

VARIABILITY OF FUNDAMENT TRAITS IN PRIMIPAROUS SIMMENTAL HEIFERS

Dragan Nikšić¹, Vlada Pantelić¹, Dušica Ostojić-Andrić¹, Predrag Perišić², Marina Lazarević¹, Ivan Ćosić¹, Maja Petričević¹

¹ Institute for Animal Husbandry, Autoput 16, P. Box 23, 11080, Belgrade-Zemun, Republic of Serbia

² University of Belgrade, Faculty of Agriculture, Nemanjina 6, 11080, Belgrade-Zemun, Republic of Serbia

Corresponding autor: draganniksic84@gmail.com

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Abstract: Visual evaluation and recognition of dairy traits of cows are preliminary indicators of milk yield, longevity, and reproductive ability of the individual animal, which is very important from the aspect of the economics of milk production. The deficiencies in the fundament traits lead to poor production, poor health and premature culling of cows from the herd. The paper examines the frequency of preferred scores of a certain trait in the first calving heifers according to the housing method (animals reared by individual agricultural producers and farm animals) and their origin (domestic and imported animals), as well as the impact of these two factors on the observed properties. Four fundament traits were analysed: the position of the hind legs, the development of the hocks/joints, the pastern joints and the height of the feet on a total of 954 first-calving Simmental heifers. Observed by the housing method, the higher frequency of the preferred scores for all of the fundament traits, was achieved by the farm cows, while according to the origin of the cows, the higher frequency of the preferred scores for all of the fundament traits was realized by imported animals in relation to domestic cows. The influence of the factors of the housing method and origin of animals examined by χ^2 test on all the tested linear scores (frequency of scores) of the fundament traits was statistically very significant ($p \leq 0.001$), while the analysis of the variance (F test) determined high significance ($p \leq 0.001$) of the interaction between the origin and housing method on the height of the feet, as well as significant effect ($p \leq 0.05$) on the position of the hind legs, while on other linear scores of the fundament traits it did not exhibit statistical significance ($p > 0.05$).

Key words: Simmental breed, fundament, rearing method, origin, linear scores

Introduction

The evaluation of the exterior of animals is based on knowledge of the structure and function of individual organs as well as the most important relationships between the individual parts of the body.

Assessment of body development of cattle is a critical evaluation of whether the affected animal, by its overall appearance and individual parts of the body, can guarantee good health and high production, or longevity. Inclusion of a linear type score, contributes to the estimation of the cow's breeding value, which positively reflects on the overall results of the selection and the success of production (*Pantelić et al., 2006*).

Linear assessment includes the evaluation of each trait in its biological extremes, according to the scale ranging from 1 to 9 in the scorecard, and it should be emphasized that the highest score (9) is not the most favourable for each trait, because for some traits the average grades (5) is the best (*Petrović and Pantelić, 2015*).

A minimum set of feet and leg traits required in an effective selection program include the results or measurements of one or more feet traits and the assessment of the leg traits. The combination of angles, length and diagonals of the hind feet seems to be the best combination that allows the ease and precision of scoring or measurement and predictive values for the lameness traits of the feet. In fact, some data suggest that only the diagonal of the feet is sufficient measurement (*Boelling, 1994; McDaniel and Vilc, 1996*). Which traits of the hind legs should be included is not so well established. Most programs use the position of the rear legs - side view, which primarily reflects the angle of the hock joint. *Boelling (1994)* finds that it is more related to locomotion results than to feet measurements. Other data show that the position of the hind legs is more informative for the prediction of survival (*McDaniel et al., 1993*), although less hereditary than the side view. When available, estimates of locomotive properties look like useful predictors. The actual incidence of lameness should be included when present, but the studies do not compare its value with respect to the indirect selection based on scores for feet and leg traits and locomotion results.

By studying the incidence of deformity of the extremities of the Simmental cows depending on the type of bedding, *Stojanović et al. (2018)* reached the following results: of the total number of studied cows 3.45% had "X" front leg position, 14.8% had "X" position of the hind legs. The convergent position of the front legs was recorded in 35.86%, and divergent in 8.28% of animals. The convergent position of the hind legs was established in 16.55% of cows, and divergent in 2.76%. The forward protruding position of the front legs was recorded in 4.14% of cows, inducted position in 11.03%, and a broad position in 4.14% of animals. The sickle position of hind legs was recorded in 17.24% of the cows, and 7.59% of animals were post-legged. The pronounced soft front leg pasterns were

determined in 7.59% of the cows, and the soft pasterns of the hind legs in 33.79% of the total number of estimated cows. The observed changes in the joints in the shape of swellings were recorded in 1.38% of cattle on the carpal joint and 2.76% on the tarsal joint. The affected blade and body joint (scurry shoulder) was recorded in 43.45% of the total number of cows. The body weight of Busha cows in the area of the Pirot district amounted to 226.07 kg, the height to withers 104.33 cm, the height to rump 104.12 cm, pelvis width 32.52 cm, breast depth 53.97 cm, breast girth 130.48 cm, and body length 119.67 cm.

By studying correlations between the milk performance and the fundament traits, results obtained show mainly negative correlations (*Boelling and Pollott, 1997*). Their results suggest that lameness will increase as a result of the selection on increased milk yields, unless taking into account the traits of the fundament. *Uribe et al. (1995)* find that genetic correlations of production with "troubleshooting of leg problems" ranged from 0.20 to 0.27 and indicate that long-term selection on yield has probably reduced the problems that arise in the fundament traits. Foot and leg disorders were correlated with milk performance in the United States, $r = 0.48$ (*Lions et al., 1991*) and the Netherlands $r = 0.26$ (*Groen et al., 1994*).

Material and methods

The basic data on the traits of the fundaments, as well as the data on the origin of all examined cows, were collected in cooperation with the farm "Lazar" Blace housing a number of animals included in this research. For animals housed on individual farms, data on these traits were collected in cooperation with breeding organizations, which implement the breeding program in the area of Toplica district.

The total number of animals ($n = 954$) used in the analysis of morphometric traits were divided into two groups based on the housing method, and two groups based on origin, in the following way:

Based on the housing method:

Group 1: animals reared by individual producers ($n = 504$);

Group 2: animals reared on the farm ($n = 450$);

Based on the origin:

Group 1: animals of domestic origin ($n = 718$);

Group 2: imported animals ($n = 236$).

All of the properties of the fundament were evaluated linearly after the first calving: the position of the hind legs, the development of the hocks, the pastern joints and the height of the hoof.

The processing of collected data consisted in determining the frequency for each assessment individually, the frequency of the preferred scores for all the traits of the fundament and the comparison of the received frequencies by groups.

Subsequently, the influence of the housing method (applied χ^2 test) and the influence of the origin (χ^2 test applied) on the frequency of linear scores for each property of the fundament was examined, while the analysis of variance examined the influence of the housing method and origin, as well as their interaction with all linear scores, in the following model with a fixed influence on the housing method and origin and their interaction:

$$Y_{ij} = \mu + N_i + P_j + NP_{ij} + e_{ijk}$$

- Y_{ij} : examined trait,
- μ : population average for given trait,
- N_i : fixed effect of i housing method ($i=1,2$),
- P_j : fixed effect of j origin ($j=1,2$),
- NP_{ij} : effect of interaction between factors (housing method and animal origin),
- e_{ijk} : random error

For statistical data processing and application of the specified model, the software SPSS Statistics for windows, Version 23.0 was used.

Results and Discussion

Based on the results shown in Table 1, it can be concluded that the majority of animals had preferable scores for studied trait, with animals reared on the farm (79.56%) and animals originating from import (83.05%) had a higher frequency of desirable scores compared to animals reared by individual producers (60.12%), and animals of domestic origin (64.76%). The effect of animal origin and housing method was statistically very significant ($p \leq 0.001$) on the frequency of the rear leg assessment, examined by the χ^2 test. By variance analysis (F test), significant influence ($p \leq 0.05$) of origin and interaction of origin and housing method was determined. The frequency of preferable scores for the development of the hock joints was twice as high in farm animals compared to the first-calving heifers reared by individual producers and amounted to 49.33%. A higher percentage of preferred scores was also recorded in imported animals (40.25%) compared to animals of domestic origin (33.85%).

On the basis of the χ^2 test of the independence of the trait, a statistically very significant correlation ($p \leq 0.001$) of the origin and score for the development of the hock joints was established in the first place, as well as the housing method and scores for the same trait. The variance analysis (F test) showed a high significance of the housing method ($p \leq 0.001$), while the origin of the animal and the interaction of origin and housing method did not have a statistically significant effect ($p > 0.05$) on the development of the joints.

Table 1. Linear estimates and their frequencies for the position of hind legs and the development of hock joints in the first calving heifers of Simmental breed

Scores	Housing						Origin					
	Animals reared by individual producers			Farm animals			Domestic			Imported		
	N	%	% of the group	N	%	% of the group	N	%	% of the group	N	%	% of the group
REAR LEG POSITION												
1	0	0.00	20.63	0	0.00	5.33	0	0.00	15.18	0	0.00	8.05
2	21	4.17		0	0.00		21	2.92		0	0.00	
3	83	16.47		24	5.33		88	12.26		19	8.05	
4	2	0.40	60.12	26	5.78	79.56	7	0.97	64.76	21	8.90	83.05
5	80	15.87		262	58.22		225	31.34		117	49.58	
6	221	43.85		70	15.56		233	32.45		58	24.58	
7	97	19.25	19.25	63	14.00	15.11	142	19.78	20.06	18	7.63	8.90
8	0	0.00		5	1.11		2	0.28		3	1.27	
9	0	0.00		0	0.00		0	0.00		0	0.00	
χ² Test												
Housing χ ² =259.311*** p=0.000						Origin χ ² =86.763*** p=0.000						
F Test												
Housing F=1.097 ^{nz} p=0.295						Origin F=6.281* p=0.012						
Housing x Origin F=4.498*									p=0.034			
HOCK JOINT DEVELOPMENT												
1	0	0.00	0.59	0	0.00	1.11	0	0.00	0.97	0	0.00	0.43
2	0	0.00		0	0.00		0	0.00		0	0.00	
3	3	0.59		5	1.11		7	0.97		1	0.43	
4	1	0.20	76.39	11	2.44	49.56	4	0.56	65.18	8	3.39	59.32
5	153	30.36		153	34.00		226	31.48		80	33.90	
6	231	45.83		59	13.11		238	33.15		52	22.03	
7	110	21.83	23.02	153	34.00	49.33	198	27.58	33.85	65	27.54	40.25
8	6	1.19		68	15.11		44	6.13		30	12.71	
9	0	0.00		1	0.22		1	0.14		0	0.00	
χ² Test												
Housing χ ² =168.306*** p=0.000						Origin χ ² =29.770*** p=0.000						
F Test												
Housing F=18.871*** p=0.000						Origin F=0.499 ^{nz} p=0.480						
Housing x Origin F=0.660 ^{nz}									p=0.417			

***- p≤0.001; ** - p≤0.01; * - p≤0.05; ns - p>0.05

By analysing the pastern joints and the height of hoofs, according to the groups (Table 2), the lowest percentage of cows with favourable scores for pastern joints were cows grown by individual producers (52.78%), then cows of domestic origin (63.37%), (74.15%) and the highest percentage with favourable scores for the pastern joints were cows reared on the farm (80.89%).

By testing the frequencies using the χ^2 test, it was found that there was statistically very significant variation ($p \leq 0.001$) for pastern joints influenced by the method of rearing of cows and their origin. By analysing the variance (F test), a highly significant influence of the rearing method was determined ($p \leq 0.01$), significant influence of the animal origin ($p \leq 0.05$), while the interaction of origin and housing did not have a statistically significant effect ($p > 0.05$) on the pastern joints.

The frequency of the preferred scores for the observed trait was considerably higher in farm animals (67.11%), than in the animals reared by individual producers, where only 18.25% of first calvers obtained preferred scores. If the observed population is viewed on the basis of animal origin, it can be noted that the frequency of preferred scores was slightly higher for the imported animals (41.95%), than for the animals of domestic origin, where 41.09% of first calving heifers received preferred scores for the height of the hoofs.

The influence of the animal origin and the method of housing was statistically very significant ($p \leq 0.001$) on the frequency of scores for the height of the hoofs, examined by the χ^2 test. By variance analysis (F test), a very significant influence ($p \leq 0.001$) of the way of housing, the origin of the animals and their interaction was also determined.

Table 2. Linear estimates and their frequencies for the properties of pastern joints and height of the hoofs in first calving heifers of Simmental breed

Scores	Housing						Origin					
	Animals reared by individual producers			Farm animals			Domestic			Imported		
	N	%	% of the group	N	%	% of the group	N	%	% of the group	N	%	% of the group
PASTERN JOINTS												
1	0	0.00	22.42	0	0.00	0.44	0	0.00	12.67	0	0.00	10.17
2	21	4.17		0	0.00		21	2.92		0	0.00	
3	92	18.25		2	0.44		70	9.75		24	10.17	
4	5	0.99	52.78	30	6.67	80.89	12	1.67	63.37	23	9.75	74.15
5	40	7.94		125	27.78		121	16.85		44	18.64	
6	221	43.85		209	46.44		322	44.85		108	45.76	
7	59	11.71	24.80	61	13.56	18.67	106	14.76	23.96	14	5.93	15.68
8	66	13.10		23	5.11		66	9.19		23	9.75	
9	0	0.00		0	0.00		0	0.00		0	0.00	
χ² Test												
Housing χ ² =188.453*** p=0.000							Origin χ ² =50.272*** p=0.000					
F Test												
Housing F=6.595** p=0.010							Origin F=4.542* p=0.033					
Housing x Origin F=0.073 ^{nz}										p=0.788		
HOOF HEIGHT												
1	0	0.00	3.17	0	0.00	5.56	0	0.00	4.60	0	0.00	3.39
2	0	0.00		0	0.00		0	0.00		0	0.00	
3	16	3.17		25	5.56		33	4.60		8	3.39	
4	3	0.60	78.58	33	7.33	27.33	9	1.25	54.31	27	11.44	54.66
5	82	16.27		49	10.89		86	11.97		45	19.07	
6	311	61.71		41	9.11		295	41.09		57	24.15	
7	86	17.06	18.25	185	41.11	67.11	186	25.91	41.09	85	36.02	41.95
8	6	1.19		117	26.00		109	15.18		14	5.93	
9	0	0.00		0	0.00		0	0.00		0	0.00	
χ² Test												
Housing χ ² =376.879*** p=0.000							Origin χ ² =87.933*** p=0.000					
F Test												
Housing F=28.317*** p=0.000							Origin F=22.492*** p=0.000					
Housing x Origin F=19.328***										p=0.000		

***- p<0.001; **- p<0.01; *- p<0.05; nz - p>0.05

Conclusion

By examining the fundament traits in the first calving heifers of Simmental breed observed according to the method of housing, the higher frequency of the preferred scores for all the fundament traits was recorded for farm cows, while in regard to the origin, a higher frequency of the preferred scores for all fundament properties was recorded in imported cows compared to cows of domestic origin. The influence of the factors of housing method and origin on all tested linear estimates (frequency of estimation) of the fundament traits, examined by χ^2 test, was statistically very significant ($p \leq 0.001$), while the analysis of the variance (F test) determined high significance ($p \leq 0.001$) of the effect of origin and housing method on the height of hoofs, as well as significance ($p \leq 0.05$) of the effect on the position of the hind legs, while on other linear scores of the fundament traits it did not exhibit statistical significance ($p > 0.05$).

Genetic improvements in fundament traits are unlikely to prevent all foot problems, but the choice of animals with preferred scores for the height of hoofs, pastern joints, the development of the hock joints, and the position of the hind legs can reduce their incidence in the herd. By examining the scores of the fundament traits, it can be concluded that their significance lies in the longevity of the cows and, consequently, on the livestock production.

Problems with extremities are more pronounced than stated in the literature, since these problems are often the primary reason for the incidence of sterility that is not recorded when cows are culled from production, and as the reason their consequence is stated, i.e. sterility.

Varijabilnost osobina fundamenta kod prvotelki simentalске rase

Dragan Nikšić, Vlada Pantelić, Dušica Ostojić-Andrić, Predrag Perišić, Marina Lazarević, Ivan Ćosić, Maja Petričević

Rezime

Vizuelna procena i prepoznavanje mlečnih karakteristika krava su preliminarni pokazatelji mlečnosti, dugovečnosti, kao i reproduktivnih sposobnosti grla, što je veoma važno sa aspekta ekonomičnosti proizvodnje mleka. Nedostaci u osobinama fundamenta dovode do slabije proizvodnje, lošeg zdravstvenog stanja i preranog isključenja krava iz zapata. U radu je ispitivana učestalost poželjnih ocena određene osobine kod prvotelki podeljenih po načinu držanja (grla kod individualnih proizvođača i grla sa farme) i podeljenih po poreklu (grla domaćeg odgoja i grla iz uvoza), kao i uticaj ova dva faktora na posmatrane osobine.

Analizirane su četiri osobine fundamenta: položaj zadnjih nogu, razvijenost skočnog zgloba, kičični zglobovi i visina papaka na ukupno 954 prvotelke simentalke rase. Posmatrano prema načinu držanja, veću frekvenciju poželjnih ocena za sve osobine fundamenta iskazane u ocenama ostvarile su krave sa farme, dok su prema poreklu krava, veću frekvenciju poželjnih ocena za sve osobine fundamenta iskazane u ocenama ostvarile krave poreklom iz uvoza u odnosu na krave domaćeg porekla. Uticaj faktora načina držanja i porekla grla ispitivani χ^2 testom na sve ispitivane linearne ocene (frekvenciju ocena) osobina fundamenta bio je statistički vrlo visoko značajan ($p \leq 0,001$), dok je analizom varijanse (F test) utvrđena visoka značajnost ($p \leq 0,001$) interakcije porekla i načina držanja na visinu papaka, kao i značajnost ($p \leq 0,05$) na poziciju zadnjih nogu, dok na ostale linearne ocene osobina fundamenta nije ispoljila statističku značajnost ($p > 0,05$).

Ključne reči: simentalna rasa, fundament, način držanja, poreklo, linearne ocene

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