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Factors for Standardizing 305-day Lactation Records of Friesian Cows for Age at Calving

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THE EFFECT of farm, season and year of calving, and age on milk yield was investigated on 2205 lactation records of Friesian cows from two farms belonging to the Ministry of Agriculture in Egypt.

A least-squares analysis of variance of the data showed highly significant effect of farm, year and age as a linear and quadratic terms on milk production, while the effect of season of calving was not significant.

A set of multiplicative age factors was derived for each season of calving and for all seasons by fitting a polynomial of second degree of production on age. The apparent difference between correction factors in different seasons and regions suggests that the development of a separate set of correction factors for each deserves a serious consideration for standardizing 305-day lactation records for age at calving.

Key words : Friesian cows, calving age, Lactation records.

Milk yield in dairy animals is altered by many non-genetic factors and it is desirable to know how milk production is being affected by these factors. Only, in this way it would be possible to develop general management programs and to make suitable adjustments in the data to obtain precise estimates of the genetic parameters which are needed for genetic evaluation of breeding animals.

Age at calving is one of the major nongenetic factors affecting lactation yield. The adjustment of production records for age differences is widely used for reducing sampling variation due to unequal ages and for removing biases from comparisons of cows of different ages particularly in sire evaluation when their young daughters are compared with older herdmates (Miller, 1964).

Galal *et al.* (1974) developed age correction factors for Friesian cattle in Egypt using three methods (gross comparison, fitting a second degree polynomial of production on age and paired comparison) to calculate three sets of age correction factors. They indicated that the second method seemed to be relatively the most successful in removing the effect of age on production. Several workers (*e.g.* Van Vleck and Henderson, 1961; Miller *et al.*, 1970 Norman *et al.*, 1978) found that a significant interaction between age and season (or month) of calving caused many inaccuracies in developing age correction factor. This interaction arises because younger cows are less adversely affected by the unfavorable season of calving than are older cows (McDonald and Corley, 1966, and Miller and Henderson, 1968). McDaniel (1973), Cooper and Hargrove (1982) and others suggested that different mature equivalent factors should be used for each season of calving to minimize effectively interaction between age and season of calving. In the same time, the new electronic machine processing of data minimizes the need to limit the number of factors and encourages the use of more sets of factors but more accurate.

Investigation of nongenetic factors affecting milk yield with emphasis on the effect of age of the cow in Friesian cattle, construction of separate age correction factors for every season of calving and comparison of these factors to other published factors were three objectives of this study.

Material and Methods

A total of 2205 normal complete lactation records of cows from the Friesian herd maintained at Sakha and El-Karada experimental farms belonging to the Ministry of Agriculture during the period from 1967 through 1979 was used in this study. Records included age at calving. The number of records and 305-day milk yield least square means are presented in Table (1).

TABLE 1. Number of records and 305-day milk yield least square means in different parities.

Parity	Number	Mean ± SE (kg)
1	723	2728±46
2	593	2869±29
3	467	2882±34
4	262	2803±55
5+	160	2632±79

Animals were grazed on Egyptian clover, berseem, during October-May. During the rest of the year, the animals were fed on concentrate mixture along with wheat or rice straw and limited amount of clover hay when available, cows producing more than 10 kg a day and those that are pregnant in the last two months of pregnancy were supplemented with extra concentrate ration. Cows were hand-milked twice a day till 1971 and machine-milked thereafter.

The following statistical models were assumed to fit a separate quadratic function in age for every season of calving and for all seasons. Because of the limited numbers of records insubclasses, all the possible interactions were ignored to allow more precision in adjusting main effects.

1. Records in each season of calving were analysed according to :

$$Y_{ijm} = a + f_i + r_j + B_1X_{ijm} + B_2X^2_{ijm} + e_{ijm}$$

2. Records in all seasons of calving were analysed according to :

$$Y_{ijkm} = a + f_i + r_j + s_k + B_1X_{ijkm} + B_2X^2_{ijkm} + e_{ijkm}$$

where :

- Yijm is the 305-day milk of the m*th* cow in the j*th* year of calving in the i*th* farm,
- Yijkm is the 305-day milk of the m*th* cow in the k*th* season and j*th* year of calving in the i*th* farm,
- a is the intercept,
- f_i is the effect due to the i*th* farm, i=1 : Sakha, 2 : El-Karada,
- r_j is the effect due to the j*th* year of calving, J = 1 : (1967), 2 : (1968), —, 13 : (1979),
- s_k is the effect due to the k*th* season of calving, k = 1 : (winter), 2 : (spring), 3 : (summer) and 4 : (autumn),

B_1, B_2 are the linear and quadratic regression coefficients, respectively, of 305-day milk yield on age at calving (X). X is ranging between 25 and 103 months, and

e_{ijm} or e_{ijkm}) is the residual term.

Then, the prediction equations of 305-day milk yield (Y) from age at calving (X), where : $Y = a + b_1 X + b_2 X^2$, were constructed. To develop age correction factors, the solution of each equation for ages 24 to 120 mo gave the denominator for a factor. The numerator in each season of calving and in all seasons was calculated as follows :

1. Equating the first derivatives of the five prediction equations (four for four seasons of calving and one for all seasons) with zero and their solutions gave the age 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 season and for all seasons. This yield was the numerator for the age correction factor.

Results and Discussion

Table (2) represents the least-squares analysis of variance fitting farm, year and season of calving, age and age squared in the model. The effect of both farm and year of calving on 305-day milk yield was highly significant ($P < .01$), while the effect of season of calving was not significant. Galal *et al.* (1974) arrived at the same results of the effectiveness of both year and season of calving using another set of Friesian records. On the basis of the

TABLE 2. Least-squares analysis of variance of 305-day milk yield, kg.

Source of variation	d.f.	Mean squares
Farm	1	9193928**
Season of Calving	3	178212
Year of calving	11	10713281**
Regressions		
Age linear	1	52115293**
Age quadratic	1	28082904**
Residual	2187	260676

** Highly significant ($P < .01$)

magnitude of constants, Sakha farm showed significantly higher production than El-Karada. The differences in production between farms might be due to differences in management practices. There was no apparent yearly trend in milk production.

The linear and quadratic regression coefficients of 305-day milk yield on age at calving were highly significant ($P < .01$), as reported by many investigators, *e.g.* Cooper and Hargrove (1982). The prediction equations used in deriving age correction factors and the number of records in each season appear in Table (3). The maximum milk yield for winter, spring, summer and autumn and for all seasons, hence, the base of 1.000 was for cows averaging 76.9, 78.8, 85.7, 96.8 and 80.1 mo of age, respectively. At such ages, the cow is much mature when body weight and size are fully developed followed by increase in the size and function of digestive and circulatory systems, mammary glands, and other body systems. With advanced age, the physiological activities of all body systems start to decrease and the secretory tissue of the udder is partially degenerated leading to a gradual decrease in the amount of milk yield. Galal *et al.* (1974) showed that peak yield was reached at approximately 84 mo of age.

TABLE 3. Prediction equations of 305-day milk yield (Y) of Friesian cattle from age at calving (X)●.

Number of records	Dependent variable		Intercept		Age coefficient			(Age)² coefficient
589	Y_{Winter}	=	1016	+	46.118	X	—	$.300X^2$
704	Y_{Spring}	=	762	+	53.126	X	—	$.337X^2$
534	Y_{Summer}	=	1494	+	29.561	X	—	$.173X^2$
378	Y_{Autumn}	=	1493	+	28.692	X	—	$.148X^2$
2205	$Y_{all\ seasons}$	=	1235	+	46.935	X	—	$.293X^2$

● X ranging between 25 and 103 mo.

TABLE 4. Age correction factors for 305-day milk production for different seasons of calving : Winter (W), Spring (S), Summer (Sr) and Autumn (A) and for all seasons (All).

Age	Factors					Age	Factors				
mo	W	S	Sr	A	All	mo	W	S	Sr	A	All
24	1.429	1.550	1.312	1.374	1.420	48	1.098	1.126	1.097	1.139	1.107
25	1.407	1.519	1.299	1.360	1.400	49	1.091	1.117	1.092	1.133	1.100
26	1.385	1.491	1.286	1.347	1.380	50	1.084	1.109	1.086	1.126	1.093
27	1.365	1.464	1.274	1.334	1.361	51	1.078	1.101	1.081	1.120	1.086
28	1.345	1.439	1.262	1.321	1.343	52	1.071	1.093	1.076	1.115	1.080
29	1.326	1.414	1.251	1.309	1.326	53	1.065	1.085	1.071	1.109	1.074
30	1.309	1.391	1.240	1.297	1.309	54	1.559	1.078	1.067	1.103	1.068
31	1.292	1.370	1.230	1.286	1.293	55	1.054	1.072	1.062	1.098	1.063
32	1.276	1.349	1.220	1.275	1.278	56	1.049	1.066	1.058	1.093	1.058
33	1.261	1.329	1.210	1.264	1.264	57	1.044	1.060	1.054	1.088	1.053
34	1.246	1.311	1.200	1.254	1.250	58	1.039	1.054	1.050	1.083	1.048
35	1.232	1.293	1.191	1.244	1.237	59	1.035	1.049	1.047	1.079	1.044
36	1.218	1.276	1.182	1.234	1.224	60	1.031	1.044	1.043	1.074	1.039
37	1.206	1.260	1.174	1.225	1.212	61	1.027	1.039	1.040	1.070	1.035
38	1.194	1.245	1.166	1.216	1.200	62	1.024	1.035	1.036	1.066	1.032
39	1.182	1.230	1.158	1.207	1.189	63	1.021	1.030	1.033	1.062	1.028
40	1.171	1.216	1.150	1.198	1.178	64	1.018	1.027	1.030	1.058	1.025
41	1.161	1.203	1.142	1.190	1.168	65	1.015	1.023	1.027	1.054	1.022
42	1.150	1.191	1.135	1.182	1.158	66	1.013	1.020	1.025	1.051	1.019
43	1.141	1.179	1.128	1.174	1.149	67	1.011	1.017	1.022	1.047	1.016
44	1.131	1.167	1.122	1.167	1.140	68	1.008	1.014	1.020	1.044	1.014
45	1.123	1.156	1.115	1.160	1.181	69	1.006	1.012	1.018	1.041	1.012
46	1.114	1.146	1.109	1.152	1.123	70	1.005	1.009	1.016	1.038	1.010
47	1.106	1.136	1.103	1.146	1.115	71	1.004	1.007	1.014	1.035	1.008

TABLE 4. (Continued).

Age	Factors					Age	Factors				
mo	W	S	Sr	A	All	mo	W	S	Sr	A	All
72	1.003	1.006	1.012	1.032	1.006	96	1.041	1.036	1.007	1.000	1.024
73	1.002	1.004	1.010	1.030	1.005	97	1.046	1.040	1.008	1.000	1.028
74	1.001	1.003	1.009	1.027	1.003	98	1.050	1.045	1.010	1.000	1.031
75	1.000	1.002	1.007	1.025	1.002	99	1.056	1.050	1.011	1.000	1.034
76	1.000	1.001	1.006	1.022	1.002	100	1.061	1.056	1.013	1.000	1.039
77	1.000	1.000	1.005	1.020	1.001	101	1.067	1.061	1.015	1.000	1.043
78	1.000	1.000	1.004	1.018	1.000	102	1.073	1.068	1.017	1.001	1.047
79	1.000	1.000	1.003	1.016	1.000	103	1.079	1.074	1.019	1.001	1.052
80	1.001	1.000	1.002	1.014	1.000	104	1.086	1.081	1.021	1.001	1.057
81	1.002	1.001	1.001	1.013	1.000	105	1.093	1.088	1.024	1.003	1.062
82	1.003	1.001	1.001	1.011	1.000	106	1.100	1.095	1.026	1.004	1.067
83	1.004	1.002	1.001	1.009	1.001	107	1.108	1.103	1.029	1.005	1.073
84	1.006	1.003	1.000	1.008	1.001	108	1.116	1.111	1.032	1.006	1.079
85	1.007	1.004	1.000	1.007	1.002	109	1.125	1.120	1.035	1.007	1.085
86	1.009	1.006	1.000	1.006	1.003	110	1.134	1.129	1.038	1.009	1.092
87	1.011	1.008	1.000	1.005	1.004	111	1.143	1.139	1.042	1.010	1.099
88	1.014	1.010	1.000	1.003	1.006	112	1.153	1.149	1.045	1.012	1.106
89	1.016	1.012	1.001	1.003	1.007	113	1.163	1.160	1.049	1.013	1.113
90	1.019	1.015	1.001	1.002	1.009	114	1.174	1.171	1.053	1.015	1.121
91	1.022	1.018	1.002	1.001	1.011	115	1.185	1.182	1.057	1.017	1.129
92	1.025	1.021	1.002	1.001	1.013	116	1.197	1.195	1.061	1.019	1.138
93	1.029	1.024	1.003	1.000	1.016	117	1.210	1.207	1.065	1.021	1.147
94	1.033	1.028	1.004	1.000	1.018	118	1.223	1.221	1.070	1.023	1.156
95	1.037	1.032	1.005	1.000	1.021	120	1.250	1.250	1.079	1.028	1.176

A set of multiplicative age factors was estimated and the result is shown in Table (4) and Fig. (1). The mature equivalent factors from this study show a rapid decline for the younger cows relative to the gradual decline thereafter.

For the comparisons between the separate factors of different seasons, and absolute difference of at least 0.05 was considered large enough to warrant separate set of correction factors at any stage of the curve (Cooper and Hargrove, 1982). While there are differences between correction factors which are more than 0.05 (Fig. 1), more estimates are needed on larger bodies of data to determine if they are significantly different.

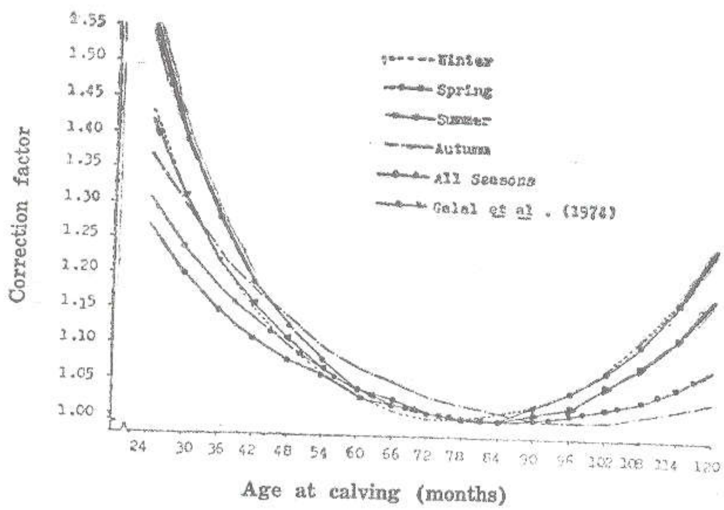

Fig. 1. Age correction factors of different seasons and other published factors.

Figure (1) shows that the change of age correction factors with age could be different from one season to another. It also shows that the factors of different sets are more similar at middle ages (45-96 mo) than at extreme ones. However, more data are required to show the necessity of having separate sets of correction factors for each season since estimated correction factors at the extreme ages are more subject to estimation error than those at the middle. Comparison of present factors of all seasons and those of Galal *et al.* (1974) shows an agreement at ages ranging between

43 and 107 mo. (Fig. 1). A high percentage of difference in correction factors (present minus Galal *et al.,* 1974) is large and positive at age less than 36 mo and more than 114 mo, and generally the factors of the present study are higher than theirs.

The apparent difference between correction factors in different season and regions suggests that the development of a separate set of correction factors for each deserves a serious consideration.

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معاملات لتعديل سجلات اللبن لابقار الفريزيان فى ٣٠٥ يوما للعمر عند الولادة

عادل صلاح خطاب وعبد الحليم انيس عشماوى

كلية الزراعة بكفر الشيخ ـ جامعة طنطا وكلية الزراعة ـ جامعة عين شمس ـ القاهرة ـ مصر

تم بحث تاثير المزرعة وموسم وسنة الوضع والعمر على كمية اللبن باستخدام ٢٢٠٥ سجل حليب لابقار الفريزيان فى مزرعتين تابعتين لوزارة الزراعة بمصر .

ولقد بينت طريقة أقل المربعات لتحليل التباين للبيانات أن تأثير كل من المزرعة وسنة الوضع والعمر عند الولادة كانحدار خطى وانحدار من الدرجة الثانية (تأثير خطقوسى) معنوى جدا ، بينما كان تأثير موسم الوضع غير معنوى .

اشتقت مجموعة من عوامل التعديل للعمر لكل موسم ولكل المواسم معا باستخدام معادلة كثيرة الحدود من الدرجة الثانية للانتاج على العمر . ولقد بين الفرق الواضح بين معاملات التعديل للعمر فى المواسم والمناطق الى ضرورة الاخذ فى الاعتبار عند استنباط معاملات التعديل للعمران تكون منفصلة لكل موسم ولكل منطقة وذلك لتعديل كمية اللبن فى ٣٠٥ يوما للعمر عند الولادة .