J. Agric. Sci. Mansoura Univ., 30 (7): 3637 - 3653, 2005

GENETIC EVALUATION FOR MILK PRODUCTION, REPRODUCTION TRAITS AND PERSISTENCY OF LACTATION USING SINGLE- AND TWO-TRAIT ANIMAL MODEL ANALYSES FOR FRIESIAN COWS IN COMMERCIAL HERDS IN EGYPT

Shalaby, N. A.

Animal Production Department, Faculty of Agriculture, Mansoura University, El-Mansoura, Egypt. E-mail: zedan121@yahoo.com

ABSTRACT

A total of 1293 normal first lactation records of Holstein Friesian cows were collected from two commercial dairy herds during the period from 2000 to 2003. Genetic parameters and breeding values for productive, reproductive traits and persistency of lactation were analyzed by using single-trait and two-trait animal model analyses of each reproduction, persistency and age at first calving traits jointly with milk yield. Traits studied were total milk yield (TMY, kg), 305-day milk yield (305-d MY, kg), 70-day milk yield (70-d MY, kg), days in milk (DIM, days), calving interval (CI, day), the days open (DO, day), age at first calving (AFC, month) and persistency of milk yield (Per MY). Spearman rank correlations between EBVs for traits studied from single-trait and two-trait analysis with milk yield were estimated. Unadjusted means of AFC, DO, CI, Per MY, DIM, 70-d MY, 305-d MY and TMY were 27.7 month, 162.7, 430.2 days, 0.822 unit, 353.9 days, 1870, 5546 and 6733 kg, respectively. Therefore, the Holstein dairy farming system can show high production performances under adequate management with lower reproductive efficiency under production system of commercial herds in Egypt.

Estimates of heritability of AFC, DO, CI, Per MY, DIM, 70-d MY, 305-d MY and TMY were 0.19±0.075, 0.11±0.064, 0.12±0.066, 0.08±0.052, 0.27±0.091 0.32±0.105, 0.34±0.107 and 0.28±0.139, respectively, using single-trait analysis. Some minor differences were observed in heritabilities obtained from single versus two-trait genetic.

The genetic and phenotypic correlations between milk yield traits (TMY, 305-d MY and 70-d MY) and fertility traits (CI and DO) showed to be medium to high positive (undesirable) of Holstein Friesian cows under the commercial herds in Egypt. The phenotypic correlations between age at first calving and each of DO and CI were negative (-0.19 and -0.35, respectively), however, the genetic correlations between the same traits were positive (0.74±0.19 and 0.85±0.18, respectively). The phenotypic correlation between age at first calving and persistency of lactation was negative and close to zero (-0.07), however, the genetic correlation between the same traits was positive (0.12±0.20).

The range of breeding values obtained from single-trait analysis of all pedigree animals for AFC, DO and CI were 5.02 month, 99.71 and 105.38 days, respectively. While, the range of sire breeding values were 4.86 month, 61.59 and 106.46 days, respectively. The percentage of number of sires (animals) which had negative breeding value estimates (EBVs %) for reproductive traits and persistency of lactation ranked differently between the two analyses. Higher standard deviations of breeding values were obtained for two-trait than single-trait analyses, indicated the existence of more genetic variation among sires (animals) and hence increase the possibility of sire selection for daughter fertility. Lower correlations (differed from unity) between breeding values estimated by single-trait and the others by two-trait analysis with milk yield indicated that large re-ranking of sires would be noticed between the two methods. The present findings confirm the antagonistic relationship of milk yield with reproduction under high producing Holsteins under production system of commercial herds. Also, the sire and cow evaluations for fertility must be taken into consideration and subsequently incorporated into a multi-trait selection index. This will help the farmers to select the best heifers based on a combination of production, fertility traits and persistency of lactation.

Key words: Egypt, Holsteins, commercial herds, single and multi-trait animal model, genetic parameters, breeding value.

INTRODUCTION

Dairy production plays an important role in Egypt's agriculture. The Holstein dairy farming system can show high production performance under adequate management, especially under commercial production system in Egypt. Genetic aspects of reproductive performance of dairy cattle have been received increasing research attention. The genetic antagonism between production and reproduction traits is becoming evident in higher culling rates, especially high yielding cows being at risk for involuntary culling for health and reproductive disorders (Vollema, 1998). Such involuntary culling leads to lower lifetime production and increased replacement costs. Although, the genetic correlation between fertility and milk production traits is generally established to be antagonistic, their association is influenced by level of production and management (Royal *et al.*, 2002, Haile-Mariam *et al.*, 2003). This suggests that successful selection for higher yields may have led to a decline in fertility. The main reason for the antagonistic relationship of milk yield with reproduction and health is assumed to be that cows produce at a maximum level at the time when they are expected to show estrous and conceive. Early in lactation, cows are usually in negative energy balance, which means their need to mobilize body reserves to meet the increased nutrient demand for milk yield (Haile-Mariam *et al.*, 2003). At the same total yield, cows with lower peak yield and greater persistency may experience less energy imbalance and thus less reproductive and health problems than cows with higher peak yield. Reports indicate that cows with higher milk yield during early lactation and cows with higher genetic merit for milk yield also have longer service periods than do cows with mean yield during early lactation (Chauhan *et al.*, 1994).

Milk yield can be included as a covariate in the analysis of fertility, but that can only correct reproductive measures with respect to phenotypic differences in milk yield level. A multi-trait analysis of fertility with milk yield as an additional trait is a different approach which aims to improve accuracy of genetic evaluations for the traits involved by reducing variances of prediction error of estimated breeding values (Schaeffer, 1984).

Therefore, the main objectives of the current study were: (1) to evaluate the productive, reproductive traits and persistency of lactation of Holsteins under commercial herds in Egypt, (2) to estimate heritability (h^2) as well as genetic and phenotypic correlations among milk production, persistency of lactation and reproduction traits by using multi-trait animal model, (3) to estimate breeding values for these traits which obtained from single-trait and multiple-trait evaluations and (4) to compare breeding values for reproduction traits and persistency of lactation from single-trait evaluation and multiple-trait evaluation of these traits with milk yield as a correlated trait using the first lactation records of commercial Holstein Friesian cows in Egypt.

MATERIALS AND METHODS

Data of productive and reproductive records of Holstein Friesian cows were collected from two commercial dairy herds. Both herds are situated in Cairo-Alexandria desert road named Green Land or Delta Masr which far from Cairo by about 80 km and Alex-Kobenhagen farm which far from Alexandria by about 78 km.

Records for 1293 cows (sired by 76 sire) completing their first lactation during the period from 2000 to 2003 were collected. Edits were performed to remove records that were incomplete, had errors in sire identification, and for sire having less than five daughters. The sires are totally differs from herd to another.

The cows were fed, *ad libitum*, total mixed ration (TMR) that based on good quality corn silage and soybean meal (contained about 18-19 % crude protein). The TMR composition was kept constant around the year. Cows were machine milked three times daily at 0600. 1400 and 2200 h. in herringbone parlor. Recording system used in two farms was computer program system (Dairy cattle comp.). Milk yield was recorded individually at each milking for three days per week, then daily and weekly milk averages were calculated for each cow. Calves were suckled colostrums of their dams for three days after birth, and then they were separated. The cows were dried at two months before the next calving.

Heifers were inseminated when they reached an average of 350 kg body weight. Estrus was detected by visually monitoring cows for thirty minutes a.m and p.m near predicted estrus. Cows exhibiting estrus after day 60 postpartum were mated via artificial insemination. Insemination took place approximately 12 h after a cow was first observed standing for mounting. Pregnancy diagnosis via rectal palpation was performed on day 60 after the last service. Traits studied were total milk yield, 305-day milk yield, 70-day milk yield, days in milk, calving interval, days open, age at first calving and persistency of milk yield (measured as partial yield (days 121 – 210) divided by partial yield (days 31 – 120) as reported by Danell (1982).

The statistical analyses were performed using the MTDFREML (multivariate derivative free restricted maximum likelihood, Boldman *et al.*, 1995) program. Models for single and multiple trait evaluations were as follows:

$$Y_{ijklm} = \mu + A_i + F_j + YR_k + S_l + \beta\ \text{age} + e_{ijklm}$$

Where, μ is overall mean, A_i is the random additive genetic effect of i^{th} animal, F_j is the fixed effect of j^{th} farm (j= 1, 2), YR_k is the fixed effect of k^{th} year of calving (k= 1, 2.... 4) 1=2000..... 4=2003, S_l is the fixed effect of l^{th} season of calving (l= 1, 2....4) 1=Winter..... 4= Autumn, β is the regression coefficient for age at first calving and e_{ijklm} is measurement error. Initial analyses of each trait were conducted using a single trait animal model. The vector presentation of this model is: $Y = Xb + Zu + e$

where, Y is the vector of observations for all traits, b is a vector of common fixed effects due to farm, test batch and breed, u is a vector of random genetic effects and e is a vector of residuals and X and Z are incidence matrices relating observations to the fixed and animal effects, respectively. Firstly, single-trait animal model analyses for all traits, secondly, two-trait animal model analysis of each reproduction, persistency and age at first calving traits jointly with milk yield.

Mixed-model equations in the analyses were solved iteratively. Based on the variance of the log-likelihood function values, the convergence criterion was 1×10^{-9}. In addition, several restarts were necessary until changes in the log-likelihood function values were less than 1×10^{-5}. Restarts were performed for all analyses, using the final results of the previous analysis, in order to locate the global maximum for the log likelihoods. Starting values for variance components for two-trait analyses were obtained from single-trait analyses on individual traits. Best linear unbiased prediction (BLUP) of estimated breeding values (EBVs) were obtained by back-solution using the MTDFREML program for all animals in the pedigree file for single-trait and two-trait analysis with milk yield. The standard error for the genetic correlation was calculated as described by Falconer and Mackay (1996). Additionally, Spearman rank correlations between EBVs for traits studied from single-trait and two-trait analysis with milk yield were estimated.

RESULTS AND DISCUSSION

Unadjusted means and standard deviations for eight traits studied in first lactation of two Holstein commercial herds under Egyptian conditions are shown in Table 1. The obtained TMY (6733 kg) was considerably higher than those reviewed for other herds of Holstein Friesian cattle in Egypt (2929 to 5076 kg; Shalaby *et al.*, 2001, Ibrahim *et al.*, 2002, Farrag *et al.*, 2000, and Khattab *et al.*, 2000). Also, the present mean of 305-d MY (5546 kg) was higher than those reported by Ashmawy and Khalil (1990) (4295 kg) and Atil and Khattab (2005a) (4642 kg). The average lactation milk yields found in present study mainly reflects good management levels of Holstein commercial herds under Egyptian conditions. Commercial producers follow an intensive system of production, depending on the high productivity of the animals, and incorporate the latest feed and management technology in this industry. Therefore, the Holstein dairy farming system can show high production performances under adequate management. Milk production of European breeds in sub-tropical regions can be problematic, if environmental conditions are not ideal. The present study indicated that the Holstein dairy farming system in commercial herds in Egypt can show high production performance under adequate management.

Results of reproductive performance of cows under commercial production system are comparatively high values (unfavorable). The means days open interval of 162.7 day in this study is longer than that reported by Shalaby *et al.* (2001) (141 day), Ibrahim *et al.* (2002) (151.7 day), Grosshans *et al.*(1997) (101.1 day) and Kadarmideen *et al.*(2003) (107 day), but was slightly lower than that estimated by Dematawewa and Berger (1998) (169.3 day). Consequently, the present mean of CI (430.2 day) was longer than that found by Shalaby *et al.* (2001) (422 day), Atil and Khattab (2005b) (390 day), Grosshans *et al.* (1997) (375.8 day) and Kadarmideen *et al.* (2003) (387 day). Higher value of days open reported in the present study (lower reproductive efficiency) indicated that higher producing cows are more likely to be in negative energy balance when re-breeding is attempted.

Table 1: **Unadjusted means ($\bar{x}$), standard divisions (S.D) and coefficients of variation (C.V %) for milk production, reproduction and persistency traits.**

Traits	Abbreviations	$\bar{x}$	S.D	C.V%
Age at first calving (month)	AFC	27.7	3.8	13.7
Days open (day)	DO	162.7	110.4	67.9
Calving interval (day)	CI	430.2	84.5	19.6
Persistency of lactation	Per MY	0.822	0.143	17.4
Days in milk (day)	DIM	353.9	93.5	26.4
Initial milk yield (Kg)	70-d MY	1870	488.4	26.1
Milk yield in 305 days (Kg)	305-d MY	5546	2030	36.6
Total milk yield (Kg)	TMY	6733	3026	44.9

Age at first calving was used as a measure of heifer fertility and the earliest measurable fertility trait. The mean of AFC was lower than that reported by Ashmawy (1986) (32 month), Atil and Khattab (2005a) (28.8), and Khattab and Sultan (1990) (31.3 mo). In this respect, Thompson *et al.* (1983) found that problems of parturition increased significantly when AFC is less than 22 mo. However, Simerl *et al.* (1992) reported that the frequency of dystocia was greater in the young (<24 mo.) or old (>27 mo.) heifers, partially explaining the detrimental effect of early calving on yield.

Cumulative milk production during first 70 days of lactation period was higher and presented 27.8% of TMY. Selection for production has led to a greater dependence on body tissue mobilization to support milk production in early lactation, as intake is not sufficient to sustain lactation in this period (Veerkamp, 1998). This suggests that minimizing negative energy balance in early lactation will have beneficial effect on subsequent reproductive performance by selection of persistency of lactation. This study confirms that cows with higher yield during early lactation have longer DO and that longer DO increases subsequent yield

This study revealed that many of the productive and reproductive traits are characterized by wide ranges of values and high coefficients of variation (ranged from 13.7 to 67.9%). Such large coefficients of variation are indicative leaders for opportunities for improvement in these traits. Holsteins in commercial herds in Egypt are showing high production performance under adequate management. However, milk production and reproduction of Holstein cows can be problematic if the environmental conditions are not ideal. Genetic problems are already evident as result from selection only for milk production traits, having a negative effect on reproduction (Royal *et al.*, 2002, Haile-Mariam *et al.*, 2003).

Heritability

Heritability estimates and their standard errors for milk production, reproduction and persistency traits obtained from single- and two-trait genetic analyses (with milk yield as a correlated trait) in the first lactation are shown in Table 2. Single-trait analysis of the data gave an estimate of 0.19±0.075 for the heritability of AFC. The heritability estimated in this study fall within the range of the available reported estimates in the literature. Published estimates of the heritability of AFC in Holsteins range from 0.05 (Seykora and McDaniel, 1983) to 0.75 (Atil and Khattab, 2005a). Ojango and Pollott (2001) reported that a heritability estimate of 0.38±0.09 was obtained for AFC. They also concluded that AFC is economically important because it determines when an animal begins its productive life and hence could influence the lifetime productivity of an animal. Grosshans *et al.* (1997) found that heritability estimate for AFC was 0.13±0.011. The moderate heritability estimated herein for AFC, the genetic improvement can be achieved through selection for this trait.

Table 2: Heritabilities (h^2) of milk production, reproduction and persistency traits obtained from single- and two-trait genetic analyses (with milk yield as a correlated trait).

Traits	Single-trait model h^2± S.E	Two-trait model h^2± S.E
AFC	0.19±0.075	0.18±0.056
DO	0.11±0.064	0.13±0.016
CI	0.12±0.066	0.13±0.068
Per MY	0.08±0.052	0.10±0.043
DIM	0.27±0.091	0.26±0.088
70-d MY	0.34±0.107	0.31±0.102
305-d MY	0.32±0.105	....
TMY	0.28±0.139	....

The CI is traditionally the predominant measure of reproduction during the productive life of the animal, particularly in dairy cattle (Rege and Famula, 1993), and it can be considered a good indicator of cow fertility because of the high correlation between CI and several direct measures of fertility (Grosshans et al, 1997; Pryce *et al.*, 1998). Minor difference was found between heritability estimate of CI (0.12±0.066) and DO (0.11±0.066) in the first parity (Table 2). The heritability estimate of CI was somewhat higher than those reported by Atil and Khattab (2005b) (0.09), Haile-Mariam *et al.* (2003) (0.04), Wall *et al.* (2003) (0.033), Kadarmideen *et al.* (2000) (0.022), and Pryce *et al.* (1997) (0.053). The heritability of DO reported herein (0.11) was higher than estimates reported by Abdallah and McDaniel (2000) (0.03), Weigel and Rekaya (2000) (0.058), and Pryce *et al.* (1997) (0.041), Hayes *et al.* (1992) (0.10). The heritability of DO obtained in this study was slightly higher than 0.12 estimate of Dematawewa and Berger (1998) for DO in first lactation. Higher hertabilities for fertility traits measured in this study might be due to that cows in the first lactation are more affected by stress factors and thereby the genetic differences among progeny groups are more strongly expressed, Hodel et al (1995) came to the same conclusion. Genetic variation between animals in fertility traits do exist which can be used for selecting superior animals for breeding. Similar findings have also been reported by Kadarmideen *et al.* (2000). The improvement of fertility traits could be achieved through better management besides genetic selection.

A heritability estimate of 0.08±0.052 was obtained for Per MY (Table 2). Haile-Mariam *et al.* (2003) found somewhat similar a h^2 of 0.09 for Per MY. Muir *et al.* (2004) and Van der Linde *et al.* (2000) reported that heritability of Per MY was 0.18. Heritability of lactation Per MY in first lactation, calculated as a by-product of random regression modeling of test day yields, was much higher "0.30" (Jamrozik *et al.*, 1998). Heritability of Per MY seems to be differing according to the measure used.

Some minor differences were observed in heritabilities obtained from single versus two-trait genetic analyses (Table 2). In this respect, Schaeffer (1984) compared accuracies of single- and multiple-trait analyses of milk and fat yields and concluded that genetic and residual correlations between traits affect the choice of analysis and are more important than the number of animals. He argued that multiple-trait analysis of milk and fat yields would reduce prediction error variance no more than 5% because heritabilities are similar and differences between error and genetic variances are small. Similar findings have also been reported by Costa *et al.*, (2000) and Kadarmideen *et al.* (2003). Also, Dechow *et al.*, (2001) reported that adding milk yield as a covariate in the model is a totally different approach from a multi-trait analysis. They added that the covariate option essentially corrects fertility record for milk yield. Whereas, multi-trait approach considers milk yield as a correlated trait and aims to improve accuracy of genetic evaluations and reduce effects of culling or selective treatment bias (practiced on either fertility or milk yield or both) on genetic evaluations.

Genetic and phenotypic correlations

Estimates of genetic and phenotypic correlations among traits with bivariate analysis are summarized in Table 3. The genetic and phenotypic correlations between milk yield traits (TMY, 305-d MY and 70-d MY) and fertility traits (CI and DO) were shown to be medium to high positive (undesirable) at first lactation. These estimates indicated that higher-yielding animals were associated with more DO and hence longer calving intervals. The main reason for the antagonistic of milk yield with reproduction and health is assumed to that cows produce at a maximum level when they are expected to show oestrous conceive. The effect of high milk production on the incidence of reproductive disorders may be related to the degree to which energy balance becomes negative in the early postpartum period. During early lactation, many high producing cows are unable to consume enough feed to meet their energy demands, which could result in reduced reproductive performance (Gröhn *et al.*, 1994). Therefore the selection for initial milk yield or peak milk yield did not usefully tool to improve reproduction traits. In this respect, Solkner and Fuchs, (1987) reported that the effort to minimize the negative effect of selecting for milk yield on fertility and health traits might be helped by considering Per MY. A related advantage of improved Per MY may be that more persistent cows with lower peak yield can be fed on cheaper diet (increased roughage proportion) than cows with higher peak yield. Pryce *et al.*, (1998) concluded that when selecting for milk yield alone, the CI prolong by 5 to 10 days per 1000 kg milk. Although the correlation between fertility and milk traits is generally established to be the antagonistic, association is influenced by level of production management (Juarez *et al.*, 2000). Results from this study revealed an antagonistic relationship between milk production and reproductive performance under the commercial herds in Egypt. This agreed with many other studies (Grosshans *et al.*, 1997; Dematawewa and Berger, 1998; Kadarmideen *et al.*, 2000; Roxström *et al.*, 2001; Haile-Mariam *et al.*, 2003). Results from this study revealed that sire and cow evaluations for fertility must be calculated and subsequently incorporated into a multi-trait profit index. This will help the farmers to select the best heifers based on a combination of production and fertility traits.

Table 3: Genetic correlations ± S.E. (above diagonal) and phenotypic correlations (below diagonal) among milk production, reproduction and persistency traits.

Traits	AFC	DO	CI	TMY	305-d MY	DIM	70-d MY	Per MY
AFC		0.74±0.19	0.85±0.18	0.85±0.17	0.93±0.28	0.82±0.18	0.83±0.20	0.12±0.20
DO	-0.19		0.83±0.08	0.82±0.07	0.75±0.13	0.79±0.07	0.86±0.11	0.64±0.27
CI	-0.35	0.65		0.92±0.06	0.77±0.17	0.97±0.01	0.77±0.13	0.89±0.23
TMY	0.25	0.49	0.35		0.95±0.04	0.85±0.06	0.83±0.07	0.58±0.21
305-d MY	0.36	0.66	-0.42	0.85		0.68±0.15	0.77±0.11	0.44±0.16
DIM	-0.20	0.69	0.93	0.59	0.29		0.83±0.10	0.96±0.24
70-d MY	0.29	0.20	-0.18	0.52	0.44	-0.20		0.90±0.32
PER MY	-0.07	0.11	-0.17	0.12	0.31	-0.11	-0.16	

The positive genetic and phenotypic correlations between AFC and the milk production traits (TMY, 305-d MY and 70-d MY) indicate that older heifers at first calving are superior in milk production. This implies heifers with genetic potential for high milk production would tend to be older at first calving. Ojango and Pollott (2001) found that the phenotypic correlation between AFC and milk yield was small and negative (−0.2), but the genetic correlation between the traits was moderate and positive (0.54). However, Atil and Khattab (2005a) reported that the genetic correlation between 305-d MY and AFC was negative and significant (-0.22) and suggested that selection for high yielding cows would cause a correlated decrease in their AFC. It seems that the relationship between milk production traits and AFC depends on the level of production, means and variation in AFC.

The phenotypic correlations between AFC and each of DO and CI were negative (-0.19 and -0.35, respectively). However, the genetic correlations between the traits were positive (0.74±0.19 and 0.85±0.18, respectively). In this connection, Hodel *et al.* (1995) found that among first lactation cows, those with an AFC of more than 32 month had poorer fertility than cows that calved at an earlier age. Also, Fatehi and Schaeffer, (2003) estimated a positive and linear relationship between AFC and days open. While, Muir *et* *al.* (2004) reported that the genetic correlation of age at first insemination with nonreturn rate at 56 d after first insemination in first lactation was negative, indicating that heifers younger than average when first inseminated tended to have a better chance of conceiving at first insemination after first calving.

The phenotypic correlation between AFC and Per MY was negative and close to zero (-0.07). However, the genetic correlations between the traits were positive (0.12±0.20). The present result indicating that an older heifer at first calving was genetically associated with higher Per MY in the first lactation. However, Muir *et al.* (2004) concluded that early maturing heifers with a lower age at first insemination also had better persistency and later peak yields in first lactation.

The genetic correlations between Per MY and each of DO and CI were estimated to be 0.64±0.27 and 0.89±0.23, respectively. The present results indicated that longer DO and CI are generally undesirable; therefore, genetically an antagonistic relationship existed between Per MY and each of DO and CI in first lactation. However, Haile-Mariam *et al.* (2003) reported the absence of antagonistic genetic correlation between fertility and Per MY of lactation (~0) suggests that selection for Per MY might not affect fertility. Swalve and Gengler (1999) reported that cows with superior reproductive performance are subject to higher metabolic stress because peak yields coincide with the beginning of pregnancy. They add that high metabolic stress should have a depressing effect on Per MY. Thus, a cow with superior fertility may exhibit poorer Per MY. In this connection, Muir *et al.* (2004) concluded that lower peak yields may have provided a positive environment for conception; therefore a favorable correlation between Per MY and conception success resulted indirectly through lower peak yields. Also, they found the genetic correlation between day in milk of peak milk yield and Per MY was 0.54, indicating that as the interval from initiation of lactation to peak yield increased the Per MY improved. Relationships between Per MY and reproductive traits in later lactations may be different than those found here in first lactation.

The phenotypic correlations between Per MY of lactation and each of TMY and 305-d MY were positive (0.12 and 0.31, respectively). However, the phenotypic correlations between Per MY and each of DIM and 70-d MY were negative (-0.11 and -0.16, respectively). While, the genetic correlations between Per MY and production traits were positive and high. In this respect, Muir *et al.* (2004) found that the genetic correlation between 305-d MY and Per MY in first lactation was 0.21 (± 0.06). In contrary, Ferris *et al.* (1985) and Rekaya *et al.* (2000) found an antagonistic genetic correlation between lactation milk yield and persistency.

Estimated breeding values (EBVs)

Summary of animal and sire estimated breeding values, standard deviations (S.D), range of estimated breeding values (EBVs) and percentage of animals which had negative breeding values (EBVs%) from single- and two-trait analyses of reproductive traits evaluated with milk yield for different traits studied is presented in Table 4. Regarding the breeding values obtained from single-trait analysis, the range of all pedigree animals for AFC, DO and

Table 4: Standard deviations (S.D.), range of estimated breeding values (EBVs) and percentage of animals which had negative breeding values (EBVs%) from single-trait and two-trait analyses of reproductive traits evaluation with milk yield in all pedigree and sire of heifers only.

Traits	All pedigree animals								Sire of heifers only							
	Single-trait EBVs				Two-trait EBVs				Single-trait EBVs				Two-trait EBVs			
	S.D.	Min	Max	EBVs%	S.D.	Min	Max	EBVs%	S.D.	Min	Max	EBVs%	S.D.	Min	Max	EBVs%
AFC	0.63	-2.29	2.73	51.8	0.886	-3.28	3.14	52.2	0.887	-2.13	2.73	57.9	1.17	-3.28	2.61	57.9
DO	9.80	-40.12	59.59	58.4	17.45	-84.38	87.61	52.8	12.85	-24.88	36.71	52.6	15.99	-40.12	59.52	55.3
CI	10.21	-43.15	62.23	53.3	16.24	-82.78	91.23	55.2	16.11	-42.23	64.23	51.6	17.53	-25.95	44.52	53.2
PER MY	0.012	-0.057	0.066	51.3	0.016	-0.061	0.075	53.0	0.019	-0.045	0.050	52.6	0.021	0.057	-0.046	53.9
DIM	15.46	-96.99	79.05	50.2	17.68	-84.38	87.28	52.5	22.92	-96.99	45.83	47.4	23.60	-84.38	54.70	51.3
70-d MY	130.4	-532.6	506.5	49.7	136.1	-498.5	501.2	50.9	186.15	-444.4	458.4	51.3	186.8	-518.4	506.5	55.3
305-d MY	482.8	-1857	2060	52.2	.....	.....	.....	.....	683.8	-1472	1466	56.6	.....	.....	.....	.....

CI were 5.02 months, 99.71 and 105.38 days, respectively. While, the range of sire breeding value were 4.86 months, 61.59 and 106.46 days, respectively. The present study indicated that the wide range of breeding values for all reproductive traits, suggests the existence of genetic variation between animal (sires) and hence the possibility of sire selection for daughter's productive traits by using two-trait reproductive traits evaluation with milk yield. Selection to improve the reproductive traits in the next generation is a goal of dairymen. In this connection, Olori *et al.* (2002) estimated the predicted transmitting ability of CI by 11.46 days. Kadarmideen *et al.* (2003) reported that the range of breeding values for CI was 30.83 days for all pedigree animals and sire breeding values. Atil and Khattab (2005b) found that the range of cow, sire and dam breeding values of AFC were 17.94, 14.31 and 9.09 month, respectively. Atil and Khattab (2005a) found that the range of sire breeding value for AFC was 14.31 months.

The range of all pedigree animals breeding values for 305-d MY, DIM and 70-d MY were 3917 kg, 176.04 days and 1039.1 kg, respectively. While, the range of sire breeding value were 2938 kg, 142.82 days and 902.8 kg, respectively. The present results showed large differences among breeding values of animals in different traits studied. Thus, selection of cow, dam and sire for the next generation would lead to higher genetic improvement in commercial herds in Egypt. Atil and Khattab (2005b) reported that the range of sire breeding values were 388 kg and 4.46 days for 305-d MY and DIM, respectively. The same authors found that the range of sire breeding value for 305-d MY was 2186 kg of Holstein Friesian cattle in Turkey.

Regarding the including or the excluding milk yield as a correlated trait, single and multi-trait genetic evaluations, range and standard deviations of breeding value, percentage of animals which had negative breeding values and correlations between sire (animal) rankings for the same trait by single-and multi-trait analysis were comparable. The current results showed higher estimate of standard deviations for two-trait than single-trait analyses, indicating wide range of breeding values for Per MY and fertility traits (Table 4). The differences in distribution (S.D) of breeding values between single-trait versus multi-trait analyses may be due to high absolute differences between genetic and phenotypic correlations between milk yield and fertility traits. Higher standard deviations of breeding value for two-trait than single-trait analyses obtained in the present study indicated the existence of more genetic variation among sires (animals) and hence increases the possibility of sire selection for daughter fertility. Kadarmideen *et al.* (2003) reported similar results. In this respect, Togashi *et al.* (2004) concluded that multiple-trait evaluation appears desirable because it takes into account the genetic and environmental variance-covariance of all traits evaluated. For these reasons, multiple-trait evaluation would reduce bias from selection and achieve a better accuracy of prediction as compared to single-trait evaluation. They add that the number of traits included in multiple-trait evaluation should depend upon the breeding goal. Also, Pollak and Quaas (1983) found that the multiple-trait model is usually preferred over the single-trait model as the former uses the covariance structure among traits and the records with missing information, both of which are ignored by the latter For these reasons, BLUP multi-trait model is able to remove bias from selection on correlated traits and give a better accuracy of evaluation. Moreover, Lin and Lee (1986) stated that the evaluation of genetic values and estimation of genetic parameters are conditional on what traits are included in multi-trait analysis. Genetic values of economic traits vary depending upon whether two-trait, three-trait or other multi-trait analyses are used. They suggested that the inclusion of traits in a multi-trait analysis should depend upon the breeding goal. If the breeding goal is to improve one trait, single-trait model analysis should be used. If the breeding goal aims to improve three traits, then three-trait simultaneous analysis should be used.

Regarding percentage of number of sires (animals) which had negative breeding value estimates (EBVs %) for reproductive traits and persistency of lactation (Table 4), the EBVs % of animals being ranked differently between two methods of analyses. The present study indicated that the change in position of ranking of EBVs for sires was quite large for single- or two-trait analyses. Similar results reported by Kadarmideen *et al.* (2003).

Correlation between EBVs from single and multi-trait analyses

Correlations between EBVs provided by single-trait analysis and by two-trait analysis with milk yield, as well as animal rank correlation of EBVs for all animals or sires from two genetic evaluations are presented in Table 5. Correlations between EBVs of all animals in pedigree provided by two genetic evaluations were much lower than one (range 0.52–0.89) and ranged from 0.61 to 0.94 for sires only. Rank correlations of animal (sires) between two analyses were lower than the correlations of EBVs and were the lowest for persistency of lactation and reproduction traits.

Table 5: Correlation coefficients between actual EBVs and rankings based on EBVs of all animals or only sires from single- and two-trait analysis of the same trait with milk yield.

Traits	All animals		sires	
	EBVs	rankings	EBVs	rankings
AFC	0.58	0.52	0.71	0.68
DO	0.61	0.56	0.71	0.66
CI	0.63	0.59	0.77	0.71
Per MY	0.52	0.49	0.61	0.58
70-d MY	0.89	0.81	0.94	0.90

Lower correlations (differed from unity) between breeding values estimated by single-trait and the others by two-trait analysis with milk yield indicated that large re-ranking of sires would be detected between the two methods. Therefore, breeders can choose the traits which are economically important for them and can rank the animals based on the appropriate EBVs or index. Selection of the superior animals from this ranking allows breeders to make genetic progress in those economically important traits. Similar results have been reported by Kadarmideen *et al.* (2003).

CONCLUSIONS

The present study indicated that the Holstein dairy farming system in commercial herds in Egypt can show high production performance under adequate management. Unfortunately, the high yielding was associated with lower reproductive performance. The productive and reproductive traits are characterized by wide ranges of values and high coefficients of variation (ranged from 13.7 to 67.9%). Such large coefficients of variation are indicative leaders for opportunities for improvement in these traits. Genetic problems are already evident as a result from selection only for production traits, having a negative effect on reproduction. According to moderate heritabilities estimated in this study for different traits studied, the genetic improvement can be achieved through selection for these traits. The present results showed some minor differences in heritabilities obtained from single versus two-trait genetic analyses. Higher standard deviations of breeding value for two-trait than single-trait analyses obtained in the present study indicated the existence of more genetic variation among sires (animals). These caused in change in position of ranking of EBVs for sires for single- and two-trait analyses, and hence increase the possibility of sire selection for daughter fertility.

REFERENCES

Abdallah, J. M. and B. T. McDaniel (2000). Genetic parameters and trends of milk, fat, days open, and body weight after calving in North Carolina experimental herds. J. Dairy Sci. 83: 1364.

Ashmawy, A. A. (1986). Relationship between milk yield in the first lactation, age at first calving and stay ability in dairy cattle. Egypt. J. Anim. Prod., 25: 255.

Ashmawy, A. A. and K. A. Khalil (1990). Single and multi-trait selection for lactation in Holstein-Friesian cows. Egypt. J. Anim. Prod., 27(2): 171.

Atil, H. and A. S. Khattab (2005 a). Use of multiple traits animal model for genetic evaluation of milk yield and age at first calving of Holstein Friesian cattle in Turkey. Pakistan J. Biol. Sci., 8: 114.

Atil, H. and A. S. Khattab (2005 b). Estimation of genetic trend for productive and reproductive traits of Holstein Friesian cows in Turkey. Pakistan J. Biol. Sci., 8: 202.

Boldman, K. G., L. A: Kriese, L. D. Van Vleck, C. P. Van Tassell, and S. D. Kachman (1995). A manual for use of MTDFREML. USDA, ARS, Clay Center, NE.

Chauhan, V. P. S., J. F. Hayes, and T. Brown (1994). Relationships between days open and milk production traits in Canadian Holsteins. Proc. 5th World Congr. Genet. Appl. Livest. Prod. 17: 109.

Costa, C. N., R. W. Blake, E. J. Pollak, P. A. Oltenacu, R. L. Quaas, and S. R. Searle (2000). Genetic analysis of Holstein cattle populations in Brazil and the United States. J. Dairy Sci. 83: 2963.

Danell, B. (1982). Studies on lactation yield and individual test-day yields of Swedish dairy cows. III. Persistency of milk yield and its correlation with lactation yield. Acta Agricultura Scandinavica. 32: 93.

Dechow, C. D., G. W. Rogers, J. S. Clay (2001). Heritabilities and correlations among body condition scores, production traits and reproductive performance. J. Dairy Sci. 84: 266.

Dematawewa, C. M. B. and P. J. Berger (1998). Genetic and phenotypic parameters for 305 day yield, fertility and survival in Holsteins. J. Dairy Sci. 81: 2700.

Falconer, D. S. and T. F. C. Mackay (1996). Introduction to Quantitative Genetics, 4th Edition. Longman, Harlow, UK.

Fa rag, F. H. H., A. S. A. El-Barbary, M. F. Abdel-Glil and K. Hussein (2000). 1- Environmental factors affecting milk production. J. Agric. Sci., Mansoura Univ., 25 (10): 6095.

Fatehi, J., and L. R. Schaeffer (2003). Data management for the fertility project. (Mimeo) Dairy Cattle Breeding and Genetics Committee Report to the Genetic Evaluation Board, March 2003.

Ferris, T. A., I. L. Mao, and C. R. Anderson (1985). Selecting for lactation curve and milk yield in dairy cattle. J. Dairy Sci., 68: 1438.

Gröhn, Y. T., J. A. Hertl and J. L. Harman (1994). Effect of early lactation milk yield on reproductive disorders in dairy cows. Am.J. Vet. Res. 55: 1521.

Grosshans, T., Z. Z. Xu, L. J. Burton, D. L. Johnson, and K. L. Macmillan (1997). Performance and genetic parameters for fertility of seasonal dairy cows in New Zeiand. Livest. Prod. Sci., 51: 44.

Haile-Mariam, M., P. J. Bowman, and M. E. Goddard (2003). Genetic and environmental relationships among calving interval, survival, persistency of milk yield and somatic cell count in dairy cattle. Livest. Prod. Sci., 80: 189.

Hayes, J. F., R. I. Cue and H. G. Monardes (1992). Estimates of repeatability of reproductive measures in Canadian Holsteins.J. Dairy Sci., 75: 1701.

Hodel, F., J. Moll, and N. Kuenzi (1995). Analysis of fertility in Swiss Simmental cattle–genetic and environmental effects on female fertility. Livest. Prod. Sci., 42: 95.

Ibrahim, Z. M. K., A. I. Haider, N. A. Shalaby and M. A. Z. Alemam (2002). Evaluation of productive and reproductive performance of Friesian cows raised in Egypt. Proc., 1st Ann. Sc. Conf. Anim. & Fish Prod Mansoura 24 & 25 Sep.

Jamrozik, G. Jansen, J., L. R. Schaeffer, and Z. Liu (1998). Analysis of persistency of lactation calculated from a random regression test day model. Interbull Bull. 17, Rotorua, New Zealand, pp. 64.

Juarez, C. H., P. A. Oltenacu, R. W. Blake, C. E. McCulloch, E. G. Cienfuegos-Rivas (2000). Effect of herd environment on the genetic and phenotypic relationships among milk yield, conception rate and somatic cell score in Holstein cattle. J. Dairy Sci., 83: 807.

Kadarmideen, H. N., R. Thompson, and G. Simm (2000). Linear and threshold model genetic parameters for disease, fertility and milk production in dairy cattle. Animal Science. 71: 411.

Kadarmideen, H. N., R. Thompson, M. P. Coffey, and M. A. Kossaibati (2003). Genetic parameters and evaluations from single- and multiple-trait analysis of dairy cow fertility and milk production. J. Livest. Prod. Sci., 81: 183.

Khattab, A. S. and Z. A. Sultan (1990). Estimates of phenotypic and genetic parameters for first lactation performance in Friesian cattle in Egypt. Egypt. J. Anim. Prod., 27: 147.

Khattab, A. S., M. N. El-Arian and H. Atil (2000). Estimation of producing ability of Holstein Friesian cattle in a commercial herd in Egypt. Pakistan J. Biol. Sci., 3: 1076.

Lin, Y. C., and A. J. Lee (1986). Sequential estimation of genetic and phenotypic parameters in multivariate mixed model analyses. J. Dairy Sci., 69: 2696.

Muir, B. L., J. Fatehi and L. R. Schaeffer (2004). Genetic relationships between persistency and reproductive performance in first-lactation Canadian Holsteins. J. Dairy Sci., 87: 3029.

Ojango, J. M. K. and G. E. Pollott (2001). Genetics of milk yield and fertility traits in Holstein-Friesian cattle on large-scale Kenyan farms. J. Anim. Sci., 79: 1742.

Olori, V. E., Meuwissen, T. H. E., and R.F. Veerkamp (2002). Calving interval and survival breeding values as measure of cow fertility in a pasture-based production system with seasonal calving.J.Dairy Sci.85: 689.

Pollak, E. J., and R. L. Quaas (1983). Definition of group effects in sire evaluation models. J. Dairy Sci., 66: 1503.

Pryce, J. E., R. F. Veerkamp, R. Thompson, W. G. Hill, and G. Simm (1997). Genetic aspects of common health disorders and measures of fertility in Holstein Friesian dairy cattle. Animal Science 65: 353.

Pryce, J.E., R. J. Esslemont, R. Thompson, R. F. Veerkamp, M. A. Kossaibati and G. Simm (1998). Estimation of genetic parameters using health, fertility and production data from a management recording system for dairy cattle. Anim. Sci., 66: 577.

Rege, J. E. O. and T. R. Famula (1993). Factors affecting calving date and its relationship with production traits of Hereford dams.Anim.Prod.,57: 385.

Rekaya, R., M. J. Carabano, and M. A. Toro (2000). Bayesian analysis of lactation curves of Holstein-Friesian cattle. J. Dairy Sci., 83: 2691.

Roxström, A., E Strandberg, B Berglund, U. Emanuelson and J. Philipsson (2001). Genetic and environmental correlations among the female fertility traits, and between the ability to show oestrus and milk production in dairy cattle.Acta Agric.Scand.,Sect.A,Animal Sci.,51, 192.

Royal, M. D., J. A. Woolliams and A. P F. Flint (2002). Estimation of genetic and phenotypic associations between endocrine and traditional fertility parameters and production traits in Holstein–Friesian dairy cows. J. Dairy Sci., 85: 958.

Schaeffer, L. R. (1984). Sire and cow evaluation under multiple trait models. J. Dairy Sci., 67: 1567.

Seykora, A. J., and B. T. McDaniel (1983). Heritabilities and correlations of lactation yields and fertility for Holsteins. J. Dairy Sci., 66: 1486.

Shalaby, N. A., E. Z. M. Oudah and M. Abdel-Momin (2001). Genetic analysis of some productive and reproductive traits and sire evaluation in imported and locally born Friesian cattle raised in Egypt. Pakistan J. Biol. Sci., 4: 893.

Simerl, N. A., C. J. Wilcox and W. W. Thatcher (1992). Postpartum performance of dairy heifer freshening at young ages. J. Dairy Sci., 75: 590.

Solkner, J. and W. Fuchs (1987). A comparison of different measures of persistency with special especial respect to variation of test day milk yields. J. livest. Prod. Sci., 16: 305.

Swalve, H. H., and N. Gengler (1999). Genetics of lactation persistency. In: Metabolic stress in dairy cows. Occasional Publication No. 24 – British Society of Animal Science. Pp. 75-82.

Thompson, J. R., E. J. Pollak and C. L. Pelissier (1983). Interrelationships of parturition problems, production of subsequent lactation, reproduction, and age at first calving. J. Dairy Sci. 66: 1119.

Togashi, K., C. Y. Lin and K. Yokouchi (2004). Overview of genetic evaluation in dairy cattle. Anim. Sci., J. 75: 275.

Van der Linde, A. Groen, and G. de Jong (2000). Estimation of Genetic Parameters of milk production in dairy cattle. Proceedings of the 2000 Interbull Meeting in BLED, SLOVENIA, May 14-15 2000, Interbull Bulletin 25: 113.

Veerkamp, R. F. (1998). Selection for economic efficiency of dairy cattle using information on live weight and feed intake: A review. J. Dairy Sci., 81:1109

Vollema, A.R. (1998). Selection for longevity in dairy cattle. Ph. D. thesis, animal breeding and genetics group, Wageningen agricultural university.

Wall, E., S. Brotherstone, J. A. Woolliams, G. Banos, and M. P. Coffey. (2003). Genetic evaluation of fertility using direct and correlated traits. J. Dairy Sci., 86: 4093.

Weigel, K. A. and R. Rekaya (2000). Genetic parameters for reproductive traits of Holstein cattle in California and Minnesota. J. Dairy Sci., 83: 1072.

التقييم الوراثي لإنتاج اللبن و الصفات التناسلية و المثابرة على إنتاج اللبن باستخدام التحليل الفردي والمزدوج بنموذج الحيوان لأبقار الفريزيان المرباه فى القطعان التجارية فى مصر

ناظم عبد الرحمن شلبي

قسم إنتاج الحيوان - كلية الزراعة - جامعة المنصورة - رقم بريدي ٣٥٥١٦ المنصورة - مصر

استخدمت فى هذه الدراسة السجلات الإنتاجية والتناسلية لعدد ١٢٩٣ عجلة هولشتين فريزيان فى موسم الحليب الأول. جُمعت البيانات الإنتاجية والتناسلية من مزرعتين تجاريتين فى مصر خلال الفترة من عام ٢٠٠٠ إلى ٢٠٠٣م. تم تقدير المعالم الوراثية والقيم التربوية للصفات الإنتاجية والتناسلية والمثابرة على إنتاج اللبن باستخدام نموذج الحيوان بتحليل الصفات كلا على حدة (فرديا)، وكذلك التحليل الثنائي لكل من الصفات التناسلية ، المثابرة على إنتاج اللبن والعمر عند أول ولادة مع إنتاج اللبن كصفة مرتبطة مع تلك الصفات. كانت الصفات المدروسة هى محصول اللبن الكلى ، محصول اللبن فى ٣٠٥ يوم ، محصول اللبن فى اول ٧٠ يوم من موسم الحليب ، طول موسم الحليب ، الفترة بين ولادتين ، طول الفترة المفتوحة ، العمر عند أول ولادة ،

المثابرة على إنتاج اللبن ، كما تم تقدير معامل ارتباطات الرتب للقيم التربوية الناتجة من التحليل الفردى للصفات وتلك الناتجة من التحليل الثنائى لنفس الصفة مع إنتاج اللبن ، ومحصول اللبن فى اول ٧٠ يوم من موسم الحليب.

بلغت متوسطات العمر عند أول ولادة ، طول الفترة المفتوحة ، الفترة بين ولادتين ، المثابرة على إنتاج اللبن ، طول موسم الحليب ، محصول اللبن فى ٣٠٥ يوم ، ومحصول اللبن الكلى ٢٧,٧ شهر ، ١٦٢,٧ ، ٤٣٠,٢ يوم ، ٠,٨٢٢ وحدة ، ٣٥٣,٩ يوم ، ١٨٧٠، ٥٥٤٦ و٦٧٣٣ كيلوجرام على التوالي. لذا فإن النظام الإنتاجي فى هاتين المزرعتين أدى إلى أداء إنتاجي عالي وكفاءة تناسلية منخفضة ، وبلغت قيم المكافئ الوراثى الناتجة من التحليل الفردى ٠,١٩±٠,٠٧٥ ، ٠,١١±٠,٠٦٤ ، ٠,١٢±٠,٠٦٦ ، ٠,٠٨±٠,٠٥٢، ٠,٢٧±٠,٠٩١ ٠,٣٢±٠,٣٤،٠,١٠٥±٠,١٠٧،و٠,٢٨±٠,١٣٩، لنفس الصفات السابقة على التوالي. ووجد أن هناك بعض الاختلافات البسيطة بين قيم المكافئ الوراثى المتحصل عليها من التحليل الفردى للصفات وتلك الناتجة من التحليل الثنائى لنفس الصفة مع إنتاج اللبن. كما وجد أن الارتباطات المظهرية والوراثية بين الصفات الإنتاجية والتناسلية موجبة (غير مرغوبة). كما ان الارتباط المظهرى بين العمر عند أول ولادة وكلا من طول الفترة المفتوحة ، الفترة بين ولادتين كانت سلبية (-٠,١٩ و-٠,٣٥، على التوالي)، بينما كانت الارتباطات الوراثية بين تلك الصفات موجبة (٠,٧٤±٠,١٩ و٠,٨٥±٠,١٨، على التوالي). وقد كان الارتباط المظهرى بين العمر عند أول ولادة والمثابرة على إنتاج اللبن سلبيا قريبا من الصفر (-٠,٠٧) ، ولكن الارتباط الوراثي بين نفس الصفتين كان ايجابيا (٠,١٢±٠,٢٠).

بلغ مدى القيم التربوية لكل الحيوانات الناتجة من التحليل الفردى للعمر عند أول ولادة وطول الفترة المفتوحة والفترة بين ولادتين ٥,٠٢ شهرا ، ٩٩,٧١ ، ١٠٥,٣٨ يوما على التوالي. بينما بلغ مدى القيم التربوية للطلائق ٤,٨٦ شهرا و١٠٦,٤٦ ، ٦١,٥٩ يوما على التوالي. أما النسبة المئوية للطلائق أو الحيوانات التي لها قيم تربوية سالبة للصفات التناسلية والمثابرة على إنتاج اللبن فقد اختلفت بشكل كبير بين التحليلين. ذادت قيم الانحرافات القياسية للقيم التربوية المتحصل عليها من التحليل الثنائى عن تلك المتحصل عليها من التحليل الفردى لنفس الصفة ، مما يشير إلى زيادة التباين الوراثي بين الحيوانات ، مما يزيد إمكانية الانتخاب. وتشير قلة معامل الارتباط (الاختلاف عن واحد) بين القيم التربوية الناتجة من التحليل الفردى للصفات وتلك الناتجة من التحليل الثنائى لنفس الصفة مع إنتاج اللبن إلى إعادة الترتيب للطلائق على أساس قيمها التربوية بشكل كبير بين طريقتي التحليل. وتؤكد هذه النتائج الحالية العلاقة غير المرغوبة بين الصفات الإنتاجية والصفات التناسلية تحت مستوى الإنتاج العالي للفريزيان تحت نظام إنتاج القطعان التجارية في مصر. وأوضحت النتائج الحالية أيضا أن تقييم الحيوان للصفات التناسلية يجب أنْ تحسب وتوضع بعد ذلك فى دليل متعدد للصفات. هذا سيُساعد المزارعين لاختيار أفضل الحيوانات على أساس توليفة من الصفات الإنتاجية والصفات التناسلية والمثابرة على إنتاج اللبن.