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GENETIC PARAMETERS FOR AGE AT FIRST CALVING AND LIFETIME MILK YIELD TRAITS IN FRIESIAN CATTLE IN EGYPT

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ABSTRACT: *The main objective of the present study was estimating the genetic parameters and breeding values for studied traits. The study was carried out in two farms (Sakha and ElKarada) in Kafr-Elshikh governorate which belong to Animal Production Research Institute - Agriculture research center - Agriculture Ministry. Data covered the period of 27 years from 1981 to 2008 (2940 records, 853 lactating Friesian cows, 104 sires and 689 dams).The studied traits were; age at first calving (AFC), lifetime milk yield traits [Total milk yield(TMY), Total 305 day milk yield (T305), and Total lactation period (TLP]). Fixed effects of farm, year and season of calving on these traits were studied. The overall means of those traits were 35.58 month, 9888 kg, 8750 kg, and 1091 day, respectively. Fixed Effects were significant on four traits except season of calving. Heritability estimates for AFC, TMY, T305, and TLP were 0.26, 0.29, 0.22 and 0.19, respectively. Genetic and phenotypic correlations were positive among studied traits, except AFC with life milk yield traits. Range of predicted breeding values for previous traits were from -10.1 to 13.5 month for AFC, -2077 to 4828 kg for TMY, from -1978 to 4228 kg for T305 and -200 to 424 day for TLP respectively.*

Key words:- *(genetic parameters - age at first calving- lifetime milk yield traits- Friesian cattle)*

INTRODUCTION

Most of dairy cattle in Egypt suffer from insufficiency due to keeping cows with uneconomic production in the herd. Age at first calving considered an important trait in the animal lifetime due to animal productive life start by this trait and also considered an important factor influencing the lifetime productivity. Integration of age at first calving besides lifetime milk yield traits and the relationships are important for effective control of the dairy production system for maximum economic return. However, these traits could be influenced by several factors such as farm, season and year of birth. The objectives of this study were (1) Estimating of overall means for studied traits. (2) Studying the non genetic factors which affecting the lifetime milk yield traits and AFC. (3) Estimating genetic parameters for lifetime milk yield traits and AFC. (4) Estimating predicted breeding values for lifetime milk yield traits and AFC

MATERIALS AND METHODS

Sources of data and management procedures: This study was carried out in two farms; Sakha and Elkarada (Kafr-Elshikh governorate) which belong to Animal Production Research Institute, Agriculture Research Center, Agriculture Ministry Egypt. Cows were fed mainly on berseem and rice straw (from May to November, ration consisting cotton seed cakes, barly wheat and rice bran). In addition concentrates feed mixture from December to April. Mineral mixture bricks were offered adlibitum, and on a balanced ration of a concentrates according to their production and weight. Animals were housed under open sheds. Heifers were bred for the first time at 18-22 months and/or 350 kg body weight. Cows were artificially inseminated not before 60 days of calving using frozen semen. Cows were milked two times a day by milking machine. Milk yield were recorded daily for each milking, cows were usually milked until two months before the next calving and were dried off gradually in complete milking.

Description of traits: Four traits were studied as follow; Age at first calving by months (AFC), Total lactation milk yield by kg (TMY), Total 305 day's milk yield by kg (T305), and Total lactation period by days (TLP)

Description and modifications of data records: 2940 lactation records from 853 cows which were daughters of 104 sires and 689 dam were used in this study.

Fixed effects in the study

Fixed effect of farm: Sakha farm (№ 1) and Elkarada farm (№ 2) fixed effect of season of calving: Winter (№ 1 from October to April), and Summer (№ 2 from May to September). Fixed effect of year of calving throw 23 years for lifetime milk yield traits (from 1982 to 2004). Whereas, age at first calving trait included 22 year (from 1980 to 2001).

Statistical models and programs: SAS (SAS, 2004) and GLM procedures were used to estimate fixed effects on all traits according to the following models.

Age at first calving: Fixed effects were analyzed by GLM procedures according to followed model:

$$Y_{ijkl} = \mu + F_i + Y_j + S_k + e_{ijk}$$

Where; Y= Observations of AFC trait, μ= the herd mean of AFC, F_i = Fixed effect of farm (i = 1 – 2), Y_j =Fixed effect of year of calving (j = 1- 22 year), S_k =Fixed effect of season of calving (k = 1 – 2), and e_{ijkl}=A random error associated with each individual observation (mean=0 and variance= $б_e^2$).

Lifetime milk yield traits: Fixed effects were analyzed by GLM procedures according to followed model:

$$Y_{ijklm} = \mu + F_i + Y_j + S_k + A_l + b_1 (x_{ijklm} - x^{-}) + b_2 (x_{ijklm} - x^{-}) + b_3 (x_{ijklm} - x^{-}) + e_{ijklm}$$

Where; Y=Observations of lifetime milk yield traits, μ=The herd mean of lifetime milk yield traits, F_i fixed effect of the farm (i = 1 – 2), Y_j = fixed effect of the year of calving (j = 1- 23), S_k=fixed effect of the season calving date (k = 1 – 2), A_l = age at first calving, $b_{1,2,3}$=is the partial linear regression coefficients of n trait on AFC, F305 and FLP, respectively, x_{ijklm}= is the AFC, F305 and FLP of the records of trait n for all fixed effects, x^{-} = is the average of AFC, F305 and FLP, and e_{ijklmn} = A random error associated with each individual observation (mean=0 and variance $б_e^2$).

MTDFREML program (Boldman *et al* 1995) was used to estimate genetic parameters, heritability, genetic and phenotypic correlations and predicted breeding values for studied traits. This run carried out according to the followed model: $Y_{ijklm} = \mu + A_i + F_j + Y_k + S_l + e_{ijklm}$

Where; Y_{ijklm}=records of lifetime milk yield and age at first calving trait, μ=Overall mean, A_i= Random effect of the additive genetic effect of the animal, F_j=Fixed effect of the farm, Y_k =Fixed effect of the year of calving, S_l = Fixed effect of the season of calving, and e_{ijklm}=A random error associated with each individual observation (mean=0 and variance =$б_e^2$).

RESULTS AND DISCUSION

Overall means for AFC, TMY, T305, and TLP:

Table (1) revealed that, overall mean for age at first calving was 35±1.16 month and this value was higher than results which reported by Ruiz-Sanchez *et al.* (2007) who found that age at first calving determines the beginning of the cow's productive life and influences her lifetime productivity. It has been proposed that between 22 and 24 month is optimal to minimize dystocia and to obtain adequate milk yield in first lactation.

Table (1) showed significant differences between LSM, for AFC which were 33±0.25 and 32.5±0.19 month for Sakha and ELkarada farm, respectively. These significant differences between two farms may be due to differences in management procedures in two farms, but there were non significant differences between least square means for AFC in two seasons. This may be due to replacing corn silage in summer season by berseem (clover) in winter and concentrate feed in two seasons. Winter

Table 1: Mean of squares (M.S), least squares means (LSM) and standard errors (S.E) for TMY, T305, TLP and AFC.

LSM ± S.E						
Total of Productive Traits						
Items	N	TMY(kg)	T305(kg)	TLP(day)	N	AFC(mo)
Over all means		9888 ± 2965	8750 ± 2504	1091 ± 273	853	35 ± 1.16
Farm (F)						
Sakha	368	$10089^{a}\pm250$	$9193^{a}\pm219$	$1087^{a}\pm27$	368	$33^{b}\pm0.25$
El karada	485	$9688^{a}\pm203$	$8308^{b}\pm183$	$1095^{a}\pm19$	485	$32.5^{a}\pm0.19$
M.S	-	*18291511*	*89333611***	*6733*	-	*31.3*
Season Calving Date (SCD)						
Winter	523	$9835^{a}\pm182$	$8735^{a}\pm155$	$1085^{a}\pm17$	490	$32.8^{a}\pm0.25$
Summer	330	$9941^{a}\pm252$	$8766^{a}\pm215$	$1096^{a}\pm24$	363	$33.2^{a}\pm0.19$
M.S	-	*1464981*	*127371*	*15748*	-	*11.9*
Year Calving Date (YCD)						
1980	-	-	-	-	29	$31^{gf}\pm0.77$
1981	-	-	-	-	45	$32^{edf}\pm0.78$
1982	12	$11121^{a}\pm1121$	$10698^{a}\pm955$	$1297^{a}\pm106$	30	$30^{g}\pm0.74$
1983	33	$10905^{ecd}\pm853$	$10456^{bac}\pm726$	$1254^{ba}\pm81$	49	$33^{ed}\pm0.57$
1984	44	$10328^{efd}\pm616$	$9636^{fdec}\pm525$	$1279^{bac}\pm58$	49	$33^{ed}\pm0.55$
1985	28	$9067^{fg}\pm726$	$8705^{gfeh}\pm718$	$1151^{edfc}\pm69$	32	$36^{ba}\pm1.2$
1986	49	$8530^{fg}\pm539$	$7713^{fg}\pm459$	$1114^{ebdc}\pm51$	41	$33^{ed}\pm0.59$
1987	39	$6798^{h}\pm701$	$6171^{i}\pm597$	$897^{gfh}\pm66$	51	$33^{ed}\pm0.54$
1988	38	$7556^{h}\pm745$	$6728^{i}\pm635$	$779^{egfh}\pm70$	43	$33^{d}\pm0.57$
1989	51	$8590^{hg}\pm570$	$7583^{ih}\pm486$	$1101^{ebdfc}\pm54$	27	$36^{bac}\pm1.07$
1990	44	$10399^{efg}\pm615$	$8998^{gfdeh}\pm524$	$1244^{bdac}\pm58$	21	$35^{a}\pm0.91$
1991	38	$11378^{efcd}\pm655$	$10028^{gfdec}\pm523$	$1260^{bac}\pm62$	42	$34^{bdc}\pm0.68$
1992	18	$13175^{cd}\pm1356$	$12286^{bdac}\pm1155$	$1368^{a}\pm129$	39	31^{egf} ±0..59
1993	27	$9439^{fg}\pm715$	$8360^{gfh}\pm609$	$1071^{egdf}\pm68$	55	$33^{ed}\pm0.52$
1994	50	$8768^{fg}\pm604$	$7903^{gfdeh}\pm514$	$1032^{egdfh}\pm57$	48	$33^{ed}\pm0.54$
1995	50	$10299^{efcd}\pm515$	$9444^{bdec}\pm439$	$1107^{ebdc}\pm49$	49	$33^{ed}\pm0.52$
1996	51	$10482^{efcd}\pm643$	$9200^{gfdec}\pm480$	$1078^{ebdfc}\pm53$	41	$33^{ed}\pm0.57$
1997	46	$11199^{efcd}\pm642$	$9930^{gfdec}\pm546$	$1070^{egfh}\pm61$	42	$32^{ed}\pm0.60$
1998	51	$11175^{bc}\pm505$	$9880^{bac}\pm430$	$1024^{edfc}\pm48$	31	$32^{ed}\pm0.69$
1999	36	$10463^{ba}\pm563$	$8549^{bac}\pm556$	$976^{edfc}\pm62$	49	$33^{d}\pm0.53$
2000	38	$11249^{a}\pm731$	$9127^{ba}\pm623$	$1010^{ebdac}\pm69$	26	$34^{dc}\pm0.77$
2001	34	$11460^{a}\pm692$	$9468^{a}\pm589$	$1120^{bdac}\pm65$	14	$33^{dc}\pm1.19$
2002	40	$9856^{bcd}\pm630$	$7822^{fdec}\pm537$	$992^{edfc}\pm59$	-	-
2003	23	$6817^{efg}\pm796$	$5929^{gfh}\pm678$	$769^{h}\pm75$	-	-
2004	13	$8370^{fg}\pm1231$	$6847^{gih}\pm1049$	$877^{gh}\pm117$	-	-
M.S	-	*575748187***	*47287690***	*404459***	-	*39.9***

and summer were recorded 32.8 and 33.2 months, respectively for the AFC trait. Table 1 showed that, LSM_s for AFC from 1980 to 2001 ranged between 30 month in year 1982 to 36 months in 1985 and 1989. These results considered highest than the literature results which ranged from 24 to 26 months for AFC. This may be due to management procedures and poor nutrition in the government farms. These results were higher than results which reported by Zuzana Riecka *et al.* (2010) who found that mean of AFC in dataset was 28.5 month in Holstein Friesian cattle in Slovak.

Table (1) revealed that, Overall means of TMY, T305, and TLP were 9888±2965 kg, 8750±2504 kg and 1091±273 day, respectively. TMY in Sakha farm was higher than those in Elkarada farm 10089± 250 vs. 9688 ± 203 kg. There were non significant differences between two farms in this trait. Sakha farm had recorded 9193±219 kg in T305 this value was higher than those recorded in Elkarda farm which was 8308±183 kg for the same trait with significant differences. These significant differences may be due to differences in management systems differences between two farms. Sakha farm had recorded 1087±27day in TLP trait and differences were not significant vs. Elkarada farm which recorded 1095±19 day.

Table (1) showed that, there were non significant differences between two seasons in TMY, T305 and TLP. Summer recorded 9941 ± 252 kg, 8766± 215 kg and 1096±24 days for TMY, T305 and TLP, respectively where, winter recorded, 9835± 182 kg, 8735± 155 kg and 1085±17 days for the three traits, respectively. However, differences between two seasons for these traits were non significant. This may be due to uniformity of nutrition procedures in two seasons. In summer concentrates and corn silage were the main sources for nutrition which replaced by berseem and concentrates in winter.

Table (1) showed that, TMY trait was irregular for year of calving and it was not trended. The highest value for TMY was 13175 ± 1356 kg in 1992 where the lowest value was in 1987 which was 6798±701 kg. TMY decreased in the last three years, this may be due to bad management procedures.Whereas, the highest value for T305 was 12286±1155 kg in 1992 whereas the lowest value was 5929 ± 678 kg in 2003. T305 also decreasing in the last three years that was may be due to bad management procedures. In addition, the highest value for TLP was 1368 ± 129 days in 1992 whereas the lowest value was 769±75 days in 2003. Effect of year of calving was highly significant on TMY, T305 and TLP, and there were differences among years and no trended records in these traits. This may be due to there was gap in management systems and climate among years under study.

Genetic parameters for lifetime milk yield traits and AFC trait.

Heritability estimates (h^2)

Table (2) revealed that heritability estimates for AFC was 0.26. This value was moderate, so selection for AFC will improve this trait. This result was higher than those obtained by Ceron-Munoz. (2004) who reported that heritability estimate for AFC for Holstein cattle in Brazil was 0.19, whereas in Colombia, was 0.13.

Table (2) showed also that, heritability estimate for TLP trait was 0.19, this value considered moderate and selection for total lactation period will improve this trait. This result was higher than those obtained by Volema, *et al.* (1996) who found that heritability estimates of number days of lactation were near 0.08. On the other hand this result was lower than result which obtained by Baker *et al.* (2004) who found that, heritability estimate for lactation length in Brown Swiss cattle was 0.27±0.03

Table (2) mentioned that, heritability estimate for TMY trait was 0.29, this value considered moderate, so selection for high TMY will improve this trait. The same results were obtained by Johnson and Corley (1960) who found that, Heritability estimates were ranged from 0.20 to 0.40 for total milk yield in different breeds of dairy cattle in the United States. The same result was obtained by Cruickshank *et al.* (2002) who found that, estimate of heritability for milk yield trait were 0.31.

Table (2) revealed that, heritability estimate for T305 was 0.22. This value considered moderate, so selection for high total 305 day milks yield will improve this trait. The same result was obtained by Baker *et al.* (2004) in Holstein Friesian cattle which was 0.22±0.06. This result was higher than those obtained by the same authors who found that, heritability estimates for 305 days milk yield was 0.37±0.03 for Brown Swiss. However, Atil and Khattab (2005) reported that, heritability estimate for 305 days milk yield was 0.2 in Holstein Friesian cows in turkey.

Table 2: Heritability (h^2) diagonal, genetic correlation (r_g) below diagonal and phenotypic correlation (r_p) above diagonal for lifetime milk yield traits and AFC

Traits	AFC	TLP	TMY	T305
AFC	0.26±0.09	-0.11	-0.07	-0.05
TLP	-0.89±0.22	0.19±0.08	0.90	0.89
TMY	-0.73±0.20	0.96±0.03	0.29±0.08	0.95
T305	-0.82±0.22	0.99±0.03	0.99±0.01	0.22±0.08

Genetic correlation (r_g)

Table (2) showed that genetic correlation between AFC and T305 was -0.82. This result considered high and negative, so any increasing in AFC trait will decrease T305 trait. Genetic correlation between AFC and TMY was -0.73. This result considered high and negative, so increasing in AFC trait will decrease TMY trait. The same result obtained by Ruiz-Sanchez *et al.* (2007) who reported that the genetic correlation between AFC and TMY were negative regardless of herd level. The genetic correlations were −0.44 in the complete data set, −0.31 low-level herd class, and −0.52 in the high-level herd class ($P < 0.001$). Genetic correlation between AFC and TLP was -0.89 this result considered high and negative so increasing in AFC trait will decrease total lactation period.

Phenotypic correlations (r_p)

Table (2) revealed that phenotypic correlation between AFC and TLP was -0.11 this value considered low and negative, so increasing in AFC will followed by small decreasing in total lactation period. While phenotypic correlation between AFC and TMY was -0.07, this value considered low and negative. So, that increasing in AFC will be followed by small decreasing in TMY. Phenotypic correlation between AFC and T305 trait was -0.05 this value considered low and negative so, any increase in AFC will decrease T305.

Predicted breeding values

Predicted breeding value for AFC was ranged from -10.1 to 13.5 month. This rang was higher than the rang which obtained by Atil and Khattab (2005), who found that rang of breeding value for AFC was from -5.1 to 8.7 month. Predicted breeding values for TMY, T305 and TLP ranged from -2077 to 4828 kg, from -1978 to 4228 kg and -200 to 424 day respectively.

Rank correlations among breeding values for studied traits

Spearman correlations among breeding values of AFC and lifetime milk yield traits were estimated (Table 3). Which, showed that, rank correlation coefficients among breeding values of AFC and breeding values of TLP, TMY, and T305 were -0.87, -0.71, and -0.80, respectively. All correlation values were high and negative so these results indicate that selection of low breeding value of AFC for limited value will improve lifetime milk yield traits. All correlation coefficients among breeding value for lifetime milk yield traits were high and positive so those results indicate that selection of one of them will improve other traits of lifetime milk yield.

Table 3: Rank correlations among breeding values for studied traits.

Traits	AFC	TLP	TMY
AFC	-	-	-
TLP	-0.87	-	-
TMY	-0.71	0.96	-
T305	-0.80	0.99	0.99

Conclusion

Heritability estimates for AFC, TLP, TMY and T305 were moderate so these traits will improve by selection. Phenotypic correlation between AFC and total milk yield, total lactation period and total 305 day were negative and moderate whereas genetic correlations were negative and high so increasing in AFC will follow by decreasing in TMY, T305 and TLP. All correlation coefficients among breeding value for lifetime milk yield traits were high and positive so those results indicate that selection of one of them will improve other traits of lifetime milk yield.

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المعايير الوراثية لصفة العمر عند أول ولادة وصفات إنتاج اللبن طوال الحياة الإنتاجية لماشية الفريزيان فى مصر

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الملخص العربى

تمت هذه الدراسة علي قطيعين من ابقار الفريزيان بمحطتى سخا والقرضا بمحافظة كفر الشيخ التابعتين لمعهد بحوث الإنتاج الحيوانى بمركز البحوث الزراعية وزارة الزراعة- مصر. تم تجميع ٢٩٤٠ سجل حليب على مدار ٢٧ سنة فى الفترة من سنة ١٩٨١ إلى ٢٠٠٨ لعدد ٨٥٣ بقرة فريزيان منسبة ل ١٠٤ طلوقة و٦٨٩ أم من هذه الأبقار هذه السجلات غطت الفترة من ١٩٨٤ وحتى ٢٠٠٨ وتم دراسة صفة العمر عند أول ولادة وصفات الحياة الإنتاجية للأبقار والتى شملت الصفات التالية:-(١) العمر عند أول ولادة بالشهر (٢) إنتاج اللبن الكلى لجميع مواسم الحليب بالكيلوجرام (٣) إنتاج اللبن الكلى فى ٣٠٥ يوم لجميع مواسم الحليب بالكيلوجرام (٤) طول فترات الحليب الكلية لجميع مواسم الحليب باليوم

وكان الهدف من الدراسة هو تقديرتأثيرالعوامل الثابتة المؤثرةعلي الصفات تحت الدراسة مثل تأثير المزرعة(سخا و القرضا) و تأثير سنة الولادة وكذلك تأثير فصل الولادة (الشتاء والصيف). حيث أظهرت النتائج أنه كان للمزرعة تأثير معنوى على جميع هذه الصفات تحت الدراسة وكذلك سنة الولادة. أما فصل الولادة كان تأثيره غير معنوى على جميع الصفات.

تم تقدير المتوسطات العامة لجميع الصفات تحت الدراسة وهى العمر عند أول ولادة - إنتاج اللبن لجميع مواسم الحليب - إنتاج اللبن الكلى فى ٣٠٥ يوم وطول فترات الحليب الكلية لجميع مواسم الحليب وكانت كالاتى:-٣٥,٥٨ شهر - ٩٨٨٨ كجم - ٨٧٥٠ كجم - ١٠٩١يوم على التوالى.

- تم تقدير المكافئ الوراثي لجميع الصفات تحت الدراسة وكانت كالاتى: ٠,٢٦ - ٠,٢٩ - ٠,٢٢ - ٠,١٩ للعمر عند أول ولادة وإنتاج اللبن الكلى لجميع المواسم وإنتاج اللبن الكلى ل ٣٠٥ يوم حليب لجميع المواسم وطول فترات الحليب الكلية لجميع المواسم على التوالى.

قدرت معاملات الإرتباط الوراثى والمظهرى بين الصفات المدروسة وكانت معنوية وموجبة بين كل الصفات تحت الدراسة فيماعدا إرتباط العمر عند أول ولادة بجميع صفات الحياة الإنتاجية للأبقار. حيث كانت الارتباطات سالبة .

قدر معامل الإرتباط الوراثى لصفة العمر عند أول ولادة وصفات إنتاج اللبن الكلى لجميع المواسم وإنتاج اللبن الكلى ٣٠٥ يوم حليب وطول فترات الحليب الكلية لجميع المواسم كانت - ٠,٧٣ - -٠,٨٢ - ٠,٨٩ على التوالى.بينما قدر معامل الإرتباط المظهرى لصفة العمر عند أول ولادة ونفس الصفات السابقة بـــ -٠,٠٧ - -٠,٠٥ - -٠,١١ على التوالى.

تم تقدير القيم التربوية للصفات تحت الدراسة والتى تراوحت قيمها بين :-١٠,١ إلى ١٣,٥ شهر لصفة العمر عند أول ولادة و من -٢٠٧٧ إلى ٤٨٢٨ كجم لصفة إنتاج اللبن لجميع مواسم الحليب و من - ١٩٧٨ إلى ٤٢٢٨ كجم لصفة إنتاج اللبن الكلى فى ٣٠٥ يوم حليب ومن -٢٠٠ إلى ٤٢٤ يوم لصفة طول فترات الحليب الكلية لجميع المواسم على التوالى.

تم تقدير معامل سبيرمان للإرتباط بين القيمة التربوية لصفة العمر عند أول ولادة و القيم التربوية لصفات طول فترات الحليب الكلية وإنتاج اللبن الكلى وإنتاج اللبن الكلى فى ٣٠٥ يوم حيث كان -٠,٨٧ - -٠,٧١ - -٠,٨٠ - على التوالى

كانت باقى الارتباطات بين القيمة التربوية لصفات الحياة الانتاجية موجبة وعالية مما يوضح امكانية الانتخاب لتلك الصفات من خلال الانتخاب لاحداها.

و خلصت الدراسة لان قيم المكافئ الوراثى لصفات الحياة الانتاجية لابقار الفريزيان و كذلك صفة العمر عند اول ولادة متوسطة و عليه يمكن تحسين تلك اصفات بالانتخاب. كما ان الارتباطات الوراثية و المظهرية بين صفة العمر عند اول ولادة و صفات الحياة الانتاجية سالبة و كذا معامل سبيرمان للارتباط بين القيم التربوية مما يوضح ان طول العمر عند اول ولادة يؤدى لقصر طول فترات الحليب الكلية لجميع المواسم (TMY) و(T305).