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RESEARCH ON THE MILK PRODUCTION DIFFERENCES DETERMINED BY THE CALVING MONTH OF THE DAIRY COWS

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Abstract

The paper aimed to assess the effect of the calving month on milk production and to correct the biases determined by this environmental factor in order to increase the precision in the breeding value estimation and assure a better evaluation of candidate cows as mothers of sires and bulls used in the artificial insemination to improve genetic gain in the dairy herds. A specific mathematical model, $x_{ij}=m \,.\, a_i \,.\, e_{ij}$*, where* x_{ij} *– the milk record of the daughter „j" in the month „i" (i=1,2,....12), m – a constant factor,* a_i *–multiplicative effect of the month „i",* e_{ij} *– the residual multiplicative effect, was used to process the data regarding milk yield and fat yield by month of calving collected from 4,100 Friesian dairy cows under milk testing. In order to eliminate the biases* $\hat{a}_i$*, adequate multiplicative adjusting factors were calculated as* $1/\hat{a}_i$*. The conclusion was that the calvings carried out in the fall-winter months recorded a milk yield by 3.5 % higher in January, by 5.4 % in September, by 6.3 % in December and by 10.5 % in November. The cows with early spring calving have been distadvantaged by 0.4 % in February, by 1.8 % in August up to 7.9 % in May. Therefore, correction factors are imposed to be used in order to increase precision in milk production estimation and finnaly to assure an accurate breeding value for dairy cows and bulls.*

Key words**:** *adjusting factors, calving month, dairy cows, high precision, milk yield*

INTRODUCTION

Milk production is determined by a range of environmental factors such as: calving season, nutrition, cow health, milking frequence, geographical region [4, 5, 18, 26].
Milk production performance has a great economic importance both for farmers, being in close relationship with their income and profit, and for breeding value estimation and genetic gain assurance in the dairy farms [14].
The precision in milk production evaluation is extremely important to assure the accuracy of the results regarding the assessment of the heritability of milk characters, the correlations exiting between them and breeding value for various characters of the individual animals [12].
In Europe, the value of animal production accounted for Euro 123 billion in 2005 and the annual genetic gain at farm level was just Euro 1.8 billion, representing 1.5 % [10].
As it is expected a 7 % world consumption of animal products for the next decade, the genetic gain in milk production is recognized as a major tool, besides nutrition, involved in milk production increase. More than this, taking into account the limited land resource for producing forages, production increase should be supported by 3 % genetic gain compared to 1.5 % in the previous period [13]
For this reason, the increase of precision is requested for a more accurately breeding value estimation [1]
In this respect, the scientists have already set up various mathematical models. [12, 16, 19, 21, 25, 30]
Among the non genetic factors influencing milk yield is the calving season and month [2, 3, 6, 7, 11, 15,17, 20, 22, 23, 24, 31, 35, 36]
There are large differences in milk yield among the cows calving in different months. Usually, dairy farmers practice three calving plans: spring, fall and year-around calving, each one with a different impact on the value of weaned calves, annual cow costs and facilities cost. If calving is moved from early spring season to a late season, the calf live

weight for sale will be lower and the income produced per cow and year as well. Feeding cost represents 65-70 % of the total annual production costs/cow and forages are usually the most expensive cost item. A calving planed in the period when the harvested forages are used in cow diet, production cost per cow will be higher and diminish the farmer's profit. Also, an earlier calving increases maintenance cost in the shed for protecting the new born calves and post partum cows from bad weather conditions. A late calving assures calf health, reduced mortalities and the benefit of grazing for cow and calf. Therefore, the month of calving is closely linked to production performance, animal health and farm profitability. [4, 8,33, 34].

Regarding the precision in the breeding value estimation, the research results pointed out important solutions destined to eliminate the influence of the calving month on milk characters [6, 15, 36, 27, 28, 29, 30].

In this context, taking into account that in Romania there are few results regarding the effect of calving month on milk production [9, 27, 28, 29,32], the purpose of this paper is to study and assess the effect of the month of calving on the two basic characters used in cow selection: milk quantity and fat quantity, to establish the corresponding adjusting factors and predict the correct production level which has to be considered for increasing precision of the breeding value estimation.

MATERIALS AND METHODS

A number of 4,100 Friesian dairy cows raised in 221 farms situated in 35 counties of Romania were used as biological material. Their 305 days milk performances for the of the 1st lactation were grouped by calving month and the specific statistical parameters such as: milk yield and fat yield for the 305 days of the 1st lactation, standard deviation and variation coefficient were determined according to the following mathematical formulas:

Milk Yield (MY), $MY = \frac{X_1 + X_2 + ... X_n}{n}$, (1)

where n = the number of dairy cows and X= milk yield/cow/month

Milk yield variance or dispersion of variables,

$$\boldsymbol{S^2}, S^2 = \frac{\sum_{i=1}^{n}(X_i - \overline{X})}{n-1}, \qquad (2)$$

Standard Deviation, S,

$$S = \left(\sqrt{\frac{\sum_{i=1}^{n}(X_i - \overline{X})^2}{n-1}} \right) \qquad (3)$$

Variation Coefficient, $V_{\%}$,

$$V_{\%} = \frac{S}{\overline{X}} \text{ x } 100 \qquad (4)$$

The assessment of the calving month effect on milk production in terms of milk quantity and milk fat quantity was based on the following linear mathematical model:

$x_{ij} = m \,.\, a_i \,.\, e_{ij}$ (5)

where x_{ij} – the milk performance of the „j" daughter in the calving month „i" (i=1,2,....12), m – a constant factor (geometrical average), a_i –the multiplicative effect of the month „i", e_{ij} – the multiplicative residual effect.

An additive model was associated to the model presented above, as follows:

$Y_{ij} = M + A_i + E_{ij}$, (6)

where: $Y_{ij} = \lg X_{ij}$, $M = \lg m$, $A_i = \lg a_i$, $E_{ij} = \lg e_{ij}$ and applying the least square method resulted

$M + A_i = Y_i/n_i$, (7)

where the presence of the point indicates the summation according to the index which is substituted.

In order to separate A_i from M, the following conditions was imposed:

$$\widehat{A}_1 + \widehat{A}_2 + ...\widehat{A}_{12} = 0. \qquad (8)$$

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As a result, $\sum M + A_i = 12M + \sum A_i = 12\widehat{M}$

or $M = \frac{1}{12}\sum M + A_i,$ implicitely

$A_i = M + A_i - \widehat{M}$ si $\widehat{a}_i = 10^{Ai}$ (9)

In order to eliminate the biases determined by the effect of $\hat{a}_i$, it was applied the adjusting factor calculated as $1/\hat{a}_i$.

RESULTS AND DISCUSSIONS

The average milk production varied between 3,119.42 kg/cow in the month of November and 2,656.98 kg/cow in the month of March (Table 1).

Table 1.Parameters of milk yield by calving month

Calving month	N	$\overline{X} \pm s_{\overline{X}}$	S	V%
1	285	2,940.5±49,6	837.9	28
2	329	2,848.1±49,4	896.1	31
3	580	2,656.9±36,3	875.5	33
4	581	2,709.8±35,8	864.6	32
5	420	2,660.1±45,6	936.4	35
6	321	2,730.0±47,1	844.4	31
7	242	2,716.5±49,9	777.2	29
8	216	2,821.0±60,6	890.9	32
9	227	2,987.9±55,7	839.4	28
10	222	3,063.6±53,5	797.9	26
11	348	3,119.4±44,3	827.7	27
12	329	3,023.0±48,3	876.5	29

Source: Own calculations

In general, in the interval March-July, production records were lower than in the period October-February.

The milk fat yield registered the highest average value in the Winter months, and the maximum value was noticed in December, 118.39 ± 1.69 kg/cow and the minimum of 09.9 ± 1.61 kg/cow in the month of May.

The evolution of the milk fat yield across the year was in general similar with the one recorded by milk yield, if we take into consideration calving season and month (Tabel 2).

The variation coefficient registered almost similar values for the both milk characters, for the same reason mentioned above, varying between 26-35 %.

Table 2.Parameters of milk fat yield by calving month

Calving month	n	$\overline{X} \pm s_{\overline{X}}$	S	V%
1	285	110.8±1.93	32.6	29
2	329	107.1±1.88	34.2	32
3	580	99.4±1.38	33.4	34
4	581	101.5±1.39	33.5	33
5	420	98.9±1.61	33.1	34
6	321	102.2±1.78	31.9	31
7	242	102.4±1.97	30.6	30
8	216	107.6±2.36	34.7	32
9	227	112.8±2.11	31.8	28
10	222	114.6±2.03	30.3	26
11	348	118.3±1.69	31.5	27
12	329	114.2±1.89	34.3	30

Source: Own calculations

The effects of the calving month on the two milk production characters registered, in general, similar values, following aproximately a similar trend along the year (Table 3).

Table 3.The effect estimate of the calving month for milk yield and milk fat yield at the 1st lactation

Calving month	The effect of the calving month on milk yield	The effect of the calving month on milk fat yield
1	1,035	1,037
2	0,996	0,996
3	0,924	0,921
4	0,944	0,939
5	0,921	0,911
6	0,956	0,951
7	0,957	0,959
8	0,982	0,995
9	1,054	1,055
10	1,086	1,079
11	1,105	1,116
12	1,063	1,066

Source: Own calculations

The calculated values show that the cows calving in the months of Fall-Winter seasons had higher milk records than the real data by 3.5 % in January, by 5.4 % in September, by 6.3 % in December and by 10.5 % in November. The cows with the first parturition in Spring to Summer seasons were disadvantaged by 0.4 % in February, by 1.8 % in August up to 7.9 % in the month of May.

The adjusting factors for the month of calving aimed to eliminate these biases in order to allow the comparison of the production record at the first parturition among the dairy cows.(Table 4).

Table 4.The multiplicative adjusting factors for milk production by calving month

Calving month	Correction factors for milk yield	Correction factors for milk fat yield
1	0.966	0.965
2	1.004	1.004
3	1.082	1.086
4	1.059	1.065
5	1.086	1.098
6	1.046	1.051
7	1.045	1.043
8	1.019	1.005
9	0.948	0.948
10	0.921	0.927
11	0.905	0.896
12	0.940	0.938

Source: Own calculations

For instance, considering two cows, of which Cow A, which had the calving in January and produced 2,940 kg milk and 110 kg milk fat and the Cow B, which had the parturition in May and produced 2,660 kg milk and 90 kg milk fat, to establish which of them has A higher production potential. At the first sight, not taking into account the calving month, it looks that the cow A has a higher production than the cow B. But, after making the required corrections upon milk records for the both cows, one may notice that the cow B achieved 32 kg milk in addition, and, respectively, 3 kg milk fat in addition compared to the cow A.

Corrected milk character records for the calving month and the differences of production compared to the real data are presented in Table 5.

After the application of the correction factors for the month of calving, the corrected data of the milk yield reflect that the peak of average production was registered in May, March, August, April, February, January, November and October.

The highest differences between the corrected milk yield and the real milk yield are registered in the Spring months reflecting that Spring parturitions have a lower effect on milk production record. Similar remarks are available for the differences recorded between the corrected milk fat yield and the real milk fat yield.

Table 5.Corrected milk yield and milk fat yield according to the calving month

Calving month	Real milk yield RMY (kg)	Correction factor	Corrected milk yield CMY (kg)	Differences CMY-RMY (kg)	Real milk fat yield RMFY (kg)	Correction factor	Corrected milk fat yield CMFY (kg)	Differences CMFY-RMFY (kg)
1	2,940.5	0,966	2,846.47	-94.1	110.8	0,965	106.9	-3.9
2	2,848.1	1,004	2,859.49	+11.39	107.1	1,004	107.0	-0.1
3	2,656.9	1,082	2,874.85	+217.87	99.4	1,086	107.9	+8.5
4	2,709.8	1,059	2,869.73	+159.88	101.5	1,065	108.1	+6.6
5	2,660.1	1,086	2,888.94	+228.77	98.9	1,098	108.6	+9.7
6	2,730.0	1,046	2,855.65	+125.58	102.2	1,051	107.4	5.2
7	2,716.5	1,045	2,839.22	+122.26	102.4	1,043	106.8	+4.4
8	2,821.0	1,019	2,874.66	+53.6	107.6	1,005	108.1	+0.5
9	2,987.9	0,948	2,710.18	-277.74	112.8	0,948	106.9	-5.9
10	3,063.6	0,921	2,821.64	-242.04	114.6	0,927	106.2	-8.4
11	3,119.4	0,905	2,823.07	-296.35	118.3	0,896	106.0	-12.3
12	3,023.0	0,940	2,841.65	-181.39	114.2	0,938	107.1	-7.1

Source: Own calculations

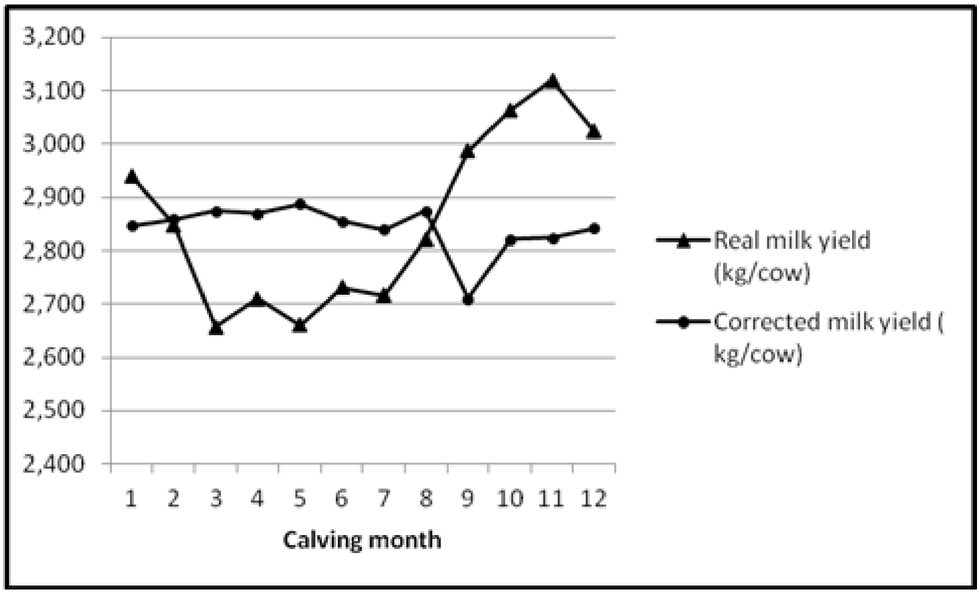

Fig.1.Real milk yield and corrected milk yield for the calving month

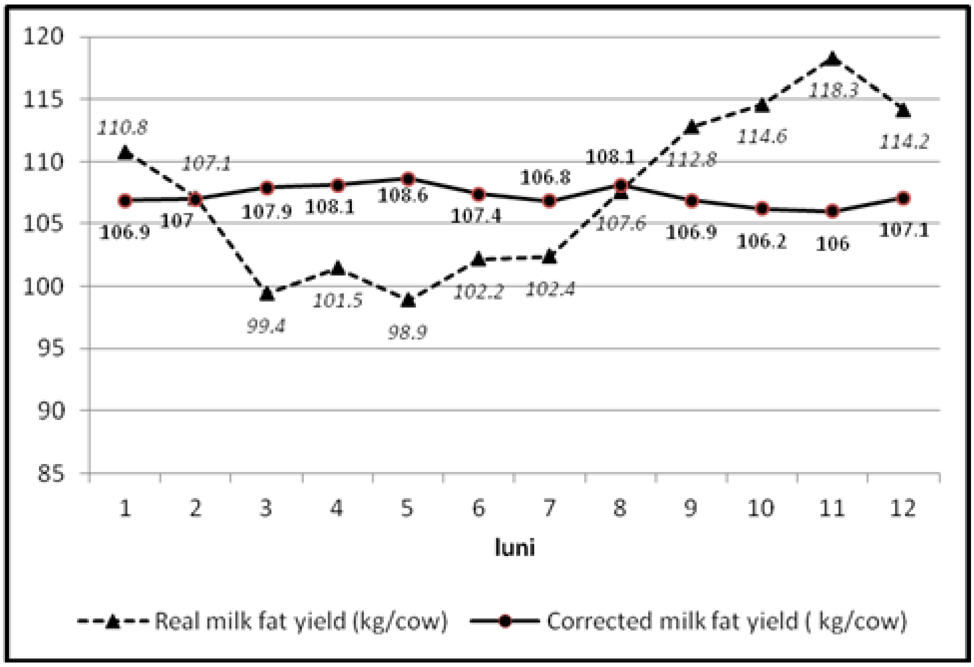

Fig.2.Real milk fat yield and corrected milk fat yield for the calving month

The results are in accordance with other results belonging to the American scientists who calculated the correction factors for the calving month in the prediction of the 305-day lactation yields in the USA dairy herds as mentioned in the study entitled "A Review of the Calving Pattern Management in Dairy Herds" (Table 6).

As one can see from Table 6, the differences between the calving month regarding the milk and milk yield fat were 5.7 and 4.3 % in Holstein cows and 7.7 and 5.7 % for the both Guernsey and Jersey breeds.

However, comparing with the adjusting factors calculated in this experiment, one can notice that in Romania, the value of the correction factors is much different from a month to another because of the large range of raising conditions in various dairy farms with a deep influence on production performance.

Also, milk yield is much lower than lactation yield in the USA.

Table 6. Correction factors for calving month in the prediction of the 305-day lactation yields in the USA for Guernsey, Holstein and Jersey dairy breeds

Month of calving	Guernsey	Holstein	Jersey
1	0.97	0.99	0.98
2	0.97	0.99	0.99
3	0.98	0.98	0.98
4	0.96	0.99	0.98
5	1.00	0.99	0.99
6	1.04	1.02	1.02
7	1.03	1.04	1.03
8	1.04	1.03	1.03
9	1.04	1.01	1.02
10	1.01	1.01	1.00
11	0.99	1.01	1.01
12	0.99	1.02	1.02

Source: A Review of the Calving Pattern Management in Dairy Herds, www.dairyco.org.uk

The effect of the calving month on the total lactation yields in terms of milk yield index

Taking into account that the lowest production was recorded in the month of March (March=100), it was also determined the effect of calving month on the milk yields in terms of milk yield index.

Table 7. The effect of the calving month on the milk yields in terms of milk yield index for the Romania's Friesian dairy cows

Month of calving	Milk yield index (March=100)	Lactation yield (kg)
1	110.7	2,940.5
2	107.2	2,848.1
3	100.0	2,656.9
4	101.9	2,709.8
5	100.1	2,660.1
6	102.8	2,730.0
7	102.2	2,716.5
8	106.2	2,821.0
9	112.4	2,987.9
10	115.3	3,063.6
11	117.4	3,119.4
12	113.8	3,023.0

Source: Own calculations, adapted from Amies (1981) and Poole (1984), cited in A Review of the Calving Pattern Management in Dairy Herds, www.dairyco.org.uk

In this respect, it was used the model adapted from Amies (1981) and Poole (1984) as mentioned in the British study "A Review of the Calving Pattern Management in Dairy Herds"(Table 7).

The effect of the calving month on the milk yields for 305 days of lactation developed in the United Kingdom referred to two dairy breeds were used: the British Friesian and Jersey as presented in Table 8.

Table 8.The effect of the calving month on the total lactation yields in terms of milk yield index for the of UK Holstein dairy cows

Month of calving	Milk yield index (July=100)	Milk yield index (July=100)	Lactation yield (kg)
1	111	105	5,642
2	108	103	5,530
3	105	104	5,580
4	104	103	5,507
5	102	102	5,455
6	101	101	5,383
7	100	100	5,353
8	104	101	5,396
9	109	103	5,523
10	112	107	5,704
11	114	108	5,808
12	113	109	5,857

Source: A Review of the Calving Pattern Management in Dairy Herds, www.dairyco.org.uk

The study pointed out large differences between cow calving in different months. The yields varied from 4,227 kg for Jersey and 7,169 kg for Holstein, with the highest individual of 17,282 kg achieved by the British Friesian which has a lactation length of 305 days and a calving interval of 341 days, and also is the most dominant dairy breed in UK.

CONCLUSIONS

The values of the effects of calving month on the production records of the dairy cows should not be ignored, on the contrary, they should be eliminated by correcting the real data using the corresponding adjusting factors.

Because the effects of the calving month could be amplified by the cow age at the first parturition, it is imposed to study the cumulated effects of these two factors on milk production.

The correction factors must be updated every year, so that the variations which could appear from a year to another to be avoided.

The application of the correction factors for the calving month is very important because it bring an additional precision in milk production estimation, dairy cow evaluation and bull ranking based on their daughters performance assessment and the preserve in the top of the breeding pyramid the best bulls.

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