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Genetic evaluation of some reproductive traits of commercial Friesian cattle under Egyptian conditions

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Abstract

This study was conducted to evaluate the effect of some of genetic and non-genetic parameters on the reproductive traits of Friesian cows. The data were obtained from a commercial farm (Gharbawy farm) located in El-Sharkia governorate, Egypt. A total of 1630 records of 465 pure Friesian cows covered the period from 1998 to 2007 were collected. The data values of reproductive traits which include; days open (DO), calving interval (CI) and dry period (DP) were measured. The actual means of DO, CI and DP were 140.47, 432.76 and 93.57days, respectively. Parity, year and season of calving had a significance effect ($p \leq 0.01$) on all studied traits. Estimates of direct heritability (h^2) for all studied traits were low, with equal h^2_a values (0.02) for both DO and DP, it was 0.04 for CI. Concerning maternal permanent environment, effects were low ranging from 0.0003 to 0.01. Moreover, error variance effects represent the largest proportion of the total variation ranging from 0.96 to 0.98. All coefficients were positive for phenotypic correlations and ranged from 0.388 to 0.746. Moreover, the coefficients of genetic correlations among all studied reproductive traits were positive and ranged from 0.230 to 0.492. Non-genetic factors have a strong influence on the herd under study, which requires the stability of technical and administrative processes to improve reproductive performance. Moreover, additional assessment studies required to improve the accuracy of information to increase productivity of such herds.

Keywords: genetic evaluation, reproductive, heritability, Friesian cattle.

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1. Introduction

Friesian dairy cattle have a good adaptability, faster growth rate and early maturity beside high milk yield and long productive life under Egyptian conditions (Omran, 2013). In this respect, basic information on reproductive performance and the factors influencing it in exotic breeds is routinely need for the planning and management for maximum herd production and high fertility (Hammoud *et al*., 2010). In general, both non-genetic and genetic factors influence Friesian cow productive and reproductive performance (Farrag *et al*., 2020). Herd management, environmental conditions, nutrition, number of lactations, year and season of calving are all non-genetic elements that have been shown to have a major influence on animal performance (Almasri *et al*., 2020; Kamal El-den *et al*., 2020). On the other hand, direct measures of fertility records can be utilized to complement genetic merit estimates for fertility (Zahed *et al*., 2019). Moreover, the optimal reproductive traits depend upon the interactions of genetic and environmental factors (Shehab El-Din, 2020). As a result, the destination of this study was to assess some non-genetic and genetic factors that influence reproductive features (days open, calving interval and dry period) in an Egyptian commercial Friesian cattle herd.

2. Materials and methods

Data used in this investigation was collected from 1630 lactation records of pure Friesian cows raised at the station of Gharbawy farm located in El-Sharkia governorate, Egypt, among 465 cows (daughters of 426 dams and 170 sires) from 1998 to 2007. All cows were naturally mated, and heifers were mated when they reached body weight of about 300-350 Kg. Animals were checked for heat twice daily at morning and evening using a teaser bull, they were mated about 45-60 days after parturition. Pregnancy was routinely diagnosed by rectal palpation after two months from service. The reproductive traits studied were days open (DO), calving interval (CI) and dry period (DP).

2.2 Statistical analysis

Data of milk yield (MY) traits was analyzed by Analysis of Variance (ANOVA), using the General liner Model (GLM) of SAS (2008). Significance differences among sub-class means were separated by Duncan’s multiple rang test **(Duncan, 1955)**. Data were analyzed by using the following Model:

$$Y = \mu + Pi + Rj + Sk + eijkl$$

Where, Yijkl = on observation on TMY, 305 day MY and LL. μ = general mean, common element to all observations. Pi = the fixed effect for parity (i = 1-7), Rj = the fixed effect for year of calving (j =1 - 10), Sk = the fixed effect of the season (k = 1, 2, 3, and 4, 1=winter, 2=summer 3= spring and 4 = autumn), eijkl = random error distributed with mean zero and variance σ^2_e.

2.3 Genetic parameters

Data analyzed to estimate heritability, variance and covariance components with derivative-free restricted a maximum likelihood (REML) procedure using the MTDFREML program of Boldman et al. (1995). To estimate heritability for the traits studied, the animal model used was as follows:

$$Y = X_b + Z_a + Z_{pe} + e$$

Where, y = Vector of milk traits, X = matrix for fixed effects, b = overall mean and fixed effects, Z_a = matrix for random effects, a = Vector of direct genetic effects, pe= a random permanent environmental effect and e = random errors.

3. Results and discussion

Means, standard deviation (SD) and coefficients of variation (CV %) for reproductive traits (DO, CI and DP) of Friesian cattle are given in Table (1).

Table (1): Means, standard deviations (SD) and coefficients of variation (CV %) for study trait s in Friesian cows raised in Egypt.

Variable	Mean	SD	CV%
DO (day)	140.47	71.92	51.20
CI (day)	432.76	88.88	20.53
DP (day)	93.57	42.85	45.80

DO=Days open, CI=calving interval, DP= Dray period.

The present mean of DO was 140.47day. This mean was higher than that obtained by Halaby *et al*. (2013) who stated that DO of Friesian cattle in Egypt was 121 days, and 120 days was obtained by El-Awady *et al.* (2016). However, it was a slightly less than that recorded by Abu-Bakr *et al*. (2006), Osman *et al*. (2013), Faid-Allah (2015) and El-Tarabany and Nasr (2015) whose estimates ranged from 154-158 days. Regarding CI, the present mean (432.7 day) was shorter than that of 472.0 days obtained by Farrag *et al*. (2017). While, it was within range of 414.43- 433.2 day reported by Abosaq *et al.* (2017), Zahed *et al.* (2019) and Habib *et al.* (2020). Concerning DP, the present mean (93.57) was shorter than means detected in different commercial Friesian herds (95.05, 108, and 211.97 d) obtained by Hassan *et al*. (2018), Shalaby *et al.* (2018) and Ali *et al.* (2019) respectively. The differences in estimates of reproductive traits between the current study and previous results may be due to differences in management techniques and environmental conditions, as well as the genetic potentiality and breeding value of different Friesian herds.

3.1 Non-genetic effects

Least-square means (LSM) and standard

errors (SE) for fixed effects affecting reproductive traits are presents in table (2). In the current study, parity had a significant effect (P≤ 0.01) on all traits. Moreover, cows in the first parity have almost the lowest means and increasing progressively as parity advanced, then decreased again (Table 2). Many authors revealed that significant and trend for parity by Abdel-Gader *et al*. (2007), Faid-Allah (2015), Sanad (2016) and Abo-Lenin (2018).

Table (2): Least-squares means (LSM) and their standard errors (SE) of the factors affecting for traits study in Friesian cows.

Factor	LSM ± SE		
Parity	CI	DO	DP
1	366.14 ± 18.81	95.64±2.84	90.96±4.80
2	410.06 ± 6.05	102.27±4.87	96.83±2.88
3	430.65 ± 5.96	124.57±3.54	125.80±5.98
4	423.68 ± 9.82	124.39±7.90	96.25±4.68
5	416.45 ± 13.06	95.69±10.51	94.83±6.22
6	410.54 ±7.43	88.93±8.96	90.40±15.14
7	395.17 ± 30.08	85.97±24.21	85.96±14.33
Sig.	**	**	**
Year of calving			
1998	385.62±15.0	97.15±12.14	84.56±7.19
1999	401.23±9.76	124.72±7.85	92.93±4.65
2000	439.02±8.78	120.99±7.07	108.40±4.2
2001	394.89±8.42	105.59±6.77	84.09±4.01
2002	411.80±9.05	121.80±7.28	93.11±4.31
2003	426.48±9.50	131.50±7.65	90.10±4.58
2004	425.91± 8.83	134.56±7.10	79.82±4.28
2005	425.12± 8.99	137.12±7.24	85.53±4.29
2006	407.77±12.5	127.56±10.07	84.67±5.96
2007	365.99±32.1	42.76±25.85	120.1±15.3
Sig.	**	**	**
Season of calving			
Winter	423.19±7.02	127.84±5.65	98.86±3.34
Spring	416.38±10.44	121.84±8.40	90.80±4.98
Summer	417.12±9.37	126.75±7.54	94.22± 4.46
Autumn	376.83±7.65	81.08±6.17	80.81± 3.65
Sig.	**	**	**

LSM ± SE =Least square means ± Standard error Sig. = significant, **=P ≤ 0.01

Most previous literature attributed this effect in managerial systems especially those associated with the improvement in reproductive management, environmental conditions, physiological efficiency and physiological maturity of the cows among parities. Moreover, the variation in reproductive traits among different parties could be attribute to the variation in breeding systems concerning the service time, failure of cows to conceive after one service, insufficient nutrition, the physiological status of the cow and the quality of semen (Zein Elabdeen, 2004). Regarding the year of calving, it had a significant effect (P≤ 0.01) on DO, with an inconsistent trend from one year to another. These results confirm the reports of Hammond *et al.* (2010), Osman *et al.* (2013), Faid-Allah (2015), Sanad (2016) and Abo-Elenin (2018). This effect was attributed by different investigators to annual changes in atmospheric conditions such as variation in humidity and temperature, quantity and quality in feeds available, differential management practices presented every year, disease pattern and the interaction between some or all previous no genetic factors. Regarding calving season, the results presented in Table (2) indicated that the season of calving had a significant effect (P≤0.01) on DO, CI and DP. Moreover, longest mean among all traits have been recorded in winter and the shortest in autumn. In this respect, different studies revealed that, season of calving contributed significantly (P≤0.001) to the variance of DO, CI and DP (Abou- Bakr *et al*. 2006; Amasaib *et al*., 2011; El-Awady *et al*., 2016; Faid-Allah, 2015; Hammoud *et al*., 2010; Sanad, 2006; Satter *et al.*, 2005; Shalaby *et al*., 2001; Tawfik *et al*., 2000). In addition, most of them attributed this variation to seasonal variation and its links to variation in feed quantity and quality, lower metabolism, thermal stress and interaction between nutritional inadequacy and thermal stress and all that reasons individually or jointly, cause depression of reproductive traits and prolonging CI attributed this effect.

3.2 Genetic aspects for reproductive traits

3.2.1 Heritability (h^2_a)

Table (3) shows the ratios of direct additive effects heritability's (h^2_a), permanent environmental effects (pe^2), and error (e^2) for the reproductive traits Friesian cattle with their standard errors (SE). Estimates of direct heritability for all studied traits were low (Table 3), the h^2_a values for both DO and DP were equal and it was 0.04 for CI.

Table (3): Variance components and genetic parameters for reproductive traits.

Trait	σ^2a	σ^2pe	σ^2e	σ^2P	h^2_a	Pe^2	e2
CI	42	2.08	998.4	1042.84	.04±.001	0.0003±.008	0.96±.021
DO	27.0	1.50	1140.0	1168.50	.02±.010	0.001±.065	0.98±.065
DP	29.0	1.00	1176.0	12006.00	.02±.000	0.0008±.000	0.98±.000

σ^2 a = direct additive genetic variance, σ^2pe = maternal permanent Environmental variance, σ^2 e = residual (temporary environmental Variance), σ^2 p = phenotypic variance, h^2 = direct heritability, p^2e=Fraction of phenotypic variance due to maternal permanent Environmental effects and e^2 = residual effects.

In this respect, the current result for h^2_a were within rang reported from most literature, were they indicated that the reproductive traits have lower estimates of heritability and sometimes close to zero (Canaza-Cayo *et al*., 2018; Eid *et al*., 2012; El-Bayoumi *et al*., 2015; Ibrahim *et al*., 2009; Shalaby *et al*., 2001; Kakati *et al*., 2017; Zeleke *et al*., 2016; Zink *et al*., 2012). Reviewed studies based on their results attributed this to the high phenotypic variance fractions due to influence of herd management practice and other environmental variation. This revealed that selection based on phenotypic performance of animals could not be effective in the population or the population has low response to selection. In this respect, Zeleke *et al*. (2016) reported that for a long-term strategy for achieving change in these traits it should be firstly through improvement of the production environment and then by gene transfer through crossbreeding. Concerning maternal permanent environment effects, were little and negligible ranging from 0.0003 to 0.01. Moreover, error variance effects represent the largest proportion of the total variation ranging from 0.96 to 0.98. The difference between the estimates of the current study and those of other studies may be due to differences in genetic variation between populations, differences in statistical models used for analysis, or different responses of the same breed to different environmental conditions.

3.2.2 Genetic and phenotypic correlation among reproductive traits

Genetic and phenotypic correlations among reproductive traits are represented in Table (4). All coefficients for phenotypic correlations were positive and ranged from 0.388 to 0.746. Moreover, the coefficients of genetic correlations among all studied reproductive traits were positive and ranged from 0.230 to 0.492.

Table (4): The genetic correlations (below the diagonal) and phenotypic correlations (above the diagonal) of the reproductive studied traits for Friesian cows.

	DO	CI	DP
DO		0.746**	0.388**
CI	0.492**		0.519**
DP	0.421**	0.230**	

**=P ⩽ 0.01.

In this regard, Divya, (2012) and Ayalew *et al*. (2017) reported positive genetic correlations between DO and Cl. They added that DO can be used instead of CI for genetic evaluation of the reproductive performance of dairy breeders especially if the CI data are incomplete for some reason, cows culled due to abortion.

4. Conclusion

Non-genetic factors have a strong influence on the herd under study, which requires the stability of technical and administrative processes to improve reproductive performance and reduce the negative effects of these factors from year to year, especially in light of the investment system in the field of animal production for profit. Moreover, additional assessment studies required to improve the accuracy of information to increase productivity of such herds.

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