milk performance traits in progeny test by years (standard lactation)

Trait		Calving year			
		2007	2008	2009	2010
Milk yield, kg	*X*	4319.24	4400.51	4238.83	4420.34
	Min	1847	2663	1675	2233
	Max	7637	7745	8303	7207
	SD	628.93	630.23	574.03	760.12
	CV (%)	14.56	14.32	13.54	17.20
Milk fat content, %	*X*	3.91	3.93	3.95	3.94
	Min	3.33	3.29	3.40	3.34
	Max	4.64	4.38	4.65	4.65
	SD	0.11	0.08	0.11	0.09
	CV (%)	2.81	2.04	2.78	2.28
Milk fat yield, kg	*X*	169.02	172.85	167.29	174.73
	Min	64.00	103.32	65.85	88.90
	Max	312.20	316.00	320.00	292.54
	SD	25.21	26.53	23.20	31.76
	CV (%)	14.92	15.35	13.87	18.18

The content of milk fat in relation to the milk and milk fat yield is largely influenced by the genotype in relation to the effect of the external factor *(Pantelić, 2006).* The average milk fat content was 3.93% with a standard deviation of 0.10 and a coefficient of variation of 2.51%. Approximately the same value is stated by *Pantelić (2006), Petrović et al. (2006).* Observed by years, the percentage of milk fat varied slightly, and the highest value was achieved in 2009 when the lowest milk yield was achieved.

Milk fat yield in standard lactation depends on milk yield and milk fat content. The average yield of milk fat in first-calving heifers under control in a four-year period was 171.11 kg with a standard deviation of 27.16 kg and a coefficient of variation of 15.87%. By 2008, the yield of milk fat increased to drop sharply in 2009 (167.29 kg) and then increase again, when the highest production of 174.73 kg with the highest variability (CV = 18.18%) was achieved in 2010.

Table 4 shows the effect of genetic and non-genetic sources of variability on milk performance traits.

Bull-sires exhibited significant influence (P<0.01) on all milk performance traits in the first standard lactation. *Stojić (1996)* has established in his research a high significance (P<0.01) of the bull-sire on the traits of milk yield, yield of milk fat and 4% MCM in the first standard lactation, while the milk fat content did not show significant effect (P>0.05). According to *Pantelić (2006),* in the first-calving heifers of Simmental breed, bull-sires had a very significant influence (P<0.01) on all the studied milk performance traits. The year of calving showed a highly significant effect (p<0.01) on all milk performance properties observed in the progeny test. The same results are reported by *Đurđević et al (1994). Perišić et al. (1999a), Pantelić (2006)* report insignificant impact of the year on the production results for the first-calving heifers in their researches. The calving season showed a high significance (p<0.01) on the yield of milk and milk fat while it significantly influenced (p<0.05) the percfentage of milk fat.

Table 4. The general averages of the leastsquares (μ) and their errors (Se) for milk performance traits, F-test of the tested influences

Trait	μ	Se	F values of tested influences		
			Sires	*Year*	*Season*
			df1=80	*df1=3*	*df1=1*
			df2=7760	*df2=7760*	*df2=7760*
Milk, kg	4345.88	35.11	17.62^{**}	6.64^{**}	24.68^{**}
Milk fat, %	3.93	0.004	13.04^{**}	15.91^{**}	3.99^{*}
Milk fat, kg	171.04	1.51	19.41^{**}	5.94^{**}	23.47^{**}

$p>0.05^{NS}$, $p<0.05^{*}$, $p<0.01^{**}$

The impact of the year on the yield of milk and milk fat is mainly reflected in the quality and quantity of food available. The effect of the year will be more

pronounced in those years when vegetation is more extensive and better than in the average years.

Table 5 shows BLUP solutions and 15 best ranked bulls for milk yield in the progeny test.

The best ranked bull for milk yield is HB 1197, and it is in the first place also in regard to the yield of milk fat, while it is ranked 13 according to the content of milk fat.

Table 5. Evaluation of the Breeding value of bull-sires (BLUP) and rank of 15 best bulls for milk yield in the progeny test

Sire's HB	Number of daughters	Milk, kg	Rank milk, kg	Milk fat, %	Rank milk fat, %	Milk fat, kg	Rank milk fat, kg
1197	97	795.04	1	0.034	13	32.92	1
V028	42	634.18	2	0.015	28	25.24	2
1410	124	502.06	3	0.022	23	20.97	5
1171	67	497.42	4	0.083	1	23.52	3
800	75	452.84	5	0.071	2	21.28	4
1383	111	374.33	6	0.028	17	16.20	6
B54	43	351.92	7	0.021	26	14.46	9
859	302	347.67	8	0.031	14	15.19	8
1382	42	340.50	9	0.009	37	13.38	11
1479	80	340.14	10	0.044	5	16.16	7
788	113	335.61	11	0.012	33	13.75	10
1206	266	316.01	12	0.021	25	13.32	12
1465	66	313.59	13	0.011	35	12.49	14
1031	94	287.16	14	0.040	8	13.05	13
1491	55	270.28	15	-0.026	63	9.37	17

Observing the 15 best ranked bulls for milk yield, it is also noted that they are within the 15 best bulls for milk fat yield while being poorly ranked for milk fat content. Bull HB 1171 is found to be the first in regard to the milk fat content, ranked 4th in regard to the milk yield, and third in regard to the yield of milk fat.

Considering that the ranking of bulls for the three milk performance traits was determined, the degree of agreement between the obtained ranges was tested using the Spirman coefficient of correlation of rank, Table 6.

The determined coefficients of the rank correlations indicate that there was a medium to complete positive interdependence between the ranks of the bulls. The rank correlation of bulls of 0.989 was established between the yield of milk and the yield of milk fat in standard lactation. The medium correlation was determined between the content and the yield of milk fat of 0.494. The medium correlation of 0.402 was determined between the yield of milk and the content of milk fat.

Table 6. The rank correlation of bulls

Trait	Milk yield, kg	Milk fat content, %	Milk fat yield, kg
Milk yield, kg	—	0.402**	0.989**
Milk fat content, %	—	—	0.494**
Milk fat yield, kg	—	—	—

$p>0.05^{NS}$, $p<0.05^{*}$, $p<0.01^{**}$

Ranking of bulls and determination of rank correlations among the examined milk performance traits will enable more efficient use of bulls in artificial insemination programs.

Conclusion

Looking at the obtained results, it is evident that a lot of selection work is needed to reach the level of production of the Simmental population in the more advanced countries (Germany, Austria). It is encouraging that a positive trend is observed over a four-year period, and the established variability provides enough room for improving the quality of milk performance. From the aspect of the genetic potential of dairy cows, the most important measure for increasing the yield of milk in the following period is the implementation of systematic breeding and selection work in the main population. The choice of parental pairs of future generations of dairy herds, selection criteria for heifers and their proper rearing in terms of nutrition and housing and keeping conditions should be given a primary importance.

Varijabilnost osobina mlečnosti praćenih u progenom testu bikova simentalske rase

Marina Lazarević, Vlada Pantelić, Dragan Nikšić, Nevena Maksimović, Miloš Marinković, Nenad Mićić, Dragan Stanojević

Rezime

Za ispitivanje varijabilnosti osobina koje se kontrolišu u progenom testu bikova simentalske rase iskorišćeni su podaci Instituta za stočarstvo iz Zemuna.

Analiza je zasnovana na uzorku od 7.845 prvotelki oteljenih u periodu 2007-2010 godine. Ispitivanja su obuhvatila sledeće osobine mlečnosti u standardnoj prvoj laktaciji (305 dana): prinos mleka (kg), sadržaj mlečne masti (%) i prinos mlečne masti (kg). Analiza proizvodnih karakteristika kontrolisanih prvotelki pokazala je da je njihova prosečna mlečnost na nivou od 4346,49 kg mleka sa 3.93% mlečne masti i prinosom od 171,11 kg mlečne masti. Očevi, godina i sezona teljenja ispoljili su visoko signifikantan uticaj ($p<0,01$) na sve osobine mlečnosti praćene u progenom testu. Na osnovu BLUP rešenja formiran je rang bikova za svaku osobinu a zatim utvrđeni koeficijenti korelacija ranga koji kreću se od 0,402 (povezanost ranga između prinosa mleka i sadržaja mlečne masti) do 0,989 (povezanost ranga između prinosa mleka i prinosa mlečne masti).

Ključne reči: simentalska rasa, prvotelke, osobine mlečnosti, varijabilnost osobina, progeni test.

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