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Egypt. J. Anim. prod., **29**, No. 2, pp. 185 - 196 (1992)

Adjusting Milk Yield for Age at Calving Within Parity in Egyptian Buffaloes

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A TOTAL of 3738 normal lactation records of Egyptian buffaloes raised at Mehallet Mousa farm belonging to Ministry of Agriculture, Egypt during the period 1966 through 1980 were used. Fixed effects of season and year of calving, age at calving as a covariate and random effects of sire and cow within sire on 305 day milk yield were studied.

Least squares analysis of variance showed significant effects of season and year of calving, age at calving and sires in most parities. Cows accounted for 36% of the total variation of 305 day milk yield.

A set of multiplicative age factors were derived for 305 day milk yield for each parity and for all parities by fitting a polynomial of second degree of production on age. The present results suggested a separate set of age correction factors for each parity.

Key words: Adjusting, Milk yield, Age at calving, Egyptian buffaloes

Knowledge of the relative influence of environmental factors upon milk production provides basic information for developing breeding and general management program. To increase milk yield, selection for genetically superior sires and dams must be practiced. The accuracy of selection could be improved by adjusting production data for environmental factors.

Age at calving is considered one of the important factors that affect the pattern of milk production. Abdel Aziz and Hamed (1979 b) developed age correction factors for Egyptian buffaloes, reported that the accuracy of the regression equations used in the estimation of the mature equivalent records ranged from 83% to 90%.

Signifiant effect of age at calving within parity on milk yield were reported by many workers (Bhat and Patro, 1978 ; Hansen *et al.*, 1983 ; Reddy and Taneja. 1984 and Morales *et al.*, 1989).

Galal *et al.* (1974) calculated age correction factors for Friesian cattle in Egypt. They uesd three methods (gross comparion, fitting a second degree polynomial of production on age and paired comparison) to estimate three sets of age correction factors. They suggested that the second method seemed to be relatively the most successful in removing the effect of age on production. Hansen *et al.* (1983) working on Holstein Friesian cattle, developed age correction factors for 120 d milk , 180 d milk, 305 d milk, complete lactation yield and annualized yield, found that adjustment factors were nearly constant across measures of yield within parity. The same authors indicated that 305 d factors could be applied to other measures without a substantial loss in accuracy.

Morales *et al.* (1989) suggested different mature equivalent factors should be used for each parity to minmize effectively interaction between age and parity

The objectives of this study were 1) to study the effect of season and year of calving as fixed effects, age at calving as a covariate and random effects of sire and cow within sire on 305 day milk yield and 2) to construct a separate set of age correction factors within parity and for all parities.

Material and Methods

Data

Data in the present study consisted of 3738 lactation milk records of Egyptian buffaloes mainatined at Mehallet Mousa farm belonging to the Ministry of Agriclture, Egypt over fifteen years (1966 through 1980) were used. Number of sires and cows involved were 81 and 900, respectively. Daughters of sires with fewer than 4 daughters were excluded. The least squares means of 305 day milk yield (305MY) and age at calving are presented in Table 1 . The 305 day milk yield was used as a consequence of that the average period for normal records of the present study was 314 days. In addition, the available publised work on lactation period in Egyptian buffaloes revealed that the average length of that period ranged between 279 to 328 days (Khattab *et al.*, 1985; El Barbary and Badran, 1986 : Kotby *et al.*, 1988 and Ashmawy, 1991). Managerial system and feeding regimes were described by Khattab *et al.* (1985).

Analysis

Data were analysed using Mixed Model Least Squares and Maximum Likelihood Computer Program (LSML76 of Harvey, 1977).

The following statistical models were assumed to fit a separate quadratic function in age for every parity and for all parities. Due to data limitation, some empty cells were found and it was not possible to calculate the interaction between the main effects.

TABLE 1. Number of records and least squares means of 305 MY and age at calving (AC) in different parities.

Parity	Number	305 MY	± S.E.	AC	± S.E.
1	1084	1117	15	33.5	0.30
2	914	1428	27	53.2	0.35
3	617	1533	25	73.2	0.65
4	414	1651	31	92.2	0.66
≥5	650	1686	81	108.0	0.70
+					
All records	3400	1540	55	81.5	0.82

\+
Cows with less than two records were excluded.

1 - Records in each parity were analysed according to :

$$Y_{ijkl} = M + S_i + A_j + B_k + B_L(Xijkl - \bar{X}) + b_Q(X_{ijkl} - X^{-2}) + e_{ijkl} \quad \text{Model (1)}$$

where : Y_{ijkl} = the 305 day milk yield of the ijkl th cow; M = the overall mean : s_i = random effect of the i *th* sire ; A j = fixed effect of the season of calving , j= 1 (Winter), 2 (Spring), 3 (Summer) and 4 (Autumn) : B_k = fixed effect of the k th year of calving , k = 1 (1966) 2 (1967) .... 15 (1980) : bL and bQ linear and quadratic regression coefficients of 305MY in kg on age at calving ; X_{ijkl} = the age at calving of the l *th* cow ; $\bar{x}$ = average age at calving , mo and e_{ijkl} = random elements peculier to the ijkl th observation, having expectation zero and variance σ^2e which included cow effect.

2 - Records in all parities were analysed according to :

$$Y_{ijklm} = M + s_i + c_{ij} + A_k + B_L + b_L(X - \bar{X}) - b_a(X - \bar{X})^2 + e_{ijklm} \quad \text{Model (2)}$$

Where ; cij = random effect of the j *th* cow nested within a random effect of the i *th* sire ; Q^2e = residual deviation of the lactation of a cow.

Paternal half sib heritabilities (h^2's) for 305MY in each parity were calulated as four times the ratio of σ^2s (variance component of sire) to the sum of σ^2s and σ^2e (remainder variance component). Heritability for 305MY across all parities was estimated by paternal half sib method as ; $h^2 = 4\sigma^2s / (\sigma^2s + \sigma^2c{:}s + \sigma^2e)$, where σ^2 c:s (equal variance components of cow within sire). Repeatability estimate equaled the ratio ($\sigma^2s + \sigma^2$ c:s)/ ($\sigma^2s + \sigma^2c$: s and σ^2e) Standard errors of heritability and repeatability were computed according to the approximate formula given by Swiger *et al.* (1964).

The prediction eqations of 305MY (Y) from age at calving (X), where ; $Y= M + b_L (X - \bar{X}) + bQ (X - \bar{X})^2$, were constructed. To develop age correction factors, the solution of each equation for different ages given in Table 5 gave the denominator for a factor. The numerator in each parity and in all parities was calculated as follows :

1- Equating the first derivation of the six prediction equations (five for each parity and one for all parities) with zero and their solutions gave the age of calving at the maximum production for every one.

2- Substituting age of maximum production as the concomitant variable in the appropriate equation gave the expected yield at the age of maximum production for each parity and for all parities. This yield was the numerator for the age correction factor.

Results and Discussion

Random components

Sire of the cow had significant effect on 305MY for different lactations and for all lactations ($p < 0.05$ or <0.01, Tables 2 and 3) except for 3rd and 4th lactations, indicating the possibility of genetic improvement of milk yield through selection. The present results are in agreement with the results obtained by (Basu and Tomar, 1981; Cady *et al.*, 1983 and Badran *et al.*, 1991) working on different breeds of buffaloes in different countries. Sire components of 305MY increased with increasing lactation numbers, except for 3rd and 4th lactation (Tables 2 and 3), so that h^2 increased with advance of parity and accounted for approximately 3.5, 5.5, 1.7, 1.8, 6.2 and 3% for l*st*, 2*nd*, ... and for all lactations, respectively. In this respect, Bawa and Dhillon (1980) working on Murrah buffaloes, found that h^2 for milk yield were 0.16, 0.22 and 0.24 for first, second and third lactations , respectively. Also, kornel and Patro (1988) working on Surti buffaloes found that h^2 for 305MY were 0.36 and 0.39 for first and second lactation, respectively.

The effect of cow within sire was significant ($p < 0.01$, Table 3) on 305MY as estimated from model 2. Estimates of cow component of variance obtained in this study was 36% compared to 17 % reported by Cady *et al.* (1983) . Including the cow in the model in this study raised R^2 by 44% (Tables 2 and 3) .

Cow evaluation and selection are important in a herd improvement scheme . The ultimate aim of any evaluation is to enable breeders to compare their animals by the estimated producing ability (ETA) which involves repeatability. Repeatability estimates of 305MY was 0.39 ± 0.08 as estimated from model 2. The present estimate indicate that 305MY had a moderate repeatability. Accordingly, the first lactation of each buffalo cow would lead to an accurate prediction of future performance, promices efficient selection and also would affored an opportunity for a faster return of sires to service if their evaluation can be made early.

TABLE 2. Variance compoent estimates (σ^2) and proportions of variance (V) due to sire+ for each perity and for all parities of Egyptian buffaloes and heritability++ estimates (h^2's).

Parity	Sire of cow				Remainder			
	d.f	K	σ^2_s	V	d.f	σ^2e	V	h^2_s
1	80	12.2	4079	0.035**	984	111447	0.965	0.14
2	76	10.7	10400	0.055**	818	179158	0.945	0.22
3	69	8.8	3659	0.017	589	211938	0.983	0.07
4	57	6.4	3664	0.018	340	200947	0.982	0.07
≥5	51	11.6	12429	0.062**	582	189569	0.938	0.25
All parities	78	4.1	5626	0.030*	2481	112551	0.970	0.13

+

d.f.σ^2C : S and V for cow within sire were 821, 66298 and 0.36, respect.

++

Standard errors of h's ranged from 0.07 to 0.11.

** $P < 0.01$

* $P < 0.05$

Estimates of σ^2e , the residual variance component that contains the remainder of genetic and environmental variances peculiar to the observations. The increase in error variance in later lactations may be attributed to additional sources of variation, such as dry period, which do not influence the first lactation. In general, the residual components were above 0.938 (Table 2). Abubakar *et al.* (1986) obtained high residual components of variance for milk yield and attributed the magnitude of such estimates to be dependent on the components of models used.

Estimation of non genetic effects

Table 3 represents the least squares analysis of variance fitting season and year of calving , age and age squared in the models.

Season of calving affected 305MY significantly ($p < 0.01$, Table 3) in the first lactation and for all lactations. Effect of season of calving reflects the influence of climatic conditions and kind of the available feedstuffs in the different seasons of the year. The significant effect of season of calving on milk yield were reported by many investigators in different sets of Egyptian buffaloes (Abdel Aziz and Hamed , 1979 a; Khattab *et al.*, 1985 ; Kotby *et al.*, 1988 and Ashmawy , 1991).

TABLE 3. Least squares analysis of variance for factors affecting 305 days milk yield for different parities and for all parities.

Source of variation	1 st parity		2 nd parity		3 rd pari-		4 th pari-		≥ 5 th parity		All parities	
	d.f.	M.S.	d.f.	M.S.	d.f.	M.S.	d.f.	M.S.	d.f.	M.S.	d.f.	M.S.
Sire	80	161057***	76	290645***	69	244037	57	224472***	51	333924**	78	455161**
Cow / sire											821	358640***
Season of calving	3	568914***	3	258636	3	289258	3	211161	3	93152	3	2669196***
Year of calving	14	276657***	14	539891***	14	660959***	14	605947***	14	473574***	14	620486***
Regressions												
Age Linear	1	26549	1	2144252***	1	990951**	1	45361	1	187871	1	128315
Age quadratic	1	11413	1	16505	1	93962	1	168860	1	645839*	1	40327164***
Residusl	984	111447	818	179158	589	211938	340	200947	582	189569	2481	112551
R^2%		14.44		18.19		12.62		23.69		17.47		58.00

* $P < 0.10$
** $P < 0.05$
*** $P < 0.01$

Effect of year of calving on 305MY was significant ($p < 0.01$) for each parity and for all parities (Table 3) . Abdel Aziz and Hamed (1979 a) , Kotby *et al.* (1988) and Ashmawy (1991) working on Egyptian buffaloes and Tajane and Siddiquee (1985) on Mehsana buffaloes, reported significant effect of year of calving on milk yield . On the contrary, Basu and Tomar (1981) working on Murrah buffaloes, found non significant effect of year of calving on milk yield. The influence of year of calving on milk yield is attributed mainly to different nutritional, climatic conditions and management practices over different times

Estimates of linear and quadratic regression coefficients of 305MY on age at first calving was statistically nonsignificant (Tables 3 and 4). This agree with findinges of Khattab *et al.* (1985) using another set of data for Egyptian buffaloes. In this respect , Singh *et al.* (1984) arrived at the same results on Nili Ravi buffaloes. On the contrary, Reddy and Taneja (1984) and Dutt and Yadav (1986) found a significant effect of age at first calving on milk yield. The present results show that a reduction in age at first calving will increase the productive life of the dairy animals, the generation interval may be reduced. the rearing cost to calvings may be reduced and the number of calvers could be increased with the possibility of great meat production from surplus males.

TABLE 4. Prediction equations of 305 day milk yield in Egyptian buffaloes from age at calving (x) [a].

Number of records	Dependent variable	Partial regression coefficients			
		Linear (kg/ mo)		Quadratic (kg/ mo)	
		b	s.E.	b	s.E.
1084	1 st parity	1.05 ***	2.15	-0.036	0.113
914	2 nd parity	7.02 **	2.03	-0.200	0.662
676	3 rd parity	4.56	2.10	-0.085	0.083
414	4 th parity	0.96	2.02	-0.043 *	0.048
650	≥5 th parity	2.11	2.13	-0.047 ***	0.026
3400	All parities	8.23	7.71	-0.090	0.0047

a

X ranged between 24 and 184 mo.

*** $P < 0.01$

** $P < 0.05$

* $P < 0.10$

The partial linear regression coefficients of 305MY on age at second and third lactation were significant ($P < 0.05$ or 0.01 , Tables 3 and 4), while the quadratic term was not significant. In addition, the partial linear and qudaratic regression coefficients of 305MY on age at fourth calving were not significant (Tables 3 and 4).

Estimates of partial linear regression coefficient of 305MY on age at calving estimated from model 2 (8.23 ± 7.71 kg / mo) was not significant, while the quadratic trem (0.090± 0.0047 kg / mo) was significant ($P < 0.01$ Tables 3 and 4). The maximum milk yield (Y) were 1125, 1490, 1594, 1656, 1710 and 1729 kg for first, second, ... and for all parities, respectively, reached at 48, 71, 98, 99, 128 and 128 mo of age at calving, respectively (Table 5).

Maximum milk yield in the first lactation at 48 month of age (Table 5) could be attributed to the growth of mamary system as buffaloes grow older, while the gradual decline thereafter, may be due to the accumulation of adispose tissue as a result of the late conception of buffaloes .

Results showed that maximum, 305MY is reached at an age of 128 mo and then decline (Table 5). Abdel Aziz and Hamed (1979 b) working on another set of Egyptian buffaloes, reported that the maximum milk production was reached at 127 mo of age. At such time a female buffaloe is much mature as body weight and size are fully developed followed by increasing the size and the function of digestive , mamary gland and the other systems. The present results are in close agreement with Ashmawy (1991) and Basu and Tomar (1981) working on Egyptian buffaloes and Murrah buffaloes , respectively , they found that milk yield increased with of increasing with age untill the fifth lactation and declines after that, while Mostageer *et al.* (1981) reported that the first lactation averaged 1000 kg and the milk yield increased to reach 1300 kg in the fourth lactation. Differences in the time of reaching maximum lactation yield could possibly be due to differences in the genetic make-up, age at first calving and the length of dry period. Usually when heifers freshen for the first time at later ages than normal they are nearer to maturity than those that freshen at earlier ages. The animals with long first 2 dry periods have a chance to reach their mature body weight and maximum size at an earlier lactation number than the others.

Considering age at calving in the model as a second degree polynomial regression of production on age raise R^2 by 6.1 % (Model 2)

Multiplicative age correction factors for each parity and for all parities by fitting the polynomial regression of second degree for 305MY on age at calving were derived and presented in Table 5 .

The six sets of age correction factors were applied to the data; set 1 for first parity, set 2 for second parity, etc..., and set 6 for all parities, after the data had been corrected for season and year of calving effects.

The simple correlation coefficients were estimated between age in month and age corrected milk yield , being 0.02, 0.09, 0.08, 0.01, 0.08 and 0.30 for the first, second,... etc, and for all parities, respectively. The high correlation between age in month and age corrected milk yield for all parities may be due to using cows in different lactations and also may be due to the interaction between the main effects such as age and season of calving which was not possible to be calculated in this study, thus the estimates are biased. Accordingly, it may be concluded that correction factors for milk yield using one set for all parities is less efficient in removing the dependency of age on milk production, than when using age correction factors for each parity separately. Therefore, the results suggested the application of a separate set for age correction factors for each parity.

TABLE 5. Age correction factors for 305- day milk production for different parities and for all parities (All).

1st		2nd		3rd		4th		≥5th		All parities	
mo.	Factors	mo.	Factors	mo.	Factors	mo.	Factors	mo.	Factors	mo.	Factors
24	1.019	40	1.145	70	1.050	80	1.014	90	1.047	24	2.249
25	1.018	41	1.137	71	1.046	81	1.013	91	1.045	28	2.055
26	1.016	42	1.126	72	1.043	82	1.012	92	1.042	32	1.897
27	1.015	43	1.116	73	1.040	83	1.011	93	1.040	36	1.767
28	1.013	44	1.107	74	1.037	84	1.010	94	1.038	40	1.658
29	1.012	45	1.099	75	1.028	85	1.009	95	1.036	44	1.566
30	1.011	46	1.090	76	1.031	86	1.008	96	1.033	48	1.487
31	1.010	47	1.083	77	1.029	87	1.007	97	1.032	52	1.418
32	1.008	48	1.075	78	1.026	88	1.006	98	1.030	56	1.360
33	1.008	49	1.068	79	1.024	89	1.005	99	1.028	60	1.309
34	1.006	50	1.062	80	1.021	90	1.005	100	1.026	64	1.264
35	1.006	51	1.056	81	1.019	91	1.004	101	1.024	68	1.225
36	1.005	52	1.050	82	1.017	92	1.003	102	1.023	72	1.189
37	1.004	53	1.045	83	1.015	93	1.003	103	1.021	76	1.159
38	1.003	54	1.040	84	1.014	94	1.002	104	1.020	80	1.132
39	1.003	55	1.035	85	1.012	95	1.002	105	1.018	84	1.108
40	1.002	56	1.031	86	1.010	96	1.001	106	1.017	86	1.087
41	1.002	57	1.026	87	1.009	97	1.001	107	1.015	92	1.069
42	1.001	58	1.023	88	1.008	98	1.001	108	1.014	96	1.054
43	1.001	59	1.019	89	1.006	99	1.000	109	1.013	100	1.040
44	1.001	60	1.016	90	1.005	100	1.000	110	1.012	104	1.029
45	1.001	61	1.013	91	1.004	101	1.000	111	1.010	108	1.020
46	1.001	62	1.012	92	1.003	102	1.000	112	1.010	112	1.012
47	1.000	63	1.008	93	1.002	103	1.000	113	1.009	116	1.007
48	1.000	64	1.006	94	1.001	104	1.000	114	1.007	120	1.003
49	1.000	65	1.005	95	1.001	105	1.000	115	1.007	124	1.001
50	1.000	66	1.003	96	1.001	106	1.000	116	1.006	128	1.000
51	1.001	67	1.002	97	1.001	107	1.001	117	1.005	132	1.001
52	1.001	68	1.001	98	1.000	108	1.001	118	1.004	136	1.004
53	1.001	69	1.000	99	1.000	109	1.002	119	1.004	140	1.009
54	1.001	70	1.000	100	1.000	110	1.002	120	1.003	144	1.015
55	1.002	71	1.000	101	1.000	111	1.002	122	1.002	148	1.023
56	1.002	72	1.000	102	1.000	112	1.002	124	1.001	152	1.033
57	1.003	73	1.001	103	1.001	113	1.003	126	1.001	156	1.045
58	1.003	74	1.001	104	1.001	114	1.003	128	1.000	160	1.059
59	1.004	75	1.002	105	1.001	115	1.004	130	1.000	164	1.076
60	1.005	76	1.004	106	1.002	116	1.004	132	1.000	168	1.095
61	1.006	77	1.004	107	1.003	117	1.005	134	1.000	172	1.116
62	1.007	78	1.005	108	1.004	118	1.006	136	1.001	176	1.141
63	1.007	79	1.009	109	1.005	119	1.007	138	1.002	180	1.169
64	1.008	80	1.011	110	1.006	120	1.007	140	1.003	184	1.201

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تعديل كمية اللبن للعمر عند الولادة داخل موسم الولادة لقطيع من الجاموس المصرى

كوثر عبد المنعم مراد ، عادل صلاح خطاب

معهد بحوث الانتاج الحيوانى – وزارة الزراعة – الدقى – كلية الزراعة بكفر الشيخ – جامعة طنطا

أستخدم عدد ٣٧٣٨ من سجلات اللبن لقطع الجاموس المصرى بمحطة محلة موسى التابعة لمعهد بحوث الانتاج الحيوانى بوزارة الزراعة فى الفترة من ١٩٦٦ – ١٩٨٠ م .

تم تحليل انتاج اللبن فى ٣٠٥ يوما باستخدام نموذج احصائيا يدخل فيه تأثير الاثر العشوائى للطلوقة والاثر الثابت لكل من موسم وسنة الوضع والعمر عند الولادة خطيا وتربيعيا بالنسبة لكل موسم ولادة ، كما تم ايضا اجراء التحليل لكل موسم الانتاج للبقرة بنموذج اخر يدخل فيه اضافة التأثير العشوائى للبقرة داخل مجاميع الطلائق .

بينت طريقة أقل المربعات لتحليل التباين للبيانات على وجود تأثير معنويا لكل من موسم وسنة الوضع والعمر والطلوقة فى أغلب الولادات وفى المواسم مجتمعة .

اشتقت مجموعة من عوامل التعديل للعمر لكل موسم ولكل المواسم معا باستخدام معادلة كثيرة الحدود من الدرجة الثانية لانحدار الانتاج على العمر أوضحت الدراسة انه يجب اجراء معادلات التعديل للعمر لكل مواسم الولادة .