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GENETIC EVALUATION OF SOME REPRODUCTIVE PERFORMANCE TRAITS IN THREE UPGRADING TRIALS OF DAIRY CATTLE RAISED IN HOT CLIMATE

S.A. Arafa[1], M.A. Khalil[2], E.A. Afifi[3] and S.M. Zahed[1]

1- Animal Production Research Institute, Ministry of Agriculture, Dokki, Cairo, Egypt, 2- Department of Animal Production & Breeding, College of Agriculture and Veterinary Medicine, King Saud University, Qassim, Burieda, P.O. Box, 1842, Kingdom of Saudi Arabia, 3- Department of Animal Production, Faculty of Agriculture at Moshtohor, Zagazig University, Egypt

SUMMARY

Data of three upgrading trials of local Domiati cattle with Friesian (Friesian trial), Shorthorn (Shorthorn trial), or Jersey (Jersey trial), were used to quantify the importance of direct additive effect (G^I), maternal additive effect (G^M), direct heterosis (H^I), maternal heterosis (H^M), direct recombination loss (R^I) and maternal (R^M) recombination effect for some reproductive performance in these three up-grading trials conducted under hot climatic conditions. The reproductive performance used were age at first (AC1) and second (AC2) calving and calving interval of all lactations (CI).

In the three upgrading trials , breed group effects were significant ($P<0.001$) on AC1 and CI in the Friesian trial and on CI ($P<0.05$) in the Shorthorn trial, while it did not show any significant effect on reproductive traits in the Jersey trial.

Means of AC1, AC2 and CI increased with the increase of Friesian (F) blood from 1/2 to 7/8F. Least squares means for CI in all lactations increased with the increase of the proportion of Shorthorn (S) blood from 1/2 to 7/8S, while least squares means for CI in Jersey trial did not show any clear trend as the proportion of Jersey blood increased.

For all reproductive performance in the three trials, direct heterotic superiority (H^I) of crossbred cows were evidenced over their purebred parents. Estimates of H^M for reproductive performance ranged from -1.3 to 3.4% in the Friesian trial, -0.8 to 3.4% in the Shorthorn trial and 0.8 to 11.1 % in the Jersey trial. Estimates of H^M in the three up-grading trials for CI were positive and unfavorable. Significant heterotic maternal effects for AC1 and CI ($P<0.01$) were observed in the Friesian trial only. Estimates of R^I and R^M for AC1, AC2 and CI were positive and insignificant in most cases.

Keywords: Dairy cattle, upgrading, reproductive performance, additive effect, heterosis, recombination loss

INTRODUCTION

Although crossbreeding trials in dairy cattle in Egypt have been evaluated by considerable research (e.g. El-Itriby and Asker, 1958; El-Itriby *et al*, 1963; Aboustate, 1975; Fahmy *et al*., 1976; Arafa, 1987; Mostageer *et al*., 1987), the genetic analysis and reporting of these results were often insufficient. Little genetic information is available on heterosis, additive effects and recombination losses for reproductive intervals in these trials. Although these genetic effects are rather low compared with the within breed genetic variability, they may generate significant bias in genetic evaluation, and the consequences of their inclusion in the model of analysis should be investigated (Boichard *et al*., 1993).

The objective of the present study was to quantify the direct additive effect (G^I), maternal additive effect (G^M), direct heterosis (H^I), maternal heterosis (H^M), direct recombination effect (R^I) and maternal recombination effect (R^M) for reproductive intervals in the three up-grading trials conducted under hot climatic conditions. These trials included Friesians, Domiati and their up-grades; Shorthorns, Domiati and their upgrades; Jerseys, Domiati and their up-grades.

MATERIAL AND METHODS

Records used in this study were collected from three dairy herds located at El-Gimmiza, El-Serw and Sids experimental stations. El-Gimmiza and El-Serw stations are in the north part of Nile Delta (about 150 kilometer to the north of Cairo), while the Sids station is about 160 kilometer to the South of Cairo. These stations belong to the Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture. Three up-grading trials were carried out in these stations. Animals of the El-Gimmiza station (Friesian trial) involved Friesian, Domiati and their crosses; those raised at El-Serw station (Shorthorn trial) included dairy Shorthorn, Domiati and their crosses and those raised in Sids station (Jersey trial) were Jersey, Domiati and their crosses. Details of breeding plan and management in each crossbreeding trial of the study were described by Arafa (1996).

Estimation of heterotic components

Methodology of estimating the genetic components from data on up-graded animals was described by Dickerson (1969& 1992). In this study, the six genetic components obtained were:

G^I= average individual additive effect of the cow (i.e. direct additive effect)

G^M= average maternal additive effect of the dam.

H^I= expected heterosis due to dominance in the crossbred cow (i.e. direct or individual heterosis).

H^M= expected heterosis due to dominance in the crossbred dam (i.e. maternal heterosis).

R^I= expected recombination loss in the individual cow (i.e. direct or individual recombination effect).

R^M= expected recombination loss in the crossbred dam (i.e. maternal recombination effect).

The coefficients were computed as functions of the proportion of genes obtained from each breed contributed to both genotypes of the individual (I) and its dam (M). The coefficients for individual additive effect (G^I) and maternal additive effect (G^M) were calculated as the deviation of the proportion of Domiati genes (g^I_D) from the proportion of European genes (g^I_E), i.e.

$G^I = g^I_D - g^I_E$ and $G^M = g^M_D - g^M_E$

where $g^I_{D,}$ g^I_E , g^M_D and g^M_E represent the proportion of Domiati and European genes in the individual (I) and the dam (M). The coefficients for individual heterosis (H^I) and maternal heterosis (H^M) were calculated for the daughter and the dam, respectively. These estimates of heterosis were calculated according to the probability that one gene at a locus was from the European blood ancestry whereas the other gene was from Domiati ancestry. Coefficients for expected contribution of genetic effects (in Domiati purebred and his crosses with Friesian or Dairy Shorthorn or Jersey) computed according to Dickerson (1969 & 1992) were presented in Table 1.

Table 1. Coefficients of expected contribution for genetic effects in groups of purebreds and crossbreds

Breed group$^+$	g^I_D	gI_E	G^I_{D-E}	g^M_D	g^M_E	G^M_{D-E}	H^I	H^M	R^I	R^M
Domiati	1.0	0.0	1.0	1.0	0.0	1.0	0.0	0.0	0.0	0.0
European (E)	0.0	1.0	-1.0	0.0	1.0	-1.0	0.0	0.0	0.0	0.0
1/2E-1/2D	0.50	0.50	0.0	1.0	0.0	1.0	1.0	0.0	0.0	0.0
3/4E-1/4D	0.25	0.75	-0.5	0.50	0.50	0.0	0.50	1.0	0.50	0.0
7/8E-1/8D	0.125	0.875	-0.75	0.25	0.75	-0.50	0.25	0.50	0.25	0.50
15/16E-1/16D	0.063	0.938	-0.875	0.125	0.875	-0.75	0.125	0.25	0.125	0.25
(3/4E-1/4D)$^{2++}$	0.25	0.75	-0.50	0.25	0.75	-0.50	0.375	0.50	0.625	0.50
(7/8E-1/8D)$^{2++}$	0.125	0.875	-0.75	0.125	0.875	-0.75	0.219	0.25	0.281	0.25

+ Sire breed listed first.

++ Coefficients of inter-se mating were used for estimating genetic components in Friesian and Shorthorn trials only (i.e., inter-se mating in Jersey was not practiced).

Data and statistical analysis

Data used in the present study were collected over a period of 26 consecutive years starting in 1950. Data of each crossbreeding trial were analysed separately using mixed model program of Harvey (1990). Distribution of records for different genetic groups in different years is presented in Figure 1. The traits used were age at first (AC1) and second (AC2) calving and calving interval of all lactations (CI).

The basic form of the general linear model used for analyzing age at first calving (AC1) and age at second calving (AC2) was:

$Y = XB + e$

The basic form of the general linear model used for analyzing calving interval (CI) of all lactations was:

$Y = XB + ZU + e$

where:

Y= An (Nx1) observational vector,

X= Incidence matrix for fixed effects,

B= Vector of fixed effects including covariate of age of cow. The fixed effects and covariates considered for each trait are specified in Table 2.

Z= Incidence matrix for random effect.

U= Vector of random cow effect .

e= Vector of random error.

The two models permit to derive a selected set of linear contrasts, i.e. G^I, G^M, H^I, H^M, R^I and R^M. The fitted models including these linear contrasts are presented in Table (2).

Table 2. Model and model components used in analysis of data

Model No.	Trait	Model components$^+$
Model 1	AC1, AC2	Breed group (F), year-season of birth (F)
Model 2	CI of all lactations	Breed group (F), cow within breed group (R), year-season of calving (F), parity (F), age of cow as covariate term (linear & quadratic).

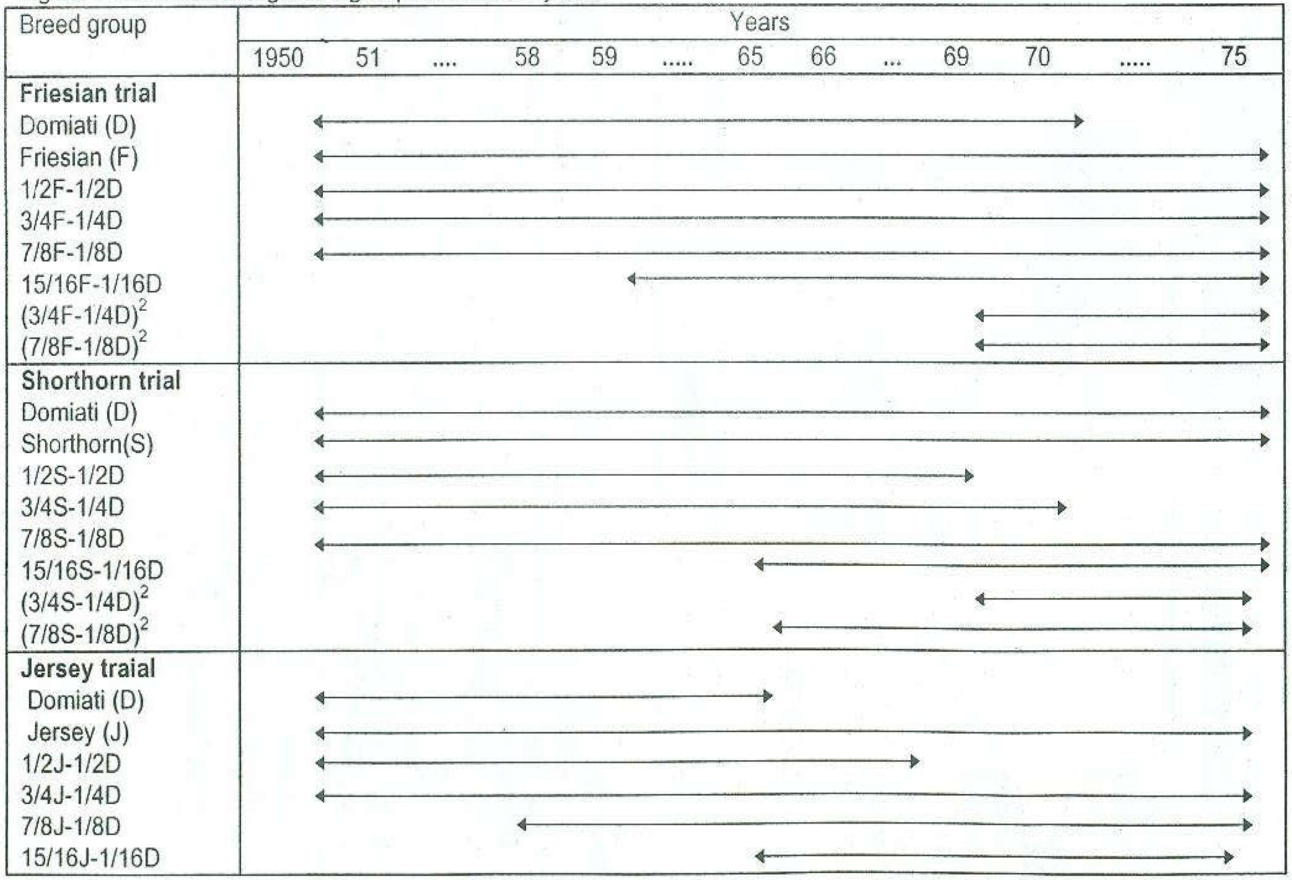
F= fixed effect , R = random effect.

RESULTS AND DISCUSSION

Means and variation of uncorrected records

In the Friesian trial (Friesian and their up-grades with Domiati), mean of age at first calving (AC1) (Table 3) was 38 months which was higher than that of 34 months obtained by Arafa (1987). Mean of AC1 in Shorthorn trial (Shorthorn and their up-grades with Domiati) was 36.0 months which was also higher than that of 35.1 months recorded by Aboustate (1975) and of 38.5 months recorded by Arafa (1987). In Jerseys and their up-grades with Domiati,

Figure 1. Distribution of genetic groups in different years



age at first calving obtained (34.8 months) was higher than that of 32.5 months recorded by Aboustate (1975).

Table 3. Actual means, their standard deviations (SD), and percentages of variation (V%) for age at first (AC1) and second (AC2) calving and calving interval (CI) in the three upgrading trials

Trait	No.	Mean	SD	V%
Friesian trial:				
AC1 (month)	745	37.99	11.64	24
AC2 (month)	617	52.89	12.03	19
CI (day)	2298	432	102	20
Shorthorn trial:				
AC1 (month)	509	36.03	6.88	18
AC2 (month)	440	50.94	8.07	15
CI (day)	1625	427	105	20
Jersey trial:				
AC1 (month)	285	34.80	11.05	21
AC2 (month)	201	48.72	11.59	20
CI (day)	735	420	93	20

*= P<0.05, ***= P<0.001.

For the three up-grading trials, means and phenotypic standard deviation for AC1 and AC2 as well as CI were generally the lowest in the Jersey trial, followed by Shorthorn, while they were the longest in the Friesian trial (Table 3).

In the three trials, year-season of birth combination, generally, affected (P<0.01 or P<0.001) AC1 and AC2 (Table 4). Also, year-season of calving effects on CI were significant (P<0.05 or P<0.01 or P<0.001). Madalena *et al.*, (1990a) showed that year-season affected most reproductive traits studied.

Means of AC1, AC2 and CI increased with the increase of Friesian blood (Table 5). Age at first (AC1) and second (AC2) calving increased with the increase of proportion of Friesian blood (F) from 1/2F to 7/8F, and from 1/2F to 15/16F for CI. The same trend also was obtained with groups of inter-se matings [i.e. $(3/4F1/4D)^2$ and $(7/8F1/8D)^2$] for AC1 and AC2 only. In Shorthorn trial, least-saquares means for AC1, AC2 as well as CI increased with the increase of the proportion of Shorthorn blood (S) from 1/2S to 7/8S (Table 5). In Jersey trial, least-squares means of AC1, AC2 and CI showed no clear trend with the increase of the proportion of Jersey blood (J) in the different genetic groups (Table 5).

Table 4. Tests of significance of ANOVA components for lactation traits across all lactations in Friesian, Shorthorn and Jersey trials

Source of variation	Breed group (BG)	Cow within BG	Parity	YS^{+}	Age at calving^{++}	
					L	Q
Friesian trial						
AC1 (months)	***	----	----	***	----	----
AC2 (months)	ns	----	----	***	----	----
CI (days)	***	***	***	***	***	***
Shorthorn trial						
AC1 (months)	ns	----	----	***	----	----
AC2 (months)	ns	----	----	***	----	----
CI (days)	*	***	***	***	***	***
Jersey trial						
AC1 (months)	ns	----	----	***	----	----
AC2 (months)	ns	----	----	*	----	----
CI (days)	ns	**	**	*	**	**

$^{+}$= Year-season effect, $^{++}$= Age at calving as a covariate (L= Linear, Q= Quadratic). ns= non-significant ($P>0.05$), *= $P\leq 0.05$, **=$P\leq 0.01$, ***=$P\leq 0.001$.

Individual (direct) additive effect (G^I)

In Friesian trial, estimate of individual additive effect ($G^I=g^I_D-g^I_F$) for AC1 was positive and in favor of Friesian cows, while G^I estimate of AC2 was negative and in favor of Domiati cows (Table 6). For both traits, effects of G^I were insignificant. G^I for CI in the three upgrading trials were generally large ($P<0.01$ or $P<0.001$) and in favor of Domiati cows (Table 6). This indicates that, relative to Domiati, Friesian cows showed longer (unfavorable) CI and they calved at the first time at younger age by 3.04 months while they calved at the second time at older age by 0.8 months than Domiati cows. Thus, the advantages of Friesian cows for lactation traits were offset partially by longer CI than Domiati cows. The same trend was observed by Thorpe *et al.* (1993) with Bos taurus and Sahiwal cattle. In literature, Martinez *et al.* (1988) reported that replacement of pure Zebu genes by Holstein genes was associated with a reduction in AC1 by 6 months along with a reduction in CI by 37 days. Touchberry (1992) showed that Holsteins exceeded Gurnseys ($P<0.05$) by 9.4 days for CI. The same author reported earlier age at first calving (8.6 days) for Guernseys than for Holsteins (non-significant). In favor of Domiati cows, a negative significant ($P<0.001$) estimate was recorded for CI.

Table 5. Least squares means and their standard errors (SE) for age at first (AC1) and second (AC2) calving and calving interval (CI) in different breed groups of the three upgrading trials

Breed group	No.	Mean±SE	Breed group	No.	Mean ±SE	Breed group	No.	Mean ±SE
AC1$^+$								
Domiati (D)	181	41.1±1.6	Domiati (D)	105	37.1±1.1	Domiati (D)	32	30.5±2.8
Friesian (F)	220	37.5±1.4	Shorthorn (S)	93	36.2±0.9	Jersey (J)	43	37.0±1.8
1/2F-1/2D	89	34.7±1.6	1/2S-1/2D	106	34.6±1.2	1/2J-1/2D	36	33.0±2.9
3/4F-1/4D	103	37.0±1.5	3/4S-1/4D	122	35.2±1.1	3/4J-1/4D	50	35.7±1.8
7/8F-1/8D	88	37.6±1.5	7/8S-1/8D	29	36.0±1.5	7/8J-1/8D	81	35.0±1.5
15/16F-1/16D	32	36.4±1.9	15/16S-1/16D	10	40.7±2.3	15/16J-1/16D	43	36.0±2.0
(3/4F-1/4D)^2	22	38.6±2.2	(3/4S-1/4D)^2	20	39.2±1.8			
(7/8F-1/8D)^2	10	41.1±2.8	(7/8S-1/8D)^2	24	37.1±1.6			
Significance		***	Significance		ns	Significance		ns
AC2$^+$								
Domiati (D)	165	54.3±1.8	Domiati (D)	99	50.6±1.4	Domiati (D)	16	39.2±4.8
Friesian (F)	175	53.4±1.6	Shorthorn(S)	69	50.7±1.2	Jersey (J)	29	52.3±2.7
1/2F-1/2D	69	49.3±1.8	1/2S-1/2D	104	49.4±1.4	1/2J-1/2D	29	45.2±4.3
3/4F-1/4D	85	51.7±1.7	3/4S-1/4D	103	52.2±1.3	3/4J-1/4D	41	51.9±2.5
7/8F-1/8D	71	52.6±1.8	7/8S-1/8D	20	52.8±2.1	7/8J-1/8D	55	49.1±2.2
15/16F-1/16D	24	52.4±2.4	15/16S-1/16D	8	55.8±3.0	15/16J-1/16D	31	48.7±2.9
(3/4F-1/4D)^2	19	54.1±2.7	(3/4S-1/4D)^2	17	51.3±2.3			
(7/8F-1/8D)^2	9	57.0±3.5	(7/8S-1/8D)^2	20	50.9±2.1			
Significance		ns	Significance		ns	Significance		ns
CI^{++}								
Domiati (D)	612	427±10	Domiati (D)	405	533±2	Domiati (D)	30	446±3
Friesian (F)	592	506±8	Shorthorn(S)	224	572±2	Jersey (J)	126	445±2
1/2F-1/2D	338	468±11	1/2S-1/2D	456	531±2	1/2J-1/2D	100	477±2
3/4F-1/4D	323	479±10	3/4S-1/4D	304	546±2	3/4J-1/4D	187	458±2
7/8F-1/8D	257	489±11	7/8S-1/8D	63	568±2	7/8J-1/8D	186	464±2
15/16F-1/16D	69	518±17	15/16S-1/16D	23	538±3	15/16J-1/16D	106	444±2
(3/4F-1/4D)^2	71	512±19	(3/4S-1/4D)^2	68	547±2			
(7/8F-1/8D)^2	36	493±24	(7/8S-1/8D)^2	82	532±2			
Significance		***	Significance		*	Significance		ns

$^+$ Age at first (AC1) and second (AC2) calving was analysed using model 1.

$^{++}$ Calving interval (CI) across all lactations was analysed using model 2.

ns= non-significant (P>0.05), *= P<0.05, **= P<0.01, ***= P<0.001.

Table 6. Estimates of individual (G^I) and maternal (G^M) additive genetic effects for reproductive intervals in the three upgrading trials

Trait	G^I		G^M	
	Estimate	SE	Estimate	SE
Friesian trial:				
AC1 (months)	3.04	2.08	-1.03	2.81
AC2 (months)	-0.81	2.64	-5.58	3.62
CI (days)	-122.0***	12.3	-139.6***	17.3
Shorthron trial:				
AC1 (months)	-1.81	1.99	-4.90	2.68
AC2 (months)	-3.97	2.56	-5.26	3.47
CI (days)	-38.8**	14.5	-49.4**	19.7
Jersey trial:				
AC1 (months)	-8.76*	4.31	-9.40*	4.68
AC2 (months)	-17.01*	7.59	-16.97*	7.90
CI (days)**	4.4	31.9	27.5	31.2

* = P<0.05, **= P<0.01, *** < 0.001.

For Friesians and Shorthorns and their crosses, AC1 and AC2 showed significant negative estimates of G^I in favor of Domiati cows. On the other hand, negative significant estimates of G^I were recorded for CI of Friesian and Shorthorn trials in favor of Domiati cows (Table 6). However, negative and significant estimates of G^I for AC1 and AC2 show that Domiati cows had younger age at first and second calving than Jersey cows. Opposite to Friesian and Shorthorn breeds, estimates of G^I for CI in Jersey trial were generally positive and non-significant (Table 6). In the literature, significant estimates of G^I were recorded for AC1 (Martinez *et al.*, 1988; Thorpe *et al.*, 1993) and for CI (Martinez *et al.*, 1988; Touchberry, 1992; Thorpe *et al.*, 1993). On the other hand, insignificant G^I was reported for CI by Madalena *et al.* (1990a) and for AC1 by Touchberry (1992).

Maternal additive effect (G^M)

In the three trials, the estimates of maternal additive effect ($G^M = g^M_D - g^M_F$) for AC1 and AC2 were negative and in favor of Domiati dams. The negative G^M estimates for AC1 and AC2 in the Jersey trial were significant ($P<0.05$) and in favor of Domiati dams (Table 6). Estimates of G^M for CI in Friesian and Shorthorn trials only were significant ($P< 0.001$) and they were also in favor of Domiati dams (Table 6), i.e. additive maternal effects of Friesian or Shorthorn dams showed longer CI and older AC1 and AC2 than of Domiati dams. So, a daughter of a Domiati dam was younger at AC1 and AC2 along with shorter CI than a daughter of Shorthorn dam. Thorpe *et al.* (1993) worked on bos taurus

(Ayrshire and Friesian), Sahiwal and their crosses showed that additive maternity of Sahiwal dams had insignificantly longer CI by 18 days than additive maternity of Bos Taurus dams. On the other hand, the same authors concluded that maternal additive effects for AC1 were 68 days in favor of Bos taurus dams. The additive maternity for AC1 and AC2 (in favor of Domiati breed) increased from the first parity to the second one.

Individual (direct) heterosis (H^I)

In Friesian trial, crossbred cows showed younger AC1 and AC2 ($P<0.01$) along with shorter CI than the average of their purebreds (Table 7). Such reduction in AC1 and/or CI was also observed by most of the studies including Friesians and their crosses (Donald *et al*, 1977; Rincon *et al.*, 1982; Teodoro *et al.*, 1984; Martinez *et al.*, 1988; Madalena *et al.*, 1990a&b; Thorpe *et al.*, 1993). H^I as absolute values (or percentages) for age at calving increased ($P<0.01$) from the first parity to the second one, i.e. H^I decreased in their negativity from the 1st parity to the 2nd one. However, significant heterotic effects were also detected by different investigators working with Friesians and their crosses (Robison *et al.*, 1981; Van der Werf and de Boer, 1989b; Ahlborn-Breier and Hohenboken, 1991; Touchberry, 1992; Zarnecki *et al.*, 1993; McAllister *et al.*, 1994).

In Shorthorn trial, heterotic superiority for reproductive intervals (Table 7) showed that crossing Egyptian cows with Shorthorn bulls led to a reduction in CI ($P<0.05$), AC1 ($P<0.05$) and AC2. The negative estimate of H^I for CI indicates that crossbred cows from Shorthorns recorded significant ($P<0.05$ or $P<0.01$) shorter CI than the average of purebreds. With Shorthorn x native cattle in Egypt, Fahmy *et al.* (1976) came to the same conclusion. Estimates (or percentages) of H^I for age at calving increased in their magnitude (i.e., H^I decreased in their negativity) from the first parity to the second.

Positive estimates of H^I in Jersey trial were recorded for AC2 and CI, but negative ones for AC1. Opposite to the present results, Donald *et al.* (1977) with Friesian x Jersey and Ayrshire x Jersey reported negative estimates of H^I for CI. Heterotic superiority (H^I) of crossbred cows for age at calving increased from the first parity to the second. The favorable significant H^I ($P<0.05$) for CI across all lactations showed also that Jersey-up-graded cows recorded longer CI than the average of their purebreds.

Maternal heterosis (H^M)

In the Friesian trial, the negative estimates of H^M for AC1 and AC2 show that crossbred dams recorded younger ages at first (AC1) and second (AC2) calving than their purebred dams (Table 7). Percentages of H^M/G^M for AC1 and AC2 indicate also that maternal heterosis in crossbred dams relative to their maternal additive in purebred dams were favorable and high (-47.6% for AC1 and -6.6% for AC2); i.e. H^M is of considerable importance to improve AC1 and AC2 of up-graded Friesian-Domiati cows. These favorable estimates of H^M for CI and AC2 were also observed by Thorpe *et al.*, (1993). Heterotic maternity of crossbred dams in Friesian trial for age at calving increased in magnitude (i.e., decreased in their negativity) from the first parity (AC1) to the second one (AC2).

Table 7. Estimates of individual (H^I) and maternal (H^M) heterortic effects for reproductive intervals in the three upgrading trials

Trait	H^I			H^M			H^I/G^I	H^M/G^M
	Estimate	SE	%	Estimate	SE	%	%	%
Friesian trial:								
AC1 (months)	-3.16**	0.84	-8.2	-0.49**	0.81	-1.3	-100.0ᵃ	-47.6
AC2 (months)	-3.52**	1.11	-6.5	-0.37	1.04	-0.7	-100.0ᵃ	-6.6
CI (days)	-6.5	4.9	-1.4	15.9**	5.0	3.4	-5.3	11.4
Shorthron trial:								
AC1 (months)	-2.24*	1.0	-6.0	-0.29	0.88	-0.8	-100.0ᵃ	-5.9
AC2 (months)	-1.60	1.26	-3.2	1.67	1.17	3.4	-40.3	31.7
CI (days)	-13.04*	6.6	-2.4	6.5	6.5	1.2	-33.6	13.2
Jersey trial:								
AC1 (months)	-0.64	2.41	-1.8	1.77	1.71	5.3	7.3	18.8
AC2 (months)	0.04	3.93	0.1	5.05	2.78	11.1	0.23	29.8
CI (days)	23.1*	10.5	5.2	3.7	10.6	0.8	100.0ᵃ	13.5

* = P<0.05, **= P<0.01, *** < 0.001. a = Estimates greater than 100%.

Favorable negative estimate of H^M in Shorthorn trials was recorded for AC1, while H^M for AC2 was positive. However, this effect was insignificant for both triats (Table 7). H^M of age at calving increased from the first parity to the second one. As in the Friesian trial, unfavorable positive estimate of H^M for CI across all lactations was observed.

Opposite to Friesian and Shorthorn trials, AC1 and AC2 in Jersey trial showed unfavorable positive estimates of H^M (Table 7). However, positive H^M for AC1 and AC2 lead to state that crossbred cows (Jersey x Domiati) from crossbred dams had different heterotic maternity for age at calving than those cows born from purebred dams. As for Shorthorn trial and opposite to Friesian trial, H^M for CI, AC1 and AC2 were lower than those estimates of H^I since maternal heterotic superiority relative to H^I [(i.e. $((H^M - H^I)/H^I)*100$ in this trial were mostly negative and averaged -61%]. As in Friesian and Shorthorn trials, unfavorable positive estimates of H^M was recorded for CI. Opposite to this result, Thorpe *et al.* (1993) found that H^M in crossbred dams could reduce CI by 18 days.

Individual (direct) recombination effect (R^I)

Estimates of R^I for reproductive intervals in the three up-grading trials are presented in Table 8. Information in the literature concerning estimates of R^I of upgrading experiments in dairy cattle are scarce. Most of these available results are contradicting. However, reviewed values for R^I were often non significant (McAllister, 1986) or significant but of small magnitude (Ericson, 1987). Van der Werf and de Boer (1989a) concluded that estimates of recombination effects were negative and smaller than estimates of heterosis.

In Friesian trial, estimates of R^I for AC1 and AC2 were positive (Table 8), but insignificant. The insignificant effect of R^I indicates that there should be little difference in heterosis as measured and expected in a particular cross. On the other hand, estimates of R^I for CI were positive and significant ($P<0.01$). Heterosis was assumed to represent dominance effects and half of additive by additive effects, whereas the recombination effects represent half of the additive by additive effects (Van der Werf and de Boer, 1989 a&b). Here, estimates of R^I for CI, AC1 and AC2 were generally larger than estimates of heterosis (Table 8), which implies that the dominance effects on these traits were negative in most parities.

Estimates of R^I recorded for AC1, AC2 and CI in Shorthorn trial were positive and insignificant (Table 8). As in Friesian trial, estimate of R^I for CI of all lactations was positive, but insignificant. Estimates of R^I for CI were larger than estimates of direct heterosis (Tables 7& 8), which implies that the dominance effect in this trait was negative.

In the Jersey trial, estimates of R^I were positive for all traits, with non-significant effect (Table 8). Fortunately, these favorable estimates of R^I in the Jersey trial indicate that there is a potential advantage in using more available heterosis to develop parental strains including Jersey blood to be used in crossbreeding in Egypt.

Maternal recombination effect (R^M)

The positive R^M for AC1, AC2 and CI in the Friesian trial were favorable for the dairy producers (Table 8). Literature concerning estimates of R^M in crossbreeding experiments in dairy cattle is not available for comparison with those obtained in the present study. Estimates of R^M for CI were generally larger than H^M which implies that the dominance effect in CI was negative. Opposite to R^I, reversible and unfavorable positive signs of R^M were observed for AC1, AC2 and CI in Shorthorn trial in most cases (Table 8). Positive insignificant estimates of R^M in Jersey trial were recorded for AC1, AC2 and CI traits (Table 8). The insignificant R^M indicates that epistatic effects appear to have little influence on these traits.

Table (8). Estimates of individual (R^I) and maternal (R^M) recombination effects for reproductive intervals in the three upgrading trials

Trait	R^I		R^I/G^I	R^M		R^M/G^M
	Estimate	SE	%	Estimate	SE	%
Friesian trial:						
AC1 (months)	0.46	0.93	15.1	0.49	0.79	47.6
AC2 (months)	0.81	1.22	100.0	1.05	1.04	18.8
CI (days)	18.8**	5.4	15.4	23.2***	4.9	16.6
Shorthron trial:						
AC1 (months)	0.71	0.86	39.2	1.54	0.83	31.4
AC2 (months)	0.59	1.15	14.9	1.16	1.14	22.1
CI (days)	1.6	6.2	4.1	6.4	6.4	13.0
Jersey trial:						
AC1 (months)	0.89	0.86	10.2	0.60	0.86	6.4
AC2 (months)	2.53	1.39	14.9	0.93	1.41	5.5
CI (days)	1.8	5.3	40.9	1.1	5.5	4.0

* = $P<0.05$, **= $P<0.01$, *** < 0.001.

The three trials recorded positive estimates of R^M for AC1, AC2 and CI (Table 8). For AC1, the Friesian trial recorded the lowest R^M , while for AC2 and CI Jersey trial recorded the lowest R^M .

CONCLUSION

The Friesian breed at El-Gimmiza showed higher individual additive effect (G^I) for calving interval (CI) compared with Shorthorn and Jersey breeds. Among the three foreign breeds, Friesian recorded a lower G^I for AC1 and AC2 than Jersey and Shorthorn.

For all trials of upgrading, additive maternity (G^M) of Friesian dams ranked first for AC1 and AC2, followed by Shorthorn and Jersey dams, i.e. Friesian dams were the youngest dams for AC1 and AC2 of the three foreign breeds. Jersey dams recorded the lowest G^M for CI.

Crossing of Domiati cows with Friesian bulls was associated with a reduction in lengths of AC1, AC2 and CI. These observations indicate that crossing of Friesian bulls with Domiati cows in important. Crossbred cows including Jersey blood had longer CI and older AC2 and younger AC1.

The insignificant effect of individual (direct) recombination effect (R^I) and maternal recombination effect (R^M) estimates for most reproductive intervals showed that epistatic recombination effects appear to have little influence on these traits, and therefore there is a potential advantage to use crossbred cows including Shorthorn or Jersey blood to develop parental strains having more available heterosis to be used in crossbreeding stratification systems in Egypt.

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التقييم الوراثى لبعض صفات الكفاءة التناسلية فى ثلاث تجارب للتدريج فى ماشية اللبن المرباه تحت ظروف المناخ الحار

سميرة عبده عرفة[١], ماهر حسب النبى خليل[٢], عزت عطا عفيفى[٣], سميح محمد زاهد[١]

١- معهد بحوث الإنتاج الحيوانى-وزارة الزراعة-جمهورية مصر العربية. ٢-قسم إنتاج وتربية الحيوان- كلية الزراعة والطب البيطرى بالقصيم-جامعة الملك سعود ص ب ١٤٨٢ بريدة- المملكة العربية السعودية. ٣- كلية الزراعة بمشتهر - جامعة الزقازيق - جمهورية مصر العربية

أستخدمت بيانات ثلاثة تجارب لتدريج الأبقار المحلية (الدمياطى) مع الفريزيان (تجربة الفريزيان)، والشورتهورن (تجربة الشورتهورن) والجيرسى (تجربة الجيرسى) لتقييم هذه التجارب تحت ظروف المناخ الحار ولتقدير التأثير التجمعى فى الفرد (G^{I}) وفى الأم (G^{M}) - قوة الخلط فى الفرد (H^{I}) وفى الأم (H^{M}) وتأثير إعادة توليف الجينات فى الفرد (R^{I}) وفى الأم (R^{M}) للصفات التناسلية وهى العمر عند أول ولادة (AC1) والعمر عند ثانى ولادة (AC2) والفترة بين ولادتين (CI). أتاحت خطة التربية فىكل تجربة من التجارب الثلاث فى فترة الدراسة إنتاج الأبقار الدمياطى والأبقار الأوروبية (الفريزيان - الشورتهورن - الجيرسى) والدرجات المختلفة الناتجة من تدريج الأبقار الدمياطى بطلائق من الماشية الأوروبية بالإضافة إلى إنتاج الأبقار الخليطة الناتجة من تزاوج الأبقار والطلائق من كل من ٤/٣ أوروبى ٤/١ دمياطى، ٨/٧ أوروبى ٨/١ دمياطى فى كل من تجربة الفريزيان والشورتهورن.

كان تأثير المجموعة التربوية معنويا ($P<0.001$) على العمر عند أول ولادة والفترة بين ولادتين فى تجربة الفريزيان ومعنويا ($P<0.05$) على الفترة بين ولادتين فقط فى تجربة الشورتهورن. بالنسبة لتجربة الفريزيان تزايد عمر البقرة عند أول وثانى ولادة وكذلك طول الفترة بين ولادتين بزيادة نسبة دم الفريزيان من ٢/١ إلى ٨/٧. أما بالنسبة لتجربة الشورتهورن فقد زادت الفترة بين ولادتين بزيادة نسبة دم الشورتهورن من ٢/١ إلى ٨/٧، بينما فى تجربة الجيرسى لم يكن هناك إتجاه واضح لتأثير زيادة نسبة دم الجيرسى فى الخلطان على الفترة بين ولادتين.

أظهرت النتائج وجود تأثير موجب لقوة الخلط الفردية بالنسبة لصفات العمر عند أول وثانى ولادة وللفترة بين ولادتين، كما أظهرت النتائج أيضا أن الأمهات من خلطان الفريزيان كانت الأعلى بالنسبة لقوة الخلط الأمية يليها الأمهات خلطان الشورتهورن ثم خلطان الجيرسى بالنسبة للصفات

التناسلية. تراوحت قيم قوة الخلط الأمية من –١,٣ إلى ٣,٤٪ فى تجربة الفريزيان، بين – ٠,٨ إلى ٣,٤٪ فى تجربة الشورتهورن وبين ٠,٨ إلى ١١,١٪ فى تجربة الجيرسى. كانت قيم قوة الخلط الأمية بالنسبة لصفة الفترة بين ولادتين موجبة وهى غير مرغوبة فى الثلاث تجارب. كما لوحظت معنوية (P<0.01) قوة الخلط الأمية فى صفتى العمر عند أول وثانى ولادة فى تجربة الفريزيان فقط. سجلت خلطان تجربة الفريزيان أحسن قيم لقوة الخلط الأمية بالنسبة لصفتى العمر عند أول وثانى ولادة بالمقارنة بباقى التجارب. أما بالنسبة لتأثير إعادة توليف الجينات فكانت غير معنوية بالنسبة لجميع الصفات المدروسة.