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Institute for Animal Husbandry

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EFFECT OF SYSTEMATIC FACTORS ON MILK PRODUCTION PER MILKING, PRODUCTIVE AND LIFETIME DAY IN SIMMENTAL COWS

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Abstract: One of the very important functional characteristics of dairy cows is milk production per milking, productive and lifetime day. Due to the pronounced action of both genetic and paragenetic factors, the phenotypic expression of this trait is characterized by high variability.The effect of fixed (breeding area - farm, season and year of birth, total number of lactations) and continuous (age of cows at first insemination) paragenetic factors was carried out on a sample of 2 548 Simmental cows distributed in three breeding areas: Zlatiborski Suvati farms with free-stall housing system (n=502), farms in Dobrichevo with a tie-stall housing (n=956) and individual tie-stall in the area of the Agricultural Cooperative "Voćar" from Kotraža (n=1090).Based on the statistical analysis using the GLM procedure, it was determined that the general average for milk production per milking, productive and lifetime day was 12.79 kg, 9.31 kg and 5.47 kg, respectively.Breeding area, year of birth and total number of lactations significantly influenced ($P<0.01$) the phenotypic expression of all the traits. Season of birth did not significantly affect any of the observed functional traits ($P>0.05$), while age at first insemination as a continuous factor significantly affected milk production per milking day ($P<0.05$) and especially milk production per productive and lifetime day ($P<0.01$).

Key words: Simmental breed, milk production, milking day, productive day, lifetime day

Introduction

The life length and the duration of the period of exploitation of cows in the production of milk and calves, as well as the level of this production, greatly affect the overall results in cattle breeding. Although the natural life limit of cows, kept in

optimal conditions, exceeds twenty or more years, certain limiting bio-economic factors determine the shortening of life and the period of their exploitation, which significantly increases the cost of this production and often makes it unprofitable.

Even though better conditions are continuously being created for the realization of desirable hereditary traits, it can be stated that the longevity and lifetime production of cows is decreasing. Numerous researchers think that the intensive, almost industrial conditions of production determine the shorter productive life of even averagely productive cows. This is also contributed to by the fact that unilateral selection of cows for high productivity regularly affects the weakening of the constitution and biological resistance, which often in intensive farming conditions ends with the premature removal of the cow from breeding, i.e. production, which affects the reduced lifetime production of milk and milk fat. This results in a high overhaul percentage, which affects the value of the selection differential, and this, in turn, affects the selection's success.

Several systematic non-genetic factors have a significant effect on total milk production during life, regardless of whether they are discontinuous-fixed in nature (breeding area, season and year of birth and calving, total number of lactations as well as their interactions) or continuous-non-categorical factors (age at first insemination or calving). In many herds, the main causes of cow exclusion are low production (30-35%), impaired physiological function of the organism (30-40%), and udder diseases (10-15%). Due to low production, cows after the first or second lactation are mostly excluded, while older cows are usually excluded due to infertility. A good indicator of adequate breeding of dairy cows is, among other things, the phenotypic expression and variability of life production characteristics, among which the most important are milk production per milking, productive and life day.

Ivanov (1990) and *Petrović et al. (2008; 2012; 2015)*, which *s*tudied the phenotypic manifestation and the effect of genetic and some paragenetic factors on lifetime milk production, state that milk production per milking day ranged from 10.86 to 14.07 kg, per productive day from 8.89 to 13.10 kg and from 5.46 to 8.01 kg per life day.

This paper aims to examine the effect of breeding area, season and year of birth, lactation in order and age of cows at first insemination in production conditions, using the appropriate methodology, on the phenotypic expression and variability of milk production per milking, productive and lifetime day in Simmental cows.

Material and Methods

The effect of systematic paragenetic factors on the phenotypic manifestation and variability of milk production per milking, productive and lifetime day was

analyzed in 2 548 Simmental cows born in the period from 1995 to 2008, which were housed in three farms: 1) Zlatiborski Suvati dairy farm, Mt. Zlatibor which provides a free-stall housing system 2) Dobričevo dairy farm, Ćuprija provides tie-stall housing, and 3) Individual tie-stall farms of Kotraža region.

Based on the data from the registers of cows located in three breeding areas, milk production per milking day (kg) (MPMD), milk production per productive day (kg) (MPPD) and milk production per lifetime day (kg) (MPLD) were analyzed.

Values for milk production per milking, productive and lifetime day were calculated based on data (dates of birth, calving and exclusion) from cow registers:

- **Milk production per milking day** was obtained by dividing the lifetime milk production in kg by the number of milking days.
- **Milk production per productive day** is calculated by dividing lifetime milk production in kg by the length of productive life in days.
- **Milk production per lifetime day** was obtained by dividing the lifetime milk production in kg by the age of the cows expressed in days.

The effect of the following paragenetic factors was observed on the expression of milk production per milking, productive and lifetime day:

- **Breeding area (farm).** The research included three localities, two of which are in the hilly and mountainous area (dairy farm on Zlatibor and individual farms in the Kotraža area) and the Dobrichevo farm in the plain area.
- **Season of birth:** 1-Spring season (March, April, May), 2-Summer season (June, July, August), 3-Autumn season (September, October, November) and 4-Winter season (December, January, February).
- **Year of birth** (cows born from 1995 to 2008).
- **Total number of lactations** (1-10).
- **Age at first fertilization**.

The analysis of the effect of systematic environmental factors on the observed traits of life production (least square means (LSM), standard errors (SE_{LSM}), significance of the influence of paragenetic factors and coefficients of determination (R^2)) was performed using the general linear model of statistical software Statistica 6.0. The following models were used to analyze the effect of individual non-genetic factors on life production characteristics:

$$\mathbf{y}_{ijkl} = \boldsymbol{\mu} + \mathbf{BA}_i + \mathbf{SB}_j + \mathbf{YB}_k + \mathbf{L}_l + \mathbf{b_1}(\mathbf{x_1} - \bar{x}_1) + \mathbf{e}_{ijkl}\text{ ,}$$ where is

$\mathbf{y_{ijkl}}$ - individual of the i^{th} breeding area, the j^{th} season of birth, the k^{th} year of birth and the l^{th} total number of lactations; $\boldsymbol{\mu}$ - general population average with equal representation of all classes of effect (OP, SR, GR, L); **BAi** - fixed effect of the ith breeding area (1-3); **SBj** - fixed effect of the j^{th} season of birth (1-4); **YBk** - fixed effect of the k^{th} year of birth (1-14); $\mathbf{L_l}$ - fixed effect of the l^{th} total number of lactations (1-10); $\mathbf{b_1}$ - linear regression coefficient of the effect of age at first fertilization and $\mathbf{e_{ijkl}}$ - another undetermined effect.

In the further analysis of the observed traits, the coefficients of determination (R^2) for each observed trait are shown, which represent the rest of the residual variance, i.e. the variance of the model divided by 100.

Results and Discussion

Table 1. Least squares means (LSM), standard errors of least squares means (SE_{LSM}), the significance of the influence of paragenetic factors and coefficients of determination (R^2) for milk production per milking, productive and lifetime day

Paragenetic influences	n	MPMD, kg LSM±SE_{LSM}	MPPD, kg LSM±SE_{LSM}	MPLD, kg LSM±SE_{LSM}
General average- μ	2548	12.79±0.041	9.31±0.05	5.47±0.04
Rearing area (A)				
Zlatibor	502	13.32±0.10^{a}	10.44±0.11^{a}	6.35±0.04^{a}
Dobričevo	956	13.31±0.07^{a}	9.08±0.08^{b}	5.35±0.10^{b}
Kotraža	1090	12.10±0.05^{b}	8.99±0.05^{b}	5.16±0.06^{c}
Season of Birth (B)				
Spring (1)	589	12.78±0.08	9.37±0.09	5.51±0,09
Summer (2)	727	12.84±0.08	9.34±0.08	5.54±0.07
Autumn (3)	570	12.80±0.09	9.30±0.10	5.33±0.09
Winter (4)	662	12.74±0.08	9.23±0.09	5.47±0.08
Year of Birth (C)				
1995	164	13.85±0.15^{a}	10.11±0.18^{a}	7.06±0.15^{a}
1996	129	13.69±0.17^{a}	10.18±0,19^{a}	6.61±0.15^{b}
1997	184	12.61±0.15^{ef}	9.42±0.17^{bc}	5.48±0.16^{c}
1998	169	13.22±0.19^{bc}	10.24±0.17^{a}	5.57±0.17^{c}
1999	246	12.44±0.15^{fg}	9.45±0.14^{b}	5.47±0.14^{c}
2000	250	11.79±0.13^{h}	9.08±0.12^{bcd}	4.94±0.13^{d}
2001	192	12.73±0.15^{def}	9.05±0.14^{cd}	5.67±0.15^{c}
2002	213	12.88±0.14^{cde}	9.37±0.13^{bc}	5.58±0.14^{c}
2003	187	13.42±0.13^{ab}	8.75±0.16^{de}	5.65±0.13^{c}
2004	167	13,00±0.15^{cd}	9.12±0.17^{bcd}	5.64±0.15^{c}
2005	172	13.10±0.13^{bc}	9.34±0.19^{bc}	5.56±0.16^{c}
2006	106	12.59±0.20^{ef}	9.03±0.29^{cd}	4.77±0.17^{d}
2007	168	12.45±0.14^{fg}	8.45±0.21^{e}	4.47±0.12^{e}
2008	201	12.17±0,11^{g}	9.01±0.16^{cd}	4.46±0.14^{e}

Table 1. (continue)

Total number of lactations (D)				
1	396	11.27±0.11^{e}	9.14±0.13^{c}	2.68±0.04^{h}
2	512	12.00±0.09^{d}	8.89±0,11^{c}	4.27±0.05^{g}
3	466	12.72±0.09^{c}	8.94±0.10^{c}	5.32±0.06^{f}
4	385	13.16±0.09^{b}	9.07±0.10^{c}	6.03±0.07^{e}
5	314	13.72±0.09^{a}	9.76±0.12^{c}	6.92±0.08^{d}
6	217	14.01±0.11^{a}	10.06±0.14^{bc}	7.52±0.10^{c}
7	143	14.07±0.13^{a}	10.05±0.15^{bc}	7.79±0.11^{b}
8	81	14.19±0.14^{a}	10.30±0.18^{ab}	8.15±0.14^{b}
9	23	14.37±0.35^{a}	11.06±0.43^{a}	8.98±0.34^{a}
10	11	13.64±0.21^{ab}	10.15±0.37^{abc}	8.36±0.28^{ab}
Age at fertilization (E)				
b_{xy}±S_b		0.247±0.172 *	-0.183±0.257 **	-0.100±0.598 **
Anova	**df**			
A	2	**	**	**
B	3	ns	ns	ns
C	13	**	**	**
D	9	**	**	**
E	1	*	**	**
Koef. deter. – R^2		0.330**	0.150**	0.725**

Mean values in columns marked with the same letters do not differ (P>0.05) based on the LSD test
F-test (Anova) and t-test (coeff. lin. regression-bxy): N.S. - P>0.05; * - P<0.05; ** - P<0.01;

The general average, corrected for the effect of observed paragenetic factors, for milk production per milking, productive and lifetime day was 12.79, 9.31 and 5.47 kg.

The ***breeding area*** or farm most often significantly affects the characteristics of life production due to different ways of rearing, nutrition, care, climatic conditions, age structure and size of the herd, as well as several other effects related to the way of work and management on the farm itself. In the conducted research, the breeding area had a very significant effect (P<0.01) on milk production, both by milking and by productive and lifetime days. The greatest manifestation of these traits was on the farm in Zlatibor due to the free-stall housing system and using grazing in the summer season. During the analysis of the effect of the breeding area on the performance of milk production by milking, productive and lifetime days, *Petrović et al. (2012; 2019)*, state its predominantly highly significant (P<0.01) effect on milk production per milking, productive and lifetime day.

The systematic effect of the ***season of birth*** of cows on longevity traits is due to changes in climatic conditions, primarily temperature and precipitation, which also causes changes in the way of housing (free-stall and tie-stall) and the health status of cows as the most important factors that determine the expression of

these traits. The season of birth of cows in our research did not significantly affect (P>0.05) any of the observed characteristics of life production.

The effect of the ***year of birth*** on the expression of longevity traits is manifested through different climatic conditions by year, in which the throat had production, and through them the quality and quantity of available food. In addition, breeding technology and the level of health care have been improving over the years, and during each year more or less annual selection success has been achieved. In the conducted research, the year of birth had a very significant (P<0.01) effect on the manifestation of the observed characteristics of life production (milk production per milking, productive and lifetime day). Despite the improvement of breeding technology and the level of health care in our research, the characteristics of life production by year of birth had a slightly decreasing trend. Increased selection criteria and intensification of production contributed to this, which directly affected the relationship between planned and unplanned exclusion, and thus the manifestation of life production characteristics and the profitability of milk production. The largest part of cow exclusion from production refers to unwanted exclusion, which can have a 2.5 times larger share compared to planned (*Pinedo et al., 2010*). According to several authors (*Nienartowicz-Zdrojewska et al., 2009; Chiumia, 2011; Ansari-Lari et al., 2012; Stojić et al., 2012*) the main reasons that lead to unplanned removal of cows from production reproductive disorders, mastitis, leg and hoof diseases and injuries.

The effect of the ***total number of lactations*** on longevity traits was very significant (P<0.01). The increase in the number of lactations, directly and indirectly, influenced the increase in the observed characteristics of life production. When considering at the research results of the effect of lactation on the reasons for exclusion in cows, it is observed that the dominant reasons for exclusion change according to lactation. Thus, the dominant reasons for the exclusion of first heifers are selection reasons (most often low production) and problems in reproduction (*Seegers et al., 1998; Stojić et al., 2012*). Of the total number of cows excluded during one year, first-calves accounted for 20 to 35% (*Maher et al., 2008; Pinedo et al., 2010; Chiumia, 2011*). Also when it comes to heifers, it was established that heifers that later became pregnant for the first time are excluded earlier, due to a higher risk of low production, as well as those with less pronounced typical characteristics (*Dürr, 1997*).

The ***regression effect of age at first insemination*** was highly significant (P<0.01) in milk production per productive and lifetime day, while its effect on milk production per milking day was significant (P<0.05). The linear regression coefficient for milk production per milking day was b_{xy}= 0.247, while for milk production per productive and lifetime day, it was negative and amounted to b_{xy}=-0.183 and b_{xy}=-0.100.

The ***coefficients of determination***, which indicate the level of explanation of variation in the observed characteristics of life production by the applied model, were highly significant, which indicates an adequate selection of paragenetic factors in the applied model. Their value was very different and ranged from only 0.150 (15%) for milk production per productive day to 0.725 (72.5%) for milk production per lifetime day.

Conclusion

Based on the applied model for analyzing the effect of systematic environmental factors and the age of cows at first insemination on the expression and variability of milk production per milking, productive and lifetime day, it can be concluded:

- The general average for milk production per milking productive and lifetime day was 12.79, 9.31 and 5.47 kg.
- The effect of breeding area, year of birth and lactation group on milk production per milking, productive and lifetime day was very significant ($P<0.01$), while the effect of the season of birth of cows was not significant ($P>0.05$).
- Age at first insemination, as a continuous factor, had a highly significant ($P<0.01$) effect on milk production per productive and lifetime day and a significant ($P<0.05$) on milk production per milking day.
- The calculated coefficients of determination (R^2) were highly significant based on the applied model, for all longevity traits they were very significant ($P<0.01$) and ranged from 0.150 (15%) for milk production per productive day to 0.725 (72.5%) in milk production per day of life.

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