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Prediction of Days Open of First Three Lactation Periods from First Milk Yield, Days in Milk and Calving Age and its Effect on Improving the Economic Performance of the Herd

[1]Reza Seyedsharifi, [2]Ali Reza Falah Kheir and [3]Morad-Pasha Eskandari-Nasab
[1]Faculty of Agriculture, University of Mohaghegh Ardabili, Ardabil, Iran
[2]University of Zanjan, Zanjan, Iran
[3]Faculty of Agriculture, University of Zanjan, Zanjan, Iran

Abstract: The economy of dairy production relies on the reproductive performance of the herd. The main aim of this study was estimation the level of milk yield and calving age of 1st lactation period to improving the performance of days open. In this way, predicted equations of days open of 1st 3 lactation periods were determined in Holstein cows of Iran using SAS statistical software package. Three interests of the highest age of 1st calving and most milk yield, the least age of 1st calving and most milk yield and the average age of 1st calving and milk yield for estimating a suitable level of days open presented. The phenotypic correlation between milk yield of 1st lactation periods and 1st days open was negative, but it was positive about 2nd and 3rd parity ($p<0.01$). The phenotypic correlation between 1st calving age and 1st days open was positive, but it was negative about 2nd and 3rd parity ($p<0.01$). The revenue minus cost per a day decreasing of days open increased by 872586 Rials per each cow. The interest of the least age of 1st calving and most milk yield compared two other interests caused less average of days open of 1st 3 lactation periods.

Key words: Day open, predicted records, revenue minus cost, holstein cow

INTRODUCTION

The aim of dairy cow breeding, is to produce cows which compared to current generation have more economic performance in the future economic situation. To increase the farmer's profit, first milk yield should be interfered in breeding aim. Later, the traits which are effective on products price and stability estimate, such as reproduction traits should be studied (Boettcher *et al*., 1999; Dekkers *et al*., 1994). Identifying the open cows can help management of the reproduction program of dairy cows. The main factors decreased the reproductive performance of dairy herd including (Jairath *et al*., 1998; Pryce *et al*., 2000; Vanraden and Klasskate, 1993):

- Decreasing of the milk yield in the herd due to long days open.
- Decreasing in number of calves burning in the herd because of the long calving intervals.
- Increasing of costs related to the number of insemination per each pregnancy which can be because of low estrus detection or abortion.
- Increasing of veterinary costs due to too much reproductive problems of cows.
- Increasing in number of Heifers which are replaces in herd forcibly.

Weigel *et al*. (1998) and Veerkamp *et al*. (2001) have studied on the interacted effects of productive and reproductive traits. A few researchers have found the correlation between days open and 305 day milk yield. The correlation between milk yield and days open makes difficult to study because of its great effect on the culling (Dunlap *et al*., 2000). The cow which does not become pregnant for a long time has the chance of being culled like a cow with low milk yield. Among all of sub fertile cows, the cows with high milk yield have lower chance to be culled compared to the ones with low milk yield. (Lee *et al*., 1997) reported the heritability of days open and calving interval is low and mainly <8% (Lee *et al*., 1997; Dong and Van Vleck, 1989).

Therefore, this trait is influenced by environmental factors and determination of a suitable levels between that 1st to 2nd calving and next ones considering the calving

Corresponding Author: Reza Seyed Sharifi, Faculty of Agriculture, University of Mohaghegh Ardabili, 56199-11367, Ardabil, Iran

age of dairy cows and suitable level of milk yield help the farmer to make suitable programs for schedule of estrus synchronization of herd. In this method, the farmer is sure that without being worried about losses, may happen for the herd reproductive performance make a suitable milk yield from the herd (Wiggans and Goodling, 2005).

The aim to do this investigation was to determine the predicted equations of days open of 1st 3 lactation periods from 1st milk yield, days in milk and calving age, estimation of the revenue minus cost per each day decreasing of days open in 3 interests of the highest 1st calving age and most milk yield, the least 1st calving age and most milk yield and the average of 1st calving age and milk yield to gain a suitable level of days open of 1st 3 lactation periods in economic program of the herd.

MATERIALS AND METHODS

The data set included 55596 records of 1st lactation of Holstein cows of Iran, which belonged to 163 different herds and were born during the years 1986-2006. The variables used in this study including effects of herd, 1st calving year, first calving season and interaction effects of herd-year-season as discontinuous variables, 305 days Milk Yield (MY), Days in Milk (DIM), Age of 1st calving in day (CAD) as continuous variables and days open of 1st, 2nd and 3rd lactations (DO1, DO2 and DO3, respectively), are considered as dependent variables.

Determination of the statistical model: The model used for the analysis of productive and reproductive traits in this investigation as follows:

$$\begin{aligned} Y_{ijkl} &= \mu + H_i + Y_j + S_k + HYS_{ijk} + b_1 * MY_{ijkl} \\ &+ b_2 * MY^2_{ijkl} + b_3 * MY^3_{ijkl} + b_4 * DIM_{ijkl} \\ &+ b_5 * DIM^2_{ijkl} + b_6 * DIM^3_{ijkl} + b_7 * CAD_{ijkl} \\ &+ b_8 * CAD^2_{ijkl} + b_9 * CAD^3_{ijkl} + e_{ijkl} \end{aligned} \quad (1)$$

where:

Y_{ijkl} = Predicted records of days open of 1st, 2nd and 3rd lactations for cow l living in herd i calving in year j during season k.
μ = Overall mean.
H_i = Fixed effects of herd I.
Y_j = Fixed effect of 1st calving year j.
S_k = Fixed effect of 1st calving season k.
HYS_{ijk} = Interaction of herd i, 1st calving year j and 1st calving season k.
b_1, b_2,b_3 = Linear, quadratic and cubic regression values of 305 day milk yield.
My_{ijkl} = Random effect of 305 day milk yield of 1st lactation.
b_4, b_5, b_6 = Linear, quadratic and cubic regression values of days in milk.
DIM_{ijkl} = Effect of days in milk of 1st lactation (covariate).
b_7, b_8, b_9 = Linear, quadratic and cubic regression values of 1st calving age.
CAD_{ijkl} = Random effect of calving age of 1st lactation (in day).
e_{ijkl} = Random residual.

Estimation of Type III mean squares, F statistics and least squares means computed using PROC GLM of SAS statistical software package (SAS Version 6.12) to select statistical model for each dependent variable in a way that all continuous and discontinuous variables existing in model being significant ($p<0.01$).

In this way, by having the regression values of continuous variables, the predicted equation for each dependent variable was derived.

Phenotypic correlation between milk yield, calving age and days open in 1st 3 lactation periods determined by software mentioned above.

Estimating a suitable level of first calving age and milk yield from predicted equations of days open: For estimating a suitable level of days open, 3 interests are used:

- The values of the highest 1st calving age (1080 day) and most milk yield (12380 kg) is considered in the equation.
- The values of the least 1st calving age (569 day) and most milk yield (12380 kg) is considered in the equation.
- The values of average of 1st calving age (771.07 day) and milk yield (5960.1 kg) is considered in the equation.

The true numerical data of 1st calving age and milk yield of 1st lactating period from 3 interests are taken in the equations and the values of days open of different periods are calculated individually and the results are compared. The values of days in milk considered as covariate.

The predicted reason of days open of different lactating periods especially about 1st and 2nd lactations is to present a perspective that makes the farmer sure if he controls the 1st calving age and milk yield in a special levels, there is no need to lengthen the calving interval too much and it is not that days open of the following days open of which the negative effects will influence the days open of later periods.

The farmer profit per a day decreasing in days open estimated by these equations:

$$\begin{aligned} RMFC_i &= (RMC_i - FC_i) \\ R_i &= (RM + RC)/CI_i \\ FC_i &= (FCM + FCD)/CI_i \end{aligned} \quad (2)$$

Where:

$RMFC_i$ = Revenue minus feeding cost per each day of calving interval i (Rials).
RMC_i = Revenue resulted from milk and calve per each day of calving interval i (Rials).
RM = Revenue resulted from milk sale of total lactations (Rials).
RC = Revenue resulted from calf sale (Rials).
Ci_i = Calving interval based on days.
Fc_i = Feed cost per each day of calving interval.
FCM = Feed and drug cost of lactation (Rials).
FCD = Feed and drug cost of all dry period (Rials).

To estimate the farmer's profit of decreasing of days open, in a 500-cow farm, the values of drug and feed costs and revenue resulted from milk or calf sale are gathered and revenue value minus cost per each day decreasing of days open were estimated.

RESULTS AND DISCUSSION

The data structure is presented in Table 1. Day length of days open of 1st lactation periods is more than next lactation periods but there is a logic trend according to the length of days open are in different lactation periods.

The phenotypic correlation between milk yield of 1st lactation period and 1st days open was negative, but it was positive about next parity. While these values were -0.0133, 0.5181 and 0.6018 about phenotypic correlation of milk yield the 1st lactation period and 1st, 2nd and 3rd days open, respectively ($p<0.01$). Results are shown in Table 2.

About negative correlation of productive and reproductive traits, there is a hypothesis that it is possible that special Alleles which are responsible for high milk yield are selected to decreasing reproductive performance directly. In fact, the Alleles which are responsible for high milk yield may non randomly linked to Alleles which limited the reproductive performance (Jairath *et al*., 1995) is very important to pay attention to it and is the main discussion of geneticians.

The phenotypic correlation between the 1st calving age and the 1st days open were positive, but for 2nd and 3rd days open it was negative ($p<0.01$) (0.0056, -0.0439 and -0.0063, respectively). So, considering this unsuitable correlation and changing the management methods on 1st calving age can prepare a suitable reproductive performance for the herd.

Table 1: Estimation of average, minimum, maximum, standard deviation and coefficient of variance about Milk Yield (MY), days in milk (DIM), 1st Calving Age in Day (CAD) and days open of 1st 3 lactation periods (DO1, DO2 and DO3, respectively)

	Average	Minimum	Maximum	Standard deviation	Coefficient of variation
MY	5960.10	2068	12380	1139.74	19.12
DIM	487.00	73	305	57.69	11.84
CAD	771.07	548	1080	86.25	11.18
DO1	108.82	84	700	49.71	30.61
DO2	92.77	71	682	62.20	45.68
DO3	96.56	76	784	77.07	79.81

Table 2: Estimation o f phenotypic correlation and standard error of Milk Yield (MY), 1st Calving Age (CAD) and days open of 1st 3 lactation (DO1, DO2 and DO3 respectively)

Trait	DO1	DO2	DO3
MY	-0.0133	0.5181	0.6018
	0.0815	0.0090	0.0024
CAD	0.0056	-0.0439	-0.0063
	0.8594	0.1662	0.8856

Prediction of days open of first three lactation periods: Predicted equations of days open of 1st, 2nd and 3rd lactation periods were as follows:

$$\hat{y}_1 = 643.7 - 1.6\times10^{-2}MY + 1.1\times10^{-6}MY^2 - 0.4\times10^{-4}MD^2 - 1.07CAD + 0.6\times10^{-3}CAD^2 \quad (3)$$

$$\hat{y}_2 = 198.4 - 1.3\times10^{-6}MY^2 - 1.1\times10^{-4}MD^2 - 0.6\times10^{-1}CAD \quad (4)$$

$$\hat{y}_3 = 154.42 - 0.6\times10^{-2}MY + 0.5\times10^{-6}MY^2 - 0.3\times10^{-6}MD^3 - 1.6\times10^{-3}CAD \quad (5)$$

where, $\hat{y}_1$, $\hat{y}_2$ and $\hat{y}_3$ were the predicted days open of 1st, 2nd and 3rd lactation periods, respectively.

It is clear the linear and quadratic effects of milk yield, quadratic effect of days in milk and linear and quadratic effect of 1st calving age for determination of predicted equation of 1st lactation period were significant ($p<0.01$), (Eq. 3). Also, the quadratic effect of milk yield and days in milk and linear effect of 1st calving age for determination of predicted equation of 2nd lactation period were significant ($p<0.01$), (Eq. 4) and for determination of predicted equation of 3rd lactation period, the linear and quadratic effects of milk yield and cubic effect of days in milk and linear effect of 1st calving age were significant ($p<0.01$), (Eq. 5); but, the other effects were not significant ($p>0.01$).

Kuhn *et al.* (2004) suggested the 1st calving age is a more effective factor in changes of days open and its decreasing or increasing due to direct effect that it has over the cow's reproductive system psychologically results in increasing or decreasing in next days open. Since, milk yield and selection of 1st calving age are things that happen sooner than days open in 1st calving, Therefore, determination of level for these variables are necessary for farmer success in controlling the number of days open of next lactation period and even a day decreasing in costs will be good for the farmer.

Comparison of three interests of first calving age and milk yield to estimate of suitable level of days open: To using the equations between the variables, it is required that the farmer know about the historical records of milk yield and 1st calving age of the herd. Here the results taken form 3 interests are mentioned:

- In case that the 1st interest was considered, the days open of 1st lactation period are shortened (63 day) but abnormal increasing of days open of 2nd and 3rd lactation periods will be really derived (268 and 192 day for DO2 and DO3 day, respectively).
- About the considering of the 2nd interest, the days open of 1st lactation periods are shortened (74 day) and days open of 2nd and 3rd lactation periods will have more usual increasing (187 and 162 day for DO2 and DO3, respectively).
- About considering of the 3rd interest, the days open will be more than 2 above mentioned and we expect an upward trend about the days open of 2nd and 3rd period (110, 243 and 229 day for DO1, DO2 and DO3, respectively).

About the 1st case (A), the average of days open of 1st, 2nd and 3rd lactation periods were 174 days and this number about cases B and C were 141 and 194 days. So considering the least 1st calving age and most milk yield of 1st lactation periods, 33 day decreasing of days open compared to 1st case (A) and 53-day decreasing of days open compared to 3rd case (C) is expected. Results of these 3 interests are presented in Table 3.

Estimation of revenue minus cost per each day decreasing in days open: Per each day increasing to days open, 26442 Rials is considered as the farmer's loss per each cow, therefore if the farmer prefers the 2nd one to the 1st one about the milk yield and 1st calving age, average of days open of 1st 3 lactations decreased by 33 days and revenue minus cost per each day decreasing of days open increased by 872586 Rials per each cow and about a 500-cow farm 436293000 Rials of the costs will be saved. This estimation in 2nd case compared to the 3rd one was decreased by 53 day of days open and 1401426 Rials of the costs will be saved per each cow and about a 500-cow farm was 700713000 Rials. In any case, the low age in 1st calving compared to average or above average age of herd are more effective in decreasing the average of days open of 1st 3 lactation.

Table 3: Estimation of numerical data of days open from predicted equations of 1st 3 lactation and average of these traits from 3 interests (A, B and C)

	MY	CAD	P DO1	P DO2	P DO3	P DO
A	12380	1080	63	268	192	174
B	12380	569	74	187	162	141
C	5960	771	110	243	229	194

A: The highest age of 1st calving and most milk yield, B: The least age of 1st calving and most milk yield, C: The average of 1st calving age and milk yield, MY: Milk Yield of 1st lactation (kg), CAD: Age of 1st calving (in day), P DOi: Predicted days open from i lactation. (i = 1, 2 and 3)

CONCLUSION

The result of this study, demonstrated that selection of the least calving age and most milk yield in evaluation of milk yield, calving age and days open of 1st lactation led to decreasing of average of days open of 1st 3 lactation and decreasing the herd maintenance additive costs.

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