Biotechnology in Animal Husbandry 31 (3), p 339-348 , 2015
Publisher: Institute for Animal Husbandry, Belgrade-Zemun
ISSN 1450-9156
UDC 636.06'636.23
DOI: 10.2298/BAH1503339L

SOURCES OF VARIABILITY OF GROWTH AND BODY DEVELOPMENT TRAITS OF SIMMENTAL BULLS IN PERFORMANCE TEST

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Original scientific paper

Abstract: To test the variability of traits of Simmental bulls in performance test, data of the Livestock - Veterinary Centres for Reproduction and Artificial Insemination of Velika Plana and Krnjača were used. In the analysis, data on 113 performance tested bulls born from 2008 to 2009 were used. The analysis included two sets of characteristics: body development traits and growth traits. The average body mass of calves entering the test was 195.75 kg, while the body mass at the end of the test was 476.50 kg, average daily gain in the test was 1138.69 g. Average values of body development traits measured at the end of the test, with 12 months of age were: height at withers 127.13 cm, chest circumference 179.42 cm, the chest depth 61.19 cm and body length 151.34 cm. The influence of their sires, the year and the Centre on the variability of traits was studied. The effect of age is present at a high level of statistical significance ($p<0.01$) for all traits that are registered at the end of the test, while the effect of the Centre was present in the variability of body mass at the end of the test, the daily gain in the test and the length of the body. The bulls-sires' influence was demonstrated ($p<0.05$) on the variability in body mass of calves entering the test.

Key words: Simmental breed, bulls, growth traits, body development, variability of traits, performance test

Introduction

Simmental cattle belong to the combined type, which means almost equal economic importance of milk and meat production. It belongs to the big breeds that have the genetic potential for intensive improvement of both components. Therefore, proper selection and selection of young bulls as future breeding bulls

should ensure improvement of traits and improvement of production of milk and meat (*Bogdanović, 2001*).

In assessing the breeding value of performance test bulls is one of the main animal husbandry practices, which determines the genetic improvement of a certain group of properties. Selection based on the results of performance test, is of special importance for traits that are characterized by medium to high heritability values *(Bogdanović, 2001).*

Performance test is used for production traits which can be determined or measured in each individual animal. This process is known as direct test because its application covers control of production traits that are directly measured on animals still in development.

The performance test of Simmental bulls in Serbia officially started to be performed during 1982 in Test station at the Center for Artificial Insemination in Velika Plana. From the very beginning, the adopted test technique was in compliance with all recommendations of the European Zootechnical Federation *(Bogdanović, 2001).*

The study of of growth and body development traits of performance tested Simmental bulls, was topic of research of several researchers in Serbia. The variability of characteristics and influence of individual factors on the variation, values of heritability, phenotypic and genetic correlations of mentuioned traits are stated in the studies of *Perković* (1999), *Romčević,* (1999) and *Bogdanović* (1999, 2001, 2002, 2003, 2006, 2007).

Bearing in mind the importance of Simmental breed in cattle production of Serbia, as well as the lack of research associated with this breed, the aim of this study was to determine the average expression and variation of traits of growth and body development, and then to determine the influence of certain genetic and non-genetic factors on traits measured in performance test.

Material and methods

To test the variability of growth and body development traits of Simmental bulls in performance test, data of the Livestock Veterinary Centres for Reproduction and Artificial Insemination (SVC) from Velika Plana and Krnjača were used. Bulls included in the test are taken to the Centre based on the application of the owner or holder of the bull, from private and state farms. Before bringing the young bulls to the Centre, examination and evaluation are carried out to determine whether they meet the basic requirements to enter the test.

Selected male calves come into the station at the age of about three months, they are placed in quarantine and adjust to conditions of housing and nutrition for at least 30 days, in order to eliminate as much as possible pre-existing effects. After a preparatory period, at the age of 4 months, the test starts and lasts

until the age of one year. Bulls in the test are held in adequate groups, not more than 5 animals in the group, formed in relation to age. Basic forage - alfalfa hay is given at will, while the amount of concentrate is limited by age. During the test, in regular one-month intervals, the body weight and the most important dimensions of the body (withers height, chest circumference, breast depth, width of round, pelvic width and length of the body) are measured. At the end of the test, the average daily gain in the test is calculated and it is a key feature on which the evaluation of bulls in the test is based.

Data on 113 performance tested bulls born from 2008 to 2009 were used in the analysis. In 2008, 72 bulls were in the test while in 2009 41 Simmental bulls were tested. In the LVC Velika Plana, from 2008 to 2009, 91 Simmental bulls finished the test while in the same period in Krnjača 22 bulls were tested. Distribution of performance tested bulls by years and centres is shown in Tables 1 and 2.

Table 1. Distribution of performance tested bulls at centres

AI Centre	V. Plana	Krnjača
No of tested bulls	91	22

Table 2. Distribution of performance tested bulls by years

Year	2008	2009
No of tested bulls	72	41

The analysis included two sets of characteristics: body development traits and growth traits.

Body development traits are represented by the linear dimensions of the body measured at the end of the test, at 12 months of age: height at withers, chest circumference, chest depth and body length.

The following growth traits are included: body weight at the beginning of the test (with 4 months of age), body weight at the end of the test (with 12 months age), average daily gain during the test.

The most attention in the test is directed towards the average daily gain during because it fully reflects the capacity and intensity of the growth of the animal, and therefore its predisposition to a particular form of production.

Statistical analysis of data obtained during the performance test was divided into two parts.

The first part of the analysis included the determination of the basic variation-statistical parameters:

- Arithmetic mean (X),
- Variation range (*Min-Max*),

- Standard deviation (*SD*),
- Coefficient of variation (*CV*).

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 various influences on traits variability in performance test. Analysis of the influence of non-genetic and genetic sources of variability was performed by the method of least squares *LSMLMW*. To analyse the influence of non-genetic sources of variability a fixed model with fixed effect of birth and centre is used.

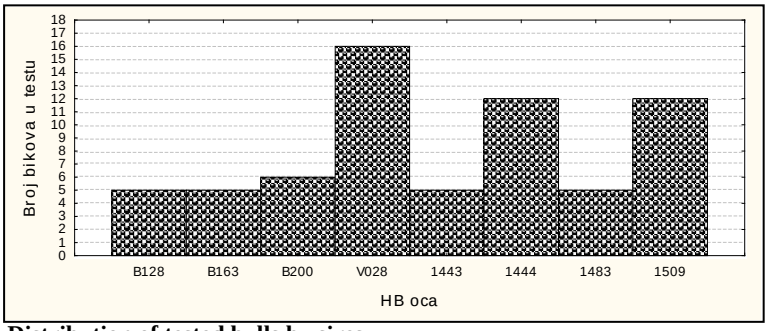
1. Fixed model for analysing the impact of non-genetic sources of variability of traits in performance test:

$$Y_{ijk} = \mu + G_i + C_j + e_{ijk}$$

where:

- Y_{ijk}: studied trait,
- μ: population average for said trait,
- G_i: fixed effect of i-th year of birth of the bull (i=1, 2),
- C_j: fixed effect of j-th centre (j=1, 2),
- e_{ijk}: random error with characteristics N $(0,\sigma^2)$.

To analyse the influence of sires on the variability of traits in the performance test of the basic sample, a sub-sample of 66 bulls originating from 8 sires was formed. For this subsample all sires with 5 and more tested sons were selected. Distribution of tested bulls by fathers is shown in Graph 1.



Graph 1. Distribution of tested bulls by sires

In this part of the analysis the mixed model with random influence of the sire was applied.

2. Mixed model for analysing the impact of sires on variability of traits in performance test:
$Y_{ijkl} = \mu + G_i + C_j + O_k + e_{ijkl}$

where:

- Y_{ijkl}: studied trait,
- μ: population average for said trait,
- G_i: fixed effect of i-th year of birth of the bull (i=1, 2),
- C_j: fixed effect of j-th centre (j=1, 2),
- O_k: random error of k-th sire (k=1,…,8),
- e_{ijkl}: random error with characteristics N $(0,\sigma^2)$.

In countries with developed cattle breeding, performance test is practically no longer performed in the test stations but in the production conditions of the population or is replaced by other methods of selection. Although the number of bulls tested at the centres decreases each year, in Serbia it is still justified given that the progeny test on slaughter traits is not performed.

Results and Discussion

Table 3 presents the descriptive statistical indicators and variability of traits in the performance test of Simmental bulls.

Table 3. Mean values and variability of traits in performance test of Simmental bulls

Trait	*X*	*Min*	*Max*	*SD*	*CV(%)*
Initial body mass, beginning of test, kg	195.75	100	300	36.59	18.69
Body mass at the age of 12 months, kg	476.50	336	685	59.44	12.47
Daily gain in the test, g	1138.69	570	1740	231.65	20.34
Height at withers, cm	127.13	116	136	3.30	2.60
Chest depth, cm	61.19	42	70	4.21	6.88
Chest circumference (girth), cm	179.42	151	210	9.49	5.29
Body length, cm	151.34	125	169	6.41	4.24

Table 4 shows the influence of non-genetic sources of variability of traits in the performance test of Simmental bulls.

The average body mass of calves entering the test was 195.75 kg, which is consistent with the findings of *Bogdanović* (2006). Body mass of young bulls at the beginning of the test is characterized by a wide range of variation. *Perković et al (1999)* state that the average body mass of calves entering the test in Krnjača was 233 kg.

The year and centre showed no statistically significant influence ($p>0.05$) on the variability of body mass at the start of the test which leads to the conclusion that the body mass of young bulls is more influenced by the farm of their origin. Due to the different climatic conditions in which farms are located, feeding and housing that are designated as farm management, body mass at the beginning of the test is more influenced by pre-test factors. The body mass of calves entering the test is heavily influenced by maternal effects and housing/rearing system prior to weaning.

The average body mass of bulls at the end of the test was 476.50 kg, while slightly higher values (515.86 kg) for Simmental bulls tested in the LVC Velika Plana are reported by *Bogdanović* (2006). *Perković et al (1999)* found that the bulls in Krnjača ended the test with a body mass of 509 kg. Body mass at the end of the test varied less in relation to initial body mass of calves entering the test as a consequence of standardized conditions for feeding, housing, etc. Year and centre statistically significantly ($p<0.01$) influenced variation of body mass at the end of the test.

Average daily gain in the test was 1138.69 g with a coefficient of variation of 20.34, which is consistent with the results obtained by *Perković et al (1999).* The high variability ($p<0.01$) was statistically significantly influenced by the year and centre.

Table 4. The influence of non-genetic factors on the variability of traits in the performance test of Simmental bulls, F values (model 1)

Trait	μ	Se	F values of tested effects	
			Year	*AI Centre*
			df1=1	*df1=1*
			df2=110	*df2=110*
Initial body mass, beginning of test, kg	198.18	4.81	2.91^{NZ}	0.05^{NZ}
Body mass at the age of 12 months, kg	492.74	6.44	8.49^{**}	28.52^{**}
Daily gain in the test, g	1171.91	25.39	18.69^{**}	14.54^{**}
Height at withers, cm	126.70	0.40	20.38^{**}	0.02^{NZ}
Chest depth, cm	60.98	0.53	9.75^{**}	0.22^{NZ}
Chest circumference (girth), cm	179.66	1.13	15.04^{**}	3.22^{NZ}
Body length, cm	152.68	0.72	10.75^{**}	19.21^{**}

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

The height of withers and depth of chest at the end of the test were not under significant ($p>0.05$) effect of centre, but the influence of year was significant source of variability ($p<0.01$). The average height to withers at the end of the test was 127.13 cm with a coefficient of variation of 2.60, the average depth of the chest was 61.19 cm with a coefficient of variation of 6.88, which is in line with the results presented in the paper by *Bogdanović (2007).* An average height at the withers of 127.1 cm is reported by *Perković et al. (1999).*

The variability of chest circumference and body length were under statistically significant ($p < 0.01$) of the year, while the variability in the length of the body also included the effect of the centre. The average chest cir4cumference (girth) of Simmental bulls at the end of the performance test was 179.42 cm and the average body length 151.34 cm. Comparing the results of this study with the results obtained by *Perković et al. (1999)*, the bulls at the end of the test had smaller chest size but greater body length compared to bulls tested in Krnjača in the period from 1992 to 1997.

By perceiving the traits of body development and growth in the monitored performance test much lower variability of body development traits can be observed. Given that both sets of characteristics are under the influence of same abiotic factors, it can be concluded that the body development of young bulls is under greater genetic influence.

The effect of the year is present at a high level of statistical significance ($p<0.01$) for all traits that are registered at the end of the test. The impact of the year includes the climatic factors, the schedule and amount of precipitation which is reflected in the quantity and quality of available food.

Although the performance test technique is the same, the influence of centre was statistically significant ($p < 0.01$) on the variability of growth traits measured at the end of the test and the body length. The effect of the centre is reflected in the geographical environment of the station, food quality, conditions in the test, management of the animals, etc.

Table 5. The influence of sires on the variability of traits in the performance test of Simmental bulls, F values (model 2)

Trait	μ	Se	F values of tested effects		
			Sires	*Year*	*AI Centre*
			df1=7	*df1=1*	*df1=1*
			df2=56	*df2=56*	*df2=56*
Initial body mass, beginning of test, kg	192.48	10.46	2.29^{*}	0.01^{NZ}	0.74^{NZ}
Body mass at the age of 12 months, kg	486.79	11.04	1.41^{NZ}	2.71^{NZ}	10.72^{**}
Daily gain in the test, g	1164.48	35.86	0.88^{NZ}	2.62^{NZ}	7.49^{**}
Height at withers, cm	127.09	0.82	1.78^{NZ}	7.04^{**}	0.96^{NZ}
Chest depth, cm	61.22	0.77	1.03^{NZ}	3.29^{NZ}	1.28^{NZ}
Chest circumference (girth), cm	177.68	1.64	0.93^{NZ}	10.71^{**}	0.82^{NZ}
Body length, cm	152.21	1.00	0.58^{NZ}	6.87^{**}	6.56^{**}

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

Table 5 shows the influence of sires on the variability of the traits in the performance test of Simmental bulls.

The effect of the bull sires ($p < 0.05$) was present in regard to the variability in body mass of calves entering the test, while their impact on the variability of traits measured at the end of the test was not significant. The reason is very different conditions on farms of origin of bulls entering the performance test. Lack of influence of sires on the variability of traits measured at the end of the test is explained by the effect of compensatory growth with a standardized feeding conditions, housing and care in the performance test will enable the young bulls, future breeding males, to fully exert additive genetic value, on which the estimates of breeding values are based.

Conclusion

Standardizing of conditions for feeding, housing and care in performance test provides the young bulls, future breeding males, to fully exert additive genetic value, on which the estimates of breeding values are based. In the variability of the monitored traits in the performance test, the effect of year was present at a high level of statistical significance ($p<0.01$) for all traits that are registered at the end of the test, while the AI Centre showed statistically significant ($p < 0.01$) influence on the variability of growth traits measured at the end of the test and the variability of body length. The effect of the bull sires ($p<0.05$), was present on the variability of body mass of calves entering the test, while their impact on the variability of trait measured at the end of the test, showed no statistical significance.

Properties covered by the performance test are characterized by medium to high heritability values indicating that they are hereditary enough to exert selection on them. The results obtained indicate that the traits of growth and body development contained sufficient variability for the successful selection and improvement of the traits of domestic Simmental cattle.

Acknowledgment

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

Izvori varijabilnosti osobina porasta i telesne razvijenosti bikova simentalske rase u performans testu

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Rezime

Za ispitivanje varijabilnosti osobina simentalskih bikova u performans testu iskorišćeni su podaci stočarsko-veterinarskog centra za reprodukciju i veštačko osemenjavanje iz Velike Plane i Krnjače. Za analizu su upotrebljeni podaci o 113 performans testiranih bikova rođenih u periodu od 2008 do 2009 godine. Analizom su obuhvaćene dve grupe osobina: osobine telesne razvijenosti i osobine porasta. Prosečna telesna masa sa kojom su telad ulazila u test iznosila je 195,75 kg, dok je telesna masa na kraju testa 476,50 kg, prosečan dnevni prirast u testu iznosio je 1138,69 g. Prosečne vrednosti osobina telesne razvijenosti merenim na kraju testa, sa 12 meseci uzrasta iznosile su: visina grebena 127.13 cm, obim grudi 179.42 cm, dubina grudi 61.19 cm i dužina trupa 151.34 cm. Analizirani su uticaj očeva, godine i centra na varijabilnost osobina. Efekat godine je prisutan na visokom nivou statističke značajnosti ($p<0,01$) za sve osobine koje se registruju na kraju testa, dok je efekat centra prisutan u varijabilnosti telesne mase na kraju testa, dnevnog prirasta u testu i dužini tela. Bikovi-očevi su ispoljili uticaj ($p<0,05$) na varijabilnost telesne mase sa kojom su telad ulazila u test.

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Received 18 June 2015; accepted for publication 10 August 2015