

ВЛИЯНИЕ НА ВЗАИМОДЕЙСТВИЕТО НА СИСТЕМНИ ФАКТОРИ ВЪРХУ МЛЕКООТДЕЛЯНЕТО НА КРАВИ ОТ ПОРОДАТА СИМЕНТАЛ В ПЪЛНА ЛАКТАЦИЯ

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THE EFFECT OF INTERACTION OF SYSTEMATIC FACTORS ON MILK PERFORMANCE OF SIMMENTAL COWS IN COMPLETE LACTATION

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РЕЗЮМЕ

Ефектът от взаимодействието между фермата и сезона на отелване, както и фермата и групи лактации върху признаци на млекоотделянето (продължителност на лактация, добив на мляко, добив на мазнини в млякото, коригирано мляко с 4% масленост и съдържание на мазнини в млякото) се анализира върху 2805 крави от породата Симентал с общо 9 718 пълни лактации, които се отглеждат в млечна ферма Златиборски сувати в Златибор (578 крави и 1968 лактации), млечна ферма на селскостопански холдинг Добричево в Чуприя (964 крави и 3237 лактации) и млекодаен добитък отглеждан в семейни ферми в района на Котража (1263 крави и 4513 лактации).

Значимостта на ефекта от

SUMMARY

The effect of interaction between the farm and calving season, as well as the farm and group of lactations on milk performance traits (duration of lactation, milk yield, yield of milk fat, 4% fat corrected milk and milk fat content) was analyzed on a sample of 2805 Simmental cows with 9718 complete lactations, housed on the farm "Zlatiborski suvati" on Zlatibor (578 cows and 1968 lactations), dairy farm of the Agricultural holding Dobričevo in Čuprija (964 cows and 3237 lactations) and dairy animals housed on family farms/households in the region of Kotražica (1263 cows and 4513 lactations).

The significance of the effect of interaction between the farm and calving season, as well as interaction between

взаимодействието на фермата и сезона на отелване, както и взаимодействието между фермата и групата лактации върху всички признаци, характеризиращи млекоотделянето при пълна лактация е много висока ($P < 0.001$), което оправдава включването им в модели на оценка на развъдния потенциал на млечните крави.

Дялът на вариациите на взаимодействията в общата вариация на признаци, характеризиращи млекоотделянето е нисък (под или около 3%), което ясно показва наличието на още повече системни фактори и взаимодействия между тях, оказващи влияние върху общата вариация при наблюдаваните признаци, характеризиращи млекоотделянето на крави в пълна лактация.

Ключови думи: системни фактори, взаимодействие, пълна лактация, порода Симентал.

INTRODUCTION

The cattle breeding procedures used today most commonly employ linear methods and models that combine fixed parameters (year, farm, season, lactation) and random variables (age at first conception or calving, genetic effect of sire, genetic effect of an individual animal, etc.) which can be mutually dependent (related) or independent, with or without interactions, depending on the trait analysed. The selected model results essentially in the breeding value of an individual animal (Bogdanović et al., 2003).

Depending on the level of production, sample size and mathematical statistical model, non-genetic discontinuous factors (year, farm, season, lactation) can account for as much as above 50% of the total variations in milk production (Stojić et al., 1996). The same authors, Stojić et al., 1996 reported that farm, year and season of calving induced 35.7% of total variations in milk production. A somewhat lower percentage of non-genetic factors (farm, year, calving season and lactation number) of 42.7% in the total variability of performance traits was found by Jovanovac (1987), whereas Hansen et al., 1983 reported a considerably higher percentage of about 45% (in terms of the farm-year-season effect).

the farm and group of lactations on all milk performance traits complete lactations was very high ($P < 0.001$), which justified their inclusion into models for assessment of the breeding value of dairy cows.

The share of variance of interactions in total variance of milk performance traits in complete lactations was low (below and around 3%), which clearly indicated even more systematic factors and their interactions which influence the total variability of observed traits of milk performance of cows in complete lactations.

Key words: systematic factors, interaction, complete lactation, Simmental breed.

The effect of season of birth of cows and their calving, i.e. beginning of lactation as systematic factor, on traits of milk performance is reflected through various climatic circumstances and nutrition throughout the year, so it is included into models for evaluation of breeding value of dairy animals. Most of domestic and foreign authors indicate significant and highly significant effect of order of lactation, i.e. groups of lactations on expression of production traits. Namely, maximum production of milk is achieved depending on the intensity of breeding in the period from the third until the fifth lactation. The lowest production of milk is in the first lactation, due to insufficient body development of animals, whereas drop in production occurring after the third i.e. fifth lactation often occurs due to health disorders. Breeding region or farm usually have significant impact on milk performance traits due to different rearing methods, nutrition, housing, care, climatic conditions, age structure and herd size, as well as series of other influences related to work and farm management.

MATERIAL AND METHODS

The effect of systematic, non-genetic factors and their interactions on traits of milk performance in complete lactations was analyzed on sample of 2805 Simmental cows with total 9718 complete lactations, housed on dairy farm "Zlatiborski suvat" on Zlatibor, dairy farm of the Agricultural holding Dobričevo in Cuprija and dairy animals housed on family farms/households in the region of Kotraž.

Distribution of complete lactations according to classes of systematic influences is presented in Table 1.

Table 1. Presentation of data across different classes of major systematic effects

Farm	Lactat. No.	Cow no.	Lactat. group	Lactat. No.	Year of birth	Lactat. No.	Season of birth	Lactat. No.	S. of calving	Lactat. No.	
I (Zlatibor)	1968	578	I (1)	2800	1982.	847	I	2298	I	2281	
			II (2)	2297	1983.	565	II	2837	II	2642	
II (Dobričevo)	2237	964	III (3)	1715	1984.	524	III	2216	III	2269	
			IV (4)	1213	1985.	541	IV	2552	IV	2528	
III (Kotraž)	4513	1263	V (5)	799	1986.	855					
			VI (6+7+8+9 +10+11+12)	894	1987.	822					
					1988.	791					
					1989.	839					
					1990.	786					
					1991.	627					
					1992.	612					
					1993.	306					
					1994.	467					
					1995.	516					
	1996.	342									
	1997.	76									
	1998.	102									

The impact of following systematic factors on expression of

production traits in complete lactations such as duration of lactation (DCL, days), milk yield in complete lactation (MYCL, kg), milk fat content in complete lactations (MFCCL, %), milk fat yield in complete lactations (MFYCL, kg) and yield of 4% fat corrected milk in complete lactations (4%FCMCL, kg), was observed:

Breeding area. The effect of three farm locations was studied (the farm on Mt. Zlatibor, Dobričevo farm and farms in the Kotraža region).

Lactation groups. Lactation groups were established in order to equalise the number of animals within different lactations as much as possible and reduce variability: group I (first lactation), group II (second lactation), group III (third lactation), group IV (fourth lactation), group V (fifth lactation), group VI (sixth and other lactations).

Calving season, i.e. the onset of lactation (I-spring season (March through May), II-summer season (June through August), III-autumn season (September through November), IV-winter season (December through February)).

Year of birth x season of birth interaction (cows that calved from 1982 to 1998 x 4 seasons (I-spring, II-summer, III-autumn and IV-winter seasons)).

Breeding area x calving season interaction (3 breeding areas x 4 calving seasons).

Breeding area x lactation group interaction (3 breeding areas x 6 lactation groups).

Age at first conception. For analysis of the mentioned non-genetic factors and their interactions on production traits in complete lactations, a general linear model was used based on application of the method of least squares of the statistical software Statistica for Windows Release 6.0, which in this case is:

$$y_{ijkl} = \mu + B_i + L_j + G_k + Cs_l + BCs_{il} + BL_{ij} + b_1(x_i - \bar{x}_i) + e_{ijkl}, \text{ where}$$

y_{ijkl} – an individual animal of the i -th breeding area, j -th lactation group, k -th group, l -th calving season,

μ – population mean with equal participation of all classes of effects (B, L, G, Cs, BCs, BL),

B_i – fixed effect of the i -th breeding area (1-3),

L_j – fixed effect of the j -th lactation group (1-6),

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

(1-68),

Cs_l – fixed effect of the l -th calving season (1-4)

BCs_{il} – fixed effect of the i -th breeding area x l -th calving season interaction (1-12),

BL_{ij} – fixed effect of the i -th breeding area x j -th lactation group interaction (1-18),

b_1 – linear regression coefficient of the effect of age at first conception, and
 e_{ijk} – other undetermined effects.

RESULTS AND DISCUSSION

In research results only the results of the effect of interaction between systematic factors on expression of milk performance traits in complete lactations according to applied model are presented.

Mean values of least squares, standard errors and significance of the influence of interaction farm and calving season on production traits of complete lactations according to applied model are presented in Table 2.

Table 2. Mean values of least squares, standard errors and significance of the influence of interaction farm and calving season on production traits of complete lactations

Systematic factors		DCL (days)		MYCL (kg)		MFCCL (%)		MFYCL (kg)		4%FCMCL (kg)		
Farm	Calving season	N	LSM	SE _{LSM}	LSM	SE _{LSM}	LSM	SE _{LSM}	LSM	SE _{LSM}	LSM	SE _{LSM}
I	I	374	341,85	3,278	4688,5	58,452	3,68	0,008	172,55	2,217	4468,2	59,34
I	II	425	337,22	3,080	4499,1	54,521	3,68	0,007	165,00	2,093	4274,9	52,94
I	III	593	330,83	2,610	4493,8	46,546	3,69	0,005	166,06	1,766	4289,2	44,81
I	IV	576	326,69	2,626	4525,0	48,829	3,68	0,005	166,17	1,776	4302,6	45,11
II	I	705	285,60	2,463	3805,7	43,915	3,79	0,005	144,03	1,666	3681,4	42,31
II	II	771	286,05	2,357	3713,1	42,029	3,77	0,005	139,99	1,594	3589,5	40,51
II	III	908	297,27	2,225	4054,3	39,681	3,78	0,005	153,72	1,505	3930,0	38,24
II	IV	853	287,22	2,206	3975,1	40,768	3,83	0,005	151,20	1,546	3852,6	39,21
III	I	1202	292,01	1,963	3799,8	35,004	3,91	0,005	149,02	1,328	3756,0	33,71
III	II	1446	294,16	1,771	3790,7	31,585	3,91	0,004	148,50	1,198	3744,4	30,44
III	III	768	294,16	2,285	3827,1	40,753	3,91	0,005	149,86	1,546	3779,5	39,21
III	IV	1097	293,36	2,001	3857,1	35,687	3,91	0,005	151,34	1,354	3613,8	34,36
F _{exp}				5,49 ^{***}		7,65 ^{***}		3,90 ^{***}		7,53 ^{***}		7,43 ^{***}

N.S. - $P > 0,05$, * - $P < 0,05$, ** - $P < 0,01$, *** - $P < 0,001$

The effect of interaction between the farm and calving season on all milk traits of complete lactations was highly significant ($P < 0,001$), therefore, inclusion not only of these individual systematic factors but also their interactions into models for evaluation of breeding value of cows is justified.

Petrović et al., 1997 and Petrović et al., 2009, in their study of the active population of Simmental cattle in Serbia, indicated that interaction between breeding region and calving season contributed to

significant variation in the milk yield and yield of milk fat ($P < 0.01$). Very significant ($P < 0.01$) and significant ($P < 0.05$) effect of breeding region, as individual systematic factor, on production traits of Simmental cows is indicated by Petrović et al., 1997 and 2006, Perišić, 1998, Rychen, 1999, Chladek and Kucera, 2000, Đurđević, 2001, Đurđević et al., 2002, Panić, 2005 and Petrović et al., 2009.

Share of interaction between farm and calving season in total variance of milk traits in complete lactations was very low and ranged from only 0.15% in case of milk fat content to 0.41% in case of milk fat yield in complete lactations, which clearly indicated the high contribution of other systematic factors in variability of these traits which are included into presented model and were not considered in this study.

Low level of share of variance of certain systematic factors in total variability of production of 4% fat corrected milk is stated in the research of Petrović et al., (2010).

Results of the analysis of the effect of interaction between breeding region and groups of lactation on production traits of complete lactations, i.e. means of least squares (LSM), standard errors of means (SE_{LSM}) and significance of observed effects are presented in Table 3.

Significance of the effect of interaction between breeding region and group of lactations on all milk traits of complete lactations was highly significant ($P < 0.001$), which justified its inclusion into evaluation of breeding value of dairy animals, as confirmed by research of Petrović et al. (2009).

Share of variance of interaction between breeding region and group of lactations in total variance of production traits of whole lactations was slightly higher and ranged from 0.62% in duration of lactation to 3.16% in milk fat yield in complete lactations.

However, the share of variance in total variability unambiguously indicates even more systematic factors and their interactions which influence total variability of observed milk traits of standard lactations, as confirmed by Petrović et al., (1997) and Petrović et al. (2009) and (2010).

Table 3. Means of least squares, standard errors of means and significance of the effect of interaction between farm and groups of lactation on production traits of complete lactations

Systematic factors			DCL (days)		MYCL(kg)		MFCCL(%)		MFYCL(kg)		4%FCMCL(kg)	
Farm	Calving season	N	LSM	SE _{LSM}	LSM	SE _{LSM}	LSM	SE _{LSM}	LSM	SE _{LSM}	LSM	SE _{LSM}
I	I	574	336,68	2,507	4197,8	44,707	3,709	0,005	154,85	1,596	4002,0	43,090
I	II	472	330,96	2,811	4561,2	50,120	3,662	0,007	165,73	1,901	4325,7	48,311
I	III	336	337,71	3,319	4797,6	59,183	3,557	0,008	176,17	2,245	4562,2	57,042
I	IV	233	331,72	3,939	4716,9	70,245	3,670	0,009	171,95	2,554	4481,6	67,704
I	V	172	334,21	4,568	4581,4	81,463	3,668	0,011	172,06	3,090	4458,0	78,517
I	VI	181	333,59	4,471	4359,5	79,736	3,719	0,010	161,91	3,024	4172,9	76,892
II	I	964	309,63	2,065	3969,7	36,820	3,812	0,005	151,32	1,397	3857,6	35,488
II	II	793	293,43	2,243	4034,5	40,005	3,799	0,005	153,16	1,517	3911,3	38,556
II	III	593	287,41	2,555	3966,6	45,573	3,787	0,006	150,89	1,729	3865,8	43,925
II	IV	402	284,38	3,046	3930,1	54,318	3,7713	0,007	147,95	2,060	3791,5	52,354
II	V	240	279,06	3,871	3777,1	69,027	3,775	0,009	142,20	2,618	3644,7	66,530
II	VI	245	280,59	3,855	3639,4	68,754	3,780	0,009	137,89	2,808	3509,5	66,267
III	I	1262	295,35	1,834	3218,0	32,707	3,9419	0,004	127,28	1,241	3198,9	31,524
III	II	1032	294,09	1,980	3511,6	35,316	3,925	0,005	138,25	1,339	3478,9	34,038
III	III	786	293,17	2,245	3826,5	40,027	3,909	0,0055	149,63	1,518	3775,5	38,579
III	IV	678	292,42	2,578	4042,3	45,973	3,898	0,006	157,34	1,744	3977,7	44,310
III	V	387	292,58	3,101	4163,1	55,303	3,899	0,007	162,89	2,098	4109,6	53,302
III	VI	468	292,94	2,893	4150,5	51,595	3,802	0,007	162,69	1,957	4102,1	49,719
F _{exp}			6,61***		34,87***		4,20***		35,71***		35,95***	

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

CONCLUSIONS

Based on presented results the following can be concluded:

The significance of the effect of interaction between farm and calving season, as well as interaction between farm and group of lactations on all milk traits of complete lactations was very high (P<0.001), which justifies their inclusion into models for evaluation of breeding value of dairy cows.

The share of variance of interactions in total variance of milk traits of complete lactations was low, which clearly indicated presence of more systematic factors and their interactions which have influence on total variability of observed milk traits of complete lactations.

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