Estimation of genetic and phenotypic parameters for milk yield, lactation length, calving interval and body weight in the first lactation of Egyptian buffalo

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Abstract: The objective of this study was to investigate the genetic and phenotypic parameters of milk yield, lactation length, calving interval and body weight at first calving and to study possibilities of genetic improving performance in the first lactation. A total number of 2066 buffalo cows, progeny of 195 sires and 1259 dams, raised at four experimental herds of Animal Production Research Institute (APRI), Ministry of Agriculture and Land Reclamation, Egypt were used. Genetic and phenotypic parameters were estimated from multiple-trait animal model using REML procedure where herd, season and year of calving effects and age at calving as a covariate were considered as fixed and animal additive genetic effect as random. Heritability estimates were 0.13, 0.11, 0.06 and 0.23 for milk yield, lactation length, calving interval and body weight at first calving, respectively. Estimates of genetic and phenotypic correlations among studied traits were ranging from -0.21 to 0.79 and from -0.12 to 0.66, respectively.

The regression coefficient of genetic and phenotypic values on year of calving for milk yield, calving interval and body weight at first calving, indicated that there were a negligible genetic and phenotypic trends. While, lactation length had a different trend. Generally, the current results showed that the direct genetic selection to improve milk yield based on the first lactation traits is not expected to have a genetic response through a selection scheme in Egyptian buffalo.

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1. Introduction

The weight at first calving has the most significant influence on milk yield and reproductive traits in dairy cattle (Lee and Pollak, 2002; MacDonald *et al.*, 2005 and Bailey and Currin, 2009). Therefore, knowledge of genetic and phenotypic relationships among these traits in buffaloes is essential for genetic improvement. In addition, including productive and reproductive traits in breeding programs would minimize the negative effects of selection for milk production only.

First lactation yield is the most commonly used trait as a selection criterion for dairy animals. In Egypt, most buffaloes have low milk yield and short lactation length in their first lactation (Metry *et al.*, 1994), therefore the decision of genetic selection in most cases, is delayed to next lactations. Thus, it would be better to consider other traits based on the performance during first lactation (El-Bramony, 2011). Moreover, genetic parameters of growth are not available for Egyptian buffalo. Therefore, The objective of this study was to investigate the genetic and phenotypic parameters and trends of milk yield, lactation length, calving interval and the body weight at first calving and to study possibilities of improving their performances.

2. Materials and Methods

Description of the data set:

Data were obtained from four experimental herds belonging to the Animal Production Research Institute (APRI), Ministry of Agriculture and Land Reclamation, Egypt. Records pertained to 1986 - 2011 years of birth and 1990 - 2012 years of the calving. A total number of 2066 buffalo cows, progeny of 195 sires and 1259 dams were available for this study. Buffaloes were kept under semi-open sheds. Amounts of rations given to animals were determined according to animal body weight and level of milk production. The body weight was measured immediately after calving, and milking buffalo cows were to be dried off two months before their expected next calving dates. Milking was practiced twice a day at 07.00 am and 04.00 pm throughout the lactation period. The ration was offered twice daily and clean water was available all the time.

Buffalo cows were naturally mated in a group-mating system. Rectal palpation was applied to check pregnancy. As a rule, buffalo heifers were to be first mated at 24 months of age or 330 kg of weight which comes first. Age at first calving averaged 37 mo with range of 29 to 71 mo. Abnormal records affected by diseases or by missing birth dates or dry off dates and yields were excluded. After editing, 89% of lactation records were kept in the data file.

Data were classified according to the month of calving into two seasons: hot (April through September) and mild for the rest of months. All known relationships among individuals were considered in the animal model. The following traits were evaluated: first lactation milk yield (FLMY, kg), first lactation length (FLL, d), interval between first and second calving (FCI, d) and weight at first calving (WAC, kg).

Statistical analysis:

Analysis of variance of fixed effects were performed from editing data using PROC GLM procedure of SAS (SAS, 2002). The breeding values and genetic parameters of studied traits were estimated by the Restricted Maximum Likelihood (REML) procedure, using the software VCE 4.0 (Groeneveld and García Cortés, 1998), fitting multiple-trait animal model and incorporating all available pedigree information. Random effects in this study were additive genetic effects and errors for each traits with the corresponding covariance matrix between them.

The following animal model, in matrix notation, was used for FLMY, FLL and FCI traits:

$Y= X\beta + Z\alpha + e$ (1)

Where:

Y denotes a vector of observations of response traits (FLMY, FLL and FCI);

β= vector of fixed effects of herd (4 classes), and year of calving (23 classes);

α= vector of random animal additive genetic effect normally and independently distributed $(0, I\sigma^2_a)$;

X and Z denotes know incidence matrices for fixed and random effects and

e denote nonobservable random vector of errors, normally and independently distributed $(0, I\sigma^2_e)$.

The following animal model, in matrix notation, was used for WAC trait:

$Y= X\beta + Z\alpha + e$ (2)

Where:

Y denotes a vector of observations of response trait (WAC);

β= vector of fixed effects of herd (4 classes), year of calving (23 classes), season of calving (2 classes) and age at first calving (as a covariate) and

α, X, Z and e are defined as in model (1).

Estimation of genetic and phenotypic trends were estimated by regression procedures of SAS (SAS, 2002). Average breeding vaules of buffalo cows were regressed on year of calving, to reflect the annual genetic trends for studied traits. The phenotypic trends were estimated as the linear regression of phenotypic averages of each trait on year of calving.

3. Results and Discussion

The descriptive statistics; means, standard erorrs (±SE) and coefficients of variation (CV%) for studied traits are given in Table 1. The mean of milk yield (1121 kg) is smaller than the corresponding estimates (1646, 1624, 1594, 1245 and 1175 kg) reviewed by Yadav *et al.* (2002), Afzal *et al.* (2007), Seno *et al.* (2010), Ahmad *et al.* (2009) and El-Bramony (2011) working on different populations of buffaloes. The higher estimates could be due to good managerial practices, as well as to the results of the selection program for milk production carried out in the countries (India and Pakistan) for decades. Therefore, much attention should be paid for improving managerial practices. As expected, FLL averaged 202 d (Table1). The mean FLL is within the estimates obtained by El-Bramony (2011), for Egyptian buffalo, Ahmad *et al*. (2009) and Afzal *et al.* (2007) for Nili-Ravi buffalo which ranged between 182 and 278 d. The mean FCI was 484 d. It varied considerably from 453 to 483 d as reported in the literature by Seno *et al*. (2010) for Murrah buffalo and Hussain *et al*. (2006) for Nili-Ravi buffalo, respectively. The mean WAC (397 kg) was close to estimate (379 kg) obtained by Marai *et al.* (2001) for Egyptian buffalo.

The results of the analysis of variance revealed that the herd and year of calving showed a significant effect (P<0.01) on all the studied traits. Age at first calving and season of calving effects showed a significant effect (P<0.01 and P<0.05, respectively), on weight at first calving. On the other hand, the interaction between year and season of calving had no significant effect (p>0.05) on all the studied traits. Similar results were reported by Marai *et al.* (2001) and Badran *et al*. (2002) for Egyptian buffalo and Johari and Bhat (1979), Thevamanoharan *et al.* (2002), Yadav *et al.* (2002), Ahmad *et al.* (2009) and Akhtar *et al.* (2012) for different populations of buffalo.

Table 1. Descriptive statistics for studied traits

Trait[1]	Mean	±SE	CV%
FLMY, kg	1120.51	7.48	30
FLL, d	201.77	0.82	18
FCI , d	484.27	1.85	17
WAC, kg	397.11	1.10	12

[1]FLMY: First lactation milk yield; FLL: first lactation length; FCI: interval between first and second calving and WAC: weight at first calving, No of records= 2066.

Table 2 shows heritabilities, genetic and phenotypic correlation coefficients for the studied traits. The heritability FLMY (0.13) was close to the estimate (0.12) obtained by El-Bramony *et al.* (2004) when working with test day records for the same population. On the other hand, heritability estimates of FLMY reported by Thevamanoharan *et al*. (2002), Malhado *et al.* (2009) and Seno *et al.* (2010) ranged from 0.10 to 0.20 for different buffalo populations. Estimate of heritability for FLL was 0.11 (Table 2). Lower heritability estimates (0.03 and 0.06) for first lactation length were reported by Malhado *et al.* (2009) and Thevamanoharan *et al*. (2002), respectively, for different populations of buffalo.

Generally, estimates of heritability obtained in the present study for FLMY and FLL are low despite the fact that the Egyptian buffalo has not gone through intense genetic selection that could result in eroding the additive genetic variance (El-Bramony, 2011).

Heritability estimate for FCI was 0.06. This estimate generally fall within the range of those obtained for buffalo (Malhado *et al.,* 2009; Suhail *et al.,* 2009 and Seno *et al.,* 2010). Thus, low estimate of heritability for FCI indicate that a genetic selection for this trait is not expected to have a genetic response through a selection scheme in this population. It should depend mainly on improving managerial practices.

Heritability estimate for the weight at first calving was 0.23 (Table 2), indicating that direct selection to improve this trait would be highly efficient. Comparable estimates were previously reported on both buffalo (Johari and Bhat, 1979 and Akhtar *et al*., 2012) and cattle (David Clark and Touchberry, 1962). Thus, the moderate estimate of heritability in the present study can be considered to promote substantial genetic response through selection scheme in this population.

Estimates of genetic and phenotypic correlations among FLMY, FLL and FCI were positive ranging from 0.13 to 0.79 and from 0.01 to 0.66, respectively, Table 2. The estimates were comparable with estimates of others studies (Malhado *et al*., 2009; Suhail *et al.*, 2009 and Seno *et al.,* 2010) for different populations of buffalo. As expected, high yielding buffalo cows usually have longer lactation length. Moreover, the high yielding buffalo cows usually have longer CI in dairy animals. Thus, a favorable correlated response is expected with subsequent lactations, through a selection scheme and improving managerial practices in this population.

Table 2. Estimates of heritabilities (bold on the diagonal), genetic (above diagonal) and phenotypic correlation coefficients (below diagonal) among studied traits with their standard errors (in parentheses)

Trait[1]	FLMY	FLL	FCI	WAC
FLMY	**0.13** **(0.02)**	0.54 (0.13)	0.13 (0.33)	-0.22 (0.14)
FLL	0.66 (0.20)	**0.11** **(0.02)**	0.79 (0.14)	-0.21 (0.12)
FCI	0.01 (0.00)	0.01 (0.00)	**0.06** **(0.01)**	0.25 0.23)
WAC	0.02 (0.00)	0.08 (0.00)	-0.12 (0.02)	**0.23** **(0.02)**

[1]See abbreviations in table 1.

The weight at first calving in the present study had low and negative genetic correlation with both FLMY and FLL (Table 2). Similarly, Moore *et al*. (1991) and Lee and Pollak (2002) reported negative estimates of the genetic correlation between weight at calving and milk yield in the first lactation that ranged from -0.22 to -0.33 for dairy cattle. In addition, David Clark and Touchberry (1962) reported that genetic correlation between weight at calving and milk yield ranged from near zero in the first lactation to -0.53 in the second lactation for dairy cattle. They indicated that the direct selection of increasing both body weight and milk yield is not expected to have positive genetic response through a selection scheme. Thus, it would be better to consider other traits positively correlated of these traits. The negative estimates obtained for genetic correlation between WAC and each FLMY and FLL could be due to increase growth rates of heifers (Hoffman *et al.,* 1996). Moreover, during the prepubertal period of heifers growth, the mammary gland sensitive to body weight gain (Sejrsen *et al*., 1982). Negative genetic associations between WAC and each FLMY and FLL suggesting no antagonism between improvement of milk and body weight. The corresponding phenotypic correlation estimates were almost nill (Table 2).

Similar result was obtained by Freking and Marshall (1992) on dairy cattle they found that phenotypic correlation between weight at calving and milk production was 0.01. Results in Table 2 show that estimate of genetic correlation between FCI with WAC was low 0.25, while the corresponding phenotypic correlation was (-0.12). Positive genetic correlation suggests that there is a favorable association between weight at first calving and first calving intervals. In dairy cows, MacDonald *et al.* (2005) stated that body weight at calving and postpubertal growth rates of heifers are important in first lactation milk yield but do not affect milk production in subsequent lactations.

Genetic and phenotypic trends of the studied traits are graphically represented in Figures (1 to 3). Genetic and phenotypic trends have not shown a substantial trends among the years, generally an irregular fluctuation was observed.

Figure 1 (A and C) shows that the insignificant annual genetic were -0.09 ± 0.07 kg/yr and 0.06 ± 0.31 d/yr, respectively, for FLMY and FCI. Their insignificant annual phenotypic trends were -0.03 ±0.02 kg/yr and -0.15 ± 0.10 d/yr for FLMY and FCI, respectively, as shown in Figure 2 (A and C). On the other hand, the significant (0.05) linear genetic and phenotypic trend of FLL were 1.5 ± 0.68 d/yr (Figure1 B) and -0.55 ± 0.27 d/yr (Figure2 B), respectively. The same parameters of WAC, as given in Figure3 (A and B), were significant at 1% as a level of significane

(-1.0 ± 0.35 kg/yr and 0.29 ± 0.04 kg/yr), respectively. Similar trend in buffalo reported by Kuralkar and Raheja, 1997; Seno *et al.*, 2010 and Chakraborty and Dhaka, 2012) for different populations in the first lactation.

According to phenotypic values for FLMY and FLL, unfavorable trend was observed in this study. Therefore, more attention should be paid for improving managerial practices. Thus, unfavorable genetic trend for FLMY, FCI and WAC, due to no genetic selection for these traits was performed through breeding scheme in this population. On the contray, favorable significant genetic trend was obtained for FLL and phenotypic trend was obtained for WAC. But the values in both trends were very low.

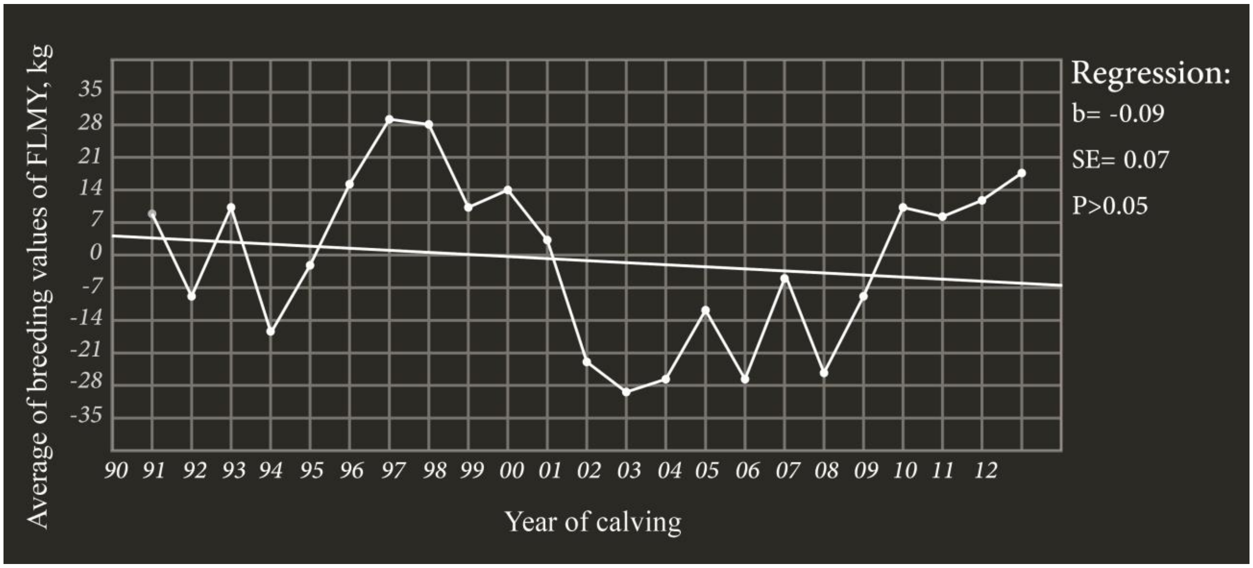

Figure1 A. Genetic trend in FLMY for buffalo cows

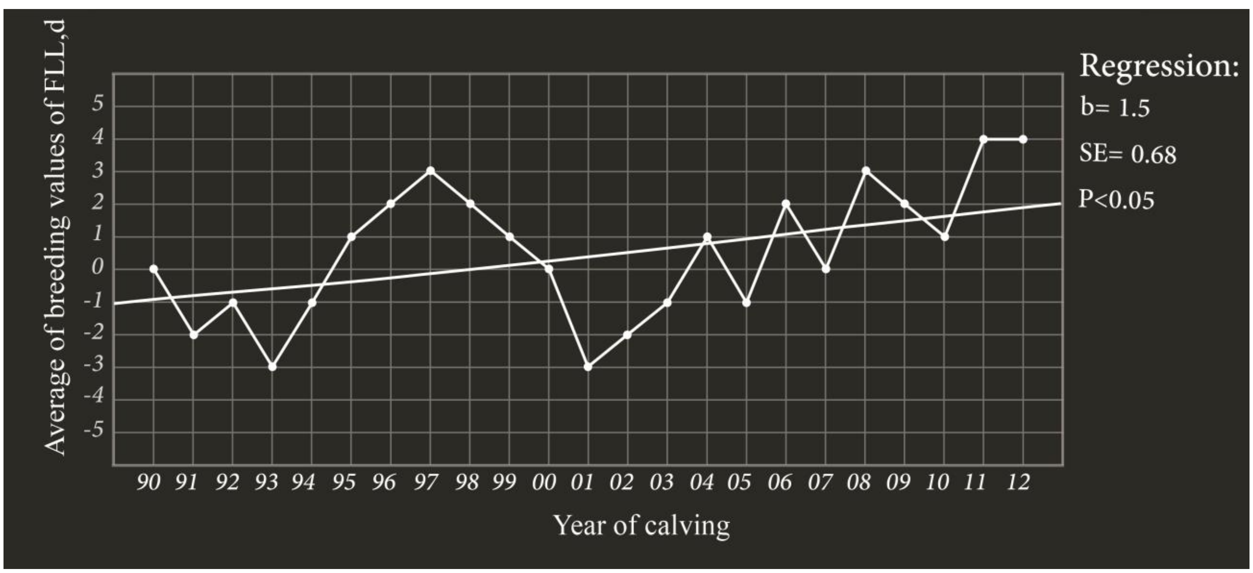

Figure1 B. Genetic trend in FLL for buffalo cow

Figure1 C. Genetic trend in FCI for buffalo cows

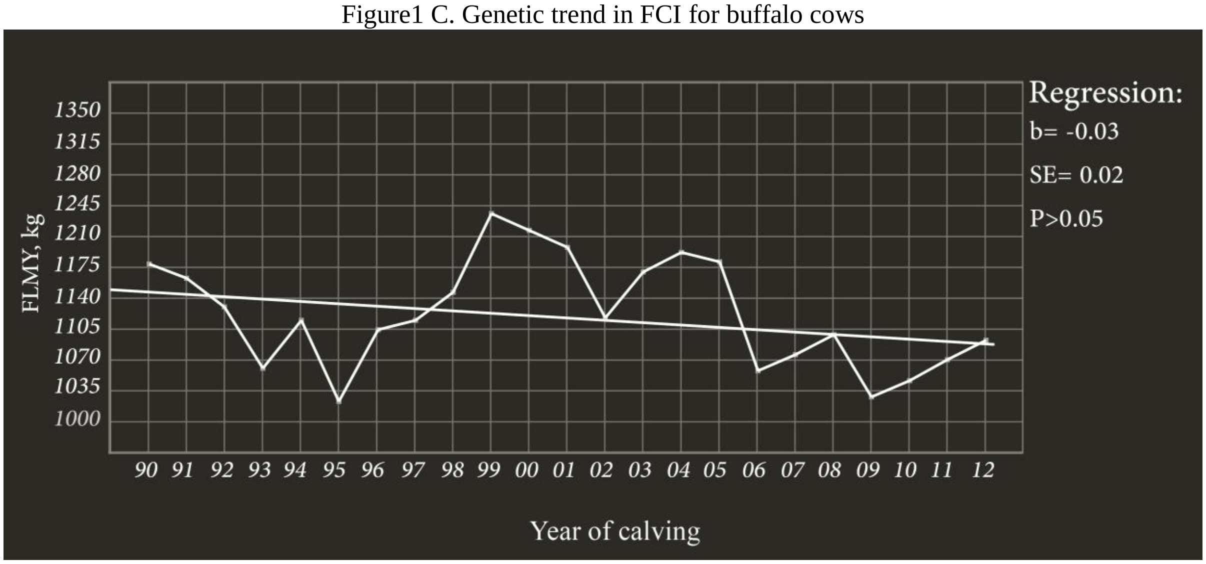

Figure2 A. Phenotypic trend in FLMY for buffalo cows

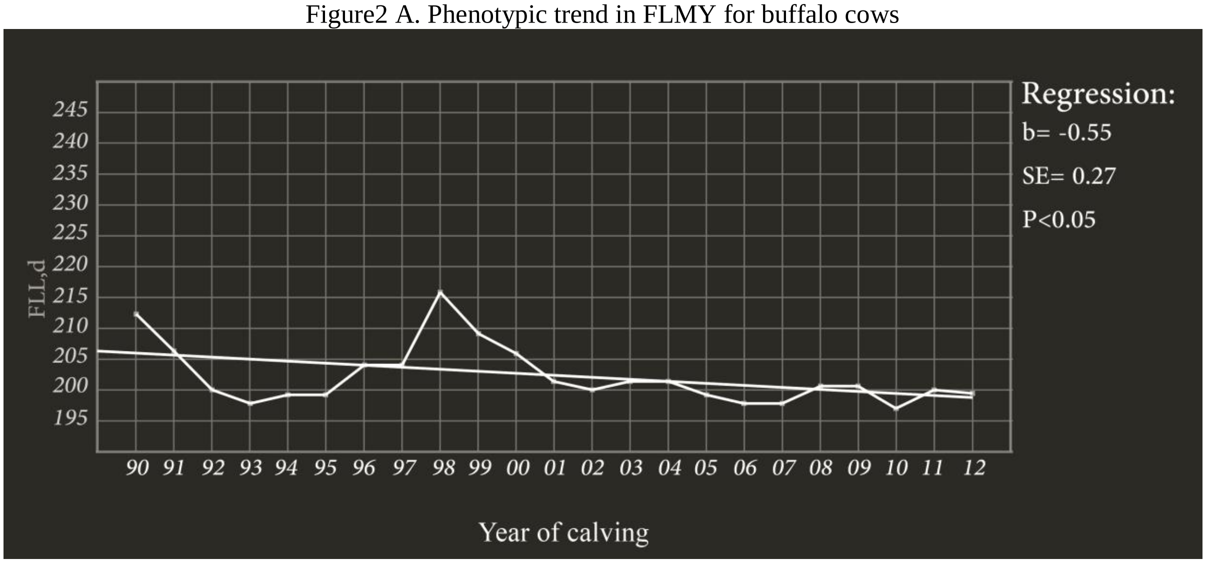

Figure2 B. Phenotypic trend of in FLL for buffalo cows

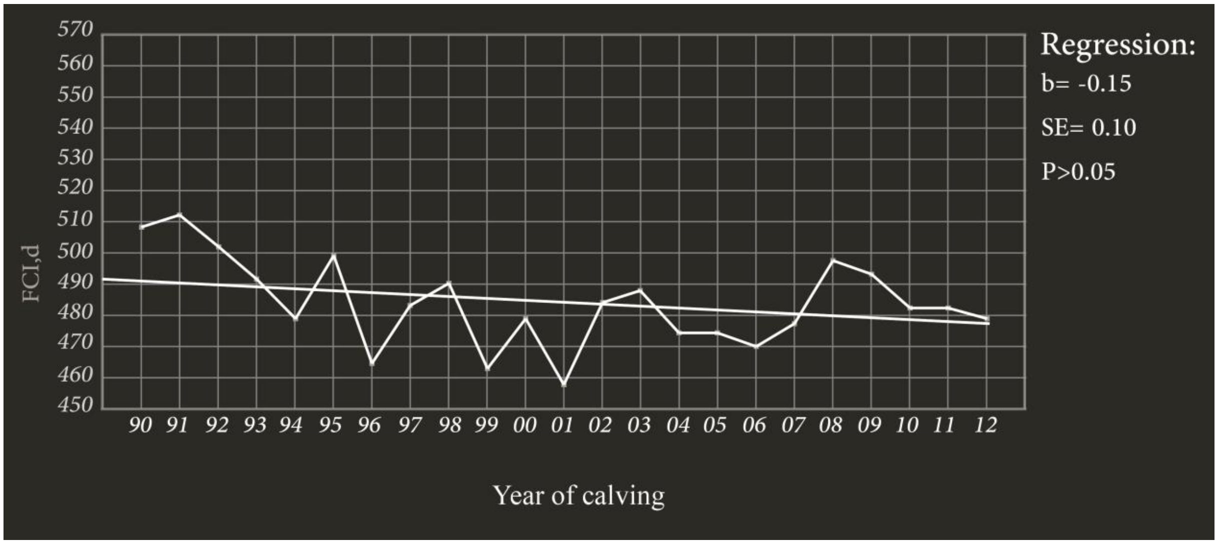

Figure2 C. Phenotypic trend in FCI for buffalo cows

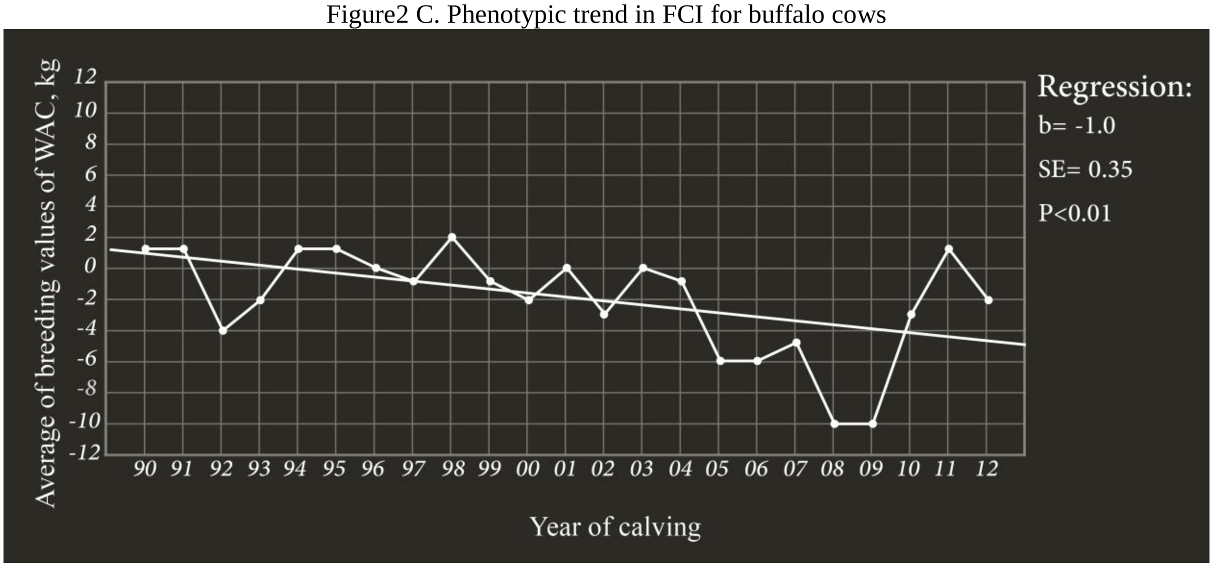

Figure3 A. Genetic trend inWAC for buffalo cows

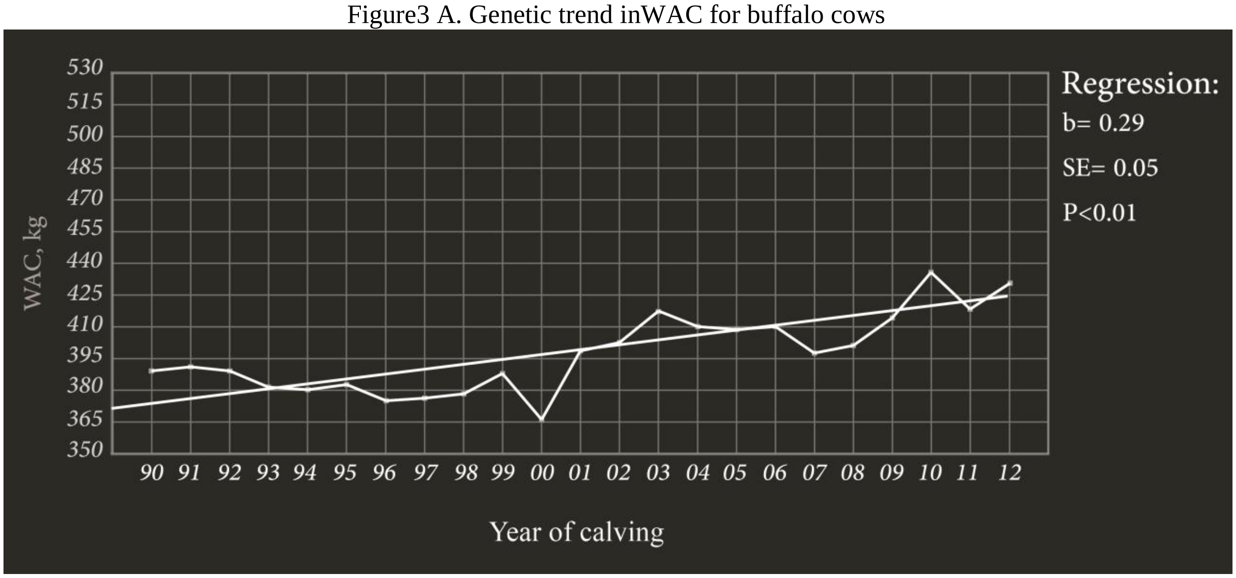

Figure3 B. Phenotypic trend in WAC for buffalo cows

Conclusion

The moderate estimate of heritability for WAC can be considered to promote substantial genetic response through selection scheme in this population.

FLMY had moderate and positive genetic correlation with FLL, indicating that genetic selection to improve one of them is expected to have an effective correlated response in the other. The low genetic correlations of weight at calving with milk yield and lactation length indicate that a selection program to improve milk yield is not expected to result in a negative effect on body weight. The positive genetic correlation suggests that there is a favorable association between FCI and WAC in the first lactation. Average genetic and phenotypic vaules of buffalo cows among years indicated that no standard selection scheme based on genetic values for these traits were performed in Egyptian buffalo. In addition, poor both productive and reproductive efficiency was due to managerial practices. For genetic improvement, application of AI (artificial insemenation) should be employed for breeding with proven sires and intense genetic selection for increasing selection differential. Adequate feeding, management and disease control must be considered.

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