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THE EFFECT OF GEOGRAPHICAL REGION ON LIFETIME MILK YIELD IN SIMMENTAL COWS

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Abstract

This study was conducted to evaluate the phenotypic expression and variability of lifetime performance traits (lifetime yields of milk, fat and 4%FCM, milk fat content, milk yield per milking day, milk yield per day of productive life and milk yield per day of life) of 2548 Simmental cows housed on three farms in three different breeding regions: Zlatiborski Suvati (Zlatibor Pastures) dairy farm on Mt. Zlatibor, employing a loose housing system with lying and resting boxes (*lige boxen*), located at about 1000m a.s.l. (n=502), Dobričevo dairy farm in Čuprija, using tie-stall housing (n=956) and individual tie-stall farms in the Kotražna region, located at 400-700m a.s.l. (n=1090).

Simmental cows included in the study achieved the following: lifetime yields of milk, fat and 4%FCM - 14604, 554.8 and 14157 kg, respectively, milk fat content of lifetime milk yield - 3.81%, milk yield per milking day - 12.79, milk yield per day of productive life - 9.31 and milk yield per day of life - 5.46 kg. The marked variability of the traits, along with a certain percent of high-producing cows, enables further success in their selection.

The effect of *breeding region* on all lifetime performance traits was very highly significant ($P < 0.001$) due to different housing systems, nutrition, care, climate, herd size and a number of other effects associated with the farm management practices used.

Key words: *Breeding region, lifetime productions, Simmental breed.*

Introduction

Cow longevity, duration of cow utilization for both milk and calf production, and the production level have a large impact on overall results in the cattle industry. Although the natural life span of a cow kept under optimal conditions exceeds twenty years, there are certain limiting bio-economic factors that shorten its life expectancy and exploitation period, thus considerably increasing the costs of production, often making it unprofitable.

In their analysis of the phenotypic expression and variability of longevity and lifetime performance traits in 143 Simmental cows housed at the Zlatiborski Suvati Farm, Petrović D. M. *et al.*, 2003 determined the following values: average number of lactations per cow – 5.59; lifetime yields of milk, fat and 4% FCM – 25,290.1; 928.84 and 24,049.5 kg, respectively, milk fat content – 3.69%, and milk yield per milking day, day of productive life and day of life – 13.27, 10.28 and 7.47 kg, respectively.

Variability in lifetime performance traits, like that in other quantitative traits, is affected both by environmental factors (non-genetic factors) and by the genetic basis (genetic factors), with the genetic variability, however, as commonly accepted, making a rather low contribution to the total phenotypic variability of these traits. Hence, these traits can be substantially increased through improvements in housing conditions, primarily nutrition, care, health and utilization intensity.

Breeding region or farm generally have a significant effect on milk performance, fertility and lifetime performance traits, due to varied housing systems, nutrition, care, climate, age structure, herd size, and a number of other effects such as farm operation and management practices.

Material and method

The phenotypic expression and variability of lifetime performance traits and the effect of breeding region on these traits were studied in 2,805 Simmental cows born from 1982 onwards. The cows were housed on three farms in three different breeding regions, with two in the uplands (a farm on Mt. Zlatibor, and private family farms in the Kotraž region), and Dobričevo farm in the lowlands, near Čuprija. The Zlatiborski Suvati (Zlatibor Pastures) farm employed a loose housing system with lying boxes, whereas the Dobričevo farm and private family farms in Kotraž used a tie-stall system.

The following **lifetime performance traits** were analyzed:

- lifetime milk yield (LMY), (kg),
- milk fat content of lifetime milk yield (MFCLMY), (%)

- lifetime fat yield (LFY), (kg),
- lifetime yield of 4%FCM (LY4%FCM), (kg),
- milk yield per milking day (MYMD), (kg),
- milk yield per day of productive life (MYDPL), (kg),
- milk yield per day of life (MYDL), (kg).

Lifetime performance traits were calculated using cow record sheet data as follows:

- *Lifetime milk yield* was obtained by summing up total milk yield from each whole lactation over a cow's lifetime,
- *Lifetime milk fat yield* was calculated by adding up total milk fat yield from each whole lactation over a cow's lifetime,
- *Milk fat content of lifetime milk yield* was calculated by multiplying the quotient of lifetime milk fat yield and lifetime milk yield by 100,
- *Lifetime 4% FCM yield* was the sum of 4%FCM from each whole lactation over a cow's lifetime,
- *Milk yield per milking day* was obtained by dividing the lifetime milk yield by the number of days in milk which represent the sum of the total length of whole lactations over a cow's lifetime.
- *Milk yield per day of productive life* was obtained by dividing lifetime milk yield by the length of productive life which represents a difference between culling age and the age at first calving,
- *Milk yield per day of life* was calculated by dividing lifetime milk yield by cow age at culling, expressed in days.

The phenotypic expression and variability of lifetime performance traits were analyzed by calculating main parameters of descriptive statistical analysis, including:

- the arithmetic mean (anscism@agrif.bg.ac.rs),
- standard error of the arithmetic mean ($S_{\bar{x}}$),
- standard deviation (SD),
- coefficient of variation (CV(%)),
- interval of variation (min-max).

The effect of farm or geographic region on the expression of lifetime performance traits was analysed using the general linear model (GLM procedure). This procedure enables simultaneous analysis of a number of different effects, regardless of their being either categorical or continuous factors. To evaluate the effects and test hypotheses, the general linear model uses the least squares method for the calculation of least squares means (LSM) and their errors (SE_{LSM}).

Results and discussion

The average expression and variability of lifetime performance traits as dependent upon breeding or geographic region are presented in *Table 1* and *Graph 1*.

Table 1. - *The average expression and variability of lifetime performance traits in three breeding regions*

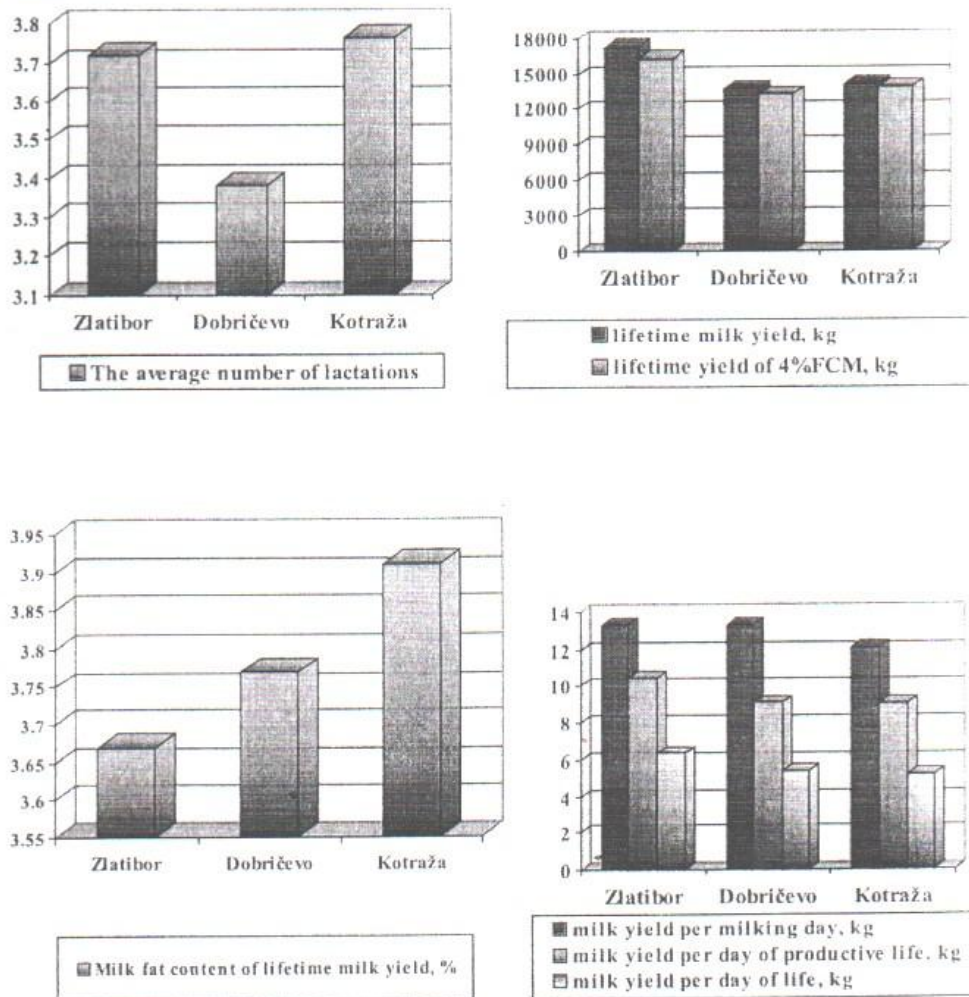
Performance	N	\bar{x}	$S_{\bar{x}}$	SD	CV(%)	Variation	
						Min.	Max.
The average number of lactations per cow	2550	3.61	0.04	2.03	56.23	1	12
Lifetime milk yield, kg	2550	14603.75	187.05	9445.54	64.68	1411	58942
Lifetime milk fat yield, kg	2550	554.80	7.06	356.53	64.26	53	2063
Milk fat content of lifetime milk yield (%)	2550	3.81	0.003	0.15	3.94	3.14	4.88
Lifetime 4% FCM yield, kg	2550	14156.81	180.58	9118.61	64.41	1374.4	54521.8
Milk yield per milking day, kg	2550	12.79	0.041	2.08	16.26	6.92	20.10
Milk yield per day of productive life, kg	2550	9.31	0.045	2.29	24.60	1.89	18.40
Milk yield per day of life, kg	2550	5.46	0.041	2.09	38.28	1.03	14.11

The average number of lactations in the three breeding regions was 3.61 and showed high variability (56 %), due to the number of lactations per cow ranging from 1 to 12.

The average lifetime yield of milk, fat and 4%FCM was 14,604; 555 and 14,157 kg, respectively, and exhibited high variability (above 60%) due to a wide range of variation.

The average milk yield per milking day, day of productive life and day of life in all breeding regions was 12.8, 9.3 and 5.46 kg, respectively, with moderate variability ranging from 16 to 38%.

The high variability of lifetime performance traits, along with a certain percentage of high-producing cows, enables further success in their selection and higher levels of production.



Graph 1. - The average expression and variability of lifetime performance traits as dependent upon breeding region

The highest number of lactations per cow (3.76) was obtained in the Kotraž region, which may be attributed to the more extensive cow exploitation method used as compared to the more intensive system on Zlatibor and Dobričevo farms. Lactation number per cow on the Zlatiborski Suvati farm was 3.72, and was higher than that on the Dobričevo farm (3.38), which was due to the more favourable effect of loose housing system on Mt. Zlatibor as compared to the tie stall environment on the Dobričevo farm. This was confirmed by Grabovski,

1997 who emphasized that loose housing gives better results in terms of length of productive life and lifetime yields of milk, fat and protein.

Lifetime milk, fat and 4%FCM yields, and milk yields per milking day, day of productive life and day of life were higher on farms than on family farms due to the use of more advanced rearing technology, and highest on Zlatiborski Suvati farm due to the more favourable effect of the loose housing system on the traits as compared to the tie-stall system on Dobričevo farm. Milk fat yield was lowest in cows on Mt. Zlatibor which had the highest milk production, and highest in the Kotražna region which gave the lowest milk yield.

An analysis conducted by Ostrec and Klopčič, 1998 on the longevity and lifetime milk yield of Slovenian Simmental, Brown and Black-and-White breeds housed on privately-owned (family) and state-owned farms shows that the average number of lactations on state-owned farms was higher than on private farms.

The results of the analysis of the effect of breeding or geographic region on lifetime performance traits, including least squares means (LSM), standard errors of the means (SE_{LSM}) and the significance of the effect, are presented in Table 2.

Table 2. - Least squares means, standard errors of the means and the significance of the effect of breeding or geographic region on lifetime performance traits.

Geog. Regio. (farm)	N	LMY (kg)		MFCLMY (kg)		LFY (%)		LY4%FCM (kg)		MYMD (kg)		MYDPL (kg)		MYDL (kg)	
		LSM	SE_{LSM}	LSM	SE_{LSM}	LSM	SE_{LSM}	LSM	SE_{LSM}	LSM	SE_{LSM}	LSM	SE_{LSM}	LSM	SE_{LSM}
I	502	27542	323.5	1024.5	11.97	3.66	0.01	26343	310.5	14.02	0.18	11.06	0.23	7.67	0.12
II	956	25467	312.6	966.5	11.57	3.76	0.01	24692	300.0	14.15	0.18	9.70	0.22	6.89	0.11
III	1090	24093	305.2	935.6	11.29	3.91	0.01	23679	292.9	12.84	0.17	9.50	0.22	6.46	0.11
F _{crit}		254.13***		173.29***		860.00***		194.00***		156.30***		90.11***		208.15***	

I-Zlatibor; II-Dobričevo; III-Kotražna; N.S. - $P > 0.05$; * - $P < 0.05$; ** - $P < 0.01$; *** - $P < 0.001$

The effect of breeding or geographic region on all lifetime performance traits was very highly significant ($P < 0.001$), due to varied housing systems, nutrition, care, climate, herd size, and other effects such as farm operation and management practices. This effect of breeding region on all lifetime performance traits clearly suggests that the correction of these traits for the fixed i.e. systematic effect of this factor is justified.

Significant and very significant effects of geographic or breeding region or farm on performance traits in cows were reported by Kemp, 1998; Rychen, 1999; Chladek and Kucera, 2000; Đurđević *et al.* 2002; Pantelić *et al.*, 2010; Petrović M.M. *et al.*, 2009; Petrović D.M. *et al.*, 2009 and 2012.

Conclusion

The results of the present study suggest the following:

- The effect of breeding or geographic region on all lifetime performance traits was very highly significant ($P < 0.001$),
- The expression of lifetime performance traits was higher on dairy farms than on family farms, due to the use of more advanced rearing technology.
- Loose housing on Mt. Zlatibor had a more favourable effect on lifetime performance as compared to the tie-stall system on Dobričevo farm.
- The high variability of lifetime performance traits, along with a certain percentage of high-producing cows, enables further success in their selection and improvement.

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