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Effect of Systematic Factors on Gestation Length in Simmental Cows

Milun. D. Petrović
Faculty of Agronomy, Čačak, Serbia

Vlada Bogdanović
Faculty og Agriculture, Zemun, Serbia

Snežana Bogosavljević-Bošković
Faculty of Agronomy, Čačak, Serbia

Radojica Đoković
Faculty of Agronomy, Čačak, Serbia

Abstract: The effect of systematic environmental factors on gestation length in Simmental cows was evaluated by calculating the least squares mean (LSM) and its error (SE_{LSM}), by analysis of variance and by calculating the coefficient of determination (R^2). The study involved Simmental cows reared at three locations, including the Zlatiborski Suvati farm (n=578), the Dobričevo farm (n=964) and individual private farms at the Voćar Farming Cooperative in Kotraža (n=1263). The analysis included gestation length in Simmental cows as affected by continuous systematic factors (age at first conception) and discontinuous factors such as farm, calving season, birth season, parity group, calf sex, type of birth and the interaction of these factors. The effect of age at first conception was statistically significant ($P<0.05$). The discontinuous factors had a very high significant ($P<0.001$) effect on gestation length. The coefficient of determination was as low as 0.086 (8.6%), undoubtedly suggesting the small effect of the non-genetic factors on gestation length, given the fact that the trait is biologically determined and that it shows low variability.

Key words: Simmental breed, systematic factors, gestation length, coefficient of determination.

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Introduction

Cattle reproduction is a very important research field and a highly complex stage of cattle production securing large reserves of milk, meat, breeding herds and byproducts (Petrović *et al.* 2003, 2004). At the current stage of development of agricultural production and zootechnical science, milk and meat production is considered a less serious problem than cattle reproduction management. Cattle reproduction physiology is a complex field being affected by a range of endogenic and exogenic factors more intensively than other stages of cattle production.

Gestation length is a genetic trait being affected to a limited degree by exogenic factors and, accordingly, showing very low variability, as reported by all authors (Čobić and Antov 1993, Perišić 1998, Schleppi 1998, Đurđević 2001, Petrović *et al.* 2004, 2007, 2008, Panić 2005, Pantelić *et al.* 2005). Gestation length can vary, depending on breed, calf sex, birth type, cow age and cow diet during pregnancy. According to most authors (Petrović *et al.* 2004, 2007, Čobić and Antov 1993), female calves are generally carried 1 to 2 days shorter than males, twins are usually born 3 to 6 days before singles (Petrović *et al.* 2004, 2007) and the gestation period is longer in older cows than in younger ones (Panić 2005).

Material and Methods

The study on the effect of systematic environmental factors on gestation length involved 2805 Simmental cows born from 1982 onwards and reared at the Zlatiborski Suvati farm on Mt. Zlatibor under a free range system (n=578), at the Dobričevo farm in Ćuprija under a tied-stall system (n=964) and at individual private farms under a tied-stall system in the region of the Voćar Farming Cooperative in Kotraža (n=1263).

The following non-genetic factors were monitored for effects on gestation length:

- *Rearing area (farm).* The study included three locations, two in the upland area (a dairy farm on Mt. Zlatibor and individual private farms in the region of Kotraža) and one at the Dobričevo farm, in the lowlands.
- *Parity groups.* To reduce variability due to a decrease in the number of cows across parity groups, the effect of seven groups of parity (group I (1st parity), group II (2nd parity), group III (3rd parity), group IV (4th parity), group V (5th parity), group VI (6th and other parities), rather than the effect of each individual parity, was evaluated.
- *Calving season i.e. the onset of lactation.* The effect of four seasons, including I – spring season (March, April, May), II – summer season (June, July, August), III – autumn season (September, October, November) and IV – winter season (December, January, February) was analyzed.
- *Calf sex:* I-male calves, II – female calves.
- *Type of birth:* I-single calves, II-twin calves. III-stillborn calves
- *Group (Interaction between year of birth* (cows that calved from 1982 to 1998) *and season of birth* (I-spring, II-summer, III-autumn and IV-winter seasons)*).*

- *Interaction between rearing area and calving season* (3 rearing areas x 4 calving seasons).
- *Interaction between rearing area and birth type* (3 rearing areas x 3 birth types).
- *Age at first conception*.

The analysis of the effect of the above systematic environmental factors was conducted using a general linear model enabling a simultaneous analysis of a number of different effects, irrespective of their being categorical or continuous ones, such as age at first conception. The general linear model involved the use of the least squares method for the evaluation of the effects observed and testing of the hypotheses made, according to the model:

$$y_{ijklmn} = \mu + R_i + P_j + G_k + SC_l + Sc_m + T_n + RSc_{il} + RT_{in} + b_1(x_1 - \bar{x}_1) + e_{ijklmn},$$

y_{ijklmn} – an individual cow of the i-th rearing area, j-th parity group, k-th group, l-th calving season, m-th sex and n-th type of birth,

μ – overall population mean under identical distribution of all classes of effects (R, P, G, Sc, Sc, T, RSc),

R_i – a fixed effect of the i-th rearing area (1-3),

P_j – a fixed effect of the j-th group of parity (1-6),

G_k – a fixed effect of the k-th group (year of birth x season of birth) (1-68),

SC_l – a fixed effect of the l-th season of calving (1-4),

Sc_m – a fixed effect of the m-th calf sex (1-2),

T_n – a fixed effect of the n-th type of birth (1-3),

RSc_{il} – a fixed effect of the interaction between the i-th rearing area and the l-th season of calving (1-12),

RT_{in} – a fixed effect of the interaction between the i-th rearing area and the n-th birth type (1-9),

b_1 – linear regression coefficient of the effect of age at first conception and

e_{ijklmn} – other non-determined effects.

Results and Discussion

The analysis of the effect of the observed systematic environmental factors on gestation length, i.e. the least squares means (LSM), standard errors of the means (SE_{LSM}) and significance of the evaluated effects are given in Table 1. Table 2 shows the analysis of variance, i.e. the significance of the tested fixed factors and age at first conception, the sums of squares of the factors, models and error (the residual sum of squares), their proportion in the total variation (the sum of squares total) and the coefficient of determination (R^2).

Tab. 1. Least squares means, standard errors of the means and the significance of the effect of systematic factors on gestation length

Systematic effects		Gestat. length (days)	
Farm	**N**	**LSM**	**SE_{LSM}**
I	2213	284.54	1.607
II	3648	279.82	1.310
III	4562	286.98	0.945
F_{exp}		***	
Calving season			
I	2452	283.74	0.775
II	2838	283.56	0.771
III	2464	283.44	0.771
IV	2669	284.37	0.771
F_{exp}		***	
Parity groups			
I (1)	2780	282.91	0.772
II (2)	2459	283.64	0.768
III (3)	1862	284.13	0.776
IV (4)	1345	284.04	0.783
V (5)	900	284.29	0.789
VI (6 and others)	1077	283.66	0.788
F_{exp}		***	
Calf sex			
I	5066	284.25	0.765
II	5357	283.31	0.766
F_{exp}		***	
Birth type			
I	9896	286.44	0.113
II	516	282.03	0.329
III	11	282.87	2.251
F_{exp}		***	
Farm x birth type			
F_{exp}		***	
Farm x calving season			
F_{exp}		***	
Group (birth year x birth s.)			
F_{exp}		***	
Age at first conception			
F_{exp}		*	

*N.S. - P > 0.05; * - P < 0.05; ** - P < 0.01; *** - P < 0.001;*

Tab. 2. Analysis of variance on gestation length. The significance of factors, sums of squares, % of the total sum and coefficients of determination (R^2)

Traits / Source	Degrees of freedom	GL (days)
Farm	2	*** 16 244 3.18
Calving season	3	*** 1 003 0.20
Parity groups	5	*** 1 804 0.35
Calf sex	1	*** 2 514 0.49
Birth type	2	*** 12 127 2.37
Farm x birth type	4	*** 1 985 0.39
Farm x calving season	6	*** 2 303 0.45
Group (birth year x birth season)	67	*** 5 964 1.17
Age at first conception	1	* 188 0.04
Model	**91**	*** **44 133** **8.63**
Residual variance	10331	466 965 91.37
R^2	**-**	**0.086**

Rearing area had a very high significant (P<0.001) effect on gestation length (Table 1). The shortest gestation period (LSM=279.82 days) was observed in the Dobričevo farm cows. Most authors agree that gestation length is substantially more affected by genetic factors than by non-genetic ones, the effect of the latter being insignificant (Skalicki *et al.* 1991, Pantelić *et al.* 2005).

Gestation length was very highly significantly affected (P<0.001) by calving season. Gestation was longest in the cows that calved in the winter season (LSM=284.4 days). As opposed to these results, most authors (Perišić 1998, Đurđević 2001, Petrović *et al.* 2007) reported an insignificant effect of calving season (P>0.05).

Parity groups showed a statistically very highly significant (P<0.001) effect on gestation. The gestation period increased with cow ageing and further cow growth, being the shortest at first calving (LSM=282.9 days) and the longest at fifth calving (LSM=284.3 days). Different results were reported on the effect of parity on gestation length. Perišić (1988) and Pantelić *et al*. (2005) showed that the effect was not statistically significant (P>0.05), as opposed to the very high (P<0.001) and highly significant effects (P<0.01) observed by Petrović (2007) and Đurđević (2001), respectively.

Gestation length was very highly significantly (P<0.001) affected by calf sex, birth type and their interaction. Gestation of male calves and singles lasted statistically very significantly longer than that of females, twins and stillborn calves. Highly significantly (P<0.01) longer gestation in male calves was reported by Perišić (1998) whereas Petrović (2007) showed that the effect of calf sex on gestation length was not statistically significant (P>0.05). Both authors suggested that the gestation period lasted statistically very significantly (P<0.01) longer in single calves than in twin calves, also being significantly (P<0.05) affected by the sex-birth type interaction as reported by Petrović (2007).

The interactions between farm and birth type, farm and birth season and group (year x season of birth) had a statistically very highly significant (P<0.001) effect on gestation length. A highly significant (P<0.01) effect of year of birth as a fixed factor was observed by Đurđević (2001).

Gestation length was significantly affected (P<0.05) by age at first conception as a continuous factor. A study by Perišić (1998) on reproductive traits affected by age at first conception as a systematic factor revealed that the effect of this factor on gestation length was not significant (P>0.05). The non-significance of this effect, as determined by calculating the coefficients of linear regression (b_{xy}=-0.003), was also confirmed by Petrović (2007 and 2008).

Table 2 shows that the statistical significance of the model applied to correct the length of the gestation period to the effect of environmental factors and age at first conception was very high (P<0.001), suggesting the adequate selection of non-genetic factors included in the model. Petrović (2000) found very high significance (P<0.001) of the selected model used in examining the effect of environmental factors (calving season, parity groups, birth type, calf sex, interaction between the type of calving and calf sex and age at first conception) on gestation length.

The proportion of the model sum of squares in the total sum of squares on gestation length was 8.63%, the coefficient of determination (R^2) being 0.086

(8.6%), which suggested that gestation length was affected not only by the factors analysed, but also by a number of other factors, genetic ones in particular, which were not evaluated in this study.

Conclusion

This study suggested the following:

The effect of fixed non-genetic factors on gestation length was very highly significant (P<0.001), whereas the effect of age at first conception, as a continuous factor, was statistically significant (P<0.05).

The statistical significance of the model applied to correct gestation length to the effect of environmental factors and age at first conception was very highly significant (P<0.001), and the proportion of the model variance in the overall variance was 8.63%.

The coefficient of determination (R^2) for the service period was 0.086.

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UTICAJ SISTEMATSKIH FAKTORA NA DUŽINU BREMENITOSTI KOD KRAVA SIMENTALSKE RASE

- originalni naučni rad -

Milun D. Petrović
Agronomski fakultet, Čačak, Srbija

Vlado Bogdanović
Poljoprivredni fakultet, Zemun, Srbija

Snežana Bogosavljević-Bošković
Agronomski fakultet, Čačak, Srbija

Radojica Đoković
Agronomski fakultet, Čačak, Srbija

Rezime

Uticaj sistematskih faktora okoline na dužinu bremenitosti analiziran je izračunavanjem sredine najmanjih kvadrata (LSM) i njegove greške (SE_{LSM}), analizom varijanse po primenjenom modelu i izračunavanjem koeficijenta determinacije (R^2). Istraživanjem su obuhvaćene krave simentalske rase raspoređene na tri lokaliteta i to farmi Zlatiborski suvati (n=578), farmi Dobričevo (n=964) i individualna gazdinstva na području Zemljoradničke zadruge "Voćar" iz Kotraže (n=1263). Na dužinu bremenitosti ispitivan je uticaj kontinuelnih sistematskih faktora (uzrast pri prvoj oplodnji) i dikontinuelnih faktora kao što su farma, sezona telenja i rođenja, grupe partusa, pola teladi, tipa rođenja i interakcija pomenutih faktora. Uticaj uzrasta pri prvoj oplodnji bio je statistički značajan ($P<0.05$), dok uticaj svih diskontinuelnih uticaja na trajanje bremenitosti bio je vrlo visoko značajan ($P<0.001$). Koeficijent determinacije iznosio je svega 0.086 (8.6%), što nedvosmisleno ukazuje na mali uticaj paragenetskih faktora na ispoljenost dužine bremenitosti obzirom da je ona biološki data i da se odlikuje niskom varijabilnošću.