Assessment of Egyptian buffaloes crossing with Pakistani and Italian buffaloes for some production traits

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Abstract: Egyptian buffaloes are considered one of the most important dual purpose farm animals that represent 44% of dairy animals in Egypt. In 1980, the Animal Production Research Institute (APRI) imported 93 Pakistani semen straws for crossbreeding to improve milk productivities. In 2003, Ministry of Agriculture (MoA) allowed the commercial importation of Italian buffalo semen, which spread in large scale buffalo farms. The study aims to evaluate the Egyptian buffalo crosses with both Pakistani and Italian buffaloes for some productive traits to assess the crossing trials. For the first trial of the study, 180 records (85 pure Egyptian buffaloes (E), 22 record ½Egyptian (E)½ Pakistani (Pa) buffaloes and 52 record ¾E ¼Pa buffaloes and 21 record 7/8E 1/8Pa) through the period from 1980 to 1998 were used for the evaluation of Egyptian (E) Pakistani (PA) crossbred. Data for the second trial, concerned with the evaluation of the Egyptian (E) Italian (I) crosses, was collected from two private farms. A total 138 records; 64 record from Ganat Elreda farm (32 record E and 32 record ½E ½I) and 74 records from "United Group farm" (26 record E and 48 record ½E ½I buffaloes) was utilized. Utilized record covers the period from 2005 to 2009. Average for total milk yield was nearly the same for Egyptian and its cross with Pakistani buffaloes. In trial 1, Milk yield generally tended to increase with the advancement of parities till the ≥7 parity**.** Egyptian buffaloes showed the highest values for all growth traits measures. In trial 2, significant difference in milk productivity between the Egyptian and its Italian crossbred, which was significantly higher ($P \leq 0.001$) in farm 2 than it is in farm 1 ($P \leq 0.01$), was observed. The same trend in difference was detected for the parity effect**.** Italian crosses showed higher least square means (LSM) estimates for total milk yield (TMY) than the Egyptian buffaloes, which also increase with the advancement of the parity, in the two farms. LSM data reveal increase of 27 and 15% in 1/2E1/2I crossbred milk production than the Egyptian in farm 1 and farm 2, respectively. Difference between the highest and lowest breeding value (BV) in the Egyptian population is larger than it is in the crossbred population. More studies are recommended for the assessment of productive, reproductive and genetic diversity of crossbred populations before the enhancement of crossbreeding activities on national level.

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1. Introduction

Egyptian buffaloes are considered one of the most important farm animals that are kept for dual purposes (milk/meat). There are nearly 4 million buffaloes, representing 44% of dairy animals in Egypt (FAOSTAT, 2009), which contribute 44 % (2,640,638 ton) of total milk production (5,960,102 ton) and 18 % (270,000 ton) of total meat production (1,528,789 ton) (FAOSTAT, 2008). Egypt suffers from a huge production gap in milk and meat production detected in annual imported milk and meat (http://www.fao.org). Production of buffalo in Egypt couldn't fill such a gap due to the absence of specialized breeds/lines for (meat/milk) and the need for national genetic improvement scheme programs.

Therefore trials for the introduction of foreign breed of buffalo (crossbreeding with both Italian and Pakistani breeds) were performed with the aim to significantly improve the genetic makeup of the Egyptian buffaloes for economic traits, as in case of the native cattle crossbreeding.

Pakistani buffaloes have the potential of producing over than 5,000 liters of milk per lactation under efficient breeding, feeding and health care program. Nili Ravi is the best breed at national and international level in terms of its production potentiality, reflected in average milk yield per lactation of 2,430 liters, while some high yielding Nili Ravi also produce 3000-5000 liters/lactation (Bilal *et al.,* 2006).

In Italy there are 300,000 buffaloes. The traditional area is the central and south of Italy but due to the quota on cattle milk buffaloes have moved towards the north and replaced dairy cows. The number of milk recorded buffaloes is around 44,000 (one third of the buffalo cows). Average milk production is 2,250 kg/lactation. It has increased the last 17 years, more depending on better management than on genetic improvement (Maria Larsson, 2009).

No previous assessment, neither genetic nor phenotypic, has been performed for assessing such crossbreeding. The main objective of the present study is to evaluate the Egyptian buffalo crosses with both Italian and Pakistani buffaloes for some productive traits to assess the crossing trials.

2. Material and Methods

This study is divided into two trials; the first is concerned with the assessment of Egyptian-Pakistani crosses (EPaC), where the animals included belong to experimental herds kept in Mahalet Mousa farm, belonging to Animal Production Research Institute (APRI), Ministry of Agriculture (MoA), Egypt. In 1980, APRI imported 93 Pakistani semen straws for crossbreeding trials for improving milk production of buffalo. APRI practiced a crossbreeding scheme since then with different crossing ratios. A total of 180 records (85 pure Egyptian buffaloes (E), 22 record ½Egyptian (E)½ Pakistani (Pa) buffaloes and 52 record ¾E ¼Pa buffaloes and 21 record 7/8E 1/8Pa) through the period from 1980 to 1998 were used for the evaluation. Traits included are total milk yield (TMY), lactation period (L), birth weight (BW), weaning weight (WW) and daily gain (DG) calculated for the period from birth to weaning.

The data were analyzed using SAS (2002), according to the following model for total milk yield:

$$\mathbf{Y_{ijk} = \mu + B_i + P_j + b(L)_{ijk} + (BP)_{ij} + (BL)_{ijk} + (PL)_{ijk} + E_{ijk}} \quad \textbf{(1)}$$

Where: Y_{ijk} : observation on the k^{th} animals of the i^{th} population in the j^{th} parity, μ : overall mean, B_i : fixed effect due to the population, (i: E, ½E ½Pa and ¾E & ¼Pa), P_j : fixed effect due to lactation parity, (j: 1, 2, …, 6, ≥7), b : regression coefficient of Y on L (lactation period), (BP) : the interaction between breed and parity, (BL) : the interaction between breed and lactation period, (PL) : the interaction between parity and lactation period and E_{ijk} : random error assumed N.I.D. (0, σ^2e).

While the model used for birth, weaning weight and daily gain traits was:

$$\mathbf{Y_{ijk} = \mu + B_i + S_j + Eijk} \quad \textbf{(2)}$$

Where: Y_{ijk}: observation on the k^{th} animals of the i^{th} population in the j^{th} sex of calve, μ: overall mean, B_i: fixed effect due to the population, (i: E, ½E ½Pa, ¾E ¼Pa and 7/8E 1/8 Pa), P_j : fixed effect due to sex of calve, (j: male and female) and E_{ijk} : random error assumed N.I.D. (0, σ^2e).

The second trial is concerned with the evaluation of the Egyptian (E) –Italian (I) crosses. . In 2003, MoA allowed the commercial importation of Italian buffalo semen, which spread in large scale buffalo farms. Two of these dairy buffalo farms were selected to be included in this study being "Ganat Elreda" farm in Ismaeleia governorate and "United Group" farm in Qaliobeia governorate. The two farms select their Egyptian buffaloes milking animals from the animal markets in their second parity. They keep the new purchased lactating animals under assessment, for production and health conditions, for two weeks, and then they decide to keep or cull them. It seems successful practical selection rules under the conditions of absence of pedigree and production recording system in the majority of small and medium scale buffalo holdings. For crossbreeding, they use imported Italian buffalo semen with known breeding values for various production and type traits. A total 138 records; 64 record from Ganat Elreda farm (32 record E and 32 record ½E ½I) and 74 records from "United Group farm" (26 record E and 48 record ½E ½I buffaloes). Records covering the period from 2005 to 2009 were used for the evaluation the crossbreeding performance for the total milk yield (TMY), lactation period (L), birth (BW) and weaning (WW) weights traits.

Data was analyzed according to the following model for total milk yield :

$$\mathbf{Y_{ijk} = \mu + B_i + P_j + C_k + S_l + b_1(L)_{ijklm} + b_2(A)_{ijklm} + ((LA)_{ijklm} + E_{ijklm}} \quad \textbf{(3)}$$

Where: Y_{ijk} : observation on the m^{th} animals of the i^{th} population in the j^{th} parity in the k^{th} year of calving in the l^{th} season of calving, μ: Overall mean, B_i: fixed effect due to the population, (i: E and1/2E 1/2I), P_j : fixed effect due to lactation parity, (j: 1, 2, 3), C_k : fixed effect due to the year of calving, (k: 2007, 2008, 2009), S_l: fixed effect due to the season of calving (l: Winter and Summer), b_1: regression coefficient of Y on L (lactation period), b_2: regression coefficient of Y on A (Age at first calving), (LA): the interaction between lactation period and Age at first calving and E_{ijklm}: random error assumed N.I.D. (0, σ^2e).

While the model used for birth and weaning weights traits was:

$$\mathbf{Y_{ijkl} = \mu + B_i + C_j + S_k + E_{ijkl}} \quad \textbf{(4)}$$

Where: Y_{ijk} : observation on the m^{th} animals of the i^{th} population in the j^{th} year of calving in the k^{th} season of calving, μ : Overall mean, B_i: fixed effect due to the population, (i: E and ½E ½I), C_j: fixed effect due to the year of calving, (j: 2005, 2006, 2007), S_k: fixed effect due to the season of calving (k: Winter and Summer) and E_{ijkl}: random error assumed N.I.D. (0, σ^2e).

The Animal model (derivative-free restricted maximum likelihood, DFREML, Meyer, 1997) was used for the prediction of buffaloes breeding value for TMY trait according to the following model:

$$\mathbf{Y = Xb + Z_a\, a + Z_c\, c + e} \quad \textbf{(5)}$$

where: Y = Vector of observations, X = Incidence matrix relating fixed effects to y, b = Vector of an overall mean and fixed effects (parity, year, season of calving and lactation period and age at first calving as a covariable), Z_a = Incidence matrix relating direct additive genetic effects to y, a = Vector of random effect (direct additive genetic associated with the incidence matrix Za, Z_c = Incidence matrix for permanent environmental effect, c = Vector of permanent environmental effect associated with the incidence matrix Zc and e = Vector of random residual effects N (0, Iσ²e); I is an identity matrix. The variance-covariance of the random effects was as follows:

$$Var \begin{bmatrix} a \\ c \\ e \end{bmatrix} = \begin{bmatrix} A\sigma^2 a & 0 & 0 \\ 0 & I_c\sigma^2 c & 0 \\ 0 & 0 & I_n\sigma^2 e \end{bmatrix}$$

Where: A = Numerator relationship matrix, I_c, I_n = Identity matrix with order equal to number of animals and number of records, respectively.

3. Results and discussion

Trial1:

Unadjusted means, standard deviations and number of records for total milk yield and lactation period are presented in Table 1.

Table (1). Unadjusted means, standard deviations (SD) and number of records (No.) for total milk yield (TMY) and lactation period (LP) in Egyptian (E) and their crossing with Pakistani (Pa) buffaloes.

Buffaloes population	TMY (Kg)		LP (Day)		NO.
	Mean	SD	Mean	SD	
Egyptian (E)	1502	344	263	60	85
1/2 E 1/2 Pa	1357	394	218	47	22
3/4 E 1/4 Pa	1383	372	193	42	29

Average total milk yield was nearly the same, considering the lactation period, for Egyptian buffaloes and its crossing with Pakistani, but Egyptian group had lower degree of deviation. For lactation period, Egyptian buffalo showed its ability to persist longer lactation than its two crosses groups. Reviewing other research articles for contemporary herds, averages total milk yield were similar to those reported by Abd El-Raoof (1995) but higher than those reported by Mostageer et al. (1981); Khattab *et al.* (1985); Kotby *et al.* (1989); Khalil *et al.* (1992); Khattab and Mourad (1992); Khalil (1993) and Mansour *et al.* (1993) in Egyptian buffaloes. It was lower than the estimates, 1564, 2159 and 1879 kg, obtained by Soliman *et al.* (1985); Ashmawy (1991) and Mourad and Mohamed (1995), respectively.

Mean-squares estimates for lactation period, shown in Table 2, present significant differences between the three studied populations, and the population/lactation interactions ($P \leq 0.05$). Expectedly, lactation period covariate had highly significant effect on milk yield, while lactation parity did not have significant effect on TMY. This result is in disagreement with Soliman (1976); Kotby *et al.* (1989); Ashmawy (1991); Khalil *et al.* (1992); Khalil (1993) and El-Menshawy (1994) for Egyptian buffaloes, all reporting high significant differences between lactation parities. Ashmawy (1991) reported that the effect of parity on milk yield traits with advance of lactation order may be attributed to the increase in weight, size, advancement in age, and/or developing the udder secretory tissues until reaching full development.

Table (2) Mean squares (MS) for total milk yield.

Source of variation	d.f	MS
Population (B)	2	315609*
Lactation parity (P)	6	117966
Covariable		
Lactation period (L)	1	2690583***
Interactions:		
B*P	12	96076
L*P	6	99301
L*B	2	278976*

*** : $P \leq 0.05$ *** : $P \leq 0.001$**

Milk yield generally tend to increase with the advancement of parities till the ≥7 parity group (Table 3). These results are in agreement with Soliman (1976); Khalil *et al.* (1992) and El-Menshawy (1994). Such results reflect the buffalo ability to develop milk production and its biological processes for longer production life span (longevity) than the cattle. The population of ¼P ¾E showed the highest milk production followed by the ½P ½E population, reflecting the effect of crossbreeding ratio on the trait. The higher Egyptian blood percentage group was favorable, which might be due to the adaptation of Egyptian buffalo population to the Egyptian environment.

Table (3). Least squares means (LSM) and their standard errors (SE) of factors influencing total milk yield (TMY).

Effect	No.	LSM±SE
Parity :		
1	18	1339±150.24
2	25	1271±119.21
3	28	1552±78.23
4	25	1512±111.12
5	13	1429±117.48
6	11	1585±100.71
≥7	16	1664±88.26
Buffaloes population :		
Egyptian (E)	85	1441±42.74
1/2 E 1/2 P	22	1469±107.97
3/4 E 1/4 P	29	1527±97.35

Egyptian buffaloes showed the highest values for all growth traits measures, accompanied with higher deviation (Table 4). Result is in agreement with Fahmy (1972) Mostageer *et al.* (1981) and Alim (1991) for BW, while, lower than Fooda (1996); (42.8-44.9 kg) and El-Menshawy (1994); (42 kg). For WW, the result is in agreement with El-Naggar *et al.* (1972); Fahmy (1972) and Mahdy *et al.* (1999), while is lower than data reported by Mostageer *et al.* (1981) and El-Menshawy (1994). And is higher than Fooda (1996) and Salama and Mohy El-Deen (1997). The result for DG (from BW to WW) is in agreement with Salama and Mohy El-Deen (1997) and Mahdy *et al.* (1999) but is lower than El-Menshawy (1994); (0.66 kg).

Table (4) Unadjusted means, standard deviations (SD) and number of records (No.) for birth (BW), Weaning (WW) weight and daily gain (DG) in Egyptian (E) and their crossing with Pakistani (P) buffaloes.

Buffaloes Population	BW (Kg)			WW (Kg)			DG (Kg)		
	Mean	SD	No.	Mean	SD	No.	Mean	SD	No.
Egyptian (E)	35.0	6.4	73	92	8.4	73	0.54	0.06	73
1/2E 1/2P	34.0	1.5	22	-	-	-	-	-	-
3/4E 1/4P	34.0	3.7	52	79	4.7	13	0.44	0.03	13
7/8E 1/8P	32.0	7.3	21	82	3.5	3	0.47	0.06	3

Although significant differences ($P \leq 0.001$) were detected in both weaning weights and daily gains among studied populations, birth weight trait did not show significant differences (Table 5). Birth weights differed significantly between the two sexes ($P \leq 0.01$). This result is in agreement with Sadek (1980) and Tantawy (1984), but is disagreement with Fooda (1996). Weaning weight and daily gain traits did not significantly affected by sex. This result is in disagreement with Sadek (1980) and Tantawy (1984), which might be due to the farm management practices, in rearing and growth periods that did not challenge males' potentiality for growth.

Table (5) Mean squares (MS) for body weights.

Source of variation	BW		WW		DG	
	d.f	MS	d.f	MS	d.f	MS
Population (B)	3	58.656	3	1007.436***	3	0.0576***
Sex (S)	1	189.116**	1	165.137	1	0.0021

**** : $P \leq 0.01$, *** : $P \leq 0.001$**

Egyptian buffaloes showed superiority in growth traits studied (weaning weight and daily gain). Population of 7/8E 1/8P showed higher estimates for the same traits than the 3/4E 1/4P indicating the effect of Egyptian population (Table 6). Mahdy *et al.* (1999) reported the same result for the DG between BW and WW.

Table (6). Least squares mean (LSM) and their standard errors (SE) for factors influencing birth (BW), Weaning (WW) weights and daily gain (DG).

Effect	Birth weight (BW, Kg)		Weaning weight (WW, Kg)		Daily gain (DG, Kg)	
	No	LSM±SE	No	LSM±SE	No	LSM±SE
Sex :						
Male	16	37±1.01	4	91±4.53	4	0.51±0.03
Female	152	33±0.49	85	83±1.76	85	0.48±0.01
Buffaloes population.:					73	
Egyptian (E)	73	37±1.01	73	96±2.51	-	0.56±0.02
1/2E 1/2P	22	36±1.39	-	-	13	-
3/4E 1/4P	52	35±0.80	13	81±2.34	3	0.44±0.02
7/8E 1/8P	21	34±1.41	3	86±5.08		0.48±0.04

Trial 2:

For the Egyptian buffalo in both farms, first parity yields were higher than the second, while the third parity, estimated for one farm, was the highest (Table 7). Low productivity in the second parity is due to the purchase of under-test new animals from the animal market in their second parity, according to the farm management. Generally in farm1, crossing buffalo produced more milk than the Egyptian in all parities, while in farm 2 Egyptian buffalo produced more milk than the crossing population at first parity. Egyptian buffalo showed longer lactation period than the crossbred population, indicating higher production persistency, with lower daily milk yield, except the third parity in farm 1. Some crossbred animals showed superior productivities in their second lactation (>4500 kg), which resulted in increase in standard deviation. Authors kept all the available records to avoid biasness. In Italy, TMY and LP for Italian buffaloes (measured for only nationally recorded dairy buffaloes; presents 28% of total population) were 2,175 kg and 270d, respectively (Maria Larsson, 2009). In the same reference, author reported TMY and LP for Egyptian buffaloes as 1,600 kg and 321 d, respectively, therefore, estimated daily milk yield for Italian and Egyptian buffaloes, respectively, are 8 and 5 kg/d. According to Fooda et al. (2010) reported the daily milk yield to be 8 kg/d/head measured from 3,495 records collected from 904 buffalo cows.

Table (8) shows the significant difference in milk productivity between the Egyptian and its Italian crossbred population, which was significantly higher ($P \leq 0.001$) in farm 2 than it is in farm 1 ($P \leq 0.01$). That might be due to different management decision in selection of the purchased Egyptian buffalo animals in the two farms. The same trend in difference is detected for the parity effect, due to the purchase of new milking animals to join the herd in their second parity, affecting the average dairy production of the farm. Parities in farm 2 do not exceed the second (Table 9).

Insignificant effect of season on milk production indicates the good management system in both farms that compensate the season effect. The sever change in lactation period between the first and the second parity, in farm 2 (Table 7) resulted in the significant effect of lactation period ($P \leq 0.01$) on milk yield (Table 8). Lactation phase of new purchased animals should be considered, to be corrected for. Both covariables, showed significant effect only in farm 2, indicating the variability in both lactation phase and the age of the Egyptian animals at purchase time.

The correction of fixed effects and covariates reveal that the Italian crosses showed higher LSM estimates values for TMY than the Egyptian buffaloes, which also increases with the advancement of the parity, in the two farms (Table 9). LSM data reveal increase of 27 and 15% in 1/2E1/2I crossbred milk production than the Egyptian in farm 1 and farm 2, respectively.

Both raw mean and LSM data (Tables 10 and 12) show that Italian crosses are superior to Egyptian buffalo in both body weights (birth and weaning), in both farms. Generally, the Italian buffalo has a body conformation that very likely to meat production animals, in addition to its superiority in milk production due to genetic improvement for dairy production and type traits. Fooda et al. (2009), reported that birth and weaning weights were 33.5 and 77.28 kg for the Egyptian buffalo using the data for 148 females and 96 males, raised in APRI experimental farms.

MSE estimates reveal that the buffalo population (Egyptian vs Italian crossbred) has the significant effect on both studied weights, except the WW in farm 2 (Table 11). For the Egyptian buffaloes kept in APRI experimental farms, Fooda et al. (2009) reported insignificant effect of year and season of calving on birth weight, while, the same author reported highly significant effects on weaning weight, for the same effects. No trend was detected for birth weight during the period covered in the study, while weaning weight showed positive trend of increase.

Figures 1 and 2 illustrate the highest and lowest breeding value for total milk yield in both included farms. Figures (1 and 2) show that the difference between the highest and lowest breeding value (BV) in the Egyptian population is larger than it is in the crossbred population (+101 to -269; 370 kg, and +425 to -135; 560 kg, for the Egyptian and crossbred populations, respectively) in farm 1 and the same trend is noticed in farm 2 (+85 to -181; 266 kg, and +81 to -70; 151 kg, for the Egyptian and crossbred populations, respectively). Comparison between the two farms indicates that farm 1 have more potential animals. Farm 1 milking buffaloes showed much wider range (maximum and minimum) breeding value than Farm 2 (+424.64 vs +85.47 for the maximum, and -269.49 vs -181.16 for the minimum).

Table (7). Unadjusted means, standard deviations (SD) for total milk yield (TMY) and lactation period (L) at various parity (P) in Egyptian (E) and their crossing with Italian (I) buffaloes.

Traits	Farm 1+			Farm 2+		
	Mean	SD	N	Mean	SD	N
Parity 1						
Total milk yield (TMY, Kg)						
E	1827	358	18	1977	510	18
1/2 E 1/2 I	2362	611	19	1647	731	40
Lactation period (L, Day)						
E	277	46	18	281	65	18
1/2 E 1/2 I	265	30	19	209	103	40
Parity 2						
Total milk yield (TMY, Kg)						
E	1540	363	7	1111	559	8
1/2 E 1/2 I	2500	1251	11	2003	900	8
Lactation period (L, Day)						
E	271	69	7	102	54	8
1/2 E 1/2 I	255	46	11	166	78	8
Parity 3						
Total milk yield (TMY, Kg)						
E	2533	244	9	-	-	-
1/2 E 1/2 I	3289	692	4	-	-	-
Lactation period (L, Day)						
E	273	30	9	-	-	-
1/2 E 1/2 I	285	30	4	-	-	-

+ Farm 1: Ganat Elreda; Farm 2: United Group

Table (8) Mean squares (MS) for total milk yield (TMY).

Source of variation	Farm 1+		Farm 2+	
	d.f	MS	d.f	MS
Population (B)	1	3055097**	1	789707***
Lactation parity (P)	2	1438118**	1	2461196***
Year of calving (C)	2	1142014*	1	44963
Season of calving (S)	1	26951	1	144730
Covariable				
Lactation period (L)	1	958218	1	366262**
Age at first calving (A)	1	327317	1	242623*
Interactions:				
L*A	1	316853	1	75239

+ Farm 1: Ganat Elreda; Farm 2: United Group

*** : $P \leq 0.05$ ** : $P \leq 0.01$ *** : $P \leq 0.001$**

Table (9) Least square means (LSM) and their standard errors (SE) for total milk yield (TMY).

Effect	Farm 1+			Farm 2+		
	LSM	SE	N	LSM	SE	N
Population						
E	2156	135	32	1802	69	26
1/2 E 1/2 I	2728	112	32	2077	77	48
Parity						
1	2139	100	36	1524	46	58
2	2338	148	17	2356	120	16
3	2848	191	11	-	-	-
Year						
2007	2790	193	11	-	-	-
2008	2215	119	31	1991	213	20
2009	2320	123	22	1888	48	54
Season						
Winter	2465	117	31	1880	62	45
Summer	2418	116	33	1999	83	29

+ Farm 1: Ganat Elreda; Farm 2: United Group

Table (10). Unadjusted means, standard deviations (SD) for birth and weaning weights (kg) in Egyptian (E) and their crossing with Italian (I) buffaloes.

Traits	Egyptian buffaloes (E)			1/2 E 1/2 I		
	Mean	SD	N	Mean	SD	N
Farm 1+						
Birth weight (BW)	35	9.12	6	41	2.15	12
Weaning weight (WW)	91	4.31	6	101	6.86	11
Farm 2+						
Birth weight (BW)	41	4.63	25	46	6.24	49
Weaning weight (WW)	105	4.42	25	106	3.74	49

+ Farm 1: Ganat Elreda; Farm 2: United Group

Table (11) Mean squares (MS) for birth and weaning weights

Source of variation	BW		WW	
	d.f	MS	d.f	MS
Farm 1+				
Population (B)	1	150.358*	1	222.907*
Year of calving (C)	2	15.752	2	83.574
Season of calving (S)	1	14.405	1	30.804
Farm 2+				
Population (B)	1	166.45*	1	6.18
Year of calving (C)	1	6.28	1	7.38
Season of calving (S)	1	60.06	1	1.24

+ Farm 1: Ganat Elreda; Farm 2: United Group

*** : P ≤ 0.05**

Table (12) Least square means (LSM) and their standard errors (SE) for birth (BW) and weaning (WW) weights.

Effect	BW			WW		
	LSM	SE	N	LSM	SE	N
Farm 1+						
Population						
E	34	2.88	6	92	2.90	6
1/2 E 1/2 I	41	1.67	12	101	1.73	11
Y						
2005	39	2.33	7	98	2.62	6
2006	38	2.70	5	92	2.71	5
2007	36	2.53	6	100	2.54	6
SE						
Winter	39	1.79	11	95	1.80	11
Summer	36	2.77	7	98	2.94	6
Farm 2+						
Population						
E	43	2.50	25	104	1.74	25
1/2 E 1/2 I	47	2.01	49	105	1.40	49
Y						
2006	44	0.82	55	106	0.57	55
2007	44	1.55	19	106	1.08	19
SE						
E	46	2.38	35	105	1.66	35
1/2 E 1/2 I	44	2.11	39	104	1.47	39

+ Farm 1: Ganat Elreda; Farm 2: United Group

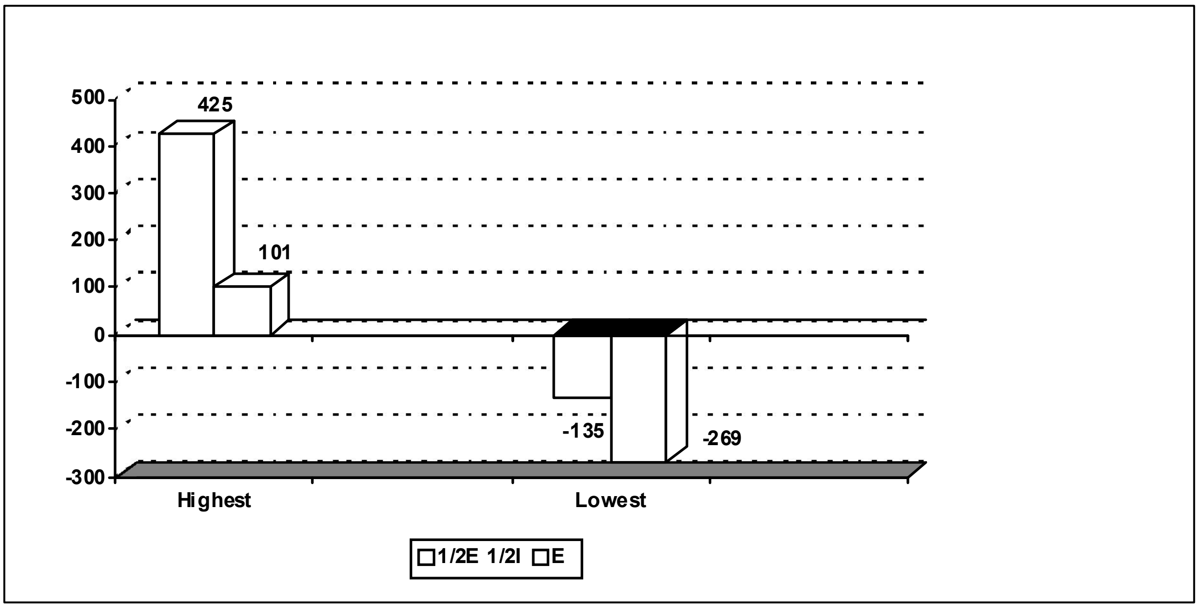

Fig (1). Highest and lowest breeding values for total milk yield in Ganat Elreda farm.

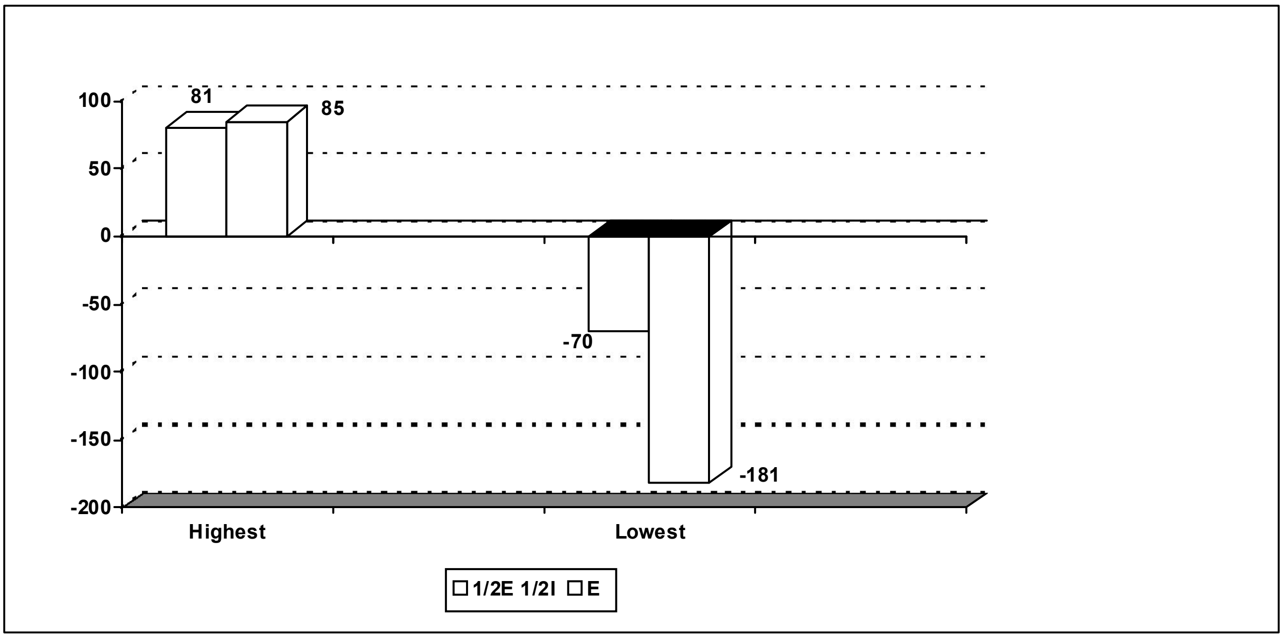

Fig (2). Highest and lowest breeding values for total milk yield in United Group farm.

Conclusion

It can be concluded that from the results obtained:

Trial 1:

- Only slight increase in milk productivity was noticed due to crossbreeding with the Pakistani buffaloes. Concerning weaning weight and daily gain (from birth to weaning), high significant differences were detected, favoring the Egyptian buffaloes population. It can be then concluded that the Egyptian buffalo is a better dual purpose animal than the Pakistani crossbred.

Trial 2:

- Since the Italian buffalo semen is from the same source and with very close breeding values, the difference in crossbred production performance is due to the Egyptian buffalo's genetic merit. Paying more attention to the genetic improvement of the Egyptian buffalo is quite likely to improve its productive performance.
- Reviewing the results obtained for birth and weaning weights raise the question of the opportunities of using Italian buffalo for improving the national meat production from buffalo.
- There is still need for milk composition analysis, lactation curve fitting, and the assessment of the reproductive performance for the crossbred populations for more accurate assessment of crossbreeding and its performance under local conditions.

A general conclusion can be summarizes as more studies are needed for the assessment of productive, reproductive and genetic diversity of crossbred populations before the enhancement of crossbreeding activities on national level.

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