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THE EVALUATION OF BREEDING VALUE OF SIMMENTAL BULLS FOR MILK PERFORMANCE IN SERBIA

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Abstract: The basis for selection work is knowledge of the quality of bull sires used for conception, as well as how the major traits are passed on to the progeny. BLUP method (Best Linear Unbiased Prediction) is the basis of the most favourable solution for evaluation of additive gene value in cattle production, and it is implemented in various variants depending on the structure of data used. This research included 2.121 Simmental first calvers under control, with lactations completed within one year. All first calvers were located on holdings of individual agricultural producers on the territory of the Republic of Serbia. Evaluation of the bull breeding value for lactation duration, milk production, milk fat yield, yield of 4% FCM and percentage of milk fat, was carried out by using the mixed model (BLUP), the calculation included random effect of bull sire and fixed effect of the region, year and season of calving. In this study, bull sires which had in two or three regions over 20 daughters – first calvers of Simmental breed. Number of first calving heifers ranged from 22 to 215 animals per bull sire. By using BLUP method in evaluation of breeding value of bulls in terms of yield of milk, milk fat, content of milk fat and 4% FCM and by ranking, results were obtained showing superiority and inferiority of breeding males.

Key words: Simmental breed, bulls, breeding value, milk performance

Introduction

Simmental breed of cattle is predominant in Central Serbia, where the total cattle population is approx. 819 000 heads, of which approx. 538.000 are cows and pregnant heifers. Active population of Simmental breed in Republic of Serbia consists of animals recorded in the main livestock/cattle registry (approx. 75.000 animals or 14%). Breeding goal for Simmental breed is to achieve maximum genetic potentials in economically relevant traits, in accordance with economical

effects of genetic improvement achieved by this breed in developed world countries.

In evaluation of breeding value for milk traits/performance, especially of bulls in progeny testing, in Serbia until recently the CC method – Contemporary comparison was used, as well as selection index, and in last years, the Best Linear Unbiased Prediction is used (BLUP). According to *Sullivan and Schaeffer (1994)* the Best Linear Unbiased Prediction (BLUP) has become world standard in evaluation of the genetic value.

Vidović et al. (1993) evaluated the breeding value of Simmental bulls based on their progeny using both BLUP and CC method. Results obtained by authors indicated that the evaluation of the bulls' breeding value and their ranks, obtained by BLUP-1 and BLUP-2 methods, were similar to evaluation and rank obtained by CC method.

The effect of selection in population depends, among other things, on the accuracy of the evaluation of additive value of the parent genotype, i.e. breeding value of bull sires, as concluded by *Đurđević and Vidović (1994)*. The authors evaluated the breeding value using BLUP and CC methods. Correlation of the breeding value rank showed that there was no complete concordance between these two methods.

Miščević (1995) obtained in his research results according which the correlation coefficient of the rank showed that there was significantly high dependence between BLUP and CC methods. However, the method of Best Linear Unbiased Parameters, due to inclusion of fixed effects, gave more precise results and more reliable evaluation of the breeding value of male breeding animals.

Stojić (1996) concluded that application of correction factors contributes to the accuracy of the evaluation of the breeding value in the way that more important factors with certain direction of their action are brought to the same level, and also because of increase of repeatability.

Evaluation of the genotype additive value, i.e. accuracy of its evaluation (bull breeding value) is directly associated with selection effect/success in cattle population (*Petrović et al. 1997*). By using mixed model, random effect of bull sire on milk yield, yield of milk fat, content of milk fat and 4% FCM and forming of bull rank based on breeding value, results were obtained showing significant superiority or inferiority if male breeding animals.

One of the methods for evaluation of breeding value of cows and bulls is »test-day model«. Advantage of this method is in the correction of the effect of the environment factors on individual cow performance, as stated by *Freeman (1998)*. The »test-day« model is most often used for several traits, primarily milk yield, yield of milk fat, proteins and somatic cell count in milk. »Test-day« model enables genetic evaluation for additional traits, such as persistence, milk yield in specific part of lactation, etc.

Swalve (1998) pointed out that the »test-day« model, i.e. data collected on the day of testing are used for analysis instead of concluded lactations calculated based on certain daily controls. Conventional system of data collection is an expensive and slow process, and it is necessary to wait for lactations to be put in order before proceeding with the evaluation of genetic value. By application of »test-day« model the attempt is made to calculate the effect of genetic and paragenetic factors immediately and directly when this effect is exhibited, i.e. on the day of testing.

Method officially used by INTERBULL today is multiple trait model using data from many countries, which was developed by *Schaeffer and Zhang (1993)*. This method is based on the hypothesis that the genetic correlation for certain traits between countries is less than one, i.e. that there is interaction between genotype and environment. In this way the milk performance is evaluated, also milk fat and protein yield.

Materials and Methods

This research included 2.121 Simmental first calvers under control, with lactations completed within one year. All first calvers were located on holdings of individual agricultural producers on the territory of the Republic of Serbia. In selection of model for evaluation of the bull breeding value, it is important to evaluate as accurately as possible, and eliminate the effects of many systematic factors of the environment, and to establish the heritability value for traits included in the selection process. In immediate processing and analysis of data base the following mixed model of least squares was used (*Harvey 1990*):

1. Mixed model for evaluation of bull breeding value for milk performance traits (BLUP):

$$Y_{ijklm} = \mu + B_i + R_j + G_k + S_l + e_{ijklm}$$

Y_{ijklm} = expression of the trait in m cow, daughter of bull-sire i , which produced in j region, and calved in year k and l season

μ = general average

B_i = random effect of i bull sire

R_j = fixed effect of j region

G_k = fixed effect of k calving year

S_l = fixed effect of l calving season

e_{ijklm} = random error

The evaluation of the breeding value of bulls for following traits: duration of lactation, milk yield, milk fat yield, yield of 4% FCM and content of milk fat, was calculated using mixed model (BLUP), in which equation also random effect of bull sire and fixed effect of region, year and season of calving were included. Bull sires with over daughters – first calvers of Simmental breed in two or three regions, were tested. Number of first calvers ranged from 22 to 215 per bull sire, and total of 2.121 daughters were tested.

Results and Discussion

Breeding values and bull rank for milk performance traits in standard lactation, evaluated based on production of their daughters in all regions are presented in Table 1.

Depending on the structure of linear model, which usually contains combination of several effects on traits, absolute BLUP solutions are obtained which are used for ranking of the selection candidates. Equations/formulas contain effects with fixed (region, year, season) and random classification (sires). Model can also include information about relatives, genetic trend in the population, matrix of kinship, genetic groups or their combination. BLUP is the best linear method because it is the least biased method in evaluation of genetic and paragenetic factors, as concluded by *Latinović et al. (1997)*.

The best ranked bull in regard to milk yield was HB 1197 whose production deviated by 357,62 kg, followed by HB 1206 with deviation of 329,60 kg, and on the third place was HB 1334 with deviation of 291,11 kg. The lowest ranked bull was HB 1260 which deviated by -666,69 kg and was ranked on 37th place. In front of him was the bull HB 973 with breeding value of -532,61 kg ranked 36th. At 35th place in regard to milk yield was the bull HB 1039, with deviation of -340,92 kg.

Obtained results indicate that the best production was realized by foreign bulls that are on loan in our country or whose semen had been imported for planned insemination of female breeding animals of domestic Simmental population. Some of these bull sires have in their genetic basis certain share of Red Holstein or Montbeliard genes. The lowest ranked bulls were domestic bulls.

In regard to the content of milk fat, the best ranked bull was HB 920 (BV 0,08), followed by HB 921 (BV 0,06), and on the third place the bull HB 1319 (BV 0,06). The lowest ranked bull for the percentage of milk fat was HB 1039 (BV -0,09), in front of him, ranked 36 was the bull HB 1189 (PV -0,07), and ranked 35th the bull HB 877(PV -0,05).

Table 1. Superiority (BV) and bull rank for milk performance traits in standard lactation

HB bull	No. of daughters	DL, days		MY, kg		CMF, %		MFY, kg		4%FCM, kg	
		BV	Rank	BV	Rank	BV	Rank	BV	Rank	BV	Rank
671	63	-2.85	22	-181.47	32	0.03	9	-6.02	30	-162.82	32
788	30	-4.71	29	-209.29	33	0.02	10	-7.39	33	-194.64	33
877	27	-7.17	33	152.55	8	-0.05	35	3.80	14	118.06	13
895	34	-4.75	30	-6.75	20	0.00	21	-0.60	21	-11.61	20
920	46	-3.17	23	-81.97	27	0.08	1	-0.10	20	-34.34	23
921	62	6.06	9	123.44	12	0.06	2	7.12	6	156.15	7
926	42	-7.38	34	97.08	15	-0.04	33	2.24	18	72.52	17
973	24	15.20	1	-532.61	36	0.05	6	-19.09	36	-499.28	36
975	63	3.93	11	55.38	18	0.00	20	2.09	19	53.53	18
978	215	-1.32	19	76.64	17	0.01	13	3.10	16	77.15	16
980	97	-3.19	24	165.91	5	-0.02	28	5.74	8	152.46	8
1000	55	5.19	10	160.88	6	-0.02	29	5.52	9	147.09	9
1032	46	12.37	2	-63.47	26	0.00	19	-2.39	26	-61.11	26
1039	38	8.86	3	-340.92	35	-0.09	37	-16.48	35	-383.53	35
1053	49	7.16	6	201.98	4	0.01	15	8.20	5	203.80	4
1066	67	1.07	13	-13.51	22	-0.03	31	-1.73	24	-31.41	22
1102	60	-0.86	18	7.62	19	0.06	5	2.67	17	43.13	19
1108	89	-3.94	25	-7.04	21	-0.02	24	-0.86	22	-15.75	21
1111	27	-1.34	20	144.35	9	0.03	8	6.89	7	160.94	6
1121	77	8.40	4	-101.72	29	0.01	17	-3.47	27	-92.67	28
1122	34	-4.03	26	115.94	13	0.01	16	4.78	11	118.10	12
1133	36	-4.22	27	-219.39	34	0.03	7	-7.40	34	-198.81	34
1143	69	-6.28	32	88.78	16	0.00	18	3.57	15	89.06	15
1144	29	6.89	7	-153.65	31	0.06	4	-3.60	28	-115.54	29
1151	60	-0.08	17	-53.82	25	-0.05	34	-3.86	29	-79.45	27
1166	32	8.14	5	-30.40	23	-0.02	25	-1.82	25	-39.57	25
1177	30	-2.78	21	112.68	14	0.01	14	4.77	12	116.62	14
1178	77	1.00	14	141.17	10	-0.02	26	4.71	13	127.09	11
1185	22	-8.27	36	-137.77	30	-0.04	32	-6.58	32	-153.92	31
1189	39	-7.82	35	-83.53	28	-0.07	36	-6.17	31	-125.95	30
1197	38	2.28	12	357.62	1	-0.02	27	13.16	2	340.51	1
1198	126	-4.37	28	137.16	11	-0.01	23	4.96	10	129.22	10
1206	69	-5.80	31	329.60	2	0.01	12	13.37	1	332.33	2
1260	54	-9.67	37	-666.69	37	0.01	11	-25.78	37	-653.39	37
1287	110	6.40	8	-30.57	24	-0.01	22	-1.51	23	-34.85	24
1319	48	0.48	16	154.68	7	0.06	3	8.47	4	189.03	5
1334	37	0.59	15	291.11	3	-0.03	30	9.69	3	261.84	3

Similar to the previous case, the best ranked bulls were imported ones, however, bulls who are brothers after their father from the famous Horror line, took the first two places. The lowest ranked bull for percentage of milk fat - HB 1039 was ranked exceptionally low also in regard to milk yield - 35th place. Austria has managed by application of strict selection in 2004 to reach the average content of milk fat of 4,21% for entire population of Simmental cattle in 212.563 concluded lactations (Zoufaly et al. 2005).

Bulls with good results in regard to milk yield also were superior in regard to milk fat yield but with changed mutual order. So the best ranked bull was HB 1206 (13,37 kg), followed by the bull HB 1197 (13,16 kg), and the bull HB 1344 (9,69 kg).

However, in regard to the lowest ranked bulls for milk fat yield, the situation is identical to results obtained for yield of milk. The lowest ranked bull was HB 1260 with deviation of -25,78 kg and at the 37th place. In front of him at the 36th place is the bull HB 973 with deviation of -19,09. At the 35th place in regard to milk fat yield was the bull HB 1039, with negative breeding value of -16,48 kg.

If milk yield is calculated as 4% FCM, identical rank of bulls is obtained, however deviation values are slightly higher and lower. The best ranked bull was HB 1197 whose production deviated by 340,51 kg, followed by HB 1206 with breeding value of 332,33 kg, and bull HB 1334 with deviation of 261,84 kg. The lowest production was recorded in daughters of the bull HB 1260 with values deviating by -653,39 kg at 37th place. In front of him was the bull HB 973 with deviation of -499,28. At 35th place in regard to yield of 4% FCM was the bull HB 1039, with breeding value of -383,56.

For duration of lactation, the best ranked bull sire was HB 973 (15,20 days) who had the lowest results for milk performance traits. At the last place, 37th, was the bull HB 1260 (-9,67 days) who was the lowest ranked bull for all tested production traits.

The following authors studied also the evaluation of the bull breeding value using the BLUP method, their ranking, and also their effect on milk performance traits and fertility traits: *Latinović et al. (1997)*, *Vidović et al. (1993)*, *Durđević and Vidović (1994)*, *Sullivan and Schaeffer (1994)*, *Petrović et al. (1997)*, *Miščević (1995)*, *Stojić (1996)*, *Freeman (1998)*, *Swalve (1998)*, *Marković (1999)*, *Panić and Vidović (2006)*, *Trivunović (2006)*.

Production of milk and milk fat is limited to only one gender, therefore potential capacity of breeding males for these traits is established based on production results of mothers, sisters, daughters. Knowledge of the quality of bulls and how certain traits are transmitted to the progeny is central issue of breeding programs. Application of artificial insemination and long term semen storing

results in decrease of number of bulls in populations, therefore their individual effect on the selection results is considerably greater.

Conclusion

Basic requirement of the modern cattle production is improvement and enhancement of the genetic capacities of animals for production of milk, meat and calves. In application of high quality breeding males with proven genetic potential will contribute to improvement of production and reproduction traits of the cattle population in Serbia.

In this process, the evaluation of the parents' breeding value is one of the priorities. Application of linear methods in evaluation of breeding value contributes to significant improvement of the evaluation from the aspect of inclusion of more available information.

BLUP is one of the leading methods used to achieve progress in population genetics, since it is possible to include own results and production results of individual animals. By combining the methodology of mixed model, method of least squares and selection index method, BLUP is applied world wide as standard.

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Ocena priplodne vrednosti bikova simentalске rase za osobine mlečnosti u Srbiji

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Rezime

Osnovu za svaki selekcijski rad predstavlja poznavanje kvaliteta bikova očeva koji se koriste za oplodnju, kao i način prenošenja važnijih svojstava na potomstvo. U osnovi najpovoljnijeg rešavanja problema ocene aditivne genotipske vrednosti osobina u govedarstvu leži BLUP metod (Best Linear Unbiased Prediction), koji se primenjuje u raznim varijantama zavisno od strukture podataka.

Ovim istraživanjem je obuhvaćena 2.121 kontrolisana prvotelka simentalске rase, sa laktacijama zaključenim u toku jedne godine. Sve prvotelke su

se nalazile na imanjima individualnih poljoprivrednih proizvođača na području Republike Srbije. Ocena priplodne vrednosti bikova za osobine trajanje laktacije, proizvodnju mleka, mlečne masti, 4% MKM i procenat mlečne masti, izračunata je pomoću mešovitog modela (BLUP), u čiju jednačinu je uključen slučajni uticaj bika-oca i fiksni uticaj regiona, godine i sezone telenja. Ispitani su bikovi-očevi koji u dva ili tri regiona imaju 20 i više kćeri prvotelki simentalne rase. Broj prvotelki je bio od 22 do 215 po biku-ocu. Korišćenjem BLUP metoda za ocenu priplodne vrednosti bikova na prinos mleka, mlečne masti, saržaja mlečne masti i 4% MKM i formiranjem ranga dobijeni su rezultati koji pokazuju znatnu superiornost ili inferiornost priplodnjaka.

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