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Estimates of Phenotypic and Genetic Parameters for First Lactation Performance in Friesian Cattle in Egypt

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PHENOTYPIC and genetic parameters of initial milk yield (IMY), 305-day milk yield (305 MY), total milk yield (TMY), lactation period (LP) and age at first calving (AFC) were estimated using 767 first lactation records of Friesian cows. A least squares analysis of variance showed significant effect of sire, year and month of calving for all traits studied except the effect of month of calving on each of lactation period and age at first calving. Age at first calving on each of lactation period and age at first calving. Age at first calving had a curvilinear effect on each of IMY and 305 MY, but effect linear on TMY. Maximum yield of IMY and 305 MY was attained in heifers calving for the first time at 39 mo and 42 mo, respectively. Heritability estimates, by half-sib correlations were 0.19 ± 0.10, 0.43 ± 0.12, 0.31 ± 0.11, 0.08 ± 0.09 and 0.59 ± 0.14 for IMY, 305 MY, TMY, LP and AFC, respectively. All the phenotypic and genetic correlations among different traits were positive ($P < 0.01$) except the phenotypic and genetic correlations between age at first calving and lactation period which was negative ($P < 0.01$). In addition, the phenotypic correlation between IMY and LP was small and not significant.

Key words : Friesian cattle, 1st lactation, Phenotypic and genetic parameters.

Dairy cattle improvement, largely, depends on emphasis placed upon increasing milk yield by selection. Selection on milk yield occurs mainly during the first lactation (Allaire and Henderson, 1966 and Reddy and Basu, 1986). Performance of first lactation has been the standard of evaluation for most genetic studies with dairy cattle. First records are available sooner on more cows and are less susceptible to error from selection, injury, previous days dry and mastitis than are later records.

Genetic correlation between yield in the first and later lactations ranged between 0.75 to 0.92 as reported by many authors

(Barker and Robertson, 1966; Maijale and Hanna, 1974; Rothschild and Henderson, 1979, Tong *et al.*, 1979; Hoque and Hodges, 1980; Powell *et al.*, 1981 and Weller and Van Vleck, 1986). Cows with higher first lactation performance were likely to remain in the herd longer and produced at a higher rate in later lactations than the lower producers in the first lactation.

The main objectives of this study were : 1) to determine the effect of year and month of calving on each of initial milk yield, 305-day milk yield, total milk yield, lactation period and age at first calving in the first lactation. 2) to determine the relationship between lactation traits and age at first calving, 3) to estimate heritability, phenotypic and genetic correlation coefficients between different traits.

Materials and Methods

Data used in this study were collected from the milk production records of the Friesian dairy herd raised at Sakha farm located in the Northern part of the Delta, Kafr El-Sheikh Governorate, Egypt. They comprised 767 first parity cows born during 1968 to 1977. The number of sires and the harmonice mean of number of daughters per sire were 94 and 7.48, respectively.

Cows of that herd were kept under a regular system of feeding and management adopted by the Research Center, Ministry of Agriculture. Animals were grazing on Egyptian clover (*Trifolium alexandrinum*), Berseem during October to May. During the rest of the year, animals were fed on concentrate mixture along with wheat or rice straw and a limited amount of clover hay when available. Milking cows producing more than ten kilograms of milk per day and pregnant cows over seven months of pregnancy were given extra amounts of concentrate to meet their essential nutritional requirements. Cows were initially inseminated 60-70 days post-partum. Cows were hand-milked twice a day till 1971 and were machine-milked thereafter, and milk yield was recorded individually for each cow by weighing to the nearest kilogram. Heifers were mated for the first time on the basis of their age (not less than 18 months of age) and weight (not less than 350 kg).

Information on individual cows included, date of calving, actual initial milk yield (the amount of milk production during the first two months of lactation), 305-day milk yield, total milk yield and number of days in milk. Records were excluded due to abnormal termination (days in milk less 180, cows died or sold before finishing lactation or cows affected by mastitis or abortion). Further, records on daughters of sires with fewer than 4 daughters were excluded. Due to this restriction a small number (39) of records was excluded. Records from 180 days to 305-day were considered 305-day lactation (Hoque and Hodges, 1980).

The data were analysed by Mixed Model Least squares and **Maximum Likelihood Computer Program** (LSML 76) developed by Harvey (1977). The following mixed model (1) was used to study the effect of year and month of calving as a fixed effect, age at first calving as covaraite and sire as a randem effect on each of initial milk yield (IMY), 305-day milk yield (305 MY), total milk yield (TMY) and lactation period (LP) on the first lactation.

$$Y_{ijkl} = U + t_i + m_j + B_1 (x_{ijk} - \bar{x}) + B_2 (x_{ijk} - \bar{x})^2 + s_k + e_{ijkl}$$

where : Model 1

Y_{ijkl} = the observation lactation trait for the 1th cow ; U = the overall mean ; t_i = fixed effect of the *ith* year of calving ; i= 1 (1968) 2 (1969), ..., 11 (1979) ; m_j = fixed effect of the *jth* month of calving, j= 1 (January), 2 (February), ..., 12 (December) ; B_1, B_2 = a linear and quadratic regression coefficients for IMY, 305-MY, TMY in kilogram and LP in days on age at first calving ; x_{ijk} = average age at first calving of the 1th cow in the sub-classes, $\bar{x}$ = average age at first calving, mo ; s_k = randem effect of the k*th* sire; e_{ijkl} = randem element having expection zero and variance $\sigma^2 e$.

To study the effect of year and month of calving on age at first calving, a similar model (2) was used and B_1 and B_2 were deleted.

In order to obtain a unique solution of the least squres equations, a restrictions was imposed that the sum of all levels of a fixed effect was equal zero.

Due to limitation of the data, many empty cells were found, and it was not possible to calculate the interaction between the main effects.

Estimates of sire σ^2 s and error σ^2 e components of variance and covariance were computed according to Method II of Henderson, (1953). Heritability estimates were calculated from four times the intraclass correlation among half-sibs. Standard error of heritability was calculated using an approximation formula described by Swiger *et al.* (1964). Estimates of genetic correlations with standard errors and phenotypic correlation were obtained by computing techniques described by the LSML 76 program of Harvey (1977).

Results and Discussion

The least squares means of IMY, 305 MY, TMY and LP were 756 ± 8 kg, 2484 ± 33 kg, 3877 ± 51 kg and 363 ± 5 days respectively (Table 1). The present means were higher than those estimated by Ragab *et al.* (1973) which were 639 ± 5 kg, 2304 ± 18 kg, 2712 ± 27 kg and 346 ± 3 days, respectively, using another herd of Friesian cattle at Tahrir province, Egypt. The average AFC was 34 ± 0.5 mo. The estimate of 34.4 mo was reported by Mostagger *et al.* (1987).

Effect of year of calving

The effect of year of calving on the different traits studied were highly significant ($P < 0.01$) except for lactation period (Table 2). A gradual increase in the least squares means from year to year was observed (Table 1). Changes in production from year to year can be attributed to changes in herd size, age of animals and improved maganerial practices introduced from year to year. Gacule *et al.* (1968), Balaine *et al.* (1970), Chaudhary and Chaudhary (1977), Basu *et al.* (1982), Sharma *et al.* (1982), Palia and Arora (1983), Khattab *et al.* (1987) and Maarof *et al.* (1987) in different breeds of dairy cattle, reported a highly significant difference between year of calving on milk yield. Khattab *et al.* (1986) and Ponce and Gomez (1988), working on Friesian cattle, reported that the effect of year of birth on age at first calving was significant.

Effect of month of calving

The month of calving had a highly significant effect on each of IMY and 305 MY, while the different traits were not affected by month of calving (Table 2). Results in the present study (Table 1) showed that cows calving in November and December had higher

TABLE 1. Least squares means and standard errors of different factors affecting initial milk yield (IMY), 3051day milk yield (305-My), total milk yield (TMY), lactation period (LP) and age at first calving (AFG) of Friesian cows in their first lactation.

Classifications	n	IMY		305-MY		TMY		LP		AFG	
		Mean, ±	S.E.	Mean, ±	S.E.	Mean, ±	S.E.	Mean, ±	S.E.	Mean, ±	S.E.
		kg	kg	kg	kg	kg	kg	kg	kg	kg/mo	kg/mo
Year of calving	767	756	8	2484	33	2871	51	363	5	34	0.45
1968	101	539	41	1711	129	1880	223	363	29	22	1.45
1969	106	636	38	2297	118	2574	204	325	27	25	1.38
1970	84	684	35	2337	108	2597	186	353	24	26	1.27
1971	109	689	31	2163	97	2452	167	343	22	31	1.19
1972	105	706	28	2350	90	2526	154	353	20	34	1.11
1973	66	838	33	2596	103	3252	177	341	23	40	1.23
1974	98	842	30	2647	95	3235	164	413	21	38	1.15
1975	45	840	37	2711	115	3360	199	393	26	43	1.37
1976	39	839	39	2813	123	3132	212	394	28	41	1.47
1977	14	953	54	3210	168	3750	291	338	38	42	2.01
Month of calving											
1	69	756	20	2413	64	2795	109	376	14	34	0.81
2	83	748	18	2319	60	2841	101	364	13	34	0.75
3	91	713	17	2268	57	2777	95	385	12	33	0.75
4	93	727	17	2382	56	2811	95	383	12	34	0.72
5	99	740	17	2427	56	2844	95	363	15	35	0.71
6	52	783	22	2583	70	3084	119	370	12	34	0.87
7	82	799	18	2585	58	2969	98	372	17	33	0.73
8	36	776	25	2626	79	2898	136	359	18	34	0.98
9	35	730	26	2485	83	2744	142	346	18	35	1.03
10	34	728	26	2463	83	2692	143	342	19	34	1.03
11	33	787	27	2626	86	2895	148	236	19	35	1.06
12	60	787	26	2627	66	3008	112	354	14	35	0.82
Age of first calving											
Linear		7.04	1.56	17.71	4.80	19.02	8.34	0.23	1.10		
Quadratic		—0.09	0.02	—0.21	0.07	—0.20	0.12	0.001	0.02		

amount of each of IMY and 305 MY, while March and April had the lowest. Cows calving in November and December get Berseem between (Jan-May) throughout their lactation period and they start and continue their lactation in mild climatic conditions. Mostageer *et al.* (1987), working on Friesian cattle in Egypt, reported that autumn calves had higher 305-day milk yield in the first lactation compared with those calving in summer and spring. Moreover, Hardie *et al.* (1978) and Ferris *et al.* (1985) found significant effect of season of calving on milk yield.

Effect of age at first calving

To test the significance of curvilinearity of relationship between AFC and different lactation traits, a polynomial of the third degree curve was filted and yielded a nonsignificant partial cubic regression coefficient of different traits on AFC.

Estimates of partial linear and quadratic regression coefficients of each of IMY and 305 MY on AFC were highly significant ($P<0.01$), Table 2), being 7.05 ± 1.56 kg/mo, and -0.09 ± 0.02 kg/mo^2, respectively for IMY on AFC and 17.71 ± 4.80 kg/mo and -0.21 ± 07 kg/mo^2, respectively for 305 MY on AFC (Table 1). These estimates revealed that the effect of AFC on each of IMY and 305 MY were expressed in a curvilinear. The same pattern was reported by (Lee, 1976; Ashmawy and Mokhtar, 1984 and Sallam *et al.* (1988).

The present results indicated that the maximum IMY and 305 MY were attained when heifers calved at 39 and 42 mo, respectively, using the regression predicted equations (Table 1). Including the linear and quadratic regression coefficients of AFC in the model, resulted in a reduction of 2.9 and 1.9% in the residual mean squares for IMY and MY, respectively.

The partial linear regression coefficient of TMY on AFC was 19.02 ± 0.34 kg/mo), and was significant ($P < 0.01$), while the quadratic term (-0.20 ± 0.12 kg/mo^2, was not-significant (Table 1). Chaudhary and Chaudhary (1977), Sharaby and El-Kimary (1982). Hansen *et al.* (1983), and Ashmawy *et al.* (1986) also found linear relationship between milk yield and age at first calving.

TABLE 2. **Least squares analysis of variance for factors affecting initial milk yield (IMY), 305-day milk yield (305 MY), total milk yield (TMY), lactation period (LP) and age at first calving (AFC).***

Source of variation	d.f.	M.S.				
		IMY	305 MY	TMY	LP	AFC
Sire	93	25530**	336991**	872384**	10777	12.39
Year of calving	9	84159**	1800377**	2722783**	15041	11.74
Month of calving	19	44935**	769873**	575135	10934	1.19
Regressions						
AFC linear	1	383690**	2428310**	2799095**	437	
AFC quadratic	1	293306**	1711670**	1576766	61	

* **Residual mean squares of IMY, 305-MY, TMY and LP were 18725 kg, 178294 kg, 539037 kg and 9367 day, respectively with 651 d.f. and 26 mo for AFC with 653 d.f.**

Sire effect

Differences among sires were significant for all traits except for lactation period (Table 2), and accounted for 4.85, 11.87, 8.25, 2.01 and 17.27% of the total variation in IMY, 305 MY, TMY, LP and AFC. Similar other studies (Harville and Henderson, 1966; Lee, 1974; Bhati, 1980; Basu *et al.*, 1982; Hansen *et al.*, 1983; Ruvuna *et al.*, 1984 and Sallam *et al.*, 1988) reported the importance of sire effect on milk yield. Harvilla and Henderson (1966) and Sharaby and El-Kimary (1982) working on Friesian cattle, found that sire accounted for 18.00 and 6.32 percent of the total variability in AFC.

Estimate of heritability, phenotypic and genetic correlations

The estimate of heritability of IMY was 0.19 ± 0.10 (Table 3).

Estimates of heritability of 305-day milk yield and total milk yield were 0.43 ± 0.12 and 0.31 ± 0.11, respectively (Table 3).

TABLE 3. Heritability estimates, phenotypic and genetic correlation coefficients of different traits in Friesian cows (first lactation).a

Traits	X_1	X_2	X_3	X_4	X_5
Initial milk yield (IMY) X_1	0.19±0.10	0.68	0.45	0.025	0.13
305-day milk yield (305-MY) X_2	1.00±0.12	0.43±0.12	0.77±	0.31	0.12
Total milk yield (TMY) X_3	1.00±0.21	0.94±0.06	0.31±0.11	0.79	0.07
Lactation period (LP) X_4	0.76±0.67	0.44±0.39	0.68±0.24	0.08±0.09	−0.010
Age at first calving (AFC) X_5	0.51±0.22	0.35±0.18	0.14±0.22	−0.46±0.44	0.59±0.14

a The diagonal figures heritabilities, phenotypic and genetic correlation are above and below diagonal.

Rothschild and Henderson (1979) and Swalve and Van Vleck (1966) using first lactation records of Holstein Friesian, reported that heritability of 305-day milk was 0.41 and 0.33, respectively. Our results were less (0.12 to 0.28) than in (Van Vleck and Bradford, 1966; Ragab *et al.*, 1973; Tong *et al.*, 1979; Weller and Van Vleck, 1986; Ali and Schaeffer, 1987, Jager and Kennedy, 1987 and Leroy, 1988).

The heritability estimates of length of lactation period was 0.06 ± 0.09 (Table 3), which is inaccordance with the estimate of 0.06 reported by Abubakar *et al.* (1986) working on Holstein Friesian cattle in Colombia, but is lower than 0.54 ± 0.166 and 0.24 ± 0.07, reported by Ragab *et al.* (1973) and Lin and Alliare (1978) both working on Friesian cattle. The present estimates may indicate the presence of lower genetic variability for lactation period in the Friesian cattle studied.

The heritability estimate for AFC was 0.59 ± 0.14 (Table 3) which was in similarity with the estimate of 0.59 ± 0.14 reported by Sharaby and El-Kimary (1982) on Egyptian buffaloes. Higher heritability estimates for AFC was obtained by different workers in different countries for different breeds of dairy cattle (Nagarcenkar, 1964; Lee, 1974; El-Khidir *et al.*, 1979; Lin and Allaire, 1978; Basu *et al.*, 1982 and Patro and Rao, 1983) all estimates varied between 0.22 to 0.68.

The results indicated that AFC is a moderately heritable character. Gill and Allaire (1975) emphasized that AFC was genetically controlled. Lee (1974) also, noticed that the confounding of year and month of birth with sire effects inflated the sire variance components and accordingly the heritability value of AFC.

The phenotypic correlation between IMY and each of 305-MY and TMY were positive, being 6.68 and 0.45, respectively, but were small for LP (Table 3). Ragab *et al.* (1973 and 1987) on Friesian and Czaplicka and Puchojda (1987) on Polish cattle, arrived at the same results. It could be concluded that IMY could be used for evaluating the milk producing ability in dairy cows. The phenotypic correlation between 305 MY and each of TMY and LP were positive, being 0.77 and 0.31, respectively (Table 3). The high phenotypic correlation of 0.79 was obtained between TMY and LP. The results in Table (3) show that LP much more important than IMY in determining TMY. In other words, cows lactating for the longer time tended to have the higher 305 MY and TMY.

The phenotypic correlations between AFC and each of IMY and 305-MY were low and positive 0.13 and 0.12, respectively, while small for TMY and negative for LP (Table 3). Czaplicka and Puchojda (1987) found that the phenotypic correlation between AFC and 305 MY was 0.15, while Lin and Alliare (1978) and Abubakar *et al.* (1986) found negative phenotypic correlation between AFC and 305-MY (—0.43 and —0.13, resp.).

Most of the genetic correlations estimates obtained between lactation characters (IMY, 305 MY, TMY and LP) were positive and higher than 0.50 (Table 3).

The genetic correlation between IMY and each of 305 MY and TMY were unity, (Table 3). These results are in agreement with similar work on Friesians (Ragab *et al.*, 1973 and 1987 and Ferris *et al.*, 1985). The genetic correlation between 305 MY and TMY was 0.94. The initial milk yield as well as 305 MY are excellent guides to the total lactation yield and could be used as indicators to early selection process.

The genetic correlation between LP and each of IMY, 305 MY and TMY were positive, being 0.76 ± 0.67, 0.44 ± 0.39 and 0.68 ± 0.24, resp. (Table 3). These results indicate that genes associated with long lactation period are correlated with genes favorable for milk production.

The genetic correlation between AFC and LP was —0.14, while the genetic correlation between the former trait and each of IMY, 305 MY and TMY were positive, being 0.51 ± 0.22, 0.35 ± 0.12, resp. (Table 3) Abubakar *et al.* (1986) found negative genetic correlation between AFC and 305 MY.

From the relatively high estimates of heritability for IMY, 305 MY and AFC in Friesian cattle reported heren, it can be concluded that genetic improvement of MY traits can be achieved through selection breeding. Therefore, more research work in this respect is needed on data with larger size.

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تقدير المعايير المظهرية والوراثية لموسم الحليب الاول فى ماشية الفريزيان فى مصر

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قدرت المعايير المظهرية والوراثية لكل من كمية اللبن المبدئى ، كمية اللبن فى ٣٠٥ يوم ، كمية اللبن الكلية ، طول موسم الحليب والعمر عند أول ولاده وذلك باستخدام سجلات الموسم الاول لعدد ٧٦٧ حيوان . بينت طريقة المربعات الصغرى أن تأثير كل من الأب وسنه وشهر الوضع كان معنويا (عند مستوى ١ ٪) على جميع الصفات التى درست فيما عدا تأثير شهر الوضع على كل من طول موسم الحليب والعمر عند اول ولاده .

بلغت قيمة المكافىء الوراثى المقدرة من انصاف الاشعة ١٩ر ± ١٠ر ، ٤٣ر ± ١٢ر ، ٣١ و ± ١١ر ، ٠٨ر ± ٠٩ر ، ٥٩ ± ١٤ر على التوالى لكل من كمية اللبن المبدئى ، كمية اللبن فى ٣٠٥ يوم ، كمية اللبن الكلية طول موسم الحليب ، العمر عند أول ولاده .

كانت جميع معاملات الارتباط المظهرى والوراثى بين جميع الصفات معنويا على مستوى ١٠ر٠ ٪ فيما عدا معامل الارتباط المظهرى والوراثى بين العمر عند أول ولاده طول موسم الحليب حيث كان سالبا وكذلك معامل الارتباط الظاهرى بين كمية اللبن المبدئى وطول موسم الحليب كان صغيرا جدا .