Study on the 305- day Milk Yield of Jersey Cows under Small Scale Family Conditions Raised in Albania. II. Adjustment Factors for 305- day Milk Yield

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Data of 935 first lactations, 607 second lactations and 432 third lactations obtained by 1476 Jersey cows that are managed in small scale family farms, under conditions of low input production system, were analyzed in order to study effects of factors: calving age and season on variance of 305-day milk yield and their effect adjustment. ML (Maximum Likelihood) Method was used to obtain unbiased prediction for adjustment factors, as it is able to take into account and estimate not only differences "between cows" but also "within cow". Analysis of variance carried out according to mixed linear regression model indicates that all factors included in this model show statistically significant effects (P<0,001) on the variance of 305 day milk yield. Mixed linear model with "age of calving x month of calving" increased significance (P<0.05) of this model in explanation of total phenotypic variance of milk yield for first three lactations only by 0,72 %. This situation doesn't justify the use of joint multiplicative factors for calving age and month.

Key words: Milk production, Jersey, Small scale farms, Maximum Likelihood, effect of age and season on calving

Arnavutluk'ta Küçük Ölçekli Aile İşletmesi Koşullarındaki Jersey İneklerinde 305 Günlük Süt Verim Özellikleri Üzerine Bir Araştırma-II. 305 Günlük Süt Verimi İçin Düzeltme Faktörleri

Yetersiz girdili üretim sistemleri koşullarında, küçük ölçekli aile işletmelerinde yetiştirilen 1476 Jersey ineğinden elde edilen 935 birinci ,607 ikinci,432 üçüncü laktasyon sırasındaki verim kayıtlarında buzağılama yaşı ve mevsiminin 305 günlük süt verimi ve düzeltme etki faktörleri değişkenliğindeki rolü incelenmiştir. Düzeltme faktörlerinin sapmasız tahminlerini elde etmek konusunda yanlızca "inekler arası "farklılığı değilde fakat ayni zamanda " inekler içi" farlılığıda dikkate aldığından Maksimim olabilirlik meteodu kullanılmıştır. Karışık Doğrusal Regresyon metoduna göre yürütülen varyans analizi; modele dahil edilen tüm tüm faktörlerin 305 günlük süt verimi değişkenliği üzerine etkilerinin istatistik olarak önemli olduğunu göstermiştir(P<0,001). "Buzağılama yaşı x Buzağılama ayı "ögesini içeren karışık doğrusal model de bu unsurun ilk üç laktasyon için süt verimindeki toplam varyasyondaki açıkladığı kısmın yanlızca % 0.72 olduğu ve önemli olduğu(P<0.05) gözlenmiştir.Bu durum buzağılama yaşı ve ayına göre çoklu düzeltme faktörleri için birleşik carpım faktörleri kullanımının doğru olmadığını belirtir.

Anahtar Kelimeler :Süt verimi, Jersey sığırı, Küçük ölçekli işletme, makimum olabilirlik metodu, buzağılama üzerine yaş ve mevsim etkisi

Introduction

The overlapping of factors "age of calving" and "number of lactation" was not observed in the herd of Jersey cows. In addition, age of calving exceeds from one lactation to the next by about 3 to 5 months respectively. Under these conditions, study of reciprocal effect "age at calving x number of lactation" is not necessary, due to the fact that these two factors can be fully identified to each other. So, we are right, when using statistical model without including factor 'number of lactation' for studying of adjusting method of milk production in order to reduce effect of "age of calving".

Different authors have paid great attention the study and choosing of adjustment method of milk production in order to reduce effect of factor 'age of calving' (Miller 1970, Leroy, P.et al. 1980, Kume . et al. 1989, 1990, Moster . et al. 2001, Cassell 2004). Criteria that have to be completed in order that adjusting factors be unbiased, are treated in those studies. There are in literature two methods for estimation of adjustment factors in the cases where these methods will be used for adjusting milk yield for some lactations:

1. Method of the entire comparison, which computes adjusting factors started from averages of milk yield for all lactations
2. Method of couple comparison according to which, adjusting factors are calculated by comparing yields of cow obtained by consecutive lactations

In the cases, where cow selection is carried out supported on the data of first lactation, the results obtained by ML (Maximum Likelihood)Method are used for estimation of adjustment factors for age and month of calving.

A milk performance recording system is applied to a limited Jersey cow population, which is managed in small scale family farms in Albania. Under those conditions, although cow selection is not usually carried out in first lactation, due to shortage in data recording, cows may be considered that are under conditions of a 'susceptible selection' that at the end of first lactation. So, this is a 'virtual selection' but bringing about consequences for quality of adjustment factors. Therefore, ML was used to obtain unbiased prediction for adjustment factors. As emphasized in literature, this method is able to take into account and estimate not only differences 'between cows' but also 'within cow'.

Adjustment of data for milk production can be made by additive or multiplying factors. To judge for the efficiency of these factors in the case of adjusting data for milk production of some lactations, the following criteria might be used:

1. Repeatability of milk yield is estimated, using data of consecutive lactations adjusted according to different ways. Adjusting factors that give the highest value of repeatability are the most efficient ones
2. Means of milk yield corresponding to different classes of factor "age of calving" are compared after adjusting – these means should almost be the same
3. Value of variation coefficient of milk production should not change due to adjusting
4. Adjustment should be accompanied by the reduction of part of total phenotypic variance caused by the effect of factor "age of calving". Literature recommends that in the cases where:

a. Values of index of selection in the herd of cows are negligible that at the first lactation, and

b. Repeatability is low as a consequence of high variations in cow management, characteristic of low input production system, multiplying factors should be used, which should be estimated supported on the results of analyze of variance carried out according to *the method of Maximum Likelihood*

Material and Method

1974 complete lactations records obtained from 1476 Jersey cows were analyzed. Data for milk yield, adjusted for 305 day lactation, were analyzed by mixed linear model as follows

$$Y_{ijkm} = \mu + a_i + b_j + h_k + c_{mk} + e_{ijkm} \quad (1)$$

where :

Y_{ijkm} – 305 day milk yield

a_i – effect of factor " age of calving" (33 class: 21-26, 31-41 and 44-59 months)

b_j – effect of factor "month (season) of calving" (j = 1 to 12)

h_k - effect of factor "herd" (k = 1 to 3)

c_{mk} - effect of cow "m " that is at herd "k"

e_{ijkm} – residual effects

In this model, effect "cow" is considered as "random" one $N(0, \sigma^2_c)$ and e_{ijkm} -residuals are random $N(0, \sigma^2_e)$. It is assuned that cov (c_{mk}, e_{ijkm}) = 0

Analysis of variance for this model was carried out according to *method of Maximum Likelihood*. The function of Maximum Likelihood (L) corresponding to mixed linear model (1) is as follow:

$$L = \prod_{ijkm} (1/\sqrt{2\pi\sigma^2_e}) \exp\{-1/2\sigma^2_e (Y_{ijkm} - \mu - a_i - b_j - h_k - c_{mk})^2\} \prod_{mk} (1/\sqrt{2\pi\sigma^2_c}) \exp\{-c_{mk}^2/2\sigma^2_c\}$$

System of equations obtained by differentiation of above function of *"Maximum Likelihood"* is as follow:

$$\begin{pmatrix} P & N_1 & N_2 \\ N`_1 & Q_1 & N_3 \\ N`_2 & N`_3 & Q_2 \end{pmatrix} \begin{pmatrix} x \\ t \\ c \end{pmatrix} = \begin{pmatrix} y_1 \\ y_2 \\ y_3 \end{pmatrix}$$

where :x - effects of factors "age of calving" and "month (season) of calving"

t - effect of factor "herd"

c- effect of cow

This system is different from system of normal equations of "least squares" method, only from the fact that at the elements of diagonal in block Q_2, corresponding to equations related to effect of cow, ratio $\sigma^2_e / \sigma^2_c = (1-r)\ r$ is added. Where r – coefficient of repeatability for 305-day milk yield.

Results and discussion

Analyze of variance (Table 1) carried out according to mixed linear model (1) shows that all factors included in this model are statistically significant (P<0,001) on the variance of 305 day milk yield. The "*maximum likelihood"* means (Table 2) corresponding to different classes of factors "age and month of calving" were estimated by model (1). The above regression model was used for computing the adjusting factors for age of calving. Referential age is 25 months. This age was of the highest frequency of calving in our population. In this way, the computing process takes no much time. Milk yield corresponding to each of calving age was estimated by this regression model. Adjusting factor was computed by dividing milk yield predicted by regression model for each of age of calving by milk yield predicted at the age of 25 months.

Table1 Results of analysis of variance: model (1)

Source of variance	d.f.	m.s.*	F
Age of calving	33	15,496	10,89***
Month of calving	11	7,371	5,18***
Herd	3	32,785	23,04***
Residuals	1928	1,423	

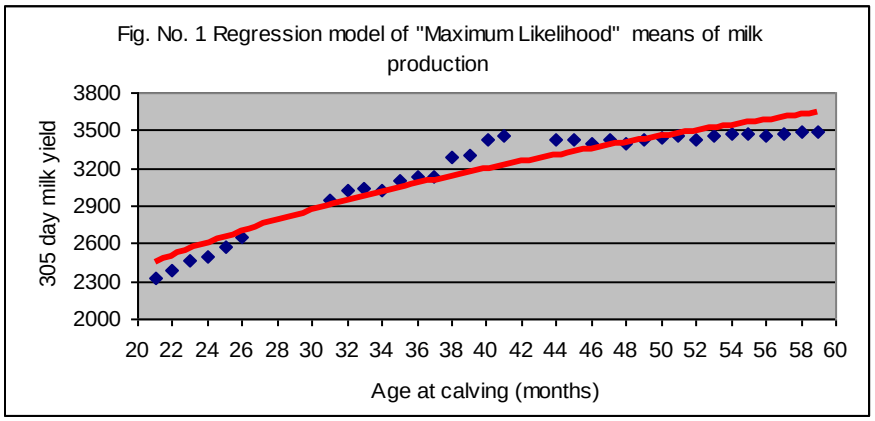
*Value must be multiplied by 10^4
*** (P<0,001)

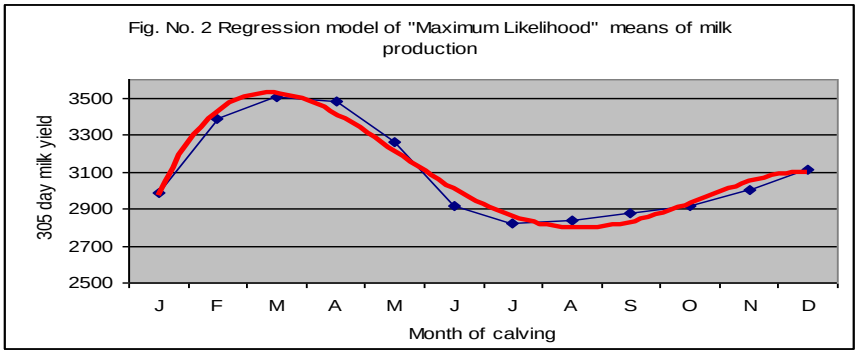
Table 2 *"Maximum likelihood"* means, for milk yield of cows according to age of calving and month of calving

age	$\mu + a_i \pm s$	age	$\mu + a_i \pm s$	age	$\mu + a_i \pm s$	Month	$\mu + b_j \pm s$
21	2325±32	37	3140±33	51	3460±38	January	3176±31
22	2386±34	38	3290±37	52	3430±41	February	3396±34
23	2470±23	39	3310±32	53	3455±39	March	3506±41
24	2490±42	40	3435±36	54	3476±42	April	3445±38
25	2577±33	41	3460±38	55	3481±35	May	3230±32
26	2650±31	44	3420±31	56	3462±42	June	2938±29
31	2950±28	45	3430±36	57	3478±39	July	2820±27
32	3020±29	46	3390±28	58	3496±38	August	2836±30
33	3045±30	47	3420±29	59	3482±41	September	2881±26
34	3024±31	48	3395±30			October	2920±28
35	3095±27	49	3425±32			November	3002±31
36	3130±32	50	3440±40			December	3116±39

The relation between 305 day milk yield for first three lactations and age of calving was estimated using *"maximum likelihood" means* is shown Figure 1. Regression line, which is used for estimation of adjusting factors for the effect of calving month was requested as an fourth order polynomial function. Using "*Maximum likelihood"* means assessed by mixed linear model (1) this regression line is shown as follows (Figure 2):

$$y = -1.1683x^4 + 35.758x^3 - 362.16x^2 + 1308x + 1989.6$$





Adjustment of data for milk yield in order to reduce the effect of factor "month of calving" was carried out, using as referential month – April. This month was of the highest frequency of calvings. By means of above coefficients is achieved to be carried out the adjustment of milk production for 305- day lactation at first three lactations, separately age of calving and month of calving.

Different authors (*Wunder,.McGilliard 1967, Wood 1972, Fimland, et al. 1972, Hanset, 1978. Aleandri,. et.al. 1983*) have explained that if there is a reciprocal interaction "age of calving" x "month of calving" it is necessary to consider the importance of this component, even depending on it, decision for using multiplicative adjustment factors, separate or joint, for both factors should be taken

For this purpose, analyze of variance was carried out according to requests of mixed linear model, where reciprocal interaction factor "age of calving x month of calving" was included in.

Results of this analyze showed statistically significant effect ($P<0.05$) of this factor. Meanwhile, it is important to emphasize that the inclusion of this factor in linear model increased significance of the model in explanation of total phenotype variance of milk yield for first three lactations only by 0,72 %. This situation doesn't justify the use of joint multiplicative factors for age and month of calving

In addition, *Kume,(1989)* emphasized that if it were to use joint adjustment factors, it would have the loss of information (during adjustment process) that is caused by overestimation of low producing cows, which have calved at favorable season and the underestimation of high producing cows, which have calved at non favorable season.

In particular, this situation is undesirable where level of inputs ensured by production system is under minimum requests for normal development of physiological processes conditioning consecutiveness of milk production during the lactation.

To verify efficacy of above adjustment coefficients, data for 305-day milk yield for first three lactations of Jersey cows, which are managed under conditions of small scale family farms were adjusted. The adjusted data were submitted analyze of variance according to mixed linear model (1). Results of this analyze are given in Table 4.

Table 3. Multiplicative Adjustment factors for "age of calving" and "month of calving" for first three lactations

Age	coefficient	age	coefficient	age	coefficient	Month	coefficient
21	1,0816	37	0,8548	51	0,7625	January	1,1481
22	1,0600	38	0,8426	52	0,7593	February	1,0041
23	1,0392	39	0,8386	53	0,7518	March	0,9673
24	1,0192	40	0,8281	54	0,7475	April	1,0000
25	1,0000	41	0,8217	55	0,7444	May	1,0590
26	0,9815	44	0,8030	56	0,7381	June	1,1035
31	0,9138	45	0,7922	57	0,7340	July	1,1923
32	0,8983	46	0,7898	58	0,7290	August	1,2113
33	0,8907	47	0,7828	59	0,7260	September	1,1902
34	0,8745	48	0,7794			October	1,1638
35	0,8688	49	0,7737			November	1,1107
36	0,8618	50	0,7681			December	1,1000

Table 4. Results for analysis of variance, of the adjusted data: model (1)

Source of variance	d.f.	m.s.[1]	F
Age of calving	33	3,044	2,76*
Month of calving	11	0,750	0,68
Herd	3	17,780	16,12***
Residuals	1928	1,103	

[1]Value must be multiplied by 10^4
*** (P<0,001) * (P<0,05)

These results show that by adjusting milk yield by means of above given multiplicative coefficients, fixed effect of calving month is statistically eliminated, meanwhile, effect of calving age is essentially modified, but no eliminated. Total phenotype variance is almost halved and coefficient of variation for milk yield was not undergone essential changes. Therefore, right decisions can be taken in relating to real genetic capacity of cows even when lacking data for their additive genetic values. Besides that, farmer using these the adjusted data, is able to really judge for the improvements that have to be done in the cow management and feeding.

Conclusions

Adjustment by means of separate multiplicative factors for age of calving and month of calving, estimated by using the results of analyze of variance carried out according to *Maximum Likelihood method* is the most efficient. For Jersey cow population that are managed under conditions of small scale family farms in Albania, 305-day milk yield for first three lactations must be adjusted in order to reduce effects of age of calving and month of calving using multiplicative adjustment coefficients, which are given in Table 3.

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