# EFFECT OF PARITY IN AGE ADJUSTMENT FACTORS IN THE ITALIAN HOLSTEIN FRIESIAN CATTLE BREED

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## SUMMARY

Inclusion of parity in multiplicative adjustment factors for age at calving was investigated for the Italian Holstein Friesian cattle breed. Separated age adjustment factors for first, second, third and later parities are necessary because cows of the same age but different parity have different production. Differences in production were particularly evident for first and second parity cows of same age. If parity is not accounted for, first lactation mature equivalent production can be underestimated. Because progeny testing is based on first lactation production, underestimation of a fraction of mature equivalent records may be reflected in genetic indexes.

## INTRODUCTION

Age at calving, month of calving and days open are factors that significantly affect milk, fat, and protein production. Records are usually preadjusted for age and month of calving in genetic evaluation, mainly to reduce computing time in solving equations with iterative procedures.

Bagnato et al. (1989) calculated multiplicative age adjustment factors for milk, fat kg, and protein kg with a repeatability model for the Italian Holstein Friesian. Coefficients were calculated for days open and for age*month of calving separately for 8 different zones defined by Aleandri et al. (1983). Wilmink et al (1987) suggested that the same set of age adjustment factors can be used for different herd production levels. Keown and Everett (1984) indicated that multiplicative adjustment factors should be estimated periodically. Often parity is not accounted for in calculating age adjustment factors. Mao et al. (1973) concluded that cows of the same age but different parity do not need different age adjustment factors. Bonaiti et al. (1993) indicated that the estimated genetic trend is extremely sensitive to age adjustment factors.

The objective of this study was to investigate the effect of inclusion of parity in age adjustment factors for milk, fat, and protein yield.

## MATERIALS AND METHODS

More than 1.860.000 production records of Italian Holstein Friesian recorded from 1988 to 1992 were used in the analysis. All lactations were extended to 305 d. Record in progress, lactations with missing information on days open (except for the terminal record of each cow), age at calving and month of calving were eliminated. Age at calving ranged from 22 to 120 months. Days open was classified in 25 classes (class 1=11/20 days open). Days open greater than 260 were assumed to not affect production and grouped in class 25. Class 25 (no effect of days open) was assigned as value for days open in terminal lactations. Cows were classified into three groups: first, second, and older parity cows. Three zones were defined according to climatic conditions (north, middle and south Italy). A fourth zone was defined for herds producing Parmigiano Reggiano cheese, because of the special feeding management system.

Two different animal models were used to obtain estimates for age at calving and age*parity interaction effects that were successively compared. The first model (model 1) included fixed factors for herd-year of calving (51445 levels), age at calving (99 levels), zone by month of calving interaction (48 levels), and days open class (25 levels). The second model (model 2) included a fixed factor for parity by age interaction (125 levels) while factor age at calving was removed. Random factors were the additive genetic effect, permanent environmental effect, and the residual error for each observation. Traits considered were milk fat and protein kg. Heritability and repeatability were assumed .25 and .5 respectively for all the traits. Genetic groups were defined as in the routine

national genetic evaluation (Jansen, 1990) according to Westell et al. (1988). Solutions were obtained iteratively and the process stopped after 200 iterations.

|         | Parity |       |
|---------|--------|-------|
| Age (mo) | 1     | 2     |
|         |   (n)  |       |
| 32      | 32965  | 1120  |
| 33      | 25074  | 1473  |
| 34      | 19205  | 3880  |
| 35      | 14078  | 9660  |
| 36      | 9964   | 18550 |
| 37      | 6674   | 28814 |
| 38      | 4864   | 37802 |
| 39      | 3408   | 43501 |
| 40      | 2534   | 44670 |
| 41      | 1763   | 43917 |
| 42      | 5327   | 40519 |

**Table 1**: Frequency of observations by parity and age class common for first two parities.
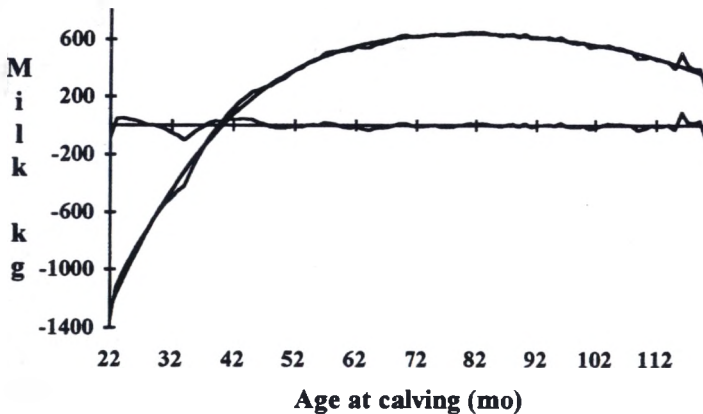


Figure 1: Solutions, polynomial regression curve, and residuals for factor age at calving.

Solutions obtained for age at calving and age-parity interaction factors were interpolated by a 4th degree polynomial regression curve to smooth differences between ages. Predicted values (**PV**) were used to calculate projection factors.

Multiplicative coefficients were calculated within parity to a base age for each parity, and across parities to the base age (84 months) of later parities.

**RESULTS**

Table 1 shows, by parity, the frequency of age at calving classes common for the first two parities. More then 36% of the observations in first and second lactation are found in classes common to both parities.

Figure 1 shows age at calving solutions for milk production, estimated with model 1, along with the interpolated regression curve and residuals. The age production relationship is expected to be biologically continuous. Given the large number of observations, standard errors of the estimates (not calculated) are expected to be small and the solutions are expected to lie along a continuous curve (the polynomial regression curve plotted). Solutions up to age 50 deviate (residuals) from expectation. This indicates that other sources of variation not accounted for needed to be considered.

Figure 2 shows solutions (estimated with model 2), interpolation curves and residuals for age*parity interaction for milk production. As shown, cows of the same age but in different parity have different production. First parity cows produce generally less than second parity cows of the same age. This difference increases to more than 280 kg of milk for cows older than 40 months of age at calving. Later parity cows produce less then second parity cows calving at the same age.
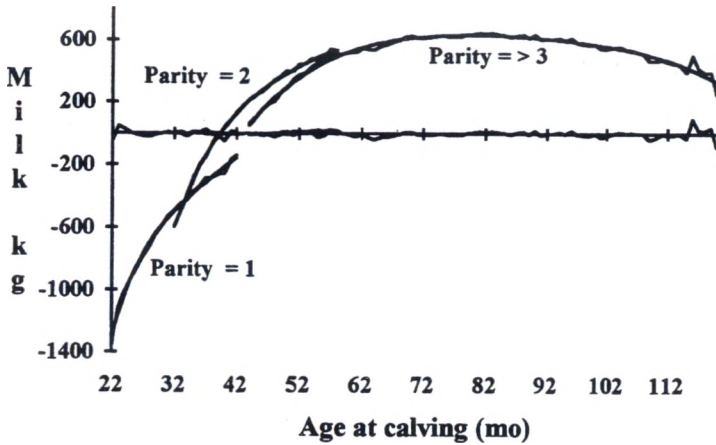
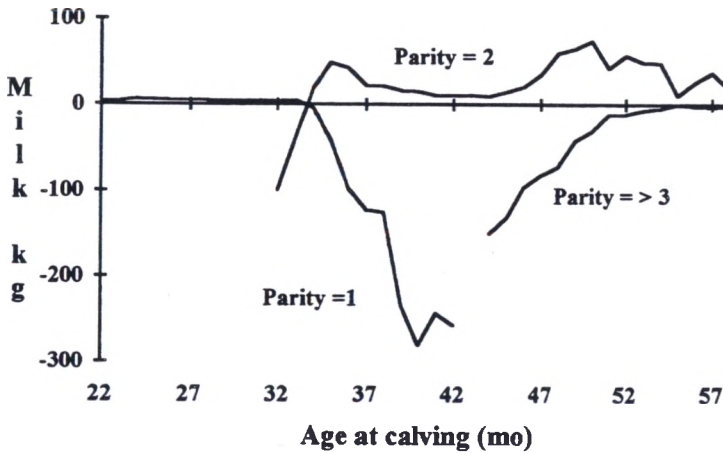Figure 2: Solutions, polynomial regression curves, and residuals of parity by age interaction effect.



Figure 3: Differences between solutions of age*parity interaction effect and age at calving effect.

In Figure 3 differences between solutions for age*parity interaction (estimated with model 2) and solutions for age at calving (estimated with model 1) are shown by parity for milk production. If parity is not accounted for, age adjustment factors for first parity cows calving after 32 months of age will be smaller, and mature equivalent production will be underestimated.

Figure 4 shows age by parity coefficients for milk fat and protein yield. Coefficients are continuous and approach maturity smoothly due to the use of PV. Differences in multiplicative factors for cows of the same age in different parities are greater for first and second parity then for second and third parity cows. Differences were greater then 5% for first and second parity cows calving calving at 42 months.

Mao et al. (1973) with a similar model concluded that parity effect was not important in adjusting for age at calving.

Estimates of month of calving were different for each of the four zones identified. Cows with 100 days open interval produce 370 kg of milk more than cows with 40 days open interval. Difference in production between a 250 d and a 100 days open interval was 180 kg.

32

## DISCUSSION

The first proof of a bull is based only on its daughters first lactation performance. Lactations of cows calving late in first parity are underestimated if not adjusted for parity effect; this can be reflected in a bull EBV, especially if his daughters are not equally distributed across ages within the same parity.

Moreover, when first and later parity production are directly compared in a genetic evaluation and first parity mature equivalent productions are underestimated, EBVs are likely to change when second lactations, projected to a correct mature equivalent, enter the evaluation procedure. Comparisons between cows in first and second lactations must be as accurate as possible in order to eliminate fluctuations of EBVs over time.

The use of multiplicative factors that adjust for age within parity give better estimation of mature equivalent production and a better comparison within and across parities. Results of this study show that adjustment of age within parity should be used to obtain correct mature equivalent production. Different coefficients should be used for milk, fat, and protein yield.
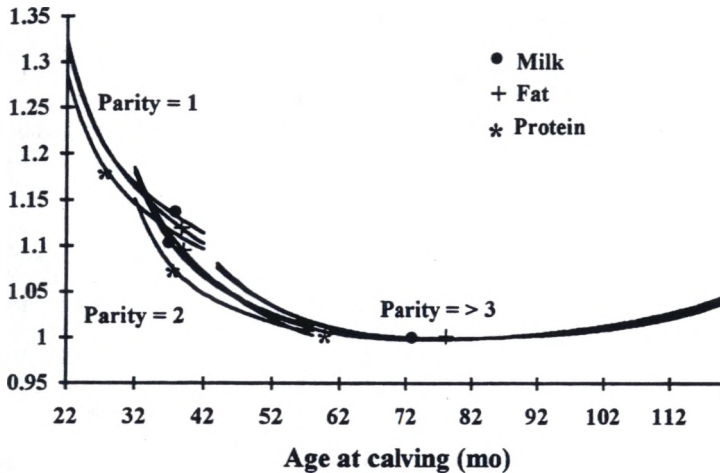


Figure 4: Age by parity multiplicative adjustment factors for milk fat and protein yield.

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