

STUDIES ON FRIESIAN CATTLE IN EGYPT

2- GENETIC FACTORS AFFECTING MILK PRODUCTION

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ABSTRACT

The same previous milk records used in studying the environmental factors affecting milk production (total of 1797 records of 765 cows) were used to study the genetic factors, repeatability, heritability and sire transmitting ability. The results showed that:

1. The phenotypic and genetic correlations between different examined traits were estimated. Repeatability and heritability estimates of total milk yield, 305 days milk yield, lactation period and 90, 180, and 270 days cumulative milk yield were (0.51 and 0.05), (0.45 and 0.02), (0.28 and 0.05), (0.47 and 0.04) and (0.50 + 0.02), respectively.
2. Rank correction between cumulative 270 days / milk yield with each of cumulative 180 and 90 day yield were 0.99 and 0.98, respectively, and between total milk yield with each of 305 day milk yield and lactation period were 0.97 and 0.96 respectively.
3. Sire had highly significant effect on total milk yield, lactation period and cumulative 180 days milk yield and only significant effect on 305 days yield. Cumulative 90 and 270 days yield. While sire had non-significant on all methods for persistency of lactation.
4. Estimating of sire transmitting ability (BLUP) to milk that indicated the actual values of sire transmitting ability for total milk yield ranged between (-530 to 744 kg), 305 days milk yield (-444 to 602 kg), lactation period (-39 to 56 days) and cumulative 90, 180 and 270 days milk yield were -338 to 189, -570 to 387 and -633 to 538 kg, respectively. Additionally, the percentage of sire having positive (BLUP) ranged from 51.5 to 54.5% for the studied different traits. This means that not all the sires could be considered as a way for genetic improvement of the examined traits. Thus the importance of expecting selection the best sire for improving the examined milk yield traits have great value.

INTRODUCTION

In spite of Friesian cattle had been most frequently imported in several tropics countries as a way for improving national production by breeding as pure or by changing the genetic made up of the native cattle, the degree of improvement depends on the genetic performance of the sires to great extent. Thus, the importance of studying the genetic relation and parameters in one hand and the sire breeding values in the other, will lead to exact goal of improving the national milk production.

The present study, make focus on the phenotypic and genetic correlations, genetic parameters of some milk production traits as well as estimating breeding values of production traits of the using to each achieve an efficient breeding program lead to increase the genetic gain.

MATERIALS AND METHODS

Total of 1797 records of 758 cows raised in the El-Shazly private farm , located in Shobratana –Basyon, Gharbia, Governorate , collected during the period from 1985 to 1993 were used in the present study.

The following milk production traits of pure Friesian cattle total milk yield (kgs) (TMY) , 305 days milk yield (kgs) (M305) , lactation period (days) (LP), 90days cumulative milk (kgs) (90DMY) , 180days cumulative milk (kgs) (180DMY) , 270days cumulative milk (kgs) (270DMY) and persistency of lactation (PL) were the basis data for the present study.

The management details of the examined animals were explained in details by Hussein (2000).

Statistical analysis:

Data for the first three lactations were analyzed using least squares and maximum likelihood program of Harvey (1987).

Data of analysis of variance for the examined traits are presented in Table (1).

Table (1): Analysis of variance from mixed model 1.

Source of variation	d.f	Sum squares	EMS
Sire	S-1	$R (\mu, F, S, B) - R (\mu, F, B)$	$\sigma^2_e + K1\sigma^2_s$
Fixed	F-1	$F Z^{-1} F$ (adjusted for sires)	$\sigma^2_e + K\sigma^2_F$
Co-variate	1	$B Z^{-1} B$	$\sigma^2_e + KK^2b$
Remainder	$n-(S+F-1)$	$Y Y - R(\mu, F, S, B)$	σ^2_e

Where:-

R = The reduction in sum of squares,

S = The number of sires,

n = The total numbers of observations,

F = The number of each other fixed effects,

σ^2_e = Variance component between sire groups, estimated from indirect analysis of Henderson (1953) as:

$$\sigma^2_e = (MSe - Mss / K1)$$

and it is equivalent to covariance of parental half-sisters:

σ^2_c = Variance component of between cows within sire.

Accordingly, estimates of sire (σ^2_s) and remainder (σ^2_e) components of variances and covariances were obtained. Genetic variance for each trait was estimated as four times the estimated variances of sire component. Genetic covariance between traits I and j was estimated as four times the estimated sire covariance between the two traits ($4 \sigma^2_{ei, ej}$). Phenotypic covariance was $\sigma^2_{ei, ej} + \sigma^2_{ei, ej}$, where $\sigma^2_{ei, ej}$ is an environmental covariance.

Estimation of genetic parameters:

Model 1 utilized to obtain estimates of variance components for sire (σ^2_s) and remainder (σ^2_e).

The heritability (h^2_s) for each trait was estimated as four times the interclass correlation coefficient between sire groups, i.e.

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

The standard error for heritability was calculated using formula of Becker (1976) as:

$$SE(h^2) = 4 \sqrt{\frac{2(n-1)(1-t)^2 [1+(k-1)t]^2}{k^2(n-s)(s-1)}}$$

Where:

- t = intraclass correlation,
- k = number of progeny per sires,
- n = total number of progeny, and
- s = number of sires.

The repeatability were calculated from the components of variance as follows:

$$R = \sigma^2c / \sigma^2t$$

Where:

- σ^2c is the cow components of variance and
- σ^2t is the total variance, define that as $\sigma^2c + \sigma^2e$

The standard error of repeatability estimate is the square root of σ^2R (Becker, 1976), where:

$$\sigma^2R = \frac{2(1+(k-1)R)^2 \cdot (1-R^2)}{k(k-1)(n-1)}$$

Where:

- n is the number of cows.
- k is the harmonic mean of the number of records per cow, and
- R is the estimate of repeatability.

The following random effects model 1 was assumed to represent an observation:-

$$Y_{ij} = V + c_i + e_{ij}$$

Where:

- Y_{ij} is an observation on j^{th} record made by the i^{th} cow,
- V is an effect common to all observations,
- c_i is the effect of i^{th} cow, and
- e_{ij} is a random error particular to each observation $e \cong (\sigma, \sigma^2e)$.

The phenotypic correlation coefficients (r_P) were estimated according to the formula given by Falconer (1981).

$$r_P = \frac{Cov_e + Cov_s}{\sqrt{(\sigma^2_{e1} + \sigma^2_{s1})(\sigma^2_{e2} + \sigma^2_{s2})}}$$

Where:

- σ^2_{e1} = The remainder component of variance of the 1st trait.
- σ^2_{e2} = The remainder component of variance of the 2nd trait.
- σ^2_{s1} = The sire component of variance of the 1st trait.
- σ^2_{s2} = The sire component of variance of the 2nd trait.
- Cov_e = The remainder component of covariance of the two traits.
- Cov_s = The sire component of covariance of the two traits estimated as $(MCF_s - MCF_e) / K$,
- MCP_s = The mean cross product of sire of the two traits.
- MCP_e = The remainder mean cross product of sire of the two traits.

K = The coefficient of the mean number of cows (daughters) per sire group:

The genetic correlation coefficient (r_G) between any two different traits studied was estimated using the following formula:-

$$r_G = \frac{\text{Cov}_s}{\sqrt{\sigma^2_{s1} + \sigma^2_{s2}}}$$

The symbols were as defined before.

The standard errors of the genetic correlation $SE(r_G)$ was approximately estimated using formula of Tuner and Young (1969) as:

$$\sqrt{SE(r_G)} = \frac{1 - r_G^2}{2} \sqrt{\frac{SE(h^2_1) \cdot SE(h^2_2)}{h^2_1 \cdot h^2_2}}$$

Best linear unbiased prediction (BLUP):

Rewriting the mixed linear model in matrix notation or the linear equation describing the previous mixed models is:

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

Where:

Y = The n x 1 observation (the records),

n = The total number of observation on each trait analysis separately,

X = A fixed and known n x p matrix,

f = An unknown p x 1 fixed vector of fixed effects,

p = Number of levels of fixed effect,

Z = A fixed of known n x q matrix whose elements are equal to zero or one,

s = A q x 1 non observable random vector (some or all of its elements represent breeding values of sires,

q = The number of levels of s,

W = n x 1 covariant regression of Y on W.

b = Vector of partial regression of Y on W.

e = Is an n x 1 non observable random vector (the error vector).

$$E \begin{pmatrix} S \\ e \end{pmatrix} = \begin{pmatrix} O \\ O \end{pmatrix} \quad \text{Var} \begin{pmatrix} S \\ e \end{pmatrix} = \begin{pmatrix} S & G & O \\ e & O & \sigma^2_e \end{pmatrix}$$

Thus, every element of s and e has mean zero. The variance covariance matrix of the elements of s is $G\sigma^2_s$, Where G is a nonsingular, symmetric matrix. In the present study, the elements of s cannot be correlated, in which case off-diagonal elements of G are zero. The elements of a are uncorrelated and have common variance, σ^2_e . It was proved by Henderson (1977 and 1978) that BLUP of all elements of S of equation.

It was also proved by Henderson (1975) that of a generalized least-squares solution. These solutions are called mixed model solution which give a BLUP estimate for each sire. The mixed model equations (Henderson, 1974), are

Where $G = \sigma_e^2 / \sigma_s^2$ or $(4 - h^2) / h^2$ for each trait which was added to the diagonals of sire effect in the matrix. The above matrix model equation are given by:

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The above analysis was carried out to estimate sire and remainder components of variance and to predict sire transmitting abilities for each trait, i.e. Best linear unbiased prediction (BLUP) values for sire for each of the first three lactations were obtained by using at least five daughters per sire.

RESULTS AND DISCUSSION

Estimates of phenotypic correlation between different traits studied are given in Table (2). The phenotypic correlations between total milk yield with both 305 days milk yield and lactation period were 0.76 and 0.66 , respectively , also the phenotypic correlations between 305 days milk yield and lactation period (0.37) was positive and highly significant which were similar to that of Shalaby (1996) , Tag El-Dein (1997) and El-Awady (1998).

Estimates of phenotypic correlation between 90,180 and 270 days cumulative milk yield with each of total milk yield and 30 days milk yield were positive and highly significant and ranged from 0.38 to 0.56 and 0.45 to 0.57 , respectively (table 2) . Nearly similar results were reported by Khattab and Sultan (1990) and Abouel-Anian (1995) . Phenotypic correlation between the first 90 days milk yield with 180 and 270 days cumulative milk yield were positive and highly significant and ranged from 0.90 to 0.84 , respectively , and phenotypic correlation between 180 days cumulative milk yield and 270 days cumulative milk was positive and highly significant (0.97) as shown in table (2) . These results are in agreement with Abouel-Anian (1995) . The present results showed that the performance of cumulative milk yield can be used as a good indicator are production in 305-day milk yield which lead to evaluating the milk producing ability in cows.

Regarding the genetic correlation, Table 2 showed that total milk yield with 305 days milk yield and lactation period (1.21 and 1.004) were highly significant. Additionally, the correlation was highly significant between 305 days milk yield and lactation period (1.18), while they were negative and highly significant with 90,180 and 270 days cumulative milk yield (-0.87, -.32 and -0.23 , respectively) The lactation period was positively highly correlated with 270 days cumulative milk yield (0.10) , and were negatively correlated with 180 days cumulative milk yield (-0.09) and 90 days cumulative milk yield (-0.001) Table (2) .

Table (2): Estimates of phenotypic correlations (above) and genetic correlations (below) between different traits.

Items Traits	Total milk yield (kgs)	305-day milk yield (kgs)	Lactation period (days)	Cumulative milk yield		
				90-days (kgs)	180-days (kgs)	270-days (kgs)
Total milk yield		0.76**	0.66**	0.38**	0.48**	0.56**
305-days milk yield	1.21±0.34**		0.37**	0.45**	0.53**	0.57**
Lactation period	1.004±0.16**	1.18±0.72**		0.05*	0.12**	0.20**
Cumulative milk yield	-0.06±0.72*	-0.87±0.65**	-0.001±0.71		0.90**	0.84**
90 days	0.01±0.57	-0.32±0.66**	-0.09±0.53	1.05±0.16**		0.97**
180 days	0.13±0.76**	-0.23±1.02**	0.10±0.77**	1.14±0.30**	1.10±0.21**	
270 days						

* P < 0.05 ** p < 0.01

Genetic correlation between 90 days cumulative milk yield with 180 and 270 days cumulative milk yield were positive and highly significant 1.14 and 1.05, respectively (Table 2). In the same trend, Abubakar *et al* (1986), Sallam *et al* (1990) and El-Awady (1998) , recorded similar results .This lead to the importance of selection on the basis of 90 days milk yield for more genetic progress than on the basis of the total milk yield . The values of repeatability (Table 3) for total milk yield (0.51) 305 days milk yield ((0.45) and lactation period (0.28) were or less than that recorded by Khattab et al (1994), Tag El- Dein (1997) Khalil *et al* (1994) and Badawy (1994). The repeatability for 90, 180 and 270 days cumulative milk yield it were 0.40, 0.47 and 0.50 , respectively (Table 3) , and were higher than reported by Badawy (1994) (0.17,0-22 and 0.11) , respectively .

Generally, the high repeatability values for milk production traits in the present study lead to the importance of total milk yield, 305 days milk yield and 90,180 and 270 days cumulative milk yield which could be achieved through selections on the other side, while efficient management condition which could improve the lactation period trait. Heritability values of the examined milk traits were clearly low table 3 for the traits total milk yield, 305 days milk yield and 90,180 and 270 days cumulative milk yield . Most of the comparable estimates of heritability values were higher (Abdel-Glil (1996)), Shalaby (1996) , El-Awady (1998) , Tagel_Dein (1997) , Mohamed (1991) and Aly (1995). However, the present estimate heritability of laccation period (0.05) was nearly similar to that of Khattab and Sultan (1990) (0.08) , Badawy (1994) (0.05) and El-Awady (1998) (0.08) , bul it was lower than that of Sallam *et al* (1990) (0.41) Aly (1995) (0.14) , El-Nady (1996) (0-19) and El-Awady (1998) (0.14).Thus , it is clear obvious the lower values of heritabilities in one hand, and from the analysis of variance the effects were either highly or only significant in all examined milk traits except the persistency of lactation Table (3). So it could be mention that in spite of the sire effects in the examined traits, the very lower heritability values make the conclusion sure enough that selection based on the phenotypic merit of animal would not be effective . In the other meaning, the major part of variation in the examined milk traits due to the non-genetic factors which lead to importance of improving management

However, non significant effect of sire on persistency of lactation using all methods of persistency calculation was obtained in (Table 3). The results of Aly (1995) indicated that sire had significant on persistency of lactation.

Table (3) : Estimates of repeatability (R) , heritability (h^2) and sire effects on performance traits in Friesian Cows .

Traits	R ± S.E	h ±S.E	Sire effect
Total milk yield	0. 51±0. 06	1. 05±0. 05	1.98**
305-day milk yield	0. 45±0. 06		1.55*
Lactation period	0. 28±0. 07	0. 02±0. 04	1.76**
Cumulative milk yield:			
Cumulative 90 day milk yield	0. 40±0. 06	0. 05±0. 05	1.48*
Cumulative 180 day milk yield	0. 47±0. 06		1.78**
Cumulative 270 day milk yield	0. 50±0. 06		1.56*
Persistency of lactation	—————	0. 02±0. 04 0. 04±0. 04 0. 02±0. 04	0.73 – 1.16 NS

Highly significant = **

Significant = *

Non - Significant =N. S.

The either highly or only significant relation effect of sire on each of total milk yield, 305 days milk yield , lactation period , and 90 , 180 and 270 days cumulative milk yield traits focusing the light on the important role of sire for improving milk traits. However, the unexpected non-significant effect of sire on persistency may be relatively lead to conclude that sire in the present experiment is not effective to improving persistency of lactation.

From the results of sire evaluation using the procedure of best linear prediction (BLUP) method for each sire had at least 5 daughters (Table 4) it could be noticed that the BLUP estimates of total milk yield ranged from –530 to 744 kg . Relatively 51.5% of the sires had positive BLUP estimates in the total milk yield traits . And the BLUP estimates for 305 days yield ranged from –444 to 602 kg . It is important to mention that relatively about the same value 51.5% of the sires had positive BLUP estimates for 305 days yield as that of total milk yield (Table 4).

Also the BLUP estimates of lactation period ranged from –39 to 56 days and about 54.5% of the sires had positive BLUP estimates for the lactation period The BLUP estimates of sire values for cumulative 90 , 180 , 270 day milk yields , which were –328 to 189 , - 570 to 387 and –733 to 538 kg , respectively . Out of the examined sires 54.5% , 54.5% and 51.5 % of them had positive estimates for 90,180 and 270 cumulative days milk yield , respectively .

So, and by the way it is important to mention some selected references to compare the present results such as Abdel-Gilil (1991 and (1996), Khattab et al (1994) , Abouel-Anian (1995) , Aly (1995) , El Awady (1998) and Badawy and Oudah (1999) .

Thus, the present results showed large genetic differences among sires for milk production traits as well as cumulative milk yield , which lead to the importance of selection one sire than others in the result of high potential as well as improvement in milk yield traits through selection .

Table (4): BLUP estimates of Friesian sires.

Code Sire	No. of Lact.	T.M.Y.	305 M.Y.	L.P.	Cumulative milk yield		
					90 days.	180 days.	270 days.
1	9	282	396	5	40	60	137
2	7	-466	-143	-24	-338	-570	-733
3	5	-530	-444	-10	-71	-139	-123
5	8	125	330	-13	180	378	477
6	7	237	116	11	20	77	199
7	6	498	447	-8	189	387	538
8	5	187	-347	18	-176	-300	-468
12	77	-32	109	2	-12	6	9
18	45	-359	-104	-18	-25	-53	-90
22	5	-310	-234	-14	37	-40	-39
35	37	45	136	-11	16	43	-4
42	17	451	163	29	167	333	464
64	15	566	76	15	174	322	424
18	34	-304	-165	-18	9	-23	-44
87	62	272	292	25	47	59	71
88	5	-120	10	56	-97	-162	-203
94	9	-412	-324	-39	61	99	23
111	54	95	-94	17	-46	-64	-105
122	19	-246	-95	1	-19	1	13
159	6	744	592	33	-155	-178	-84
164	5	-462	-294	-19	-263	-282	-535
165	87	217	15	4	-22	-76	-66
194	43	126	224	21	8	-3	-8
202	14	590	602	22	78	149	214
224	135	-161	-163	5	24	-74	-121
333	118	248	235	9	22	19	43
333	63	-73	-179	3	100	139	136
401	212	-164	-48	-12	-5	53	62
402	258	-293	-180	-20	45	88	70
403	270	-294	-197	-15	-6	15	1
404	12	-315	-221	-13	-13	-21	-67
405	119	10	6	-16	60	146	171
460	31	261	88	24	-28	-75	-42

Rank correlation among expected breeding values of sires :-

Rank correlation among expected values of sires for studied traits were ranged between 0.84 to 0.99 , (Table 5) . The highest rank correlations were found between cumulative 270 days milk yield with both of 90 and 180 days cumulative milk yield , 0.99 and 0.98 , respectively . Thus, in spite of most of the rank correlation values are quite high , the importance of these values specially with the 90 days cumulative milk yield lead to early selection of the site on the basis of this fact .

Table (5): Rank correlations among expected breeding values of sires for total milk yield , 305 days milk yield , lactation period 90 , 180 and 270 days cumulative milk yield .

Traits	Total milk yield (kg)	305-day milk yield (kg)	Lactation period (days)	Cumulative 90-day milk yield (kgs)	Cumulative 180-day milk yield (kgs)
Total milk yield	--				

305-day milk yield	0.97	--			
Lactation period	0.96	0.93	--		
Cumulative milk yield					
90 day	0.90	0.90	0.84	--	
180 day	0.90	0.90	0.84	0.96	--
270 day	0.92	0.92	0.86	0.98	0.99

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دراسات على ماشية الفريزيان فى مصر

٢- العوامل الوراثية المؤثرة على إنتاج اللبن

فايق حسنى حسين فراج^١ ، عادل سيد أحمد البربرى^٢ ، محمد فراج عبد الجليل^٣ ، كمال الدين حسين^٣

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٣ قسم تربية الحيوان - معهد بحوث الإنتاج الحيوانى - وزارة الزراعة - مصر

أجريت الدراسة لمعرفة خصائص إنتاج اللبن والمعايير الوراثية لهذه الصفات وكذلك تأثير الطلائق على هذه الصفات فى ماشية الفريزيان بمزرعة الشاذلى بشيراتانا مركز بسيون محافظة الغربية خلال الفترة من ١٩٨٥ إلى ١٩٩٣ .

وقد تبين أن كل الارتباطات المظهرية للصفات المختلفة موضع الدراسة موجبة وعالية المعنوية فيما عدا طول موسم الحليب فى إنتاج اللبن التجميى خلال ٩٠ يوم كان موجب وعالى المعنوية .

الارتباط الوراثى من إنتاج اللبن الكلى مع كل من ٣٠٥ يوم إنتاج لبن مع طول موسم الحليب وإنتاج اللبن التجميى ٢٧٠ يوم كانت موجبة وعالية المعنوية ولكن مع إنتاج اللبن خلال ٩٠ يوم كانت سالبة ومعنوية ومع إنتاج اللبن التجميى ١٨٠ يوم كانت غير معنوية وكذا الارتباط الوراثى بين ٣٠٥ إنتاج لبن مع طول موسم الحليب كانت عالية المعنوية ومع إنتاج اللبن التجميى ٩٠ ، ١٨٠ ، ٢٧٠ يوم سالبة وعالية المعنوية ويتم الارتباط الوراثى بين طول موسم الحليب مع كل من إنتاج اللبن التجميى ٢٧٠ يوم موجب وعالى المعنوية ومع ١٨٠ يوم سالب وعالى المعنوية ولكن مع إنتاج اللبن التجميى ٩٠ يوم سالب وغير معنوى .

تبين أن المعامل التكرارى والمكافئ الوراثى لصفات إنتاج اللبن الكلى ، ٣٠٥ يوم إنتاج لبن ، طول موسم الحليب ، إنتاج اللبن التجميى ، ٩٠ ، ١٨٠ ، ٢٧٠ يوم كان (,٥١ - ,٠٥) ، (,٤٥ ، ,٠٢) ، (,٢٨ ، ,٠٥) ، (,٤٠ ، ,٠٢) ، (,٤٧ ، ,٠٤) و (,٥٠ ، ,٠٢) على التوالى .

تبين أن تأثير الطلائق على المعنوية على إنتاج اللبن الكلى وطول موسم الحليب وإنتاج اللبن التجميى خلال ١٨٠ يوم ومعنوى على كل من ٣٠٥ يوم إنتاج لبن وإنتاج لبن تجميى خلال ٩٠ ، ٢٧٠ يوم بينما تأثير الطلائق غير معنوى على كل الطرق المقدر بها المثابرة على الحليب .

عند تقدير المقدره العبورية للطلائق عن طريق BLUP وجد أن القيم الفعلية للمقدرة العبورية للطلائق لإنتاج اللبن ما بين - ٥٣٠ إلى ٧٤٤ كجم ، إنتاج اللبن خلال ٣٠٥ يوم - ٤٤٤ إلى ٦٠٢ كجم ، طول موسم الحليب - ٣٩ إلى ٥٦ يوم ، إنتاج اللبن التجميى ٩٠ ، ١٨٠ ، ٢٧٠ يوم كانت - ٣٣٨ إلى ١٨٩ كجم ، - ٥٧٠ إلى ٣٨٧ كجم ، - ٧٣٣ إلى ٥٣٨ كجم على التوالى بينما كانت النسبة المنوية للطلائق الموجبة كانت بين ٥١ ,٥ إلى ٥٤ % للصفات المختلفة تحت الدراسة .

معامل ارتباط الرتب بين إنتاج اللبن التجميى ٢٧٠ يوم مع كل من إنتاج اللبن التجميى ١٨٠ يوم ، ٩٠ يوم كان ٩٩ ,٠ ، ٩٨ ,٠ على التوالى ولكن بين إنتاج اللبن الكلى مع كل من إنتاج اللبن خلال ٣٠٥ يوم وطول موسم الحليب كان ٩٧ ,٠ ، ٩٦ ,٠ على التوالى .