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# Genetic Analysis of Some Productive and Reproductive Traits and Sire Evaluation in Imported and Locally Born Friesian Cattle Raised in Egypt

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**Abstract:** Total of 1902 first lactation records of imported and locally born Friesian heifers were collected during the period from 1980 to 1993. A linear mixed model was used to study the random effect of sire, fixed effects of farm, origin of cow, year and month of calving and both age at first calving (AFC) and days open (DO) as covariate on some productive traits, i.e. annualized milk yield (AMY), Total milk yield (TMY), 305 day milk yield (305-DMY) and dry period (DP). The effects of the same factors (except DO was replaced by TMY as covariate) on two reproductive traits, i.e., DO and calving interval (CI) were also studied. Sire transmitting ability (ETA) on the basis of Best Linear Unbiased Prediction method (BLUP) as well as rank correlation coefficients among ETA's obtained for the different traits were also estimated. Least squares means of AMY, TMY, 305-DMY, DP, DO and CI were 2886, 3210, 2995 kg, 79.3, 141 and 422 days, respectively. Least squares analysis of variance showed that sire of the heifers had a significant effect on all traits except DP and CI. Farm showed significant effect on all studied traits, while origin of cow had non-significant effect. Year of calving had a significant effect on AMY, TMY and 305-DMY, while it had non-significant effect on DP, DO and CI. Month of calving had a significant effect on AMY, TMY, 305-DMY, DO and CI while, it had non significant effect on DP. Age at first calving (AFC) yielded insignificant partial linear and quadratic regression coefficients for all traits. While, DO and TMY as yielded highly significant partial linear regression coefficients of all productive or reproductive studied traits. The quadratic term was significant for dry period (DP) on DO and for DO and CI on TMY.
Heritability estimates for AMY, TMY, 305-DMY, DP, DO and CI were 0.304, 0.300, 0.316, 0.036, 0.190 and 0.170, respectively. Negative genetic, phenotypic and environmental correlations between DP and each AMY, TMY and 305-DMY concluded that selection against dry period would increase milk yield. Estimates of ETA's ranged from -159.1 to 277.6, -191.0 to 266.0, -184.4 to 289.2 kg and -29.7 to 32.3 d for AMY, TMY and 305-DMY and DO, respectively. Percentage of sires that had negative ETA's for above traits were 58.8, 52.9, 55.9 and 55.9, respectively. Sires that showed positive values for TMY, had positive values for the other traits. The rank correlation coefficients among productive traits were high and positive. Meanwhile, the rank correlation coefficients among ETA's for DO and each of AMY, TMY and 305-DMY were negative

**Key words:** Friesian, genetic parameters, sire evaluation, productive and reproductive traits, Egypt

## Introduction

It is known that the milking capacity of native cattle in Egypt is very low and selection within native stock will not increase the amount of milk in a short time (Asker *et al*., 1958). So, during the last two decades, considerable emphasis had been placed upon the importance of Friesian cattle in Egypt for milk production. Accordingly, the number of large Friesian herds had increased either in the governmental or commercial farms through importation from abroad.

In Egypt, during the last few years, most studies focused the lights on productive and reproductive performance of Friesian cattle and its crosses with native cattle. Unfortunately, few studies were carried out (El-Khashab, 1993; Marzouk, 1998) on comparing the imported animals and their progeny locally born under different environmental conditions in Egypt. Marzouk (1998) concluded that Friesian cow born and raised in Egypt were better in some reproductive traits while imported cows tended to have more TMY. He also suggested that much other information is needed to evaluate which is useful, importation of Friesian cows or producing replacement heifers. Ali *et al.* (1999) in two different studies in Pakistan, found that local born groups produced significantly less milk than their imported dams.

The objectives of the present study are: 1) to estimate some genetic and non-genetic factors affecting productive and reproductive traits, 2) to estimate genetic and phenotypic parameters for these traits, 3) to estimate sire transmitting abilities for these traits and 4) to compare some productive and reproductive traits of the imported Friesian heifers and their progeny locally-born heifers under the conditions of Damietta Province located at the eastern north part of the Nile Delta in Egypt

## Materials and Methods

**Data:** Data were collected from three farms (farms number 1, 7 and 8) of Fariskur Sector for milk production, belonging to The Egyptian Company for Meat and Milk production, Ministry of Agriculture, Egypt. The data of the year 1981 were excluded from the study because of the small numbers of animals in certain months. The farms situated at different farms in the northern part of Nile-Delta, about 8 km south of Damietta City. The herds under investigation were consisted of imported Friesian pregnant heifers from Netherlands (1076) and locally born Friesian heifers in Egypt (826). The total number of first lactation records used in this study was 1902.

**Feeding and Management:** The cows were divided into groups according to their milk production and reproductive status, each group (50 – 60 cows) was housed free in open yards. During winter and spring seasons (from December to May) cows were fed *ad libitum* on Egyptian clover (*Trifolium alexandrium*) and rice straw in addition to concentrate mixture according to the level of their milk production. While in summer and autumn seasons (from June to November) the cows were fed mainly on concentrate mixture, rice straw, clover hay and green fodder (Darawah). Daily milk yield was recorded for each cow separately once in each month to the nearest 0.5 kg. The lactating cows were machine milked twice a day at 4.00 a.m. and 16.00 p.m. and dried off about two months before the expected calving date or when daily milk yield is less than 2 kg. Heifers were put for insemination for the first time when they reached about 350-kg body weight or 18 months of age, whichever comes first. Cows were naturally inseminated at least 45 days after calving. Preg nancy was detected by rectal palpation 60 days after service and cows failed to conceive were naturally inseminated again in the next heat.

**Statistical analysis:** Data were analyzed using linear mixed model least squares and maximum likelihood (LSMLMW) computer program of Harvey (1990). Two models of statistical analysis were used for studying factors affecting some productive traits, i.e. annualized milk yield (AMY) in kg, Total milk yield (TMY) in kg, 305 day milk yield (305-DMY) in kg and dry period (DP) in day and two reproductive traits, i.e., days open (DO) and calving interval (CI) in day as follows:

The following first mixed model was used to analyze the productive traits:

$$Y_{ijklm} = \mu + S_i + F_j + B_k + M_l\, Y_m + bL_1(x1\text{-}x1) + bQ_1 (x_1\text{-}x_1)^2 + bL_2(x_2\text{-}x_2) + bQ_2(x_2\text{-}x_2)^2 e_{ijklm}$$

Where:

$Y_{ijklm}$ = the individual observation;

$\mu$ = the overall mean;

$S_i$ = the random effect of the ith sire within farm,

$F_j$ = the fixed effect of the jth farm, j = 1, 7 and 8,

$B_k$ = the fixed effect of the kth origin of the cow, k = 1 imported and 2 locally born,

$M_l$ = the fixed effect of the jth month of calving, j = 1, 2, 3 and 12 ( January, February, March..... and December);

$Y_m$ = the fixed effect of the kth year of calving, l = 1, 2,3, ....., 13 (from 1980 to 1993 with excluding the year 1981 because of the small number of animals);

$bL_1$ &$bQ_1$= partial linear and quadratic regression coefficients, respectively for productive traits on age at first calving .

$bL_2$&$bQ_2$= partial linear and quadratic regression coefficients, respectively for productive traits on days open (days),

$x_1$ = age at first calving of cow, $\bar{x}_1$ average AFC, month;

$X_2$ = days open (day) of cow, $\bar{x}_2$ average DO (days); and

$e_{ijklm}$ = residual term assumed to be random and distributed as a normal distribution with mean zero and variance $\sigma^2$.

2) The following fixed model was used to analyze the reproductive traits:

$$Y_{ijklm} = \mu + S_i + F_j + B_k + M_l + Y_m + bL_1\ (x_1\text{-}\bar{x}_1) + bQ_1(x_1\text{-}\bar{x}_1)^2 + bL_2(x_2\text{-}\bar{x}_2) + bQ_2(x_2\text{-}x_2)^2 + e_{ijklm}$$

Where all definitions as mentioned above except for:

$bL_2$&$bQ_2$= partial linear and quadratic regression coefficients, respectively for reproductive traits total milk yield (kg),

$x_2$ = total milk yield (TMY) of cow, and $X_2$ average TMY, kg.

AMY was computed according to the formula of Bar Anan and Soller (1979) as follows:

AMY = total lactation milk yield/calving interval) x 365.

The length of DP was computed as t he difference between the date of drying off and the date of the next calving in days.

The length of DO was computed as the interval in days between the date of calving and the date of successful mating. Calving interval was computed as the difference between the date of the first and the date of the second calving in days.

Heritability estimates ($h^2$) werecomputed by the paternal half-sibs method according to formula:

$$h^2 = 4\sigma^2_s / (\sigma^2_s + \sigma^2 e)$$

Estimates of heritability ($h_2$) and genetic (with standard errors), phenotypic and environmental correlation coefficients among different traits were computed by the LSMLMW program of Harvey (1990).

**Estimation of sire transmitting ability (ETA's):** The transmitting abilities of sires with at least 10 daughters were examined, and consequently the total number of sires used in estimation of ETA's was only 52 sires. Sire-transmitting ability (ETA) for different traits was estimated by Best Linear Unbiased prediction (BLUP). Data of the first lactation records were used for estimating BLUP values, one set of cross-classified non interacting random effect (sire) is absorbed according to Harvey (1990) where BLUP estimates for random sire effects absorbed by maximum likelihood were obtained. The above model could be written in matrix notation as follows:

$$Y = Xf + Zs + Wb + e$$

Where:

Y = a vector of observations for each trait,

X = a known fixed design matrix,

f = an unknown vector of fixed effects representing the mean of farm, origin and month and year of calving,

Z = a known design matrix,

s = an un-observable vector of random sire effects,

W = a vector of covariate variables (independent variables), age at first calving and Days open or total milk yield,

b = a vector of partial regression coefficient of Y on w,

e = an un-observable random vector of error with mean and variance-covariance matrix $I\ \sigma^2_e$ .

The mixed model equations (Henderson, 1973) are:

$$\begin{bmatrix} X'X & X'Z & X'W \\ Z'X & Z'Z+k & Z'W \\ W'X & W'Z & W'W \end{bmatrix} \begin{bmatrix} \hat{f} \\ \hat{s} \\ \hat{b} \end{bmatrix} \quad \begin{bmatrix} X'Y \\ Z'Y \\ W'Y \end{bmatrix}$$

Where:

$K = (4\ h^2) / h^2$, for each trait was added to the diagonal of sire effects in the matrix; $h^2$ is the heritability estimate.

Rank correlation coefficients among sire transmitting abilities (ETA's) for different traits were estimated using the Spearman formula (Snedecor, 1956).

## Results and Discussion

**Productive traits:** Least squares mean of first lactation milk productive traits are presented in Table 1. The present overall least squares mean of TMY (3210 kg) was much higher than the published estimates on Friesian cattle in Egypt (e.g.1955 kg by A.O.A.D., 1984; 2461 kg by Abdel-Glil, 1996 and 2871 kg by Khattab and Sultan, 1990), but lower than those obtained by El-Awady (1998); Marzouk (1998); Khattab and Atil (1999) and Oudah *et al.* (2000) being 3423, 5022, 3698, 3709 and 3475 kg, respectively. The present overall least squares mean of 305-DMY (2995 kg) was somewhat higher than those reported by Khattab and Sultan (1990); Abdel-Glil (1996) and Oudah *et al.* (2000), working on Friesian cattle in Egypt. Meanwhile the present mean of 305-DMY was much lower than those obtained by El-Awady (1998); Marzouk (1998); Khattab and Atil (1999); Salem and Abdel-Raouf (1999) and Khattab *et al.* (2000) on Friesian cattle in Egypt. The present overall least squares mean of DP (79.3 days) was shorter than those reported by most of Egyptian studies on Friesian cattle in Egypt (Gad, 1995; Marzouk, 1998 and Salem and Abdel-Raouf, 1999). But longer than that obtained by Khattab and Atil (1999) being 65 days.

The present overall least squares mean of AMY was found to be 2886 ± 42 kg (Table 1) which was very near to the results of AMY obtained by Ashmawy and Khattab (1991) (2944 ± 36 kg). The differences between the amount of AMY and the amount of both TMY and 305-DMY given in Table 1 (2886 *vs.* 3210 and 2995 kg, respectively) are due to delaying insemination.

The differences between the present results and those of the other investigators may be due to differences in climatic conditions, management, genetic differences and/or methods of statistical analysis.

**Non-genetic factors affecting productive traits:** Least squares means (± SE) for milk production traits as affected by different factors are presented in Table 1 and Least squares analysis of variance for factors affecting milk production traits are presented in Table 2.

**Effect of farm:** The present results indicate that farm showed highly significant (P< 0.001) effect on all first lactation productive traits under investigation (Table 2). Farm Number 8 had the highest means for AMY, TMY and 305-DMY and lowest mean for DP compared to the other two farms (Table 1). The differences in milk production traits between farms may be attributed to the system of management and feeding regimes (Sadek *et al.*, 1994). Similar results were found by different authors, e.g. Morsey *et al.* (1986) found that location of the farm had highly significant effect on first lactation total milk yield. Ashmawy and Khattab (1991) also reported that there were clear and significant (P < 0.01) difference between the two farms in AMY. They attributed this difference between the two farms to differences in heat detection and breeding practices.

**Effect of origin:** The results showed that there were insignificant differences in all productive traits between imported and locally born heifers (Table 2). The insignificant differences could be attributed to the appropriate environmental conditions and good management. In contrast, Marzouk (1998) working on imported and locally born Friesian cows in Egypt (Assiut Governorate, Upper Egypt about 400 km south of Cairo) reported that the effect of origin of cow on all milk yield traits was highly significant. The differences between the present result and that of Marzouk (1998) could be attributed to genotype-environment interaction. These results could be expected since the climatic conditions between Assiut Governorate (where the cows of the study of Marzouk, 1998 were raised) and Damietta Governorate (where the cows of the present study were raised) are different. These results may lead to the conclusion that improving management and selecting the region in which a certain foreign breed would be kept are very important. This conclusion was previously confirmed by Morsey *et al.* (1986).

**Effect of year of calving:** Year of calving showed highly significant (P< 0.001) effects on AMY, TMY and 305-DMY but it had no significant effect on DP (Table 2). Generally, the overall means of AMY, TMY and 305-DMY obtained during the years from 1981 to 1986 were higher than the corresponding means obtained during the years from 1987 to 1993 (Table 1). These results are in agreement with the findings obtained in other countries e.g. Morsey *et al.* (1986); Ashmawy and Khattab (1991); Khalil *et al.* (1994); Atay *et al.*. (1995); Gad (1995); El-Nady (1996); El-Awady (1998); Khattab and Atil (1999); Salem and Kassab (1999); Khattab *et al.* (2000); Oudah *et al.* (2000) and Tawfik *et al.* (2000). The present results indicate that the changes in milk production from year to another may be due to the changes in management and climatic conditions from year to year which consequently affect the phenotypic trend of milk production.

**Effect of month of calving:** Month of calving showed significant effect on all traits except DP (Table 2). However, no specific trend was observed (Table 1).

The significant effect of month or season of calving on 305-DMY was reported by many authors working on different breeds of dairy cattle in Egypt or in other countries (e.g. Chew *et al.*, 1982; Khalil *et al.*, 1994; Abdel-Glil, 1996; Khattab and Atil (1999); Khattab *et al.*, 2000; Oudah *et al.*, 2000 and Tawfik *et al.*, 2000). Ashmawy and Khattab (1991) found that season of calving significantly (P< 0.01) affect the AMY. They concluded that such significant effect might be due to variations in atmosphere and feedstuffs available at different seasons of the year.

**Effect of age at first calving:** Least squares analysis of variance showed that values of partial linear and quadratic regression coefficients of all milk productive traits studied on AFC were not significant (Table 2). These results were in accordance with the findings of Dalal *et al.* (1993).

**Effect of days open:** Values of partial linear and quadratic regression coefficients of AMY, TMY, 305-DMY and DP on DO are presented in Table 1. All estimates of linear regression coefficients were highly significant (P< 0.001), meanwhile the quadratic regression coefficients were not significant except for DP (Table 2). The present results agreed with those of Ashmawy and Khattab (1991), who found that length of DO affect significantly AMY. Salem and Abdel-Raouf (1999) in Egypt found also that DO significantly (P< 0.01) affect 305-DMY.

It is noticeable that AMY showed an opposite trend to that shown by TMY and 305-DMY. The results given in Table 1 show that there are negative linear regression coefficients for AMY on DO (– 3.23 kg/day) and positive for 305-DMY on DO (3.57 kg/day). The observed negative relationship between AMY and DO may be due to that longer DO resulted in more days in milk which extended to the late lactation part with lower daily milk production and in more days dry (Ashmawy and Khattab, 1991). These results are in close agreement with those of Thompson *et al.* (1982). Similar results were also found by Khattab and Atil (1999), who found Negative genetic correlations between DO and each of 305-DMY and TMY. They concluded that selection against DO would increase milk yield.

Table 1: Least squares mean (± SE) for milk production traits as affected by different factors

| Classification | No. of obs. | AMY (kg) | TMY (kg) | 305DMY (kg) | DP (day) |
|---|---|---|---|---|---|
| Overall mean | 1902 | 2886 ± 42 | 3210 ± 46 | 2995 ± 42 | 79.3 ± 2.40 |
| **Farm:** | | | | | |
| 1 | 913 | 2557 ± 56 | 2808 ± 62 | 2625 ± 56 | 74.9 ± 3.36 |
| 7 | 647 | 2643 ± 56 | 2877 ± 48 | 2728 ± 57 | 97.9 ± 3.04 |
| 8 | 342 | 3458 ± 71 | 3945 ± 79 | 3631 ± 71 | 65.3 ± 3.99 |
| **Origin of cow:** | | | | | |
| Imported | 1076 | 2878 ± 97 | 3176 ± 108 | 2962 ± 97 | 77.6 ± 6.41 |
| Locally born | 826 | 2895 ± 91 | 3244 ± 101 | 3028 ± 91 | 81.1 ± 5.98 |
| **Year of calving:** | | | | | |
| 1980 | 121 | 3696 ± 236 | 4030 ± 263 | 3737 ± 236 | 74.8 ± 15.9 |
| 1982 | 315 | 3337 ± 176 | 3770 ± 197 | 3443 ± 176 | 70.7 ± 11.9 |
| 1983 | 37 | 3345 ± 217 | 3640 ± 242 | 3492 ± 217 | 90.9 ± 14.7 |
| 1984 | 375 | 3449 ± 124 | 3784 ± 138 | 3569 ± 124 | 78.0 ± 8.26 |
| 1985 | 57 | 3032 ± 146 | 3358 ± 162 | 3178 ± 145 | 83.5 ± 9.76 |
| 1986 | 169 | 3114 ± 104 | 3518 ± 116 | 3244 ± 104 | 64.6 ± 6.88 |
| 1987 | 289 | 2805 ± 99 | 3148 ± 110 | 2884 ± 99 | 64.8 ± 6.52 |
| 1988 | 198 | 2423 ± 103 | 2790 ± 115 | 2556 ± 103 | 68.1± 6.84 |
| 1989 | 111 | 2564 ± 130 | 2896 ± 145 | 2681 ± 129 | 70.7± 8.66 |
| 1990 | 83 | 2206 ± 144 | 2381 ± 160 | 2213 ± 144 | 88.1± 9.64 |
| 1991 | 105 | 2438 ± 158 | 2699 ± 176 | 2537 ± 158 | 94.7 ± 10.6 |
| 1992 | 17 | 2625 ± 268 | 2836 ± 299 | 2736 ± 267 | 109.9± 18.1 |
| 1993 | 25 | 2484 ± 229 | 2879 ± 256 | 2662 ± 229 | 72.8 ± 15.5 |
| **Month of calving:** | | | | | |
| January | 198 | 2745 ± 76 | 3056 ± 85 | 2878 ± 76 | 77.9 ± 4.92 |
| February | 212 | 2988 ± 77 | 3337 ± 86 | 3109 ± 77 | 81.1 ± 5.02 |
| March | 276 | 3001 ± 72 | 3275 ± 81 | 3050 ± 72 | 82.4 ± 4.65 |
| April | 363 | 985 ± 64 | 3293 ± 71 | 3070 ± 64 | 81.1 ± 4.07 |
| May | 202 | 3011 ± 74 | 3367 ± 82 | 3138 ± 74 | 83.0± 4.77 |
| June | 85 | 2910 ± 96 | 3246 ± 107 | 3034 ± 96 | 73.0 ± 6.36 |
| July | 76 | 3011 ± 97 | 3357 ± 109 | 3085 ± 97 | 72.4 ± 6.43 |
| August | 85 | 2846 ± 94 | 3197 ± 105 | 2962 ± 94 | 72.9 ± 6.21 |
| September | 73 | 2874 ± 99 | 3209 ± 110 | 3007 ± 99 | 80.1 ± 6.54 |
| October | 95 | 2673 ± 92 | 2969 ± 102 | 2772 ± 92 | 79.3 ± 6.02 |
| November | 102 | 2797 ± 90 | 3110 ± 100 | 2940 ± 89 | 96.2 ± 5.89 |
| December | 135 | 2791 ± 89 | 3103 ± 100 | 2891 ± 90 | 72.6 ± 5.89 |
| **Regression on:** | | | | | |
| Age at first calving (Linear) | | −6.78± 6.90 | −10.4 ± 7.69 | −7.54± 6.88 | −0.098± 0.47 |
| Age at first calving (Quad.) | | 0.173± 0.57 | 0.349± 0.63 | 0.214 ± 0.56 | 0.04 ± 0.038 |
| Days open (Linear) | | −3.23± 0.32 | 3.57 ± 0.352 | 1.25± 0.315 | 0.297 ± 0.021 |
| Days open (Quad) | | 0.002± .001 | −0.002± .001 | 0.001± 0.001 | −0.0005± 0.0 |

Table 2: Least squares analysis of variance for factors affecting milk production traits

| Source of variation | d.f | AMY | TMY | 305-DMY | DP |
|---|---|---|---|---|---|
| Farm | 2 | 37220367.3*** | 62267068.4*** | 46019676.1*** | 105611.8*** |
| Sire : farm | 765 | 534201.1** | 662423.1 ** | 535651.8** | 2099.1 NS |
| Origin of cow | 1 | 4538.7 NS | 72662.6 NS | 68979.9 NS | 199.2 NS |
| Year of calving | 12 | 2435593.5*** | 2804336.1*** | 2533568.7*** | 2711.9 NS |
| Month of calving | 11 | 963071.9** | 1165951.3* | 850793.2* | 3156.5 NS |
| Regression on: | | | | | |
| AFC (linear) | 1 | 431176.5 NS | 1024108.1 NS | 533691.3 NS | 91.0 NS |
| AFC (quadratic) | 1 | 41940.0 NS | 169942.2 NS | 64066.7 NS | 2249.9 NS |
| DO (linear) | 1 | 46893999.8*** | 57022745.5*** | 7064246.3*** | 396761.8*** |
| DO (quadratic) | 1 | 1350784.2 NS | 1447628.0 NS | 357668.0 NS | 70694.8*** |
| Remainder | 1106 | 446416.1 | 554685.9 | 444355.9 | 2054.6 |

NS = not significant. *, ** and *** = significant at $P < 0.05$, 0.01 and 0.001, respectively.

Therefore, a reduction of DO is the desirable goal of dairy men.

**Reproductive traits:** Least squares mean of reproductive traits are presented in Table 3. The present overall least square means of DO and CI (141 and 422 days, respectively) were very close to those obtained by Marzouk (1998) (152 and 426 days) working on imported and locally born Friesian cows in Egypt (Assiut Governorate, Upper Egypt about 400 km south of Cairo) and El-Sedafy (1989) (147 and 423 days, respectively) working on Friesian cows in Egypt.

On the other hand, the present findings are higher than values

Table 3: Least square means (+ SE) for days open and calving interval as affected by different factors

| Classification | No. of obs. | Reproductive traits (days) | |
|---|---|---|---|
| | | DO | CI |
| Overall mean | 1902 | 141 ± 4.85 | 422 ± 4.81 |
| **Farm:** | | | |
| 1 | 913 | 153± 6.78 | 433 ± 6.73 |
| 7 | 647 | 145± 6.52 | 428 ± 6.43 |
| 8 | 342 | 124± 8.21 | 405 ± 8.12 |
| Origin of cow: | | | |
| Imported | 1076 | 141± 11.8 | 419 ± 11.6 |
| Locally born | 826 | 140± 11.0 | 424 ± 11.0 |
| **Year of calving:** | | | |
| 1980 | 121 | 48 ± 28.9 | 323 ± 29.0 |
| 1982 | 315 | 92 ± 21.6 | 374 ± 21.7 |
| 1983 | 37 | 101 ± 26.6 | 376 ± 27.0 |
| 1984 | 375 | 72 ± 15.0 | 351 ± 15.0 |
| 1985 | 57 | 112 ± 17.8 | 389 ± 17.8 |
| 1986 | 169 | 104 ± 12.6 | 384 ± 12.6 |
| 1987 | 289 | 135 ± 12.1 | 419 ± 12.1 |
| 1988 | 198 | 162 ± 12.7 | 448 ± 12.7 |
| 1989 | 111 | 194 ± 15.9 | 479 ± 15.9 |
| 1990 | 83 | 246 ± 17.6 | 527 ± 17.7 |
| 1991 | 105 | 203 ± 19.4 | 487 ± 19.4 |
| 1992 | 17 | 222 ± 32.9 | 504 ± 33.0 |
| 1993 | 25 | 140 ± 28.3 | 428 ± 28.3 |
| **Month of calving:** | | | |
| January | 198 | 144 ± 9.19 | 425 ± 9.19 |
| February | 212 | 148 ± 9.33 | 431 ± 9.33 |
| March | 276 | 129 ± 8.72 | 409 ± 8.71 |
| April | 363 | 146 ± 7.69 | 428 ± 7.68 |
| May | 202 | 137 ± 8.99 | 418 ± 8.99 |
| June | 85 | 136 ± 11.7 | 418 ± 11.7 |
| July | 76 | 117 ± 11.9 | 399 ± 11.8 |
| August | 85 | 144 ± 11.5 | 424 ± 11.4 |
| September | 73 | 131 ± 12.0 | 411 ± 12.0 |
| October | 95 | 153 ± 11.1 | 431 ± 11.2 |
| November | 102 | 155 ± 10.9 | 439 ± 10.9 |
| December | 135 | 148 ± 11.0 | 431 ± 11.0 |
| **Regression on:** | | | |
| Age at first calving (Linear) | | − 0.518± 0.85 | −0.428± 0.85 |
| Age at first calving (Quad.) | | 0.008± 0.07 | −0.003± 0.07 |
| Total milk yield (linear) | | 0.035± 0.003 | −0.04± 0.003 |
| Total milk yield (quadratic) | | 0.000± 0.000 | 0.000± 0.000 |

Table 4: Least squares analysis of variance for factors affecting days open and calving interval

| Source of variation | d.f | Mean squares and significant | |
|---|---|---|---|
| | | DO | CI |
| Farm | 2 | 31061.0 * | 30077.2 * |
| Sire : farm | 765 | 7574.9 * | 7534.1 NS |
| Origin of cow | 1 | 8.87 NS | 353.6 NS |
| Year of calving | 12 | 8411.2 NS | 9463.3 NS |
| Month of calving | 11 | 39126.4 *** | 39749.8 *** |
| Regression on: | | | |
| AFC (linear) | 1 | 2515.9 NS | 1719.5 NS |
| AFC (quadratic) | 1 | 90.7 NS | 17.0 NS |
| TMY (linear) | 1 | 726515.0 *** | 776510.6 *** |
| TMY (quadratic) | 1 | 73099.8 *** | 72415.9 *** |
| Remainder | 1106 | 6768.0 | 6810.4 |

NS = not significant. * and *** = significant at P < 0.05 and 0.001, respectively.

Table 5: Estimation of sire variance components ($\sigma^2_s$) and error variance components ($\sigma^2_e$) and proportion of variance (V%) due to random effects for different studied traits

| Trait | Sire | | Error | |
|---|---|---|---|---|
| | ($\sigma^2_s$) | (V%) | ($\sigma^2_e$) | (V%) |
| AMY | 36667.9 | 7.59 | 446416.1 | 92.41 |
| TMY | 45002.0 | 7.50 | 554685.9 | 92.50 |
| 305-DMY | 38134.5 | 7.90 | 444355.9 | 92.10 |
| DO | 337.0 | 4.74 | 6768.0 | 95.26 |

Table 6: Heritability estimates ± SE (on diagonal) and genetic ± SE (below diagonal), phenotypic (above diagonal) and environmental (between parentheses) correlations between milk productive traits

| Trait | AMY | TMY | 305-DMY | DP |
|---|---|---|---|---|
| AMY | 0.304± 0.112 | 0.948 (0.919) | 0.949 (0.943) | −0.304(−0.209) |
| TMY | 1.015± 0.020 | 0.300± 0.112 | 0.971 (0.983) | −0.369(−0.395) |
| 305 -DMY | 0.962± 0.023 | 0.944± 0.023 | 0.316± 0.112 | −0.249(−0.199) |
| DP | − 0.619± 1.51 | −0.410± 1.29 | −0.632± 1.46 | 0.036± 0.110 |

Table 7: Heritability estimates ± SE (on diagonal) and genetic ± SE (below diagonal), phenotypic (above diagonal) and environmental (between parentheses) correlations between days open and calving interval

| Trait | DO | CI |
|---|---|---|
| DO | 0.190 ± 0.112 | 0.976 (1.00) |
| CI | 0.863 ± 0.086 | 0.170 ± 0.112 |

of 100 and 381 days, respectively, reported by Afifi *et al.* (1992a); 127 and 410 days, respectively, reported by El-Khashab (1993). Meanwhile, these values are lower than those reported by El-Sheikh *et al.* (1995) being 175 and 472 days, respectively and Morsey (1996) being 182 and 460 days, respectively.

**Non-genetic factors affecting reproductive traits:** Least squares means (± SE) for DO and CI as affected by different factors are presented in Table 3 and Least squares analysis of variance for factors affecting days open and calving interval are presented in Table 4.

Generally, the variation in the reproductive traits of Friesian cows raised under Egyptian conditions may be due to the differences among Friesian herds in management policies for breeding practices and/or the poor experience in oestrous detection which lead to delay fertile insemination and consequently long calving interval. Marzouk *et al.* (1994) pointed out that the management is considered a reason of variation in fertility results.

**Effect of farm:** Farm showed significant (P< 0.05) effect on all reproductive traits under investigation (Table 2). Farm Number 1 had the highest means for DO and CI (153 and 433 days, respectively) followed by Farm number 7 (145 and 428 days, respectively) and finally Farm number 8 had the lowest means (124 and 405 days, respectively) (Table 3). The significant differences between farms in DO and CI may be attributed to differences in heat detection and breeding practices.

**Effect of origin of cow:** Nearly similar results of DO (141 *vs.* 140 days) and CI (419 *vs.* 424 days) were found in the present study in the imported and locally born cows,

Table 8: The most frequently used sires (34 sires) with at least ten daughters and their proofs of sire transmitting abilities (ETA's) on the basis of the best linear unbiased prediction (BLUP) for milk productive and reproductive traits*

| Sire code | No. of daughters | Proof AMY (kg) Blup estimate | Rank | TMY (kg) Blup estimate | Rank | 305-DMY (kg) Blup estimate | Rank | DO (day) Bulp estimate | Rank |
|---|---|---|---|---|---|---|---|---|---|
| 6531 | 13 | 159.1 | 34 | 130.5 | 31 | 138.6 | 3 | 7.25 | 10 |
| 6863 | 10 | 148.4 | 33 | 189.2 | 33 | 162.6 | 33 | 3.48 | 23 |
| 7477 | 14 | 147.9 | 32 | 191.0 | 34 | 184.4 | 34 | 25.2 | 2 |
| 26 | 12 | 137.1 | 31 | 165.8 | 32 | 157.7 | 32 | 32.3 | 1 |
| 143 | 20 | 85.1 | 30 | 66.5 | 24 | 94.4 | 31 | 5.02 | 25 |
| 131 | 10 | 77.7 | 29 | 86.1 | 26 | 67.0 | 24 | 10.7 | 27 |
| 210 | 12 | 73.2 | 28 | 61.3 | 23 | 85.4 | 26 | 4.96 | 24 |
| 831 | 19 | 72.0 | 27 | 113.8 | 29 | 93.8 | 30 | 14.6 | 5 |
| 8 | 12 | 70.4 | 26 | 113.1 | 28 | 91.5 | 29 | 11.7 | 7 |
| 72 | 11 | 70.3 | 25 | 104.9 | 27 | 89.8 | 28 | 2.72 | 22 |
| 546 | 24 | 64.8 | 24 | 115.8 | 30 | 67.5 | 25 | 2.52 | 13 |
| 403 | 10 | 55.0 | 23 | 73.0 | 25 | 87.9 | 27 | 10.9 | 8 |
| 42 | 20 | 47.8 | 22 | 16.8 | 18 | 37.3 | 22 | 0.11 | 16 |
| 4128 | 10 | 41.2 | 21 | 35.9 | 21 | 22.9 | 21 | 1.43 | 14 |
| 1388 | 11 | 30.9 | 20 | 13.4 | 16 | 8.30 | 15 | 1.98 | 20 |
| 4132 | 10 | 28.3 | 19 | 22.0 | 14 | 17.4 | 20 | 10.8 | 28 |
| 287 | 14 | 23.6 | 18 | 17.9 | 19 | 7.53 | 17 | 1.98 | 21 |
| 45 | 16 | 22.7 | 17 | 26.8 | 20 | 41.1 | 23 | 11.9 | 6 |
| 20 | 13 | 19.3 | 16 | 18.0 | 15 | 12.0 | 14 | 15.7 | 30 |
| 8915 | 12 | 2.6 | 15 | 42.2 | 22 | 0.81 | 16 | 5.04 | 12 |
| 470 | 14 | 6.0 | 14 | 8.91 | 17 | 7.76 | 18 | 6.05 | 11 |
| 4285 | 11 | 16.2 | 13 | 40.8 | 11 | 32.4 | 12 | 1.84 | 18 |
| 121 | 21 | 19.0 | 12 | 36.4 | 13 | 22.6 | 13 | 20.2 | 4 |
| 8649 | 11 | 26.4 | 11 | 39.6 | 12 | 9.41 | 19 | 20.6 | 3 |
| 1072 | 11 | 67.1 | 10 | 67.8 | 10 | 68.3 | 11 | 6.63 | 26 |
| 7074 | 10 | 67.1 | 9 | 75.9 | 9 | 99.6 | 9 | 1.76 | 17 |
| 561 | 10 | 76.0 | 8 | 96.8 | 8 | 120.6 | 5 | 19.8 | 31 |
| 7315 | 12 | 108.5 | 7 | 114.9 | 7 | 119.2 | 6 | 29.7 | 34 |
| 254 | 20 | 111.4 | 6 | 120.9 | 5 | 113.6 | 7 | 11.8 | 29 |
| 2355 | 17 | 120.1 | 5 | 148.0 | 3 | 111.3 | 8 | 0.02 | 15 |
| 492 | 12 | 122.0 | 4 | 145.9 | 4 | 136.5 | 4 | 1.90 | 19 |
| 251 | 17 | 145.7 | 3 | 118.0 | 6 | 79.6 | 10 | 7.94 | 9 |
| 100 | 21 | 214.3 | 2 | 230.8 | 2 | 251.4 | 2 | 24.4 | 33 |
| 5463 | 11 | 277.6 | 1 | 266.0 | 1 | 289.2 | 1 | 22.5 | 32 |

In this table and the next, the estimates of ETA of DP and CI were not included since the effect of sire on DP and CI was not significant.

Table 9: Minimum, maximum and range for sire transmitting ability for milk production traits by best linear unbiased predictor (BLUP) and percentage of sires with negative estimates

| Traits | BLUP estimates Min. | Max. | Range | Negative estimates % |
|---|---|---|---|---|
| AMY (kg) | 159.1 | 277.6 | 436.7 | 58.8 |
| TMY (kg) | 191.0 | 266.0 | 457.0 | 52.9 |
| 305-DMY (kg) | 184.4 | 289.2 | 473.6 | 55.9 |
| DO (day) | 29.7 | 32.3 | 62.0 | 55.9 |

Table 10: Rank correlation coefficients among sire transmitting abilities (ETA's) for different traits

| Traits | Rank correlation coefficient TMY | 305-DMY | DO |
|---|---|---|---|
| AMY | 0.957 | 0.808 | 0.341 |
| TMY | | 0.834 | 0.473 |
| 305-DMY | | | 0.442 |

respectively (Table 3). Effect of origin of the heifer (imported or locally born) was not significant on all reproductive traits (Table 4).

**Effect of year of calving:** Year of calving showed non-significant effects on both DO and CI (Table 2). Similar results were found by different authors in Egypt and other countries (Johanson *et al.*, 1984; Morsey *et al.*, 1986 and Nieuwhof, 1989)

**Effect of month of calving:** Month of calving showed highly significant effect on both DO and CI (Table 4). However, no clear trend was observed. The significant effect of month of calving season on DO and CI was observed also by many authors in Egypt or in different countries (Rege, 1991; Ray *et al.*, 1992; El-Nady, 1996 and Salem and Abdel-Raouf, 1999).

**Effect of age at first calving:** Least squares analysis of variance showed that values of partial linear and quadratic regression coefficients of reproductive traits studied on AFC were not significant (Table 4). Similar results were obtained by different authors in different countries Mohamed, 1987, Abdel-Glil, 1991, Bracho and Perozo, 1992 and Tag El-Dien, 1997) who reported that age at first calving had no significant effect on DO and CI. Negative linear regression coefficients of AFC on DO and CI were found in the present study (Table 3). Afifi *et al.* (1992 a) showed that DO linearly decreased by the increase in age at calving within parity.

**Effect on total milk yield:** Least squares analysis of variance shows that values of partial linear and quadratic regression coefficients of reproductive traits studied on TMY of the current lactation were highly significant (P< 0.001) (Table 4). All regression coefficients were positive except for the linear regression coefficient of CI on TMY (Table 3). Louca and Legates (1968) found a quadratic relationship between days open and milk yield. This result agrees with that obtained in the present study.

**Sire variance components ($\sigma^2_s$):** Least squares analysis of variance for effect of sire (as random effect) on all milk productive and reproductive traits studied are given in Tables 2 and 4, respectively while sire variance components and proportions of variance are shown in Table 5. Results obtained in the present study showed that the sire of heifers had a significant (P < 0.01 or 0.05) effect on all traits studied except for DP and CI. The present results indicate the possibility of genetic improvement in milk production traits through sire selection, which is well established by many investigators (Afifi *et al.*, 1992a; El-Awady, 1998; Badawy and Oudah, 1999; Mostafa *et al.*, 1999; Salem and Abdel Raouf, 1999, Salem and Kassab, 1999, Khattab *et al.*, 2000, and Oudah *et al.*, 2000).

The sire variance components ($\sigma^2_s$) adjusted for fixed effects of environmental factors ranged from 4.74 to 7.59% of the total variance for all milk productive and reproductive studied traits (Table 5). The present estimates of sire variance components fall within the range of the findings of El-Awady (1998) on Friesian cattle (4.63 – 10.75%). Higher estimates for sire variance components ($\sigma^2_s$) were found by Oudah *et al.* (2000) working on another group of Friesian cattle in Egypt (10.5 and 12.7% for TMY and 305-DMY. Meanwhile, Khattab *et al.* 2000 obtained only 4% sire variance component for 305-DMY.

**Heritability estimates and correlations:**

**productive traits:** Heritability estimates (± SE) based on paternal half-sibs for milk productive traits of the first lactation as well as genetic, phenotypic and environmental correlation coefficients between milk production traits are presented in Table 6.

The high estimates of heritability of AMY, TMY, and 305-DMY reported in the present study fall within the range of the estimates reported by different authors working on Friesian cattle in Egypt (Abdel-Glil 1996; Shalaby, 1996; Badawy and Oudah, 1999; Salem and Abdel Raouf, 1999 and Salem and Kassab, 1999, Khattab *et al.*, 2000, Oudah *et al.*, 2000 and Tawfik *et al..*, 2000) which ranged from 0.12 to 0.52. Similar results of heritability estimates for 305 DMY reported in the present study (0.316) were also obtained in other countries by Swalve and Van Vleck (1986) being 0.32 working on Holstein Friesian cattles.

From the heritability estimates obtained in the present study for AMY, TMY and 305-DMY, it could be concluded that the high heritability estimates are enough to allow genetic improvement in milk production traits, which could be achieved through selection. Badawy and Oudah (1999), Mostafa *et al.* (1999), Salem and Abdel Raouf (1999) and Oudah *et al.* (2000) came to the same conclusion.

Concerning the heritability estimate of DP obtained in the present study (0.036), a nearly similar result (0.02) was found also by Salem and Abdel Raouf (1999) working on Holstein Friesian cattle in Egypt. The present low heritability estimate of DP indicate that the major part of variation in this trait is due to the non-genetic factors and great improvement could be achieved in this trait by improving management systems.

The present genetic correlation coefficients between AMY and 305-DMY (0.926) and between TMY and 305-DMY (0.944) were high and positive (Table 6). The high and positive genetic correlation coefficients among TMY and milk production traits indicate that selection for TMY will improve the other traits. Similar results were found by Tag El-Dein (1997), El-Awady (1998), Badawy and Oudah (1999) and Oudah *et al.* (2000) who reported that genetic correlations between TMY and 305-DMY were 0.90, 0.96, 0.98, 0.913 and 0.955, respectively working on different sets of Friesian cows in Egypt. On the other hand negative and high genetic correlation coefficients were found between DP and each of AMY, TMY and 305DMY being – 0.619, – 0.410 and – 0.632, respectively (Table 6). From these Negative genetic correlations, it could be concluded that selection against dry period would increase the milk yield. Therefore, a reduction of DP is the desirable goal of dairymen.

The present phenotypic correlation coefficients between AMY and 305-DMY (0.949) and between TMY and 305-DMY (0.971) were positive and highly significant. Negative and high phenotypic correlation coefficients were found between DP and Each of AMY, TMY and 305DMY being – 0.304, – 0.369 and – 0.249, respectively (Table 6). All values of phenotypic correlations were nearly similar to the corresponding values of the genetic correlations and having the same direction (Table 6). These results are in the agreement, in most cases, with those reported by Khattab and Sultan (1990); Abdel Glil (1991); Tag El-Dein (1997), Badawy and Oudah (1999), Salem and Abdel Raouf (1999) and Oudah *et al.* (2000) on Friesian cattle in Egypt.

The environmental correlation coefficients among all traits were generally less than the values of genetic correlation coefficients (Table 6) which may be due to more contribution of additive genetic deviation. Mostafa *et al.* (1999) and Oudah *et al.*(2000) came to the same conclusion.

**Reproductive traits:** Heritability estimates (± SE) based on paternal half-sibs for reproductive traits as well as genetic, phenotypic and environmental correlation coefficients between them (i.e. DO and CI) are presented in Table 7.

The low heritability estimates of DO (0.190) and CI (0.170) indicate that selection for these traits would not be effective in bringing about genetic improvement, therefore improving the environmental and managerial conditions should lead to considerable improvement in these traits. The present low heritability estimates for both DO and CI were confirmed previously by many authors under Egyptian conditions such as Afifi *et al.* (1992 b) and Salem and Abdel-Raouf (1999).

The present genetic and phenotypic correlation coefficients between DO and CI (0.863 and 0.976, respectively) were positive and highly significant (Table 7). Lower genetic and phenotypic correlation coefficients estimates were found by

Salem and Abdel-Raouf (1999) being 0.64 and 0.82, respectively.

**Sire transmitting abilities (ETA's):** The most frequently used sires (34 sires) and their proofs of sire transmitting abilities (ETA's) on the basis of the best linear unbiased prediction (BLUP) for the studied traits using 10 daughters or more for each sire are presented in Table 8, while the minimum, maximum and range of sire transmitting abilities are presented in Table 9. It could be noticed that there are large differences between the bottom and the top sires in ETA's values. The present results given in Table 8 show large genetic differences among sires for different studied traits which accordingly reflect the high potentiality for rapid genetic progress in milk production traits through selection of sires within the Friesian herds. Similar large variations among sires for different traits were observed by many authors working on Friesian cattle in Egypt (Abdel Glil, 1991; Afifi *et al.,* 1992 b; Shalaby, 1996; El-Awady, 1998 and Badawy and Oudah, 1999).

Concerning percentage of sires that had negative BLUP estimates for different studied traits (Table 9), about 52.9 to 58.8% had negative values. Selecting sires with values > 200 kg more than average of the herd in AMY, TMY or 305-DMY (sires code no. 100 and 5463), which had positive BLUP estimates, for intensive use in breeding purposes may lead to rapid genetic improvement in milk production traits. El-Chafie (1981) working on two herds of Egyptian buffaloes, found that the percentage of sires having negative estimates of sire transmitting ability of 300-DMY were 49 and 78%. Khattab and Mourad (1992) working on Egyptian buffaloes found that the percentage of sires having negative estimates of sire transmitting ability of TMY was 53%. Lower values of negative estimates were found by Badawy and Oudah (1999) working on another set of Friesian cattle in Egypt. They found that in TMY and 305-DMY traits, about 44 and 47% of the sires had negative values for the two traits, respectively.

Rank correlation coefficients among the ETA's for studied traits are given in Table 10. For the various milk production traits, sires that showed positive values for TMY showed positive and significant values for the other traits. The highest rank correlations among ETA's of sires were found between AMY and TMY (0.957); between TMY and 305-DMY (0.834) and between AMY and 305-DMY (0.808). On the other hand all rank correlation coefficients between DO and each of AMY, TMY and 305-DMY were negative and ranged between -0.341 and - 0.442. A nearly similar result was found by Mostafa *et al.* (1999) using Holstein-Friesian cattle. They reported that rank correlation coefficient between ETA's for TMY and 305-DMY was 0.95.

The following conclusions can be drawn from the present study:

The present values of heritabilities indicate that improving productive traits could be achieved through selection. Meanwhile, improving reproductive traits could be attained through better environmental and managerial conditions.

The high genetic differences among sires for the milk production traits indicate the high genetic potential for rapid genetic improvement milk production traits of Friesian cattle through sires' selection. Improving management and selecting the region in which a certain foreign breed would be kept are very important for raising this breed. No significant differences in productive and reproductive traits under study between imported and locally born cows under this system of management and environment. So, it is preferable to produce and raise replacement heifers than imported cows to save money. But Further research is needed in this area to investigate more clearly, the other traits such as longivity, resistance to some diseases... etc. to maintain this conclusion.

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