Research Article

ESTIMATION OF GENETIC AND PHENOTYPIC PARAMETERS FOR SOME PRODUCTIVE AND REPRODUCTIVE TRAITS IN EGYPTIAN BUFFOLOES

Zienab, H.S. Abo-Gamil[1]; El-Bayomi, Kh. M.[2];Abo-Salem, M.E.S.[3] ;Ramadan, Sh.I. [1] ;Darwish, S.A. [4];Eman, A. Sallam[1];Eman, A. Manaa[1]

[1]Animal Wealth Development Dept., Fac. of Vet. Med., Benha Univ.
[2] Animal Wealth Development Dept., Fac. of Vet. Med., Zagazig Univ.
[3]Forensic Medicine and Toxicology Dept., Dean of Fac. of Vet. Med., Benha Univ.
[4]Animal Production Research Institute, ARC., Ministry of Agriculture, Doki, Giza, Egypt.

[*]To whom correspondence should be addressed.
E-mail: Zienbhamdy@yahoo.com

ABSTRACT

The present study aimed to display effects of age at first services, age at first calving (AFC), calving interval, days open, number of services per conception, days dry, season of calving on total milk yield (TMY) and 305 milk yield (305MY). Also, to estimate effect of season and parity on calving interval (CI) and days open and then the effect of level of production on service per conception, age at first service, age at first calving, calving interval and days open. Heritability estimates for 305-day milk yield (0.18), days open (0.18), dry period (DP) (0.12), TMY (0.17) and CI (0.19). High heritability estimates were obtained for AFC (0.68) and lactation length (LL) (0.78). There were high positive genetic and phenotypic correlations between total milk yield and 305-day milk yield and low genetic and phenotypic correlations between most studied traits. Average EBV for AFS, AFC and 305MY were higher in cow than sire and dam. Also, average EBV for LL and DO were higher in sire than in cow and dam and average EBV for CI and DP were higher in dam than in cow and sire. But TMY was equal in sire and dam and higher than cow.

Keywords: dairy buffalo, productive and reproductive traits, heritability, genetic and phenotypic correlation, breeding values.

1. Introduction

The buffalo is considered as sluggish breeder as the reproductive efficiency of buffalo is adversely affected by certain characters such as late maturity, poor expression of the estrous signs particularly during summer, irregular estrous cycle, silent heat, seasonality in breeding, poor conception rate, early embryonic mortality and prolonged inter-calving interval ***(Madan,1990)***.

The buffalo is a difficult breed because of its inherent susceptibility to environmental stress, which causes anestrous and repeat breeder. These two conditions are responsible for a prolonged inter calving period resulting in great economic losses for the dairy industry ***(Rangamma et al., 2016)***. ***Javed et al. (2014)*** showed that reproductive efficiency in buffalo is mainly reduced by many reasons; the main reasons are relatively long calving interval and delayed maturity.

Amin (1998) mentioned Sources of financial loss due to poor reproductive efficiency are less milk sold as a result of longer days open, fewer neonate due to longer calving interval, more numbers of breeding per conception as a result of poor heat detection, greater veterinary costs treat reproductive disorder and relatively higher rate of culling on base of lower productive and reproductive efficiency.

Barile (2005) recorded that fertility can be expressed by the calving interval, calving rate, service per conception and age at first calving.

Sub-fertility, infertility and sterility is the outcome of impaired normal function, all of which result in economic losses due to anestrous, extended dry period, late maturity, decreased calving percentage and lifetime productivity of animal, increased cost of management and intense culling of the animals ***(Agarwal et al., 2005)***.

In order to enhance reproductive efficiency of buffalo, a thorough understanding of the regulatory mechanisms involved in the estrous cycle is required. The duration of the estrous cycle in buffalo is similar to that in cattle, ranging from 17 to 26 days with a mean of around 21 days ***(Jainudeen and Hafez, 1993)***.

2. Materials and Methods

Data of 1600 lactation records of Egyptian buffaloes for the present study were obtained from Kafr El-Sheikh governorates. The data were arranged and analyzed using ***SAS (2001)*** and derivative free restricted maximum likelihood (DFREML) procedures using (MTDFREMAL) program of ***Boldman et al. (1995)***.

1. First model:

$$Y_{ijklmnopq} = \mu + P_i + AFS_j + AFC_k + CI_l + DO_m + S/C_n + DP_o + S_p + b_1 (Age) + b_2 (Age)^2 + e_{ijklmnopq}.$$

Symbols in the model are defined as following:-

$Y_{ijklmnopq}$: The observed value; (i.e. total milk yield and 305 milk yield). **μ:** The overall mean. **P_i:** The effect of the i^{th} parity; (i= 1, 2, 3 and 4, where as 1=first parity, 2=second parity, 3=third parity and 4= fourth parity or more). **AFS_j :** The effect of the j^{th} age at first service; (j=1, 2 and 3, where as 1=less than 22 months, 2=22 - 24 months, and 3=more than 24 months). **AFC_k :**The effect of the k^{th} age at first calving; (k=1, 2 and 3, where as 1=less than 35 months, 2= 35-38 months, and 3=more than 38 months).**CI_l :**The effect of the l^{th} calving interval; (m=1, 2 and 3, where as 1=10 to 12 months, 2=13 - 14 months, and 3=more than 14 months). **DO_m :**The effect of the m^{th} days open; (n=1, 2, 3 and 4, where as 1=less than 47 days, 2=47 to 81 days, 3=82 - 160 days, and 4=more than 160 days). **S/C_n :**The effect of the n^{th} number of services/conception; (o=1, 2, 3 and 4, where as 1=one service, 2= two services, 3=three services, 4=four and more services). **DP_o :**The effect of the o^{th} dry period; (p=1, 2 and 3, where as 1=less than 170 days, 2=170 - 235 days, and 3=more than 235). **S_p :**The effect of the p^{th} season of calving; (q=1, 2, 3 and 4, where as 1= summer season, 2=winter season, 3=autumn season and 4=spring season).**b_1 and b_2 :** partial linear and quadratic regression coefficients of $Y_{ijklmnopq}$ on age at calving. **$e_{ijklmnopq}$:** random error.

2. Second model:

This model used to analyze the factors affecting calving interval and days open in the present investigation, the following model was assumed.

$$Y_{ijk} = \mu + S_i + P_j + e_{ijk}.$$

Symbols in the model are defined as following-:

Y_{ijk} : The observed value; (i.e. calving interval and days open). **μ :** The overall mean. **S_i :**The effect of the i^{th} season of calving; (i=1, 2, 3 and 4, where as 1= summer season, 2=winter season, 3=autumn season and 4=spring season). **P_j :**The effect of the j^{th} parity; (j= 1, 2 and 3, where as 1=second parity, 2=third parity and 3= fourth parity or more). **e_{ijk} :** random error.

3. Third model:

This model used to analyze the effect of level of production on service per conception, age at first service, age at first calving, calving interval and days open in the present investigation, and the following model was assumed.

$$Y_{ij} = \mu + L_i + e_{ij.}$$

Symbols in the model are defined as following-:

Y_{ij} : The observed value; (i.e. service per conception, age at first service, age at first calving, calving interval and days open). **μ :**The overall mean. **L_i**: The effect of the i^{th} level of production (305DMY); (i=1, 2 and 3, where as 1= less than 2221 kg, 2=2221-2669 kg and 3=more than 2669 kg). **e_{ij} :**random error.

Heritability, Genetic correlation and breeding value of studied traits were estimated with derivative free restricted maximum likelihood (DFREML) procedures using (MTDFREMAL) program of ***Boldman et al. (1995).*** The assumed model was:

$$Y = Xb + Za + e$$

Y: is the vector of the observed trait. **X**: is the incidence matrix of fixed effects. **b**: is the vector of fixed effects. **Z**: is the incidence matrix of random animal effects. **a**: is the vector of random animal effects. **e**: is the vector of random residual effects.

3. Results

Table (1) showed the Least Squares Means, Standard Errors for different factors affecting Total Milk Yield (TMY) and 305-Day Milk Yield (305DMY).

Parity had a non significant effect on TMY. First lactation season showed the lowest amount of milk (1432.39 kg) and fourth lactation or more showed the maximum yield (1619.05 kg).

Age at first services had a non-significant effect on TMY. The maximum TMY (1575.99 kg) was obtained at age 22-24 months. While, Age at first calving had a non significant effect on TMY. The maximum value of total yield of 1596.51kg obtained in animals calved for the first time at age less than 35 month.

Days open had a highly significant effect on TMY. The maximum milk yield was 1746.71 kg when DO was more than 160 days. Season of calving had a highly significant effect ($P \leq 0.01$) on TMY. The maximum milk yield was 1626.21 kg obtained in winter.

Parity had a non-significant effect on 305DMY. First lactation season showed the lowest amount of milk (2287.71 kg). Age at first calving had a non significant effect on 305DMY. The maximum value of 305DMY was 2495.75 kg obtained in animals calved for the first time at age less than 35 month.

Days open had a significant effect ($P \leq 0.05$) on 305DMY. The maximum milk yield was 2519.70 kg when DO was more than 160 days while the lowest yield was 2338.75 kg obtained when DO was less than 47 days.

Season of calving had a highly significant effect ($P \leq 0.01$) on 305DMY. The maximum milk yield was 2536.26 kg obtained in winter.

Table (2): Season of calving and parity had a highly significant effect ($P \leq 0.01$) on CI. Season of calving and parity had a highly significant effect ($P \leq 0.01$) on DO.

Table (3): In this study there was a significant effect ($P \leq 0.05$) between level of production with each of AFS and DO. While, there was a non significant effect with each of AFC, CI, and number of services per conception with the level of production.

Table (4): For milk production traits, moderate heritability estimates for 305-day milk yield and for dry period were 0.18, 0.12 respectively. Moderate heritability estimates were 0.19, 0.18 and 0.17 for CI, DO and TMY respectively. High heritability estimates for LL and AFC were 0.78 and 0.68 respectively.

There were positive correlation of AFS with AFC (0.37) and DO (0.004). But negative correlations of AFS with each of CI (-0.01), DP (-0.02), LL (-0.01), TMY (-0.12) and 305DMY (-0.16) indicating that there was a little relationship between phenotypic measurements of these traits. And low positive phenotypic correlation of AFC with each of CI (0.07), DO (0.09) and DP (0.08). However, there were low negative correlations of AFC with each of LL (-0.05), TMY (-0.03) and 305DMY (-0.01).

There was low negative genetic correlation between AFS with each of AFC (-0.13), DP (-0.06), TMY (-0.07) and 305DMY (-0.14), CI (-0.01), LL (-0.01). And low positive genetic correlation between AFC with each of CI (0.06), DO (0.08), LL (0.04), DP (0.06) and but there was low negative correlation with 305DMY (-0.12) and high negative correlation with TMY (-0.66).

Table (5): The breeding value for AFS, AFC and CI of cows ranged between -6.7 and 24.2, -10.9 and 25.1 and between -1.4 and 3.5 months, respectively. While the corresponding values for sires were between -4.3 and 5.9, -6.6 and 16.4 and between -1.1 and 2.7 months, respectively. Moreover, the corresponding values for dams were between -3.5 and 7.3, -9.4 and 11.6 and between -1.2 and 1.9 months, respectively.

4. Discussion

Table (1): The previous trend is in agreement with those recorded by ***Rehman et al. (2006)*** said that there was a non significant effect of parity on TMY. But disagree with ***Marai et al. (2009), Sohail (2010) and El-Bramony, (2011)***.

The obtained results were in the same line of those obtained by ***Sohail (2010)*** found age at puberty had a non significant effect on TMY.

The previous results are in agreement with those reported by ***Khattab and Kawthar (2007)*** noted that age at first calving had a non significant effect on TMY. On the other hand, ***Kuralkar and Raheja, (2000)*** who found that AFC had a significant effect on total milk production up to three lactations season in Murrah Buffaloes.

These results confirm those reported by ***Afzal et al. (2007)*** reported that milk yield of the animals conceiving >300 days after calving was significantly higher than the animals conceiving within 31–100 days after calving**.** On contrast ***khan et al. (2008)*** as observed that consistent and significant increase in lactation yield in animals conceiving in early lactation, than those conceiving at the end of lactation.

These results were in agreement with those obtained by ***Afzal et al. (2007)*** showed a significant effect ($P \leq 0.05$) of season of calving on milk yield per lactation.

These results are disagreement with those recorded by***, Sohail (2010) and Ahmad et al. (2009)*** showed that there was an effect of parity on 305DMY. The present result corroborates the previous study of ***Sohail (2010)*** and ***Thiruvenkadan et al. (2010)*** reported that age at first calving had no significant effect on 305-day milk yield.

In agreement with present study, ***Ahmad et al. (2009), Elmaghraby (2010)*** and ***singh et al. (2016)*** recorded that 305-day milk yield significantly affected by the calving season. The opposite results obtained by ***Sarkar et al. (2006)*** and ***Sohail (2010)***.

Table (2): The obtained results were in the same line of those obtained by ***Marai et al. (2009) and Babaei et al. (2015)*** showed that Season of calving and parity had significant effect on CI. On the contrary ***Marai et al. (2001)*** and ***Yohannes et al (2001)*** showed that season of calving and parity had a non significant effect on CI.

These results agreed with ***Marai et al. (2009)*** said that Season of calving and parity had a highly significant effect ($P \leq 0.01$) on DO. The opposite results obtained by ***Goshu et al.***

(2007) and ***Fooda et al. (2011)*** recorded that season of calving had a non-significant effect on DO. ***Yohannes et al. (2001)*** showed that Parity had a non significant effect on DO.

Table (3): On the contrary, ***Lucy (2001) and Němečková et al. (2015)*** noted that cows with higher milk production had more number of services per conception for dairy cattle.

There was direct relationship between milk yield and CI. Animals that gave more than 2669 kg showed the maximum CI (14.02 months). This occurs for cows with deep NEB which cause conception rate decrease and calving interval prolongation over 365 days ***(Pollot, 2011)***.

Table (4): The moderate heritability of 305-day milk yield was in consistence with those obtained by ***Jamuna et al. (2015)*** and ***Singh et al. (2016)*.** On the contrary to the present findings ***Sohail (2010)*** reported high heritability of 305-day milk yield**.**

The moderate heritability of calving interval was in line with ***Thiruvenkadan et al. (2010)*** and ***Gupta et al. (2015)***. The results obtained were not in consistence with the findings of ***Warade et al. (2005)***.

Moreover, the moderate heritability estimates of days open in this study were confirmed by ***Thiruvenkadan et al (2010).*** On the other hand, ***Gupta et al. (2015)*** noted low heritability for days open.

The obtained results were in the same line of those obtained by ***Barros et al. (2014)*** noted negative phenotypic correlations between AFC and MY. While, ***Seno et al. (2010***) recorded that positive correlation of AFC with CI and negative correlation with milk yield. Also, ***Mitad et al. (2007)*** reported low negative correlation of AFC with DIM.

These results were in consistence with the findings obtained by ***Seno et al. (2007)*** showed that there was negative genetic correlation between AFC with milk yield. Also, ***Gupta et al. (2015)*** recorded that there was positive genetic correlation between AFC with CI, DO, DIM. The opposite results obtained by ***Gupta et al. (2015) and Barros et al. (2016)*** noted that there was positive correlation between AFC and milk yield.

Table (5): The opposite results obtained by ***Ahmad et al. (2008)*** found that estimated breeding values for milk yield varied widely (from -323.40 to+345.12 kg), for dam of the Nili-Ravi buffaloes. Also, ***Kumar and Chakravarty (2016)*** mentioned that breeding value in bulls of Murrah buffalo varied from 1630.40 kg in to 2022.61 kg for FL305DMY.

It is concluded that the effects of these factors must be taken into consideration when evaluating dairy cows. Reproductive programs should be managed in such way that all heifers be bred for first time around 22 months of age and calve at less than 35 months of age to obtain high milk production. Also, calving in winter gives maximum milk production. Medium heritability estimates were obtained for most of fertility traits indicating that fertility was somewhat affected by environmental factors and additive genetic effects, improvement of environmental and reproductive management decisions, extensive nutritional conditions will affect buffalo's fertility. In addition, high and favorable genetic correlations among some of fertility traits indicated that animals ranked for one trait would rank similarly in the other correlated traits.

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Table (1) showed the Least Squares Means, Standard Errors for different factors affecting Total Milk Yield (TMY) and 305-Day Milk Yield (305DMY).

Table (1): Least Squares Means, Standard Errors of Various Factors Affecting Total Milk Yield (TMY) and 305-Day Milk Yield (305DMY).

		L.S.M ± S.E	
Classification	**N**	**Total Milk Yield (TMY)**	**305-Day Milk Yield (305DMY)**
<u>1. Parity.</u>			
The 1st lactation	169	1432.39^{b}±67.15	2287.71^{a}±97.62
The 2nd lactation	175	1573.09 ^{a} ±39.43	2458.26^{a}±57.32
The 3rd lactation	156	1589.84 ^{a}±32.88	2478.48^{a}±47.80
The 4th lactation and more.	479	1619.05 ^{a}±42.97	2518.62^{a}±62.46
<u>2. Age at First Service (months).</u>			
Less than22	394	1556.76 ^{a} ±26.49	2472.40^{a}±38.52
22-24	306	1575.99^{a}±27.41	2450.59^{a}±39.85
More than 24	279	1528.02^{a} ±29.63	2384.32^{a}±43.08
<u>3.Age at First Calving (months)</u>.			
Less than35	406	1596.51^{a}±30.19	2495.75^{a}±43.89
35-38	287	1528.65^{b}±28.76	2411.62^{a}±41.81
More than 38.	286	1535.61^{ab} ±25.83	2399.94^{a}±37.55
<u>4. Days Open (days).</u>			
Less than 47	280	1404.84^{c} ±36.70	2338.75^{c}±536
47-81	237	1518.40^{b}±32.98	2482.61^{ab}±47.95
82-160	246	1544.40^{b} ±29.08	2402.02^{bc}±42.28
More than 160.	216	1746.71^{a}±39.84	2519.70^{a}±57.92
<u>5.Number of Services /Conception</u>			
One Service.	517	1528.62^{a} ±26.16	2396.09^{a}±38.03
Two Services.	265	1542.16^{a}±27.50	2421.52^{a}±39.99
Three Services.	94	1564.23^{a}±40.69	2475.50^{a}±59.15
Four Services and more.	103	1579.35^{a}±38.60	2449.96^{a}±56.12
<u>6. Dry Period (days)</u>.			
Less than 170	325		
170-235	306	1717.61^{a}±34.47	2536.58^{a}±50.11
More than 235	348	1588.29^{b}±28.07	2434.94^{b}±40.81
		1354.87^{c}±32.79	2335.79^{b} ±47.68
<u>7. Season of Calving.</u>			
Summer	259	1551.05^{b}±28.53	2422.38^{b}±41.47
Winter	198	1626.21^{a}±32.24	2536.26^{a}±46.86
Autumn	366	1500.31^{b}±26.61	2343.57^{b}±38.67
Spring	156	1536.81^{b}±33.84	2440.87^{ab}±49.20

Table (2): Least Squares Means, Standard Errors of Season of Calving and Parity Affecting Calving Interval and Days Open.

S.O.V	N	L.S.M ± S.E Calving Interval	N	L.S.M ± S.E Days Open
1.Season of Calving.				
Summer.	276	$14.60^{a}\pm0.18$	309	$110.44^{b}\pm5.00$
Winter.	236	$14.47^{ab}\pm0.20$	236	$133.63^{a}\pm5.71$
Autumn.	489	$14.10^{b}\pm0.14$	456	$107.05^{b}\pm4.20$
Spring.	165	$15.00^{a}\pm0.24$	191	$134.10^{a}\pm6.43$
2. Parity.				
The 1st lactation	-	-	2260	$170.56^{a}\pm5.37$
The 2nd lactation	255	$16.05^{a}\pm0.19$	205	$111.69^{b}\pm6.14$
The 3rd lactation	198	$13.99^{b}\pm0.21$	175	$102.97^{b}\pm6.60$
The 4th lactationand more.	713	$13.59^{b}\pm0.11$	552	$99.98^{b}\pm3.76$

Within the same classification, the appearances of least square means with the different letters are significantly different ($p \leq 0.05$).

Table (3): Least Squares Means, Standard Errors of Level of Production in Relation to Fertility Traits.

Classification	N	Service per conception	N	AFS	N	AFC	N	CI	N	DO
		L.S.M ± S.E		L.S.M ± S.E		L.S.M ± S.E		L.S.M ± S.E		L.S.M ± S.E
Level of Production (kg) (305DMY).										
- less than 2221	370	1.95^{a}±0.07	368	23.25^{a}±0.20	368	36.89^{a}±0.27	247	13.9^{a}±0.19	311	113.92^{ab}±5.1
-2221-2669	371	1.86^{a}±0.07	371	23.49^{a}±0.20	371	36.87^{a}±0.27	316	13.8^{a}±0.17	334	121.16^{a}±4.9
- More than 2669.	379	1.89^{a}±0.06	378	22.69^{b}±0.20	378	36.15^{a}±0.27	349	14.0^{a}±0.16	352	103.59^{b}±4.8

Table (4): Phenotypic (above diagonal), Genetic Correlations (below diagonal) and heritability (in bold) among Different Milk Production and Fertility Traits.

Trait	AFS	AFC	LL	CI	DO	DP	TMY	305DMY
AFS	**O.E**	0.37	-0.01	-0.01	0.004	-0.02	-0.12	-0.16
AFC	-0.13	**0.68**	-0.05	0.07	0.09	0.08	-0.03	-0.01
LL	-0.01	0.04	**0.78**	-0.01	0.07	-0.29	0.39	-0.16
CI	-0.01	0.06	0.00	**0.19**	0.17	0.19	-0.03	-0.03
DO	0.00	0.08	0.27	1.00	**0.18**	0.84	-0.02	-0.07
DP	-0.06	0.06	-0.31	1.00	0.94	**0.12**	-0.29	0.08
TMY	-0.07	-0.66	0.00	0.22	0.13	-0.29	**0.17**	0.77
305DMY	-0.14	-0.12	-0.51	0.08	0.08	0.13	0.87	**0.18**

Table (5): Breeding Value Estimates for Different Studied Milk Production Traits and Fertility Traits for Cow, Sire and Dam.

Trait	Estimated Breeding Value								
	Cow			Sire			Dam		
	Min	Max	Average	Min	Max	Average	Min	Max	Average
AFS	-6.7	24.2	0.05	-4.3	5. 9	-0.01	-3.5	7.3	-0.04
AFC	-10.9	25.1	0.13	-6.6	16.4	-0.11	-9.4	11.6	-0.07
LL	-144.7	811.3	0.21	-72.3	222.9	1.2	-91.7	466.6	-0.03
CI	-1.4	3.5	-0.01	-1.1	2.7	0.001	-1.2	1.9	0.005
DO	-42.5	97.7	-0.33	-31.5	82.4	0.16	-32.2	53.2	0.12
DP	-39.4	79.9	-0.1	-24.2	46.9	-0.13	-25.5	39.4	0.04
TMY	-430	330	-3	-300	300	2	-200	200	2
305DMY	-600	400	6	-300	500	-0. 3	-300	200	2