

AGE-MONTH FACTORS - MATURE EQUIVALENT FACTORS FOR THREE YIELD TRAITS FOR NON-REGISTERED AND REGISTERED CATTLE

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ABSTRACT

Age-month adjustment factors for registered and non-registered cows were estimated for milk, fat and protein yields. Records used in analysis considered 419,860 lactation records of Holstein cows freshening from 1983 to 1985 in nine states of the Mid-West region of the United States: Arkansas, Illinois, Iowa, Kansas, Missouri, Nebraska, North Dakota, Oklahoma and South Dakota. The mixed model used to describe the data contained fixed effects due to an overall mean, age-month of calving for non-registered and registered cows, the herd-year; and as random effects, cow and error terms. There were 30 age groups by 12 months of freshening for a total of 720 age-month estimates for each of the three traits. The ratio of $\sigma^2_e/\sigma^2_c = 13/12$ based on a repeatability of .48 for milk yield was used. Results showed a definitive age by month interaction. Age is more important for younger cows while month effects assumed more importance for mature cows. Multiplicative age-month adjustment factors were developed and are presented along with plots of the age-month factors for milk, fat and protein yield. Factors differed for the three yield traits. Milk and fat factors were larger than the corresponding factors for protein. There was a general trend for factors from non-registered to be larger than those from registered cows for same age and months of calving.

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INTRODUCTION

Registered Holsteins in the United States are animals recorded by the Holstein Association with both parental lines tracing back to original importations into North America from Europe (Powell and Norman, 1986). Non-registered cattle are termed grades. Most non-registered cows are primarily of single breed ancestry. Usefulness of information from non-registered cows in genetic improvement programs, accordingly to Norman and Powell (1983) and Powell and Norman (1986), is limited because only about one-third of non-registered cows on official test are identified by sires. Sires of non-registered Holstein cows have been reported to have slightly higher average genetic merit than do sires of registered cows, as mentioned by Powell and Norman (1986). Non-registered daughters of registered bulls have contributed extensively to genetic improvement by permitting more bulls to be sampled. Currently, 65% of daughters with records used to calculate initial proofs of artificial Holstein bulls are non-registered (Norman and Powell, 1983).

Registered cows produce more than non-registered cows as 2-yr-olds in the same herd, but this superiority lessens or disappears in later lactations because non-registered cows are culled more intensely (Powell and Norman, 1986). Reasons for culling were not studied, but low yield is less likely to be tolerated among non-registered than among registered cows. This difference in culling results in higher mature average yield for remaining non-registered cows than for remaining registered cows.

At present the same multiplicative factors for age are used for both registered and non-registered Holstein cows. Traditionally, data are adjusted to mature equivalent age according to MacDaniel (1973).

Miller (1973) reported that seasonal age-correction factors were initially used in New York in 1966 when it was found that sire proofs were severely biased when all daughters of a sire calved in the same season. Season-age factors were estimated in order to reduce the seasonal fluctuation in sire proofs and were put into routine use in the New York Dairy Records Processing Center. Season-by-age interaction appeared to be the cause of this bias, as reported by Wunder and McGilliard (1967).

The primary problem associated with construction of appropriate age adjustment factors is in obtaining estimates of the average production for each age which are not biased by unequal association of age with other influences.

Keown and Everett (1985) re-estimated age-month adjustment factors for milk, fat protein yields for Holstein cattle for the Northeast region. Fat and protein factors were larger than corresponding factors for milk. Because factors are different for the three yield traits, this could cause serious biases in ranking sires and cows.

Keown and Everett (1985) also found that definite age by month effects assumed more importance as cows mature. Currently in this region the same factors are used for fat and protein as for milk.

The purpose of this study was to re-estimate age-month factors (AM) for milk, fat and protein for a large Dairy Herd Improvement Association (DHIA) data base for registered and non-registered cows, to account for any genetic and environmental change that might have occurred over time.

MATERIALS AND METHODS

Data obtained from the Mid-Sates Dairy Records Processing Center (DRPC) in Ames, IA, consisted of all Dairy Herd Improvement (DHI) Dairy Herd Improvement Records (DHIR) Dairy Herd Improvement Associations (DHIA) lactation records of Holstein cows from the nine states of the Mid-West region (Arkansas, Illinois, Iowa, Kansas, Missouri, Nebraska, North Dakota, Oklahoma and South Dakota) freshening from January, 1983, through December, 1985. A total of 419,860 lactation records of milk and fat yields were included in the study. Seventy percent of the records were from non-registered cows. Only 132,195 lactation records included milk, fat and protein yields. A separate analysis was performed with these data using the same model. All records consisted of lactation data for 305 days with 2X milking and proper identification of the animal.

The model was:

$$Y_{ijkl} = \mu + AMR_i + HY_j + C_k + E_{ijkl}$$

where Y_{ijkl} = l^{th} record of milk, fat or protein produced by the k^{th} herd-year of freshening in i^{th} age-month (AM) of freshening, where there were 12 months of freshening for 30 age groups by two registry classes, registered and non-registered, Holstein cows (R) for a total of 720 AMR categories for each yield trait; HY = fixed effect due to the j^{th} herd and year of freshening, C is a random effect due to the k^{th} cow, assuming $\sigma^2_e/\sigma^2_c = 13/12$, based on a repeatability of 48 for milk yield; and E_{ijkl} = random residual with mean 0 and variance σ^2_e .

All cows freshening with an age less than 24 months constituted one group, 23 months. The smallest number of observations in any AMR category was 80 for registered cows freshening at 34 months in February. All cows older than 81 months were also grouped into one category. All records after 180 months of age were deleted.

Equations were collected by absorbing each cow equation after all records had been processed for that cow and a variance ratio ($\sigma^2_e/\sigma^2_c = 13/12$) was added to the diagonal. The herd-year equations for a herd were absorbed once all records

for a given herd had been processed. Because each lactation had all yield traits reported (analysis I, milk and fat; analysis II, milk fat and protein), the same incidence matrix was used and, therefore, two or three separate right-hand sides were simultaneously collected. The AMR x AMR matrix, after absorption of cow and herd-year equations, was solved by direct inversion with a constraint setting the equation for cows freshening in November at 82 months or older to zero. The number of observations for this age month subclass was 1834 with the mean equal to 7475 kg. The factor (F) was calculated as the ratio of the mean (M) yield divided by the sum of the mean yield and the deviations (D) from the mean yield obtained by the solution of the equation $F = M/(M + D)$.

RESULTS AND DISCUSSION

The 30 age groups are shown in the left column in Tables I through VI for both registered and non-registered cows.

Factors for milk are in Tables I and II. They tend to be larger during June to September for all ages of freshening and smaller the remaining months of the year. However, the factors for non-registered cows appear to vary less by calendar month of freshening than the factors for registered cows. Older cows are more severely affected by summer calving than are first-lactation heifers, as illustrated in Figures 1 and 2. The same trend was found by Keown and Everett (1985), Miller *et al.* (1970) and Wunder and McGilliard (1967). Milk factors presented tend to be larger for younger ages than those developed by Cooper and Hargrove (1982); however, they were smaller than those described by Keown and Everett (1985). Also, milk factors for registered cows tended to be smaller than those for non-registered cows, mainly for younger cows.

Factors for fat are in Tables III and IV. Factors for non-registered cows (Table IV) show a tendency to be more similar than those for registered cows (Table III), mainly at older ages. These factors are smaller than those described by Keown and Everett (1985). It appears there is a strong depression of milk and fat production in the summer and this depression is more pronounced in registered and in older cows. Figures 3 and 4 show there is a definite interaction between the register groups (registered and non-registered cows) and month of calving of older cows (over 36 months) for AM factors of fat yield. Possibly Mid-West farmers are more frequently using higher predicted difference proven sires for milk (PDM) and fat (PDF) in non-registered cows which could be a possible explanation for the higher milk production observed in non-registered cows since they are used mostly for commercial milk production. This trend was also reported by Powell and Norman (1986).

Table I - Mature equivalent factors for milk by age and month of freshening for registered Holstein cows. Base period equal to 305-d production for non-registered cow freshening in November at 82 or more months of age (mean = 7575 kg).

Age	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
≤ 23	1.35	1.36	1.37	1.39	1.40	1.39	1.41	1.39	1.41	1.33	1.35	1.37
24	1.31	1.32	1.32	1.33	1.36	1.34	1.35	1.38	1.32	1.28	1.26	1.29
25	1.29	1.29	1.32	1.28	1.30	1.32	1.34	1.34	1.31	1.28	1.25	1.28
26	1.26	1.28	1.28	1.28	1.31	1.30	1.34	1.33	1.31	1.27	1.24	1.24
27	1.25	1.26	1.25	1.25	1.29	1.27	1.32	1.32	1.30	1.27	1.24	1.24
28	1.24	1.24	1.25	1.24	1.25	1.26	1.31	1.31	1.30	1.26	1.24	1.23
29	1.24	1.23	1.23	1.23	1.24	1.26	1.29	1.30	1.29	1.26	1.23	1.22
30	1.23	1.23	1.22	1.23	1.23	1.25	1.27	1.29	1.27	1.25	1.22	1.22
31	1.23	1.22	1.22	1.22	1.23	1.24	1.26	1.29	1.25	1.24	1.22	1.21
32	1.22	1.22	1.21	1.22	1.23	1.24	1.24	1.26	1.23	1.20	1.21	1.18
33	1.22	1.21	1.19	1.20	1.21	1.20	1.23	1.25	1.22	1.19	1.20	1.19
34	1.12	1.19	1.18	1.18	1.19	1.18	1.23	1.24	1.22	1.18	1.16	1.18
35	1.19	1.15	1.14	1.16	1.18	1.17	1.20	1.23	1.22	1.16	1.13	1.17
36	1.10	1.12	1.13	1.16	1.14	1.15	1.18	1.19	1.18	1.14	1.12	1.10
37-39	1.07	1.08	1.08	1.09	1.11	1.13	1.15	1.19	1.13	1.11	1.08	1.07
40-42	1.05	1.06	1.06	1.05	1.07	1.09	1.14	1.17	1.11	1.08	1.06	1.05
43-45	1.04	1.04	1.05	1.03	1.07	1.07	1.11	1.12	1.09	1.06	1.05	1.04
46-48	1.02	1.02	1.03	1.03	1.05	1.07	1.11	1.11	1.08	1.05	1.04	1.02
49-51	1.02	1.01	1.02	1.02	1.05	1.07	1.10	1.10	1.08	1.04	1.01	1.01
52-54	1.02	1.01	1.02	1.02	1.04	1.06	1.10	1.09	1.07	1.04	1.01	.99
55-57	1.00	1.00	1.01	1.02	1.04	1.06	1.10	1.09	1.07	1.02	1.01	.99
58-60	1.00	1.00	1.00	1.00	1.03	1.05	1.09	1.09	1.07	1.02	1.00	.98
61-63	.99	1.00	1.00	1.00	1.03	1.04	1.09	1.08	1.06	1.02	1.00	.98
64-66	.98	.99	.99	.99	1.03	1.04	1.08	1.08	1.06	1.01	1.00	.97
67-69	.98	.99	.99	.99	1.02	1.04	1.08	1.08	1.06	1.01	.99	.96
70-72	.98	.98	.99	.98	1.01	1.04	1.08	1.07	1.05	1.01	.99	.96
73-75	.97	.97	.99	.98	1.00	1.04	1.06	1.06	1.04	1.00	.99	.96
76-78	.97	.97	.97	.96	1.00	1.03	1.06	1.05	1.04	.99	.98	.96
79-81	.96	.96	.96	.96	1.00	1.02	1.06	1.02	1.03	.99	.98	.96
> 81	.99	.98	.99	.99	1.02	1.06	1.09	1.08	1.04	1.01	.98	.96

Table II - Mature equivalent factors for milk by age and month of freshening for non-registered Holstein cows. Base period equals 305-d production for non-registered cows freshening in November at 82 months of age (mean = 7575 kg).

Age	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
≤ 23	1.36	1.38	1.37	1.37	1.39	1.37	1.42	1.39	1.41	1.36	1.35	1.37
24	1.29	1.33	1.32	1.32	1.32	1.34	1.38	1.38	1.35	1.30	1.32	1.31
25	1.29	1.28	1.31	1.31	1.32	1.34	1.36	1.37	1.34	1.30	1.29	1.29
26	1.28	1.28	1.30	1.30	1.32	1.32	1.34	1.37	1.33	1.30	1.27	1.29
27	1.27	1.27	1.28	1.29	1.30	1.31	1.34	1.35	1.30	1.29	1.26	1.27
28	1.26	1.26	1.27	1.26	1.29	1.31	1.34	1.34	1.31	1.28	1.26	1.26
29	1.25	1.25	1.25	1.25	1.27	1.28	1.31	1.31	1.31	1.27	1.25	1.26
30	1.24	1.24	1.24	1.23	1.26	1.26	1.31	1.30	1.29	1.25	1.24	1.25
31	1.24	1.23	1.23	1.22	1.25	1.25	1.27	1.29	1.28	1.25	1.24	1.23
32	1.24	1.23	1.22	1.22	1.24	1.25	1.26	1.27	1.26	1.24	1.24	1.22
33	1.21	1.20	1.21	1.21	1.23	1.24	1.25	1.25	1.24	1.22	1.22	1.20
34	1.21	1.18	1.21	1.18	1.22	1.21	1.24	1.23	1.24	1.20	1.20	1.20
35	1.17	1.17	1.15	1.17	1.20	1.20	1.22	1.23	1.22	1.18	1.17	1.15
36	1.16	1.14	1.15	1.15	1.16	1.18	1.19	1.20	1.12	1.16	1.15	1.13
37-39	1.10	1.11	1.12	1.12	1.14	1.15	1.19	1.19	1.17	1.13	1.11	1.10
40-42	1.08	1.07	1.07	1.08	1.10	1.12	1.15	1.17	1.14	1.12	1.09	1.06
43-45	1.06	1.06	1.06	1.06	1.08	1.09	1.12	1.12	1.13	1.09	1.07	1.06
46-48	1.06	1.05	1.05	1.06	1.07	1.09	1.11	1.12	1.09	1.07	1.05	1.05
49-51	1.03	1.03	1.05	1.05	1.07	1.08	1.11	1.11	1.09	1.06	1.04	1.02
52-54	1.03	1.02	1.04	1.04	1.05	1.07	1.10	1.11	1.08	1.05	1.03	1.01
55-57	1.02	1.02	1.03	1.03	1.05	1.07	1.10	1.10	1.07	1.05	1.02	1.01
58-60	1.02	1.02	1.03	1.03	1.05	1.06	1.09	1.10	1.07	1.04	1.02	1.01
61-63	1.02	1.01	1.02	1.02	1.04	1.06	1.09	1.09	1.07	1.04	1.02	1.01
64-66	1.01	1.01	1.02	1.02	1.04	1.06	1.08	1.09	1.07	1.04	1.02	1.01
67-69	1.01	1.01	1.01	1.01	1.03	1.06	1.08	1.09	1.06	1.03	1.02	1.00
70-72	1.01	1.01	1.01	1.01	1.03	1.05	1.07	1.08	1.06	1.02	1.01	1.00
73-75	1.01	1.00	1.01	1.01	1.03	1.05	1.07	1.07	1.06	1.01	1.01	1.00
76-78	1.01	1.00	1.00	1.00	1.02	1.04	1.07	1.06	1.05	1.00	.99	1.00
79-81	.97	.99	.99	.99	1.02	1.04	1.05	1.06	1.03	1.02	.98	.99
> 81	1.00	1.00	1.01	1.01	1.02	1.05	1.08	1.09	1.07	1.02	1.00	.99

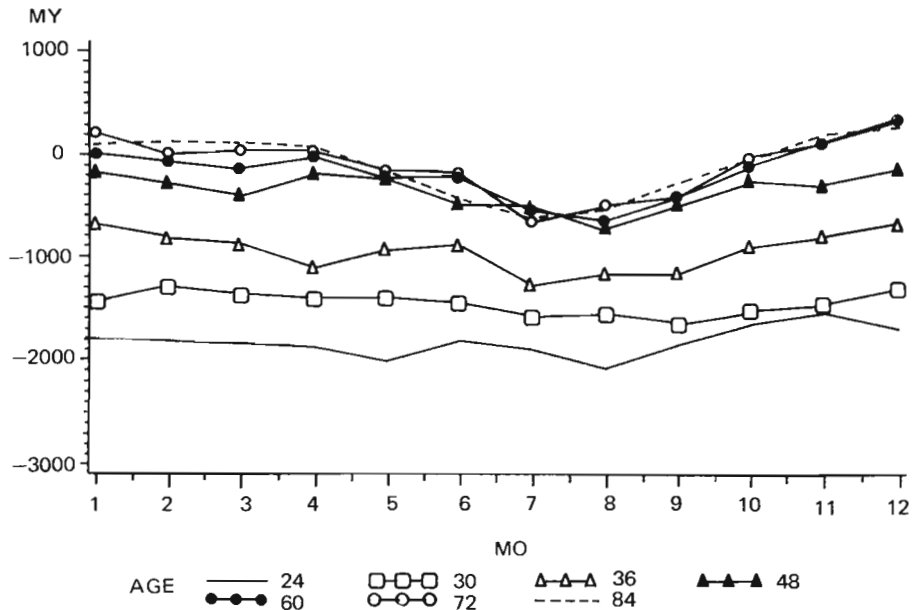


Figure 1 - Seasonal change in milk yield (kg) for age at calving in 6-month and 12-month intervals for registered Holstein cows.

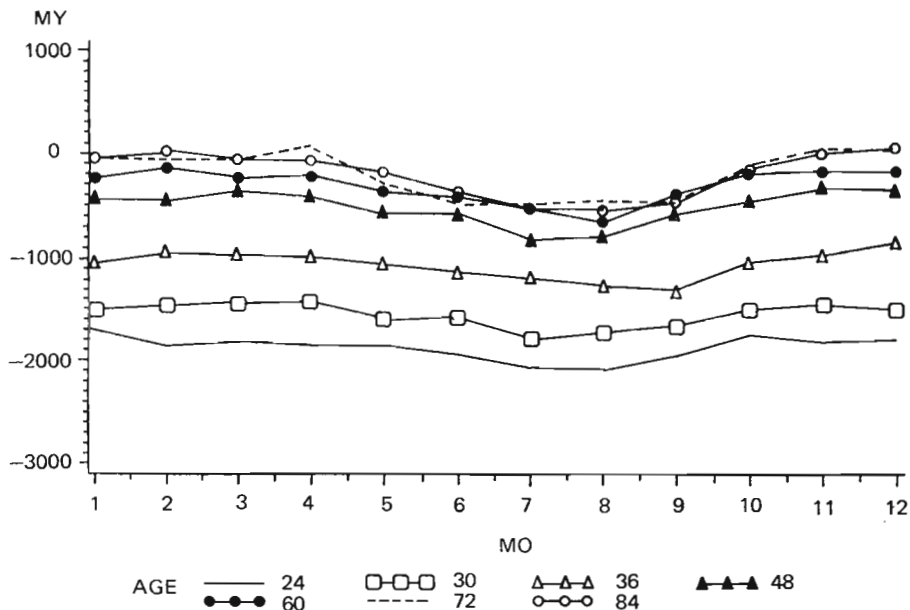


Figure 2 - Seasonal change in milk yield (kg) for age at calving in 6-month and 12-month intervals for non-registered Holstein cows.

Table III - Mature equivalent factors for fat yield by age and month of freshening for registered Holstein cows. Base period equals 305-d production for non-registered cows freshening in November at 82 or more months of age (mean = 274.72 kg).

Age	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
≤ 23	1.35	1.37	1.41	1.41	1.41	1.41	1.40	1.39	1.37	1.32	1.37	1.40
24	1.34	1.35	1.35	1.36	1.37	1.34	1.34	1.35	1.32	1.29	1.27	1.32
25	1.32	1.32	1.34	1.30	1.33	1.33	1.34	1.34	1.31	1.28	1.26	1.31
26	1.30	1.30	1.31	1.29	1.32	1.33	1.34	1.33	1.30	1.27	1.26	1.26
27	1.28	1.28	1.28	1.27	1.31	1.29	1.32	1.32	1.29	1.26	1.25	1.26
28	1.26	1.26	1.27	1.27	1.28	1.29	1.30	1.29	1.27	1.26	1.24	1.24
29	1.25	1.26	1.24	1.26	1.24	1.26	1.30	1.28	1.26	1.26	1.24	1.24
30	1.25	1.25	1.24	1.24	1.23	1.25	1.26	1.28	1.26	1.23	1.24	1.23
31	1.24	1.24	1.24	1.24	1.23	1.25	1.25	1.26	1.24	1.22	1.22	1.23
32	1.24	1.24	1.22	1.23	1.22	1.24	1.24	1.26	1.21	1.17	1.22	1.22
33	1.23	1.22	1.19	1.21	1.22	1.20	1.21	1.23	1.20	1.17	1.20	1.19
34	1.23	1.18	1.19	1.21	1.21	1.18	1.21	1.21	1.20	1.16	1.16	1.18
35	1.21	1.15	1.17	1.18	1.19	1.18	1.21	1.19	1.19	1.16	1.15	1.17
36	1.11	1.12	1.14	1.17	1.14	1.15	1.19	1.18	1.17	1.14	1.13	1.12
37-39	1.10	1.10	1.10	1.11	1.12	1.15	1.14	1.17	1.12	1.09	1.08	1.08
40-42	1.07	1.09	1.07	1.08	1.10	1.10	1.14	1.16	1.10	1.07	1.06	1.05
43-45	1.04	1.07	1.06	1.05	1.08	1.10	1.12	1.11	1.07	1.05	1.04	1.04
46-48	1.04	1.06	1.06	1.05	1.07	1.09	1.11	1.11	1.07	1.04	1.04	1.03
49-51	1.04	1.04	1.06	1.05	1.06	1.08	1.11	1.10	1.06	1.02	1.01	1.02
52-54	1.03	1.04	1.03	1.04	1.06	1.08	1.11	1.10	1.06	1.02	1.01	1.01
55-57	1.02	1.03	1.03	1.04	1.06	1.07	1.10	1.10	1.05	1.01	1.00	1.00
58-60	1.01	1.02	1.02	1.04	1.06	1.06	1.10	1.08	1.05	1.01	1.00	.99
61-63	1.01	1.01	1.02	1.02	1.05	1.06	1.10	1.07	1.04	1.01	1.00	.99
64-66	1.00	1.01	1.02	1.02	1.05	1.05	1.09	1.07	1.04	1.00	1.00	.99
67-69	1.00	1.00	1.01	1.01	1.04	1.05	1.09	1.07	1.04	1.00	.99	.99
70-72	.99	1.00	1.00	1.01	1.04	1.05	1.09	1.06	1.03	.99	.98	.98
73-75	.98	1.00	1.00	1.00	1.03	1.04	1.09	1.05	1.03	.99	.98	.97
76-78	.98	1.00	.97	1.00	1.03	1.04	1.08	1.05	1.02	.99	.97	.97
79-81	.97	.98	.97	.98	1.02	1.04	1.08	1.05	1.02	.98	.97	.97
> 81	1.01	1.00	1.00	1.00	1.03	1.07	1.11	1.07	1.03	1.00	.97	.97

Table IV - Mature equivalent factors for fat yield by age and month of freshening for non-registered Holstein cows. Base period equals 305-d production for non-registered cows freshening in November at 82 or more months of age (mean = 274.72 kg).

Age	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
≤ 23	1.39	1.40	1.40	1.40	1.41	1.38	1.43	1.39	1.39	1.36	1.36	1.38
24	1.33	1.34	1.34	1.34	1.34	1.35	1.36	1.37	1.33	1.30	1.32	1.32
25	1.32	1.32	1.33	1.33	1.34	1.34	1.36	1.36	1.33	1.30	1.30	1.31
26	1.31	1.30	1.32	1.31	1.33	1.33	1.34	1.35	1.33	1.29	1.28	1.31
27	1.30	1.30	1.30	1.30	1.32	1.31	1.34	1.35	1.29	1.28	1.28	1.29
28	1.28	1.29	1.29	1.28	1.30	1.31	1.33	1.32	1.30	1.27	1.27	1.29
29	1.28	1.27	1.27	1.27	1.28	1.30	1.30	1.31	1.30	1.26	1.26	1.27
30	1.27	1.27	1.25	1.24	1.27	1.27	1.29	1.28	1.27	1.25	1.23	1.26
31	1.25	1.26	1.24	1.24	1.26	1.26	1.26	1.27	1.26	1.24	1.24	1.24
32	1.24	1.25	1.24	1.23	1.25	1.24	1.24	1.25	1.24	1.22	1.23	1.24
33	1.24	1.23	1.23	1.23	1.24	1.23	1.24	1.25	1.23	1.22	1.23	1.22
34	1.22	1.21	1.23	1.20	1.23	1.22	1.23	1.22	1.23	1.20	1.20	1.19
35	1.19	1.20	1.19	1.19	1.19	1.20	1.22	1.21	1.21	1.16	1.17	1.17
36	1.18	1.16	1.17	1.17	1.17	1.18	1.19	1.21	1.12	1.16	1.15	1.16
37-39	1.12	1.13	1.14	1.15	1.16	1.16	1.18	1.18	1.16	1.12	1.11	1.11
40-42	1.10	1.09	1.09	1.10	1.12	1.14	1.15	1.16	1.13	1.10	1.09	1.08
43-45	1.08	1.08	1.08	1.08	1.11	1.10	1.11	1.12	1.11	1.08	1.07	1.06
46-48	1.08	1.07	1.08	1.08	1.09	1.10	1.12	1.11	1.09	1.06	1.04	1.06
49-51	1.05	1.06	1.07	1.07	1.09	1.10	1.11	1.10	1.08	1.05	1.03	1.04
52-54	1.05	1.05	1.06	1.07	1.08	1.09	1.10	1.10	1.08	1.04	1.03	1.03
55-57	1.04	1.04	1.06	1.06	1.07	1.08	1.10	1.10	1.06	1.03	1.02	1.03
58-60	1.04	1.04	1.05	1.05	1.07	1.08	1.09	1.10	1.06	1.03	1.02	1.03
61-63	1.04	1.04	1.04	1.05	1.06	1.07	1.09	1.10	1.06	1.03	1.02	1.02
64-66	1.04	1.03	1.04	1.05	1.05	1.07	1.09	1.09	1.05	1.02	1.02	1.02
67-69	1.03	1.03	1.04	1.04	1.05	1.07	1.08	1.09	1.05	1.01	1.02	1.02
70-72	1.02	1.03	1.03	1.04	1.05	1.07	1.08	1.09	1.05	1.01	1.02	1.02
73-75	1.02	1.03	1.03	1.03	1.05	1.06	1.08	1.08	1.08	1.00	1.01	1.01
76-78	1.02	1.02	1.02	1.03	1.05	1.06	1.07	1.07	1.04	1.00	1.00	1.00
79-81	1.01	1.01	1.01	1.02	1.04	1.05	1.07	1.06	1.03	1.99	.99	.99
> 81	1.03	1.03	1.03	1.04	1.05	1.07	1.09	1.08	1.06	1.03	1.00	1.00

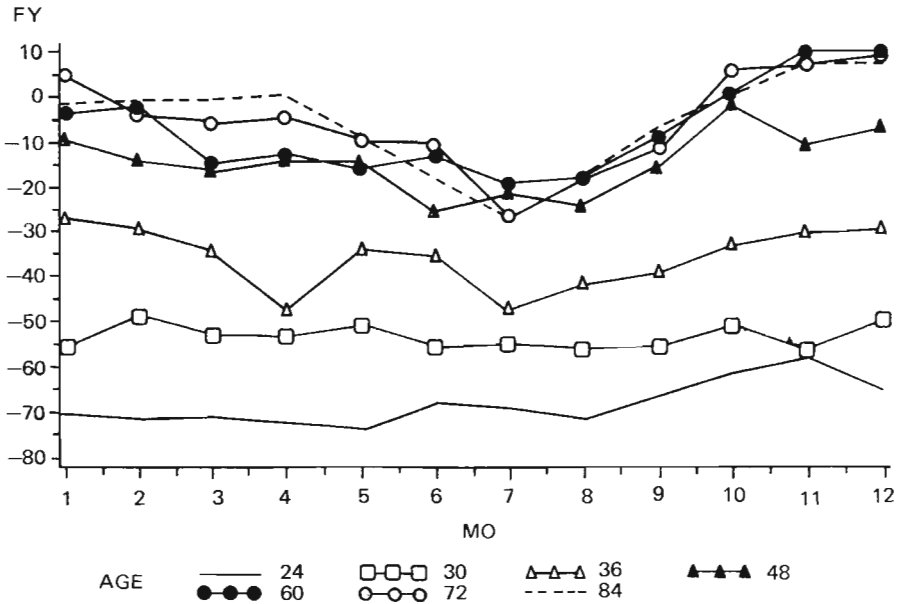


Figure 3 - Seasonal change in fat yield (kg) for age at calving in 6-month and 12-month intervals for registered Holstein cows.

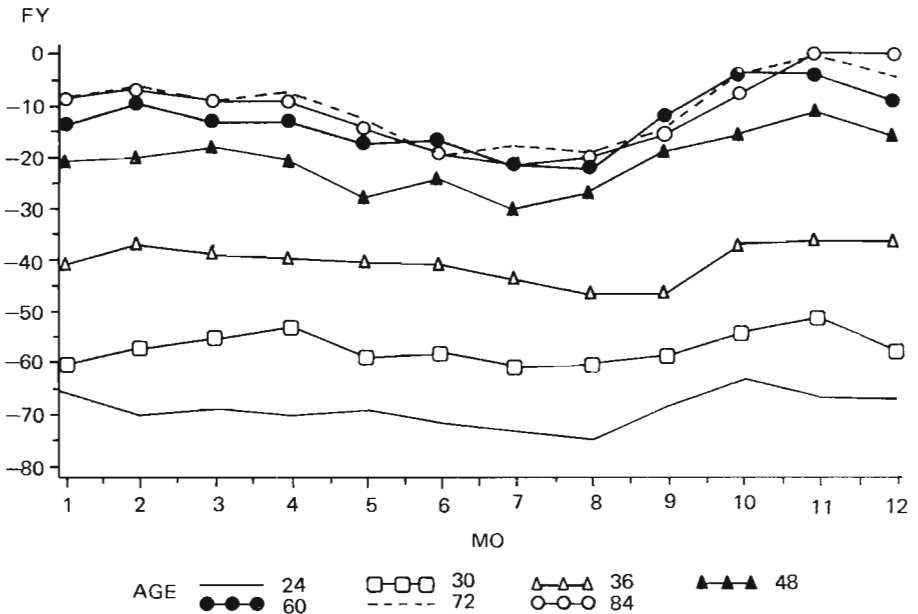


Figure 4 - Seasonal change in fat yield (kg) for age at calving in 6-month and 12-month intervals for non-registered Holstein cows.

Tables V and VI show the protein factors for both registered and non-registered cows, respectively. As described previously, for estimation of these factors only records of cows that had simultaneous information of milk, fat and protein were used. The variability of these factors is more evident than those for milk and fat, probably because of the much smaller sample size. However, a similar trend was observed when factors for non-registered cows appeared to vary less than those of registered cows, mainly for older ages. There was a decline in protein production for cows freshening from April through December, which is more evident at older ages in non-registered cows. These factors were smaller than those described by Keown and Everett (1985). The decline in production could be related to lower milk production in the summer. Compared with the milk and fat factors, these factors were much smaller. On the other hand, protein and fat factors were reported by Keown and Everett (1985) and Miller and Henderson (1968) to be larger than the milk factors. Figures 5 and 6 show the distribution of age-month factors. At older ages, both groups show a difference in age factors with calendar month of freshening. Therefore, the age-season adjustment factors are important in older cows to compare first-lactation cows, as well as to compare cows with records from different lactations. The current factors used in the Mid-West region of the United States are described by Norman *et al.* (1974).

As reported by Norman *et al.* (1974), the age adjustment factor for cows freshening in January, at 24 mo, is approximately 1.23. This factor is smaller than those reported in Tables I and II. Furthermore, the factors for milk and fat currently used are smaller than the ones reported in Tables I through IV, mainly at younger ages. However, the same trend remains throughout the calendar months of freshening, that is, larger factors are evidenced for summer months. An example may illustrate this situation. If a cow freshens in July, at 24 mo of age, and produces 7574 kg (305 d-2x), the estimate for mature equivalent production would be 9998 kg (1.32×7574), using the current factors (Norman *et al.*, 1974); however, the production would be 10,225 kg for registered cows and 10,452 kg for non-registered cows, using the factors described in Tables I and II, respectively. The corresponding mature equivalent milk production for cows freshening at 24 mo in January, would be 9316 kg (1.23×7574) using the respective current factor and 9922 kg for registered and 9770 for non-registered cows, using the factors reported in Tables I and II. This difference suggests that the production of first-calving heifers has been underestimated in the Mid-West.

In addition, the non-registered cows tend to have larger factors than the registered ones, and since 60 to 70% of the records come from non-registered cows, it is valid to develop separate factors.

Table V - Mature equivalent factors for protein yield by age and month of freshening for registered Holstein cows. Base period equals 305-d production for non-registered cows freshening in November at 82 or more months of age (mean = 235.80 kg).

Age	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
≤ 23	1.24	1.30	1.27	1.28	1.32	1.31	1.33	1.32	1.32	1.30	1.32	1.37
24	1.23	1.25	1.24	1.25	1.28	1.26	1.30	1.32	1.30	1.28	1.24	1.31
25	1.23	1.19	1.24	1.21	1.26	1.26	1.31	1.29	1.20	1.27	1.24	1.28
26	1.19	1.19	1.20	1.20	1.24	1.23	1.29	1.28	1.28	1.27	1.24	1.25
27	1.19	1.18	1.17	1.20	1.23	1.22	1.27	1.27	1.26	1.25	1.24	1.24
28	1.16	1.17	1.17	1.16	1.18	1.21	1.25	1.27	1.25	1.25	1.23	1.23
29	1.16	1.16	1.14	1.16	1.18	1.20	1.24	1.27	1.24	1.24	1.22	1.22
30	1.15	1.16	1.13	1.14	1.16	1.19	1.22	1.25	1.23	1.24	1.22	1.21
31	1.15	1.14	1.13	1.14	1.16	1.19	1.21	1.23	1.22	1.21	1.21	1.20
32	1.13	1.14	1.12	1.13	1.16	1.18	1.18	1.22	1.20	1.19	1.21	1.19
33	1.13	1.10	1.12	1.11	1.15	1.17	1.17	1.17	1.19	1.18	1.21	1.19
34	1.10	1.02	1.11	1.10	1.14	1.11	1.16	1.17	1.19	1.16	1.19	1.19
35	1.07	1.02	1.11	1.09	1.13	1.13	1.14	1.15	1.16	1.15	1.15	1.19
36	1.01	1.01	1.06	1.07	1.06	1.10	1.12	1.14	1.14	1.10	1.11	1.10
37-39	1.01	1.00	1.01	1.03	1.01	1.09	1.10	1.13	1.09	1.09	1.08	1.04
40-42	1.00	.98	.99	.98	1.00	1.03	1.07	1.10	1.07	1.04	1.04	1.04
43-45	.99	.98	.99	.96	1.00	1.03	1.06	1.07	1.06	1.04	1.04	1.03
46-48	.98	.98	.98	.96	.99	1.03	1.05	1.07	1.04	1.04	1.04	1.03
49-51	.97	.95	.97	.96	.98	1.02	1.05	1.06	1.04	1.03	1.01	1.01
52-54	.95	.95	.97	.95	.97	1.02	1.04	1.06	1.04	1.02	1.00	1.01
55-57	.93	.95	.96	.95	.97	1.00	1.04	1.06	1.03	1.01	1.00	1.00
58-60	.93	.94	.95	.93	.96	.99	1.03	1.04	1.03	1.01	.99	.99
61-63	.93	.94	.95	.93	.96	.99	1.03	1.04	1.02	1.101	.99	.99
64-66	.93	.92	.93	.91	.96	.99	1.03	1.04	1.02	1.01	.98	.99
67-69	.91	.92	.93	.91	.95	.98	1.02	1.03	1.02	1.00	.98	.98
70-72	.91	.91	.93	.91	.95	.97	1.02	1.02	1.02	1.00	.98	.97
73-75	.91	.90	.92	.90	.95	.97	1.02	1.01	1.02	1.00	.97	.97
76-78	.91	.89	.90	.89	.94	.96	1.02	1.00	.99	.98	.96	.95
79-81	.87	.89	.87	.87	.93	.95	1.00	.99	.98	.97	.94	.95
> 81	.94	.92	.94	.94	.96	.99	1.04	1.03	1.02	.99	.98	.98

Table VI - Mature equivalent factors for protein yield by age and month of freshening for non-registered Holstein cows. Base period equals 305-d production for non-registered cows freshening in November at 82 or more months of age (mean = 235.80 kg).

Age	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
≤ 23	1.25	1.29	1.28	1.31	1.33	1.32	1.37	1.33	1.37	1.35	1.33	1.35
24	1.22	1.26	1.24	1.26	1.26	1.29	1.34	1.33	1.32	1.30	1.32	1.32
25	1.20	1.21	1.22	1.23	1.26	1.29	1.31	1.31	1.31	1.29	1.29	1.29
26	1.20	1.19	1.22	1.23	1.25	1.26	1.30	1.31	1.29	1.27	1.28	1.29
27	1.19	1.19	1.19	1.22	1.24	1.26	1.29	1.31	1.29	1.27	1.26	1.28
28	1.18	1.18	1.18	1.19	1.23	1.24	1.28	1.29	1.28	1.25	1.25	1.26
29	1.18	1.16	1.17	1.17	1.20	1.22	1.25	1.28	1.27	1.25	1.24	1.23
30	1.18	1.15	1.15	1.15	1.18	1.21	1.25	1.25	1.25	1.25	1.24	1.23
31	1.17	1.14	1.15	1.15	1.18	1.21	1.23	1.23	1.25	1.23	1.22	1.23
32	1.16	1.14	1.14	1.15	1.17	1.18	1.19	1.22	1.24	1.20	1.22	1.21
33	1.16	1.12	1.13	1.14	1.17	1.18	1.18	1.19	1.20	1.19	1.21	1.19
34	1.15	1.11	1.10	1.13	1.16	1.14	1.17	1.18	1.18	1.18	1.17	1.18
35	1.09	1.08	1.08	1.11	1.12	1.13	1.14	1.16	1.17	1.14	1.17	1.14
36	1.09	1.06	1.05	1.09	1.08	1.11	1.13	1.17	1.16	1.13	1.13	1.14
37-39	1.02	1.03	1.05	1.05	1.07	1.09	1.11	1.12	1.13	1.10	1.09	1.10
40-42	1.01	1.01	.99	1.00	1.03	1.06	1.09	1.10	1.11	1.09	1.07	1.06
43-45	.99	.99	.98	.99	1.02	1.03	1.05	1.07	1.09	1.07	1.04	1.05
46-48	.99	.97	.98	.99	1.01	1.02	1.06	1.06	1.06	1.03	1.03	1.04
49-51	.98	.97	.97	.98	.99	1.02	1.02	1.05	1.06	1.06	1.03	1.02
52-54	.97	.95	.97	.98	.98	1.02	1.04	1.06	1.05	1.03	1.01	1.02
55-57	.95	.95	.96	.96	.98	1.01	1.04	1.05	1.05	1.02	1.01	1.01
58-60	.95	.95	.95	.96	.98	1.01	1.03	1.05	1.04	1.02	1.01	1.01
61-63	.95	.95	.95	.95	.97	1.00	1.03	1.05	1.04	1.02	1.01	1.01
64-66	.95	.94	.94	.95	.97	1.00	1.03	1.03	1.03	1.01	1.01	1.01
67-69	.95	.94	.94	.94	.96	1.00	1.01	1.03	1.03	1.01	1.00	1.01
70-72	.94	.94	.94	.94	.96	.99	1.00	1.03	1.02	1.00	1.00	1.00
73-75	.94	.94	.93	.94	.96	.99	1.00	1.03	1.00	1.00	1.00	.99
76-78	.93	.94	.92	.93	.96	.98	1.00	1.02	1.00	1.00	.98	.99
79-81	.93	.93	.91	.92	.95	.97	.99	1.02	.98	1.00	.97	.97
> 81	.94	.94	.93	.93	.97	1.00	1.03	1.04	1.05	1.01	1.00	.99

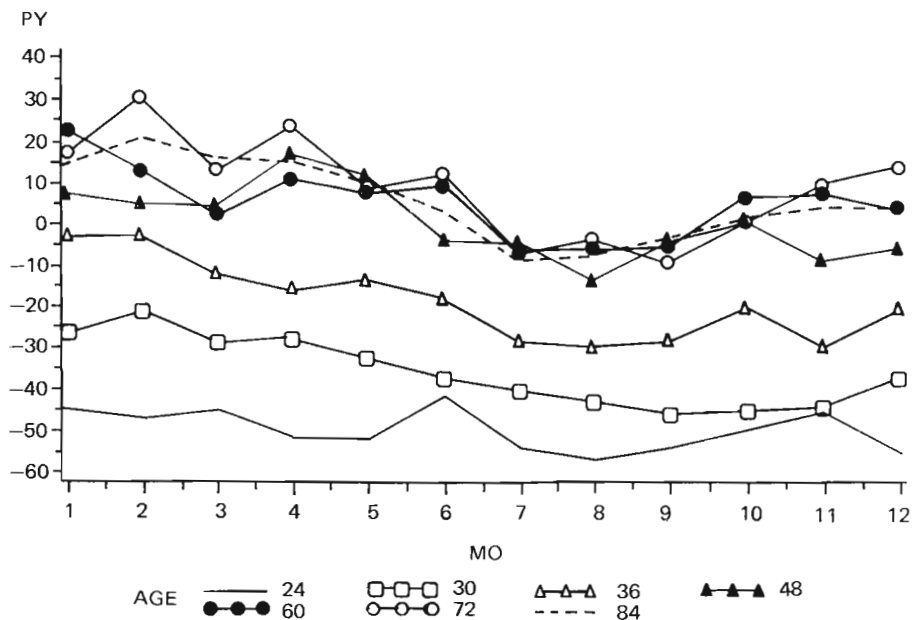


Figure 5 - Seasonal change in protein yield (kg) for age at calving in 6-month and 12-month intervals for registered Holstein cows.

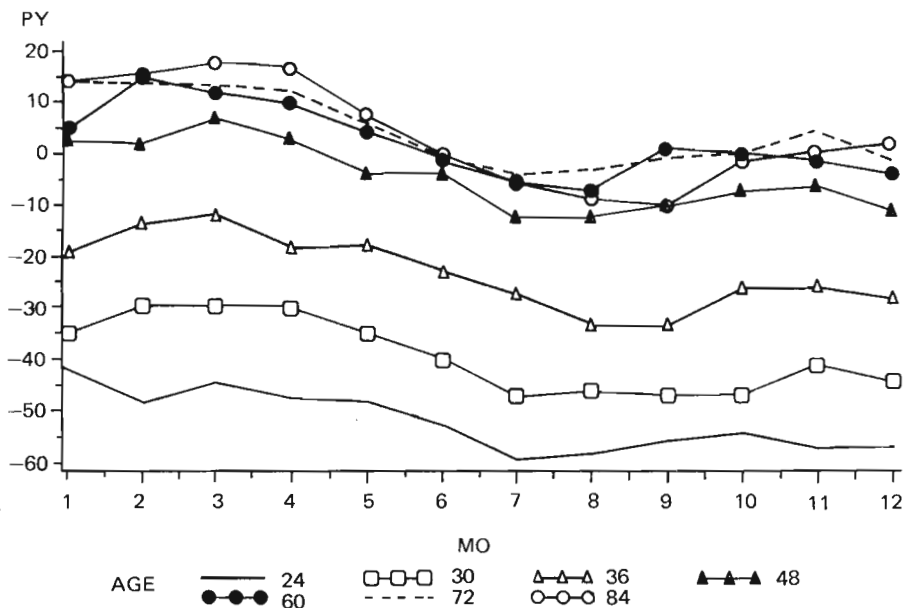


Figure 6 - Seasonal change in protein yield (kg) for age at calving in 6-month and 12-month intervals for non-registered Holstein cows.

Consequently, the difference between mature and first-lactation cows, either registered or non-registered for all three traits, is greater in fall and winter than for summer freshenings. Younger cows seem less affected by summer weather conditions than older cows. Thus, if there is no interaction between milk market price by season of the year, whenever possible, the older cows should preferentially produce a calf in a more favorable month (winter and fall) while the first lactation heifers should produce a calf year round in order to yield fresh milk during the whole year.

Therefore, it is concluded that non-registered cows presented age-season adjustment factors for milk, fat and protein with less variation than the corresponding factors for registered cows. Changes in management over time suggest the need for continuous estimation of adjustment factors, mainly considering the two groups of cows, registered and non-registered, in order to improve sire and cow evaluations. A method that would account for any management changes that occur would be to develop models for genetic evaluation that simultaneously include effects due to age and month of freshening. This would enable genetic evaluation to adjust records simultaneously for any changes in management practices. The factors presented are different for milk, fat and protein, which indicates a need for using different factors for each trait under evaluation.

RESUMO

Foram calculados fatores de ajustamento para leite, gordura e proteína para vacas Holandesas registradas, PO, e para vacas não registradas. A amostra de dados consistiu de 419.860 lactações ocorridas entre 1983 e 1985 em nove estados do meio-oeste dos Estados Unidos. O modelo misto usado para descrever os dados contém os efeitos fixos devido à média, idade e mês de parto para ambos os grupos, rebanho-ano, e efeitos aleatórios devido à vaca e resíduo. Foram formados 30 grupos de idade por 12 meses de parto perfazendo 720 estimativas de fatores de ajustamento para os efeitos de idade e mês de parto. Utilizou-se a razão $\sigma^2_e/\sigma^2_c = 13/12$ baseada na repetibilidade de 0.48 para a produção de leite. Os resultados obtidos mostraram a presença de interação idade x mês ao parto. O efeito da idade ao parto foi mais importante para vacas jovens enquanto que o efeito do mês do parto assumiu maior importância à medida que as vacas aumentam a idade. Fatores multiplicativos para ajustamento dos efeitos de idade x mês do parto foram desenvolvidos e estão ilustrados em Tabelas e Figuras. Os fatores de ajustamento para leite e gordura são maiores que os correspondentes fatores de ajustamento para proteína. Os fatores de ajustamento para idade x mês de parto para vacas não registradas tenderam a ser superiores aos correspondentes para vacas registradas.

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(Received January 5, 1990)