Direct and Maternal Genetic Trends for Some Productive and Reproductive Traits in Egyptian Buffaloes

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ABSTRAK

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Penelitian ini bertujuan untuk melihat kecenderungan fenotip genetik maternal dan genetik langsung pada sifat-sifat produksi seperti produksi susu pertama (FLMY, kg), masa laktasi pertama (FLP, hari), dan produksi susu harian laktasi pertama (FLMD, kg) serta sifat reproduksi seperti umur pertama beranak (AFC, bulan), masa kosong pertama (FDO, hari) dan jarak beranak (FCI, hari). Data yang digunakan merupakan kumpulan data laktasi pertama selama 25 tahun (1991-2015) dari 1.104 ekor pejantan dan 482 indukan yang dipelihara di peternakan Mahallet Mousa milik Lembaga Penelitian Produksi Ternak. Data dianalisis dengan model ternak untuk menentukan parameter penelitian. Nilai tengah dari FLMY, FLP, FLDM, AFC, FDO dan FCI berturut-turut adalah 1.546,5kg; 189 hari; 7,9kg; 37,9 bulan; 120,8 hari dan 428 hari. Nilai heritabilitas langsung (h^2a) untuk sifat yang sama secara berturut-turut adalah 0,25; 0,18; 0,24; 0,45; 0,18 dan 0,19. Nilai heritabilitas maternal untuk sifat yang sama secara berturut-turut adalah 0,12; 0,19; 0,22; 0,25; 0,12 dan 0,12. Hubungan genetik (rg) diantara sifat-sifat yang diteliti bervariasi antara -0,19 hingga 0,38. Ketepatan variasi nilai pemuliaan yang diprediksikan adalah antara 69 hingga 94; 0,37 hingga 94 dan 42 hingga 91% untuk FLMY, FLP, FLDM, AFC, FDO dan FCI pejantan, betina dan indukan secara berturut-turut yang mana menunjukkan bahwa pengayaan genetik dapat diaktualisasikan melalui masing-masing pejantan, betina dan indukan. Kecenderungan genetik maternal dan aditif, lingkungan dan fenotip tidak terlihat secara signifikan pada semua sifat. Hal ini mengindikasikan pentingnya penyusunan rencana untuk meningkatkan mutu genetik dan kondisi lingkungan karena mampu meningkatkan produktifitas dan keuntungan.

Kata Kunci: Kerbau, Kecenderungan Genetik Maternal dan Langsung, Kecenderungan Fenotip

ABSTRACT

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This study was done to determine the direct and maternal genetic and phenotypic trends for productive traits such as first lactation milk yield (FLMY, kg), first lactation period (FLP, d) and first lactation daily milk (FLDM, kg), and reproductive traits such as age at first calving (AFC, mo), First days open (FDO, d) and first calving interval (FCI, d). Data were collected over consecutive 25 years (1991 to 2015) of 1104 first lactation of 135 sires and 482 dams maintained at Mahallet Mousa farms of Animal Production Research Institute. Data were analyzed by Animal model to determine genetic parameters for studied traits. Means of FLMY, FLP, FLDM, AFC, FDO and FCI were 1546.5kg, 189d, 7.9kg, 37.9mo, 120.8d and 428d, respectively. The direct heritability (h^2a) for same traits were 0.25, 0.18, 0.24, 0.45, 0.18 and 0.19, respectively. Corresponding maternal heritability (h^2m) for mentioned traits was 0.12, 0.19, 0.22, 0.25, 0.12 and 0.12, respectively. Genetic correlations (r_g) among studied traits were varied between -0.19 to 0.38. Accuracy of predicted breeding value varied between 69 to 94, 0.37 to 94 and 42 to 91% for FLMY, FLP, FLDM, AFC, FDO and FCI of sires, cows and dams, respectively that revealed the genetic improvement could be actualized through each of cows or sires or dams. Additive and maternal genetic, permanent environmental and phenotypic trends were not significant for all studied traits. It indicated that it is important to set up a plan to improve genetic and environmental conditions thus, increasing productivity and realization of high profitability.

Key Words: Buffaloes, Direct and Maternal Genetic Trends, Phenotypic Trends

INTRODUCTION

Milk is an important food considered the Egyptian buffaloes an important animal for milk production and meat in Egypt. The number of buffaloes is nearly about 3.9 million. Where contribution to milk production nearly 45.5% of total milk in Egypt (FAO 2013). Liu et al. (2008) shown that the genetic correlations between productive and reproductive traits were negative. To increase genetic and phenotypic improvement in

Egyptian buffaloes for milk traits, constructed selection indices (Fooda et al. 2010). The annual genetic trend in the first three lactations in Egyptian buffaloes for total milk yield, lactation period, calving interval and days open were negative (Shalaby et al. 2016). The conception of genetic progress trend shall help in future genetic direction to be accepted by defining specific goals to breeding profitable and continuity of dairy herd (Missanjo et al. 2012). Genetic trends for milk yield and calving interval were significant and correspond to 1.57 kg/y and 0.058 d/y, respectively and phenotypic trends were 27.74 kg/y and 0.647d/y, respectively (Ramos et al. 2006). Maternal effects in the analysis models desirable for selection of productive and reproductive traits to optimize hoped for best response over long run (El-Awady et al. 2016). Therefore, the aims of current work were to determine genetic parameters, direct and maternal genetic and phenotypic trends for FLMY, FLP, FLMD, AFC, FDO and FCI in Egyptian buffaloes.

MATERIALS AND METHODS

Data utilized in the present study were collected over consecutive 25 years (1991 to 2015) of 1104 first lactation of 135 sires and 482 dams maintained at Mahallet Mousa Experimental farms (Main Mahallet Mousa, El-Nataf El-Gaded and El-Nataf El-kadim), Animal Production Research Institute (APRI), Ministry of Agriculture. Traits in this study were divided into productive traits namely first lactation milk yield (FLMY, kg), first lactation period (FLP, d) and first lactation daily milk (FLDM, kg), and productive traits namely: age at first calving (AFC, mo), First day open (FDO, d) and first calving interval (FCI, d). Egyptian buffaloes were living under the same system of feeding and management in the stations. Lactating animals were milked twice daily during the lactation period, and milk yield was recorded daily. The animals were fed on Egyptian clover (*Trifolium Alexandrinum*) during December to May with concentrate mixture and rice straw. During June to November, animals were fed on concentrate mixture, rice straw and a limited amount of clover hay or silage. The animal was feed according to their live weight, milk production, and pregnancy status. Water is available for buffaloes at all times of the day. Buffaloes were inseminated during heat after 60 days postpartum, while heifers were inseminated when attained 350 kg of live body weight or 18-24 months of age.

Statistical Analysis

Data were analyzed using MTDFREML program of Boldman et al. (1995) with the multiple models to determine genetic and phenotypic parameters for studied traits. As the following model was:

$$Y = X\beta + Za + Mm + Wpe + e$$

Where:

Y, β, a, m, pe and e = a vector of observations, a vector of fixed effects ((Month and year of calving and farm), a vector of direct additive genetic effect, a vector of maternal genetic effect, a vector of permanent environmental effect and e = a vector of residual effect, respectively. However, X, Z, M and W = are incidence matrices relating records to fixed, direct genetic, maternal genetic and permanent environmental effects, successively

MTDFREML was used to estimate the best linear unbiased perdition (BLUP) of predicted breeding values for all animals.

Genetic trends were obtained by estimation regression the means of predicted breeding values for traits studied on the year of birth as described by (Sahin et al. 2012). The annual phenotypic trend for traits was estimated with regression of least-square means on calving year. Graphs that indicted genetic and environmental trends were made by Microsoft Office Excel. The regression was estimated via SAS program of computer (SAS 2002)

RESULTS AND DISCUSSION

The present unadjusted means of FLMY, FLP, FLDM, AFC, FDO, and FCI were 1546.5kg, 189d, 7.9kg, 37.9mo, 120.8d and 428d, respectively are given in Table 1. The current mean of FLMY was lower than that observed by Madad et al. (2013) being 2220.03 kg in Khuzestan buffaloes and higher than that observed by Shalaby et al. (2016) being 1057kg in Egyptian buffaloes. The present FLP and FCI were shorter than (310.4d and 586.6d, respectively) found by Thiruvenkadan et al. (2014) in Murrah buffaloes. While the current means of FLP, FDO and FCI were longer than that reflected by Shalaby et al. (2016) in Egyptian buffaloes being 226 d, 224d, and 538d, respectively. The present mean of FLMY was lower than (1619.7kg) reversed by Thiruvenkadan et al. (2014) and contrarily for the present mean of FLDM was higher than (5.38 kg) in Murrah buffaloes. While the current means of FMY, AFC and FCI were lower than that observed by Seno et al. (2010) in Murrah buffaloes.

Coefficients of variation for traits in this study were ranging (22.9% to 71.10%) the immense CV % value for FDO (71.10 %), which showed a huge variation between individual buffalo. The present value for CV % for FMY, AFC and FCI was higher than that noticed by Seno et al. (2010) in Murrah buffaloes.

The direct heritability (h^2_a) for FLMY, FLP, FLDM, AFC, FDO and FCI were moderate 0.25, 0.18, 0.24,

Table 1. Means, standard deviation (SD) and coefficient of variation (CV%) for first lactation milk yield (FLMY), first lactation period (FLP), first lactation daily milk (FLDM), age at first calving (AFC), first days open (FDO) and first calving interval (FCI) in Egyptian buffalo

Trait	Mean	SD	CV (%)
FLMY, kg	1546.5	587.7	38
FLP, d	189	45.4	24
FLDM, kg	7.9	3.2	40.5
AFC, mo	37.9	8.7	22.9
FDO, d	120.8	85.9	71.1
FCI, d	428	103.4	24.2

Table 2. Estimate of variance components and heritability for traits under research work

Estimates	Traits					
	FLMY	FLP	FLDM	AFC	FDO	FCI
σ^2_a	9403.76	886.71	306.38	889.66	416.35	465.45
σ^2_m	4521.33	929.05	280.85	490.41	277.09	293.87
σ^2_{pe}	14295.31	1578.51	433.98	216.78	623.63	612.97
σ^2_e	9429.07	1480.49	255.32	378.77	993.15	1079.62
σ^2_p	37612.69	4872.70	1276.17	1970.75	2309.64	2449.15
σ_{am}	-36.78	-2.06	-0.36	-4.87	-0.58	-2.77
r_{am}	-0.006	-0.002	-0.001	-0.007	-0.002	-0.007
h^2_a	0.25	0.18	0.24	0.45	0.18	0.19
h^2_m	0.12	0.19	0.22	0.25	0.12	0.12
c^2	0.38	0.32	0.34	0.11	0.27	0.25
e^2	0.25	0.30	0.20	0.19	0.43	0.44

σ^2_a= additive genetic variance, σ^2_m= maternal variance σ^2_{pe} = permanent environmental, σ^2_e= residual (temporary environmental variance σ^2_p= phenotypic variance, σ_{am}= direct maternal genetic covariance, h^2_a= direct heritability, h^2_m= maternal heritability, c^2= fraction phenotypic variance to permanent environmental e^2= fraction phenotypic variance due to residual effects.

0.45, 0.18 and 0.19, respectively. While the maternal heritability (h^2_m) was moderate for FLP, FLDM and AFC being 0.19, 0.22, 0.25, respectively, While h^2_m for FLMY, FDO and FCI were slightly low and being 0.12 as illustrated in Table 2. In general, obtained low estimated h^2_a for FLMY, FLP, FDO and FCI were 0.14, 0.17, 0.07 and 0.08, respectively in Egyptian buffaloes by Shalaby et al. (2016), Madad et al. (2013) for FLMY was 0.06 of Khuzestan buffaloes, Seno et al. (2010) for FLMY and AFC were 0.20 and 0.07, respectively in Murrah buffaloes and Catillo et al. (2001) for AFC was 0.26 in Murrah buffaloes. As a matter of fact, the estimated permanent environmental ration ranged from 0.11 to 0.38, close to the finding by El-Awady & Abu El-Naser (2017) for MY, LP, DO and CI in Friesian cows. Estimated genetic correlations (r_g) among all traits varied between -0.19 to 0.38. The r_g among FLMY, FLP, and FLDM were positive and varied from 0.10 to 0.38, and the same thing goes for genetic correlations among AFC, FDO and FCI were positive, ranged from 0.03 to 0.24, as shown in table (3). The current results similar to that obtained by Shalaby et al. (2016) in Egyptian buffaloes for r_g between FLMY andFLP was positive but higher than (0.81) present result, as well r_g between FDO and FCI taken the same trend, was positive and higher than current estimation (0.99). Gupta et al. (2015) in Murrah buffalo found r_g between AFC and all of FLMY, FLP and FCI were positive and being 0.18, 0.11 and 0.19, respectively, while r_g between FLP and FCI was 0.59 and r_g between

Table 3. Estimation correlations among traits understudy in Egyptian buffaloes

Trait1	Correlations					
	Trait2	r_g	r_p	r_e	r_{pe}	r_m
AFC	FLMY	0.13	0.02	0.01	0.17	-0.14
	FLP	0.14	0.14	0.04	0.17	0.05
	FLDM	0.19	-0.16	-0.29	0.10	-0.34
	FCI	0.22	-0.14	-0.13	-0.56	-0.12
	FDO	0.24	-0.03	0.05	-0.05	0.04
FLMY	FLP	0.38	0.01	0.10	0.01	-0.22
	FLDM	0.37	0.01	0.19	0.01	0.01
	FCI	-0.01	-0.02	0.01	-0.03	-0.05
	FDO	-0.19	-0.02	0.08	-0.05	0.14
FLP	FLDM	0.10	-0.02	0.17	0.01	-0.46
	FCI	-0.04	-0.17	-0.01	0.02	-0.50
	FDO	0.11	-0.05	-0.03	0.07	0.36
FLDM	FCI	-0.09	-0.13	-0.57	-0.16	0.47
	FDO	0.23	0.07	0.04	-0.28	0.36
FCI	FDO	0.03	0.19	0.42	0.06	0.47

r_g= genetic correlation, $r_{p=}$ phenotypic correlation, r_e = residual environmental ratio, $r_{pe=}$ permanent environmental ratio and r_m= maternal genetic correlation.

FLMY and each of FLP and FCI were 0.86 and 0.49, respectively.

The phenotypic correlations ranged from -0.17 to 0.19 among all traits (Table 3). The current study exceeded that observed by Shalaby et al. (2016) in Egyptian buffaloes, r_p among FCI, FDO, FLMY and FLP were ranged from 0.166 to 0.931. Maternal correlations among studied traits ranged from -50 to 0.46, while the permanent environmental and residual ratios ranged from -0.56 - 0.17, and -0.57 to 0.17, respectively (Table 3).

The portended breeding values (EBV's) through buffalo sires, buffalo cows and buffalo dams for FMY, FLP, FLDM, FDO and FCI are presented in Table 4. The breeding values for FMY, FLP, FLDM, FDO, and FCI of buffalo sires ranged from -444.73 to 397.84kg, -27.52 to 70.07d, -3.78 to 3.74kg, -10.06 to 13.76 mo, -44.54 to 46.69 and -35.77 to 46.40 d, respectively. The corresponding value for buffalo cows ranged between -424.02 to 596.65kg , -88.37 to 120.01d, -4.93 to 3.41d, -8.29 to 15.87mo, -38.27 to 58.31d and -32.76 to 57.03d, respectively. In addition to breeding values for the aforementioned traits of buffalo dams were between -212.08 and 397.18kg, -53.39 and 62.13d, -3.15 and 4.83kg, -9.73 and 10.90, -49.42, and 79.33d respectively. The ranges breeding values of buffalo cows were higher than those for sires and dams for FLMY, FLP, FLDM, and AFC but the highest value for FDO and FCI were in dams. Accuracy of portended breeding value variation between 69 to 94, 0.37 to 94 and 42 to 91% for sires, cows and dams, respectively, revealed that genetic improvement could be actualized through each of cows or sires or dams. High accuracy levels of breeding values help breeders to select for traits in their buffaloes and from now on genetic improvement in herds. The current results agreed with El-Awady et al. (2016) and El-Awady & Abu El-Naser (2017). In Italian buffaloes, Catillo et al. (2001) reflected that the accuracy for AFC, CI and MY were0.49, 0.36, and 0.49, respectively. Additive and maternal genetic and permanent environmental trends are shown in Figure 1, 2, 3, 4, 5 and 6. Generally, it is shown that direct and maternal genetic and permanent environmental trends for study traits fluctuated on years.

It is noticeable that the additive genetic value increased to 113.12kg in year 1999 and decreased to -32.63kg in year 2011. While permanent environmental value increased to 57.6 kg in year 2014 and decreased to -79.10 in year 1992. It indicated that genetic programs and management can play an important role in the improvement of dairy buffaloes in Egypt.

Table 4. Portended of breeding values for buffalo sires, buffalo cows and buffalo dams and accuracies%, for studied traits

Traits	Breeding Values			
	Minimum ± SE	Maximum ± SE	Accuracy, %	Range
Buffalo sires (EBV's)				
FLMY	-444.73± 6.97	397.84±7.35	67-71	842.57
FLP	-27.52±1.18	70.07±1.76	74 -89	97.59
FLDM	-3.78±0.60	3.74±0.60	94 -94	7.52
AFC	-10.06 ± 2.28	13.76± 2.58	70-78	23.82
FDO	-44.54±1.70	46.69±1.38	70-81	91.23
FCI	-35.77±1.53	46.40±1.29	69-79	82.17
Buffalo cows (EBV's)				
FLMY	-424.02±6.10	596.65±5.90	79-80	1020.67
FLP	-88.37±1.45	120.01±1.42	83-74	208.38
FLDM	-4.93±1.00	3.41±1.05	74-82	8.34
AFC	-8.29±1.27	15.87±1.58	90-94	23.86
FDO	-38.27±2.20	58.31±2.01	38-53	96.58
FCI	-32.76±1.98	57.03±1.97	37-39	89.79
Buffalo dams (EBV's)				
FLMY	-212.08±8.21	397.18±8.84	45-59	609.26
FLP	-53.39±8.89	62.13±2.32	42-44	115.52
FLDM	-3.15±0.74	4.83±0.74	90-.91	7.98
AFC	-9.73±3.16	10.90±3.16	49-50	20.63
FDO	-49.42±1.66	79.33±1.68	70-71	128.75
FCI	-53.13±1.48	106.01±1.45	72-73	159.14

Table 5. Estimates of annual additive, maternal and environmental permanent trends for studied traits in Egyptian buffaloes

Traits	Additive	Maternal	Permanent
FLMY	-0.749	-0.052	2.24
FLP	0.039	-0.104	0.061
FLDM	-0.063	-0.023	0.033
AFC	-0.104	0.068	-0.035
FDO	-0.100	-0.043	0.058
FCI	-0.143	-0.067	0.006

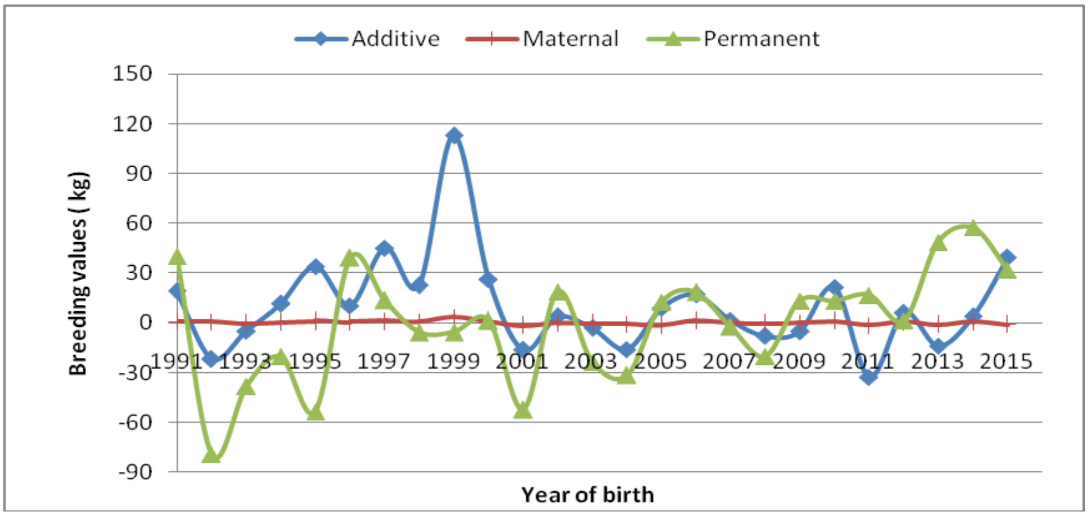

Figure 1. Additive and maternal genetic and permanent environmental for FLMY

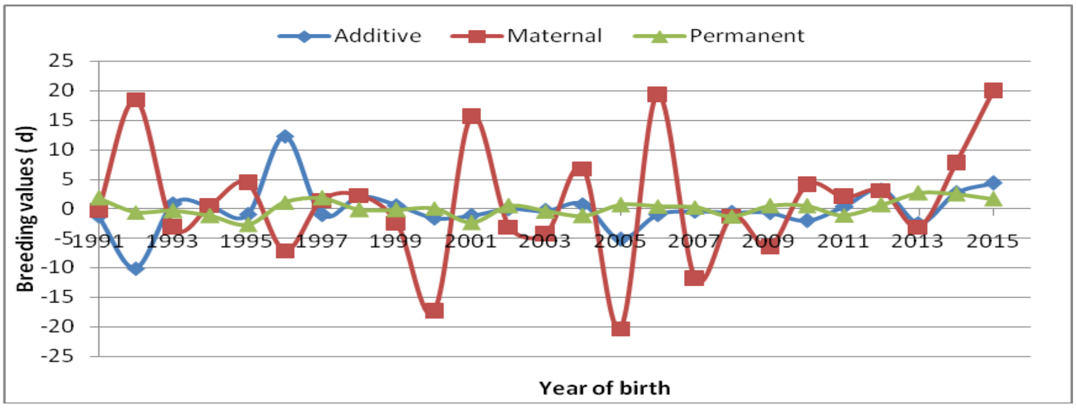

Figure 2. Additive and maternal genetic and permanent environmental for FLP

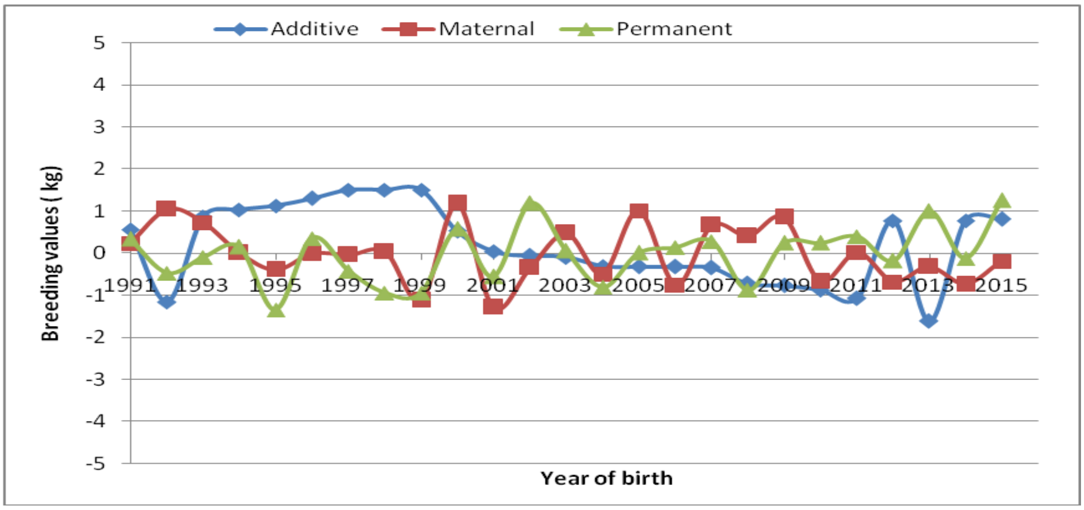

Figure 3. Additive and maternal genetic and permanent environmental for FLMD

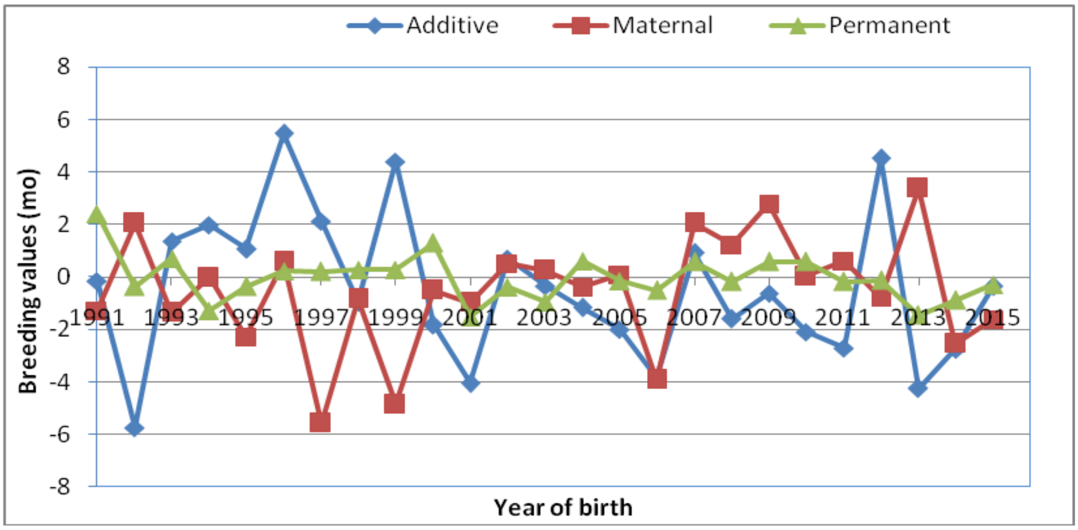

Figure 4. Additive and maternal genetic and permanent environmental for AFC

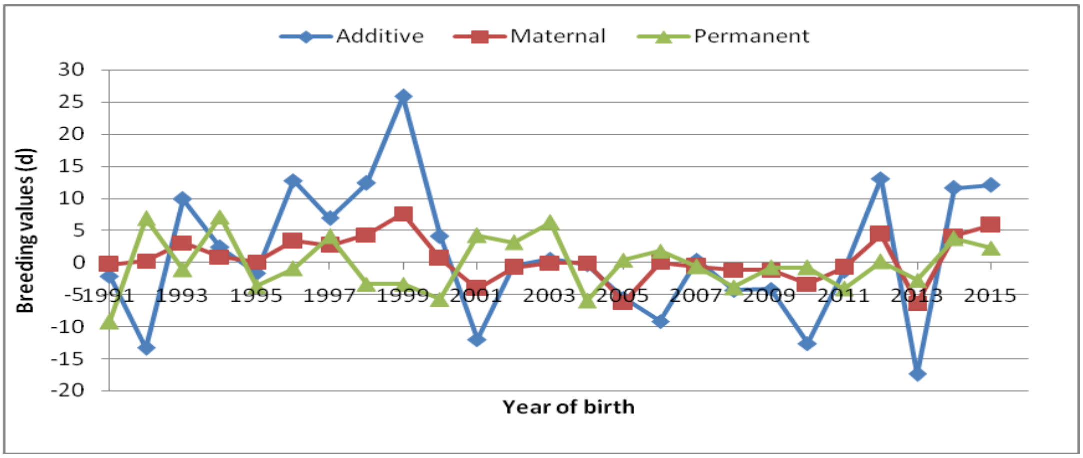

Figure 5. Additive and maternal genetic and permanent environmental for FCI

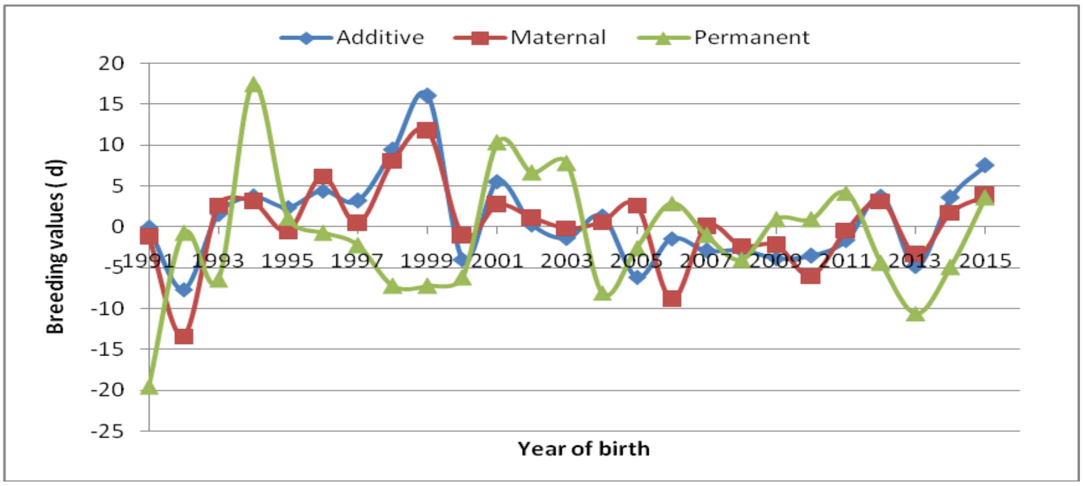

Figure 6. Additive and maternal genetic and permanent environmental for FDO

Table 6: Estimates of annual phenotypic trends for studied traits in Egyptian buffaloes

Year	FLMY, kg	FLP, d	FLDM, kg	AFC, mo	FDO,d	FCI, d
1994	1621	196.8	8.2	45.9	106.2	418.6
1995	1560	193.7	8.1	45.9	41.3	357.7
1996	1686	205.0	8.5	28.5	157.5	496.0
1997	1664	188.8	8.7	33.2	109.0	429.8
1998	1414	169.5	8.6	45.7	124.8	421.8
1999	1436	194.0	7.0	38.6	101.8	417.9
2000	1588	196.1	7.9	42.0	124.6	426.6
2001	1278	159.5	6.9	38.3	96.5	424.2
2002	1614	192.4	8.3	41.4	152.6	449.1
2003	1335	183.0	7.3	37.1	158.8	471.3
2004	1622	189.2	8.4	35.3	118.2	416.5
2005	1394	182.6	7.6	37.1	125.9	437.6
2006	1431	180.8	7.7	38.7	130.8	435.1
2007	1526	186.8	7.9	37.9	100.5	413.7
2008	1687	202.7	8.1	37.5	122.6	429.2
2009	1689	189.4	8.8	37.0	119.2	417.8
2010	1542	185.3	7.9	37.1	97.3	413.4
2011	1455	183.8	7.5	36.3	133.9	436.7
2012	1475	186.9	7.6	36.6	132.6	442.4
2013	1759	198.0	8.6	34.6	93.4	407.1
2014	1766	204.5	8.4	46.4	91.5	395.1
2015	1629	194.3	8.3	37.3	131.1	429.2
b-reg	4.29	0.168	0.0022	- 0.122	0.343	- 0.313

Similarly, noticed by El–Awady et al. (2017) for MY, LP, CI and DO in Friesian cows. The annual additive genetic trends for productive traits (FLMY, FLP, and FLMD) were non-significant and being -0.749kg, 0.03d and -0.063kg. Also annual additive trends even though negative for reproductive traits (AFC, FDO and FCI) were non-significant -0.104mo, -0.100d and -0.143d. Corresponding annual maternal genetic trends for productive and productive studied traits were non-significant and being -0.05kg, -0.104d, -0.023kg, 0.068mo, -0.043d and -0.067d, respectively. The reasons of this might be consulted to lock from animal selection or increased of culling of many preeminent buffaloes in previous years due to a greater age and ingress of many replacement heifers with less breeding value in the herd or using bulls don not have good breeding values for studied traits in insemination inside the farm. The present results similar to that reflected by Salem & Hammoud (2016) for genetic trends of sires for FMY, FLP and FDO in Holstein were negative and non-significant and he added that may be attributed for selecting sires. The coefficient of permanent environmental trends for above mentioned traits were non-significant and positive expect AFC was negative (2.24kg/y, 0.061d/y, 0.033kg/y,-0.0.35mo/y, 0.058d/y and 0.006d/y), respectively. It shows that the permanent environment had no clear effect on studied traits. That may be due to the animals in the farm was kept under control system environmental conditions and management and the betterment of the environmental conditions to desire to simplify selection programs.

Shalaby et al. (2016) obtained that the annual genetic tends for FLMY, FLP, FDO, and FCI were negative -15.80kg, -6.55d, -5.658d and -5.801d, from 1972 to 2002 in Egyptian buffaloes. Fooda et al. (2010) found the annual genetic trends for milk yield in all Mahallet Mousa farms were positive and being 0.58 kg in Egyptian buffaloes. El-Arian et al. (2012) obtained that the annual genetic change for TMY and LP was positive and being 3.70kg and 0.55d, respectively as the regression coefficient of sire breeding values per year in Egyptian buffaloes.

Annual phenotypic trends for studied traits in Egyptian buffaloes are illustrated in Table 6. Noticeable fluctuations were monitored for studied traits in different years. Corresponding estimation of annual phenotypic trends for FLMY, FLP, and FLDM were non-significant and positive. This probably refers to improvement partial in environmental conditions. Phenotypic trends for AFC and FCI were no significant and negative directions, pointing out declining trends in AFC and FCI. The alike phenotypic trend for FDO was non-significant, but positive, which is not desirable. Similarly, noticed by El-Arian et al. (2012) for MY, LP and DO in Friesian cows. In Egyptian buffaloes, Fooda et al. (2010) obtained the annual phenotypic trend for milk yield was 26 kg being in all Mahallet Mousa farms. El-Arian et al. (2012) obtained that the annual phenotypic trends for TMY and LP were highly significant and positive, (74.20 kg and 18.84 d), respectively. Over and above, they added that phenotypic improvement in milk yield was carried out during the study and shown the variation in performance between years due to different of management, nutritional and climatic conditions during the period of study in Egyptian buffaloes.

CONCLUSION

The results indicate that the direct heritability estimate for studied traits was moderate. Therefore, the ability to increase the efficiency of those traits through genetic improvement and environmental conditions is needed on the farm at the same time. Additionally, increase and ranges accuracy estimated of breeding values for studied traits inferred being more genetic difference among individuals and increase the possible selection for those traits. Moreover, genetic, phenotypic and Environment values trends fluctuated over the year and non-significant for all studied traits. It is proved that designed genetic programs, management and environmental conditions not satisfactory during the period. It is shown that it is important to set up a plan to the improvement of genetic and environmental conditions in herd Egyptian buffaloes.

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