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STUDY ON 305-DAY MILK YIELD FOR THE FIRST LACTATIONS OF JERSEY COWS, RAISED UNDER SMALL SCALE FAMILY CONDITIONS IN ALBANIA

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Jersey cattle accounts for 3% of the cattle population in Albania. The advanced crosses amount to 33% of this population. The whole population is actually raised at small scale family farms, on average 2–3 cows. A low input production system is applied to these farms. Milk yield is low. The study of the Jersey cattle response to the low input production system and estimation of effects of non-genetic factors on milk yield make also possible that the programs for efficient selection and management of Jersey cows are compiled and applied to these farms. The manyfold analysis carried out by the data of 305-day milk yield for the first lactation, showed the effects of the factors "calving age" ($P < 0.05$); "calving month" and "herd" ($P < 0.001$) on the total phenotypic variance. Under conditions of the extensive production system, the effects of the factor "calving month" showed an anomaly in the succession of physiological processes that condition the milk yield during the first lactation. The adjustment of milk yield by means of separate multiplicative factors for the calving age and the calving month considerably reduces effects of these factors. It makes also possible the implementation of selection schemes under conditions of small scale farms, which raise 2–3 cows. Large differences at the extensive production system and the low level of inputs influence the increase of percentages of atypical curves of lactation. As a consequence, the loss of milk yield is estimated about 350–550 kg milk/year. The management of effects of non genetic factors "calving age" ($P < 0.001$, 0.01, 0.05), "calving month" ($P < 0.001$, 0.01, 0.05), on variations of a, b and c parameters of the normal curves of lactation makes possible to increase the milk yield during the first lactation.

Key words: Jersey-cows; small scale farms; first lactation; lactation curve; non-genetic factors

ПРОУЧУВАЊЕ НА ПРОДУКЦИЈАТА НА МЛЕКО ЗА 305 ДЕНА ВО ПРВА ЛАКТАЦИЈА КАЈ КРАВИ ОД РАСАТА ЏЕРЗЕЈ ОДГЛЕДАНИ НА МАЛИ ФАРМИ ВО АЛБАНИЈА

На расата џерзеј отпаѓаат 3% од популацијата на говеда во Албанија. Околу 33% од оваа популација се високопродуктивни грла. Всушност, вкупната популација е одгледувана па мали семејни фарми, во просек 2–3 крави. Производниот систем koj se primenuva na ovie farmi е со низок input. Количината на млеко е ниска. Проучувањата на говедата од расата џерзеј кои одговараат на производниот систем со низок input, како и процената на ефектите на негенетските фактори врз количината на млеко, овозможуваат на овие фарми да бидат аплицирани програми за успешна селекција и menaxirawe на оваа раса крави. Многустраната анализа, заснована на податоците за количината на млеко за 305 дена во првата лактација, ги прикажува ефектите на факторите „возраст при телење" (P < 0,05); „месец на телење" и „стадо" (P < 0,001) врз вкупната фенотипска варијација. Во услови на екстензивен производствен систем, ефектите на факторот месец на телење покажуваат аномалија во непрекинатоста на физиолошките процеси кои се однесуваат на продукцијата на млеко за време на првата лактација. Регулирањето на продукцијата на млеко со значење на одделните мултипликативни фактори за возраста при телење и месецот на телење значително ги намалуваат ефектите на овие фактори. Исто така ја прави можна имплементацијата на селекциони шеми во услови на мали фарми, кои одгледуваат 2–3 крави. Големите разлики кај екстензивниот производствен систем и ниското ниво на инпути влијаат за зголемување на процентот на атипични лактациски криви. Како последица, загубата во продукцијата на млеко е проценета на околу 350–550 kg млеко годишно. Контролата на ефектите на негенетските фактори „возраст при телење" (P < 0,001, 0,01, 0,05) и „месец на телење" (P < 0,001, 0,01, 0,05) врз варијациите на параметрите a, b и c на нормалните лактациски криви овозможува зголемување на продукцијата на млеко за време на првата лактација.

Клучни зборови: крави џерзеј; мали фарми; прва лактација; лактациска крива; негенетски фактори

1. INTRODUCTION

The Jersey cattle breed constitutes about 3 % of the cattle population, whereas the advanced crosses of the Jersey breed of the local cattle accounts for 33 % of the whole cattle population in Albania. The Jersey cattle population is actually raised at small scale family farms, on the average 2–3 cows. The low input production system is applied to these farms. As a consequence, the performance of genetically improved cattle is low. The study of how this breed responds to the conditions of low input production system and the assessment of effects of non genetic factors on milk yield is necessary because, only in this way, programs for animal selection and management could also be designed and applied.

2. MATERIAL AND METHODS

Data of 305-day milk yield for the first lactations obtained from 935 cows were analyzed in order to study the way of responding Jersey cows to conditions of small scale family farms characterized by the low input production system. Cows have been managed in 783 small scale family farms, situated in the north-east region of Albania, Shkodër. The study on milk yield variation and estimation of effects of different non genetic factors on the total phenotypic variance was performed by analyzing the variance according to the *"least squares"* method (Harvey, 1974), to the Fixed Linear Model (FLM), as follows:

$$Y_{ijkl} = \mu + a_i + b_j + h_k + (ah)_{ik} + (bh)_{jk} + (ab)_{ij} + e_{ijk} \quad (1)$$

where:

Y_{ijkl} – milk yield of cow "*l*" grouped at level "*k*" of factor "herd", that has calved in month "*j*" and age of calving "*i*",

μ – mean of population

a_i – effect of calving age

b_j – effect of calving month

h_k - effect of herd

$(ah)_{ik}$ – effect of interaction "age × herd"

$(bh)_{jk}$ – effect of interaction "month × herd"

$(ab)_{ij}$ – effect of interaction "age × month"

e_{ijk} – residuals $N(0, \sigma^2_e)$.

Least squares means corresponding to factors, estimated by the model (1) have been used to compute the adjusting factors of 305-day milk yield for the factors "calving age and month". The corresponding regression lines were set up by these means in order to account the values of the adjusting factors. The calving age out of 24 months old and the calving month – April, which had the highest frequencies in the analyzed population, were used as the referring age and month of calving. Algorithm used for adjusting 305-day milk yield by means of the correcting coefficients is as follows:

It is computed:

$$\Delta_{\text{age of calving}} = (\text{adjusting factor} \times \text{305-day milk yield}) - \text{305-day milk yield},$$

$$\Delta_{\text{month of calving}} = (\text{adjusting factor} \times \text{305-day milk yield}) - \text{305-day milk yield}.$$

and

$$\text{the adjusted milk yield} = \text{305-day milk yield} + \Delta_{\text{age of calving}} + \Delta_{\text{month of calving}}$$

Computation of joint multiplicative factors to the calving age and month was carried out according to the following formula

$$K_{ij} = \mu + \hat{a}_{24} + \hat{b}_4 / \mu + \hat{a}_i + \hat{b}_j$$

for $i = 21, 26$, and $j = 1, 12$,

where μ, $\hat{a}_i$, $\hat{b}_j$ are estimations of "least squares" corresponding to the effects of calving age and month.

Adjustment of 305-day milk yield by means of these coefficients was performed as follows:

a) the adjusted milk yield = k_{ij} 305-day milk yield;

b) the adjusting additive factors were computed by the formula as follows:

$$K_{ij} = (\mu + \hat{a}_{24} + \hat{b}_{24}) - (\mu + a_i + b_j)$$

for $i = 21, 26$, and $j = 1, 12$, and milk yield adjustment was carried out according to the formula:

the adjusted milk yield = 305-day milk yield + K_ij.

Data of monthly milk records for 935 lactations were used to study consecutiveness of milk production during the first lactation.

Function "Гамма" was used to estimate lactation curves.

$$Y = a\, x^b\, e^{-cx}$$

Atypical curves were estimated by mathematical models as follows:

First type: $Y = a_0 + a_1x + a_2 x^2$

Second type: $Y = a_0 + a_1x + a_2x^2 + a_3x^3$

Third type $Y = a_0 + a_1x + a_2x^2 + a_3x^3 + a_4x^4$

Forth type $Y = ae^{-bx}$

Phenotypic variations of parameters of normal lactation curves were studied by the analysis of variance, carried out according to the fixed linear regression model:

$$Y_{ijkl} = \mu + a_i + b_j + h_k + e_{ijkl}, \qquad \text{(model 2)}$$

where:

Y_{ijkl} – value of the lactation curve parameter (a, b, c),

a_i – effect of the factor "calving age" (i =1.6; ages: 21–26 months),

b_j – effect of the factor "calving month (season)" (j = 1. 4),

h_k – effect of factor "herd" (k = 1, 4),

e_{ijkl} – residuals N (0, σ^2_e).

3. RESULTS AND DISCUSSION

The effect of the calving age on the variation of milk productions is related to biological features of the individual and depends on the time of the first heat appearance. The calving age is a non genetic factor that highly affects the total phenotypic variance of milk production. This factor accounts for 30–40 % of the total variance of milk production at the beginning of lactation, meantime, this effect reduced up to 2–5 % after 270 days of lactation (Kume K. et al., 1990; Dervishi V., 1991; Biçoku Y., 1995; Tahiri T., 2008). The calving month (season) is another nongenetic factor that affects the variance of milk yield. The effect of this factor is related to the variation of the feed base during the months of year (Miller P. D, 1970; Strandberg E., et al., 1991; Janushi M. et al., 1996; Tekerli M., et al., 2000; Mostert B. E. et al., 2001; Schutz M. M. et al., 2004). So, the effect of this factor is a priori expected to be considerable to small scale family farms characterized by a low input production system.

To judge for the effects of the factors "calving age and month" on the phenotypic variance of 305-day milk yield for the first lactation of the Jersey cows that are managed at small scale family farms in Albania, it is necessary to refer to the results of the analysis of variance performed according to the requests of the linear regression model (1) (Table 1).

Table 1

Analysis of variance : model (1)

Source of variance	**d. f.**	**m.s.***	**F**
Age of calving	5	3,975	2.02*
Month of calving	11	7,439	3.78***
Herd	3	8,127	4.13***
Calving age × herd	15	2,381	1.21
Calving month × herd	33	3,896	1.98*
Calving age × calving month	55	2,007	1.02
Residuals	814	1,968	

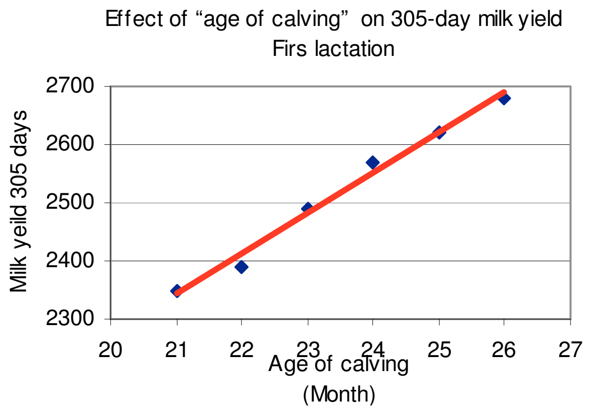
*Value must be multiplied by 10^4
* (P < 0.05), *** (P < 0.001)

As seen, factors show statistically proved effects on the variance of 305 day milk yield for the first lactation. The rate of factors' influence is different. Nevertheless, these differences amongst factors are not large as given in literature (Leroy P., 1978; Kume K., 1989; Dervishi V., 1991; Biçoku Y., 1995). As shown, the effect of the factor "herd" is smaller than that referred to literature. That is almost equal to the effect of the factor "month of calving". According to our opinion, that is for two reasons: *firstly*, cows have been managed at small scale family farms where a low input production system is applied and, *secondly,* grouping these farms into 4 levels (classes), where there are no great differences in annual average milk yield, has influenced the further reduction of the part of the total variance brought about by this factor.

"Month of calving" shows a statistically significant effect (P < 0.001), meanwhile, the effect of "age of calving" (P < 0.05) is estimated to be almost half of the effect "month of calving". The effect of "age of calving" is shown as a linear one. The higher age the higher milk yield is. The maximum difference is about 450 kg milk/lactation, comparable to that given in literature (Kume K., 1989; Dervishi V., 1991; Biçoku Y., 1995).

The effect of the factor "calving month" on the total variance of milk production is periodical. Cows that calved in the period of January–April are more favored towards the effect of this factor than cows that have calved for the period from June to November, where the "calving season" shows non-positive effects This situation is similar to that that is given in literature (Miler et al., 1970;

Fimland et al., 1972; Leroy P., 1978; Kume K. et al., 1989; Dervishi V. 1991; Biçoku Y., 1995).



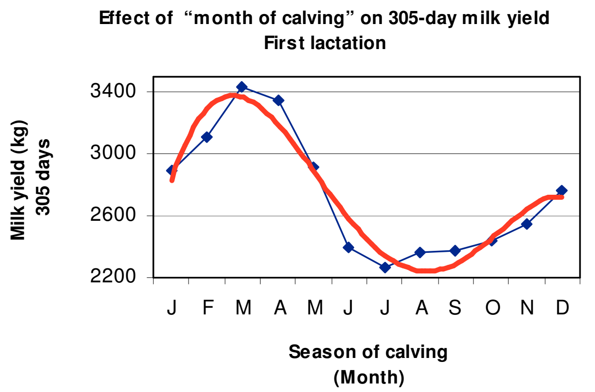


Fig. 1. Effect of the "age of calving" and the "month of calving" on 305 day milk yield

The difference between average 305-day milk yield performed by cows that have calved in March and those that have calved in July is 1080 kg or about 52% higher. This difference is about 2–3 times higher than that given in literature. This situation is explained by the fact that, in a great number of cases, the level of cows' management at small scale family farms doesn't reach to get over the necessary minimum level for ensuring normal consecutiveness of physiological processes that associate milk production. Cows that calved from January to April are favored by forage amount and quality available to this season, and for those calved from July to November, nutritional requirements are not enough in some cases. This abnormal situation that has brought about large differences in average milk yields between these both seasons is the same and also related to that that has caused high percentages of atypical lactation curves (Kume K., Tahiri F., 2005).

Coefficient of determination R^2 = 23.8%, comparable to that that is given in literature, shows that the used linear regression model is statistically acceptable. Meantime, as:

(i) In comparison with the corresponding linear model but without factors of reciprocal interaction, explanation of variance increased by 1,09%.

(ii) The effect of reciprocal interaction "age × herd" is not statistically proved, whereas the effect "month × herd" is although statistically proved ($P < 0.05$), this effect is small.

(iii) The effect "calving age × month of calving" is not statistically proved. The adjustment for reducing effects of these both factors has to be made, without taking into account interaction between them and levels of the factor "herd".

Results of the analysis of variance carried out according to the model (1) are used to judge for the efficiency of three different ways of adjustment, based on the data of milk yield, adjusted for the effects of the factors "calving age and month" (Table 2).

Table 2

Analyis of variance for studying the effect of adjustment methods

Source of variance	d.f.	Uncorrected milk yield		Joint multiplying adjustment for age and month of calving		Separate multiplying adjustment for age and month of calving		Additive adjustment	
		m.s.	F	m. s.	F	m. s.	F	m. s.	F
Age of calving	5	4,50	2.12*	2,64	1.27	1,78	0.9	3,38	1.61
Month of calving	11	8,67	4.08***	3,58	1.72	2,02	1.02	4,06	1.93*
Herd	3	11,08	5.21***	11,71	5.62***	11,58	5.81***	10,60	5.04***
Residuals	917	2,127		2,085		1,986		2,104	

As shown, three ways of adjustment highly reduce the effects of the factors "calving age and month" on the total variance of 305-day milk yield for the first lactation. As a consequence, excluding the case of adjustment by means of additive coefficients for the factor "calving month", where the effect of this factor on milk yield is not statistically eliminated (P < 0.05), at all other cases the adjustments eliminate the effects of both non-genetic factors.

The analysis of variance shows that the adjustment of 305-day milk yield of the first lactation by separate multiplicative factors for the age of calving and the month of calving is the most efficient.

This adjustment reduces the residual variance of the model by about 6.3 %, while other adjustments reduce this variance by 1,1–2,1 %. This situation is almost the same to that published by authors (Leroy P., 1978; Kume K., 1988; Biçoku Y., 1995).

Multiplicative factors that can be used for adjusting 305-day milk yield of the first lactation for the Jersey cow population included in the study are given in Table 3.

Table 3

Multiplicative factors for adjusting 305-day milk yield for the first lactation

Age at calving (months)	Coefficient	Month of calving	Coefficient
21	1,1301	January	0,9976
22	1,0733	February	0,9908
23	1,0412	March	0,9588
24	1,0000	April	1,0000
25	0,9754	May	1,0861
26	0,9553	June	1,1601
		July	1,3252
		August	1,4684
		September	1,4112
		October	1,3583
		November	1,2570
		December	1,1854

Mathematical modeling of the first lactation curves for 935 cows included in the study evidenced some types of lactation curves. These curves can be classified into two large groups – normal and atypical curves, referring to physiological rules according to which, milk production is performed during lactation. The group of atypical curves comprises curves where consecutiveness of milk production during lactation can not be reflected by the function of the type "Гамма".

Atypical curves of lactation can be grouped in four subgroups, depending on their shape:

***First type*:** The convex curve that has a low convexity coefficient and low trend of declining milk yield after seventh month of lactation (Fig. 2a). This curve is met at 6% of cases and it is mostly characteristic to cows that have calved in May and June.

***Second type*:** This curve is in the shape of bell (Fig. 2b). The gradient of increasing milk production is almost the same to the gradient of declining. Milk yield reaches the peak about the sixth or seventh month of lactation. The curves of this type are met at 13 % of cases. Such curves are in general observed to cows that have calved in December and January.

***Third type*:** Minimum milk yield is at the fourth month of lactation and maximum milk yield reaches at the ninth month of lactation. Cows, which have such lactation curves, have low milk yield and long lactation. This type of curve (Fig. 2c) is met at 4 % of cases.

***Forth type*:** Exponential type curves but with a low gradient of declining milk yield (Fig. 2d) are met at 14 % of cases.

As shown, about 37% of cows have produced milk during the first lactation according to a rule that is deviated from the normal one. Such atypical curves but with lower frequency (20–25%) of appearance had been reported by authors (Elzo M. A. et al., 2001; Mostert B. E. et al., 2001).

Such a fact should only be explained by poor conditions of cows' management and feeding. This situation is as a consequence of technically unjustified actions of farmers. About 86% of cows, which had atypical curves, had calved for the first time at the age of 23 months old. The Albanian farmer has often been interested in heifer to be conceived at the age of 14 months old.

589 out of 935 first lactations have normal curves of the type "Гамма" (P < 0.05). Using average values of parameters a, b and c of these curves of lactations, the function "Гамма" that

reflects the average curve of the first lactation for the Jersey cows is as follows:

$$Y = 10.158x^{0,482}\, e^{-0,124x}.$$

Comparison of this curve with the average atypical curve (Fig. 3a,b,c,d) clearly shows the loss of milk production only caused by the fact that the lactation curve is not normal. The loss of milk yield is estimated by about 10–15% or 350–550 kg milk.

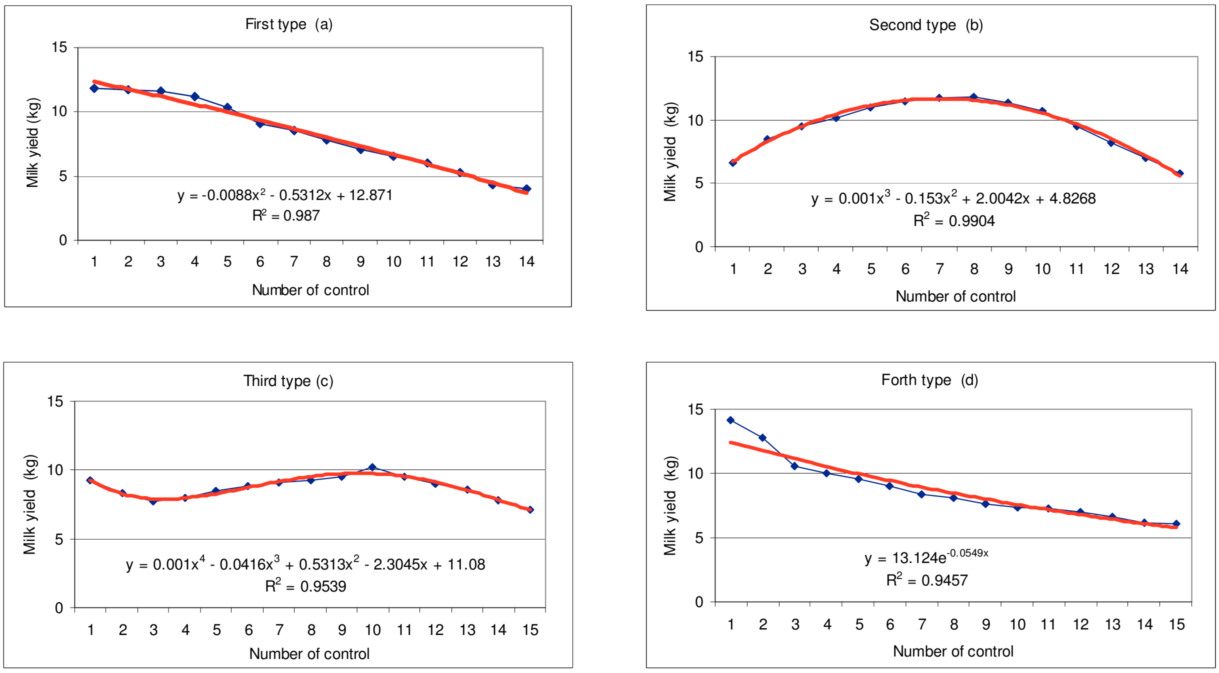


Fig. 2. Atypical lactation curves – First lactation

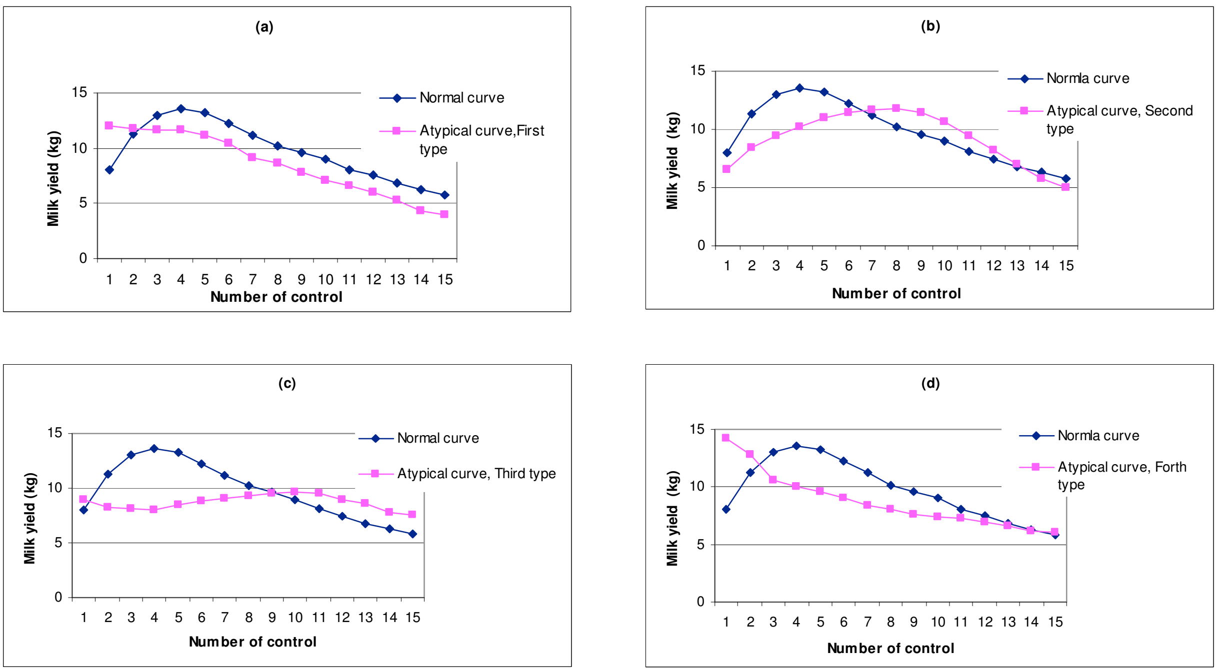


Fig. 3. Comparison of atypical curves with normal curves of the first lactation

Results of the analysis of variance, carried out according to the requests of the linear model (2) for each of normal curve parameters for the first lactation are shown in Table 4.

Table 4

Analysis of variance for parameters "a", "b" and "c" of the first lactation curve

Source of variance	d.f.	Parameter a		Parameter b		Parameter c	
		m. s.	F	m. s.	F	m. s.	F
Calving age	5	0.2783	9.065***	0,0154	7.012**	0,0084	4.982*
Calving season	3	0.3382	11.018***	0,0112	5.106*	0,0072	4.256*
Herd	3	0.1315	4.283*	0,0059	2.708	0,0025	1.507
Residuals	579	0.0307		0,0022		0,0017	

*(P < 0.05); **(P < 0.01); ***(P < 0.001)

As shown, effects of non genetic factors on the variance of the parameter "a" are statistically proved. The variance of this parameter is highly influenced by the factor "calving season" and "calving age" is the second one. These results are similar to those published by authors (Wunder W. W., 1967, Danell B., 1982, Biçoku Y., 1995). The parameter "a" reflects milk yield at the beginning of lactation. Its variance greatly depends on the variance of the first milk record. It is known that the closer day of the first milk record to the day of calving is the more milk yield of the first record is genetically conditioned. Therefore, the above given results, according to which, the effects of non-genetic factors on variation of this parameter are notable should be reservedly accepted.

This situation is at a certain rate as a consequence of the fact that the protocol of the first milk record is not rigorously respected. The first milk recording is not carried out at the same day of lactation for all cows. There is a difference by about 20 days amongst them.

The phenotypic variance of parameter "*b*" is statistically influenced by the factors "age at calving" and "season of calving" (P < 0.05, P < 0.01). That means that the increasing phase of lactation curve, especially its gradient, is greatly affected by these both factors. Such a result is approximate to that reported by Wood D. P., 1969; Elzo M. A. et al., 2001; Mason Steve, 2001. Meantime, the variance of parameter "*c*" depends on the action of these factors. The difference lies in the fact that the rate of affecting non-genetic factors on the parameter "*c*" is less than on the parameter "*b*".

Supported by the above mentioned results, it may be stated that in the low input production system, the farmer is able to interfere in consecutiveness of milk yield during the first lactation. These interferences will especially be of positive effects for increase of milk production when carrying out during the raising phase of lactation curve.

4. CONCLUSION

The age at calving and the month of calving are two non-genetic factors affecting variance of 305-day milk yield of the first lactation. The effect of the factor "month of calving" is the biggest. Under conditions of the extensive production system, in some cases, this effect causes abnormality in consecutiveness of physiological processes that condition milk production during the first lactation.

In order to compare cows correctly, under conditions when estimation of their genetic values is not possible, selection of cows could be carried out, based on 305-day milk yield adjusted for effects of the factors "calving age and month". Multiplicative adjustment of 305-day milk yield for effects of the factors "calving age and month" at first lactation is recommended to be used for the Jersey cow population included in study. Separate multiplicative factors should be used for age of calving and month of calving, which are given in Table 3.

Response of the Jersey cows to conditions of a low input production system depends on the great rate of the level of inputs. This response is very different and it often appears to the shape of atypical lactation curves. Such response of this genetic fund makes difficult efficient management of it and the implementation of selection schemes is not possible.

Establishing minimum conditions in order to have a normal consecutiveness of physiological processes that condition milk yield is also possible under conditions of the extensive production system applied to small scale farms. In such cases, the lactation curve equation could be used by the farmer as an efficient instrument for the management of milk production and the selection of animals.

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