VARIANCES AND COVARIANCES OF MONTH EFFECTS WITHIN HERD-YEAR FOR MILK PRODUCTION TRAITS FROM THREE SITUATIONS, AND THEIR IMPLICATION IN SIRE EVALUATION

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INTRODUCTION

In most models of dairy sire evaluation, the herd-year-season is the main environmental subclass within which progeny groups are compared, and each season is usually taken to be comprising 4-6 months. However, longer seasons do not seem to be reasonable because herd-year-season x month-of-calving interactions (i.e. herd-year x month-of-calving within season interactions) are large (Chauhan and Hill, 1986). In models with herd-year-season as a fixed effect, the variances and covariances of month effects are assumed to be zero. The objective of this paper was to present the information on variances and covariances of month effects within herd-year, and their implication in a BLUP model of sire evaluation.

MATERIALS AND METHODS

The results will be presented from analyses of the data on first lactations from 3 dairy cattle breeding schemes in Britain, Switzerland, and India. The description of the data and the results from Britain have been given by Chauhan and Thompson (1987). Whereas the Swiss and Indian data have been described by Chauhan (1987a) and Chauhan et al. (1987), respectively. There were 43089 records in British, 168480 in Swiss, and 6427 in Indian data sets.

Each record, represented by whatever the effects in the model (e.g. herd-year, month of calving, herd-year x month, age at calving, sire), was adjusted for all effects except herd-year and herd-year x month interaction using least squares constants obtained by method 3 of Henderson (1953). Since there is no herd structure in the field data in India, the artificial insemination centre-year effect was taken to be an equivalent of the herd-year effect in British and Swiss data. Herd-year effects were removed by expressing each record as a deviation from the herd-year mean of adjusted records. The sum of squares and the crossproducts of deviated records were calculated for different pairs of months within herd-year. These quantities were then set equal to their expected values in terms of the unknown variances and the covariances of month effects. The covariances between any pair of months the same distance apart (e.g. 1-month-apart: January with February, February with March; 2-months-apart: January with March, February with April) were assumed to be equal. Since all covariances were not estimable, the longest distance apart (i.e. 11-months-apart) covariance was constrainted to be zero. The procedure for estimating covariances, and their application in sire evaluation has been given in detail by Chauhan and Thompson (1987).

RESULTS AND DISCUSSION

The estimates of 0 to 11-months-apart covariances from British, Swiss, and Indian data sets are plotted in Figures 1, 2 and 3, respectively. The trends amongst the estimates of covariances for yields of milk and fat were quite similar. However, information on fat yield was not available in Indian data. The covarinces became smaller as the distance between months increased. The decrease from 0 through to 5-months-apart was almost linear in all three situations, and thereafter all covariances were apparently similar and small. However, the trend amongst the estimates of covariances from Indian data (Fig. 3) is not as smooth as from British and Swiss data, which is presumably because of a small data set. But an overall linear slope is clearly seen. These results suggest that the different months apart comparisons of progeny groups should not be given the same weightings.

<u>Implication in sire evaluation</u>

The implication of variances and covariances of month effects in a sire evaluation model was examined only using British data (Chauhan and Thompson, 1987). Instead of using the actual estimates of covariances for one or more months apart distances, a model was derived using only the estimate of 0-month-apart covariance (i.e. covariance among records in the same month within herd-year) in which the decrease in the covariance was assumed to be perfectly linear as the distance between months increased upto 5-months-apart, and that the 5 or more months apart all covariances were assumed to be zero. This assumption was close to the observed trend. Models such as this have been suggested by Bartlett (1978) and Wilkinson et al. (1983) for analyses of crop variety trials.

In order to quantify the gains in the accuracy of sire predictions using the assumed variance-covariance structure among months, the above model - the "rolling months" model - (as named by Chauhan and Thompson, 1987) was compared to a model in which only the variances of month effects were accounted for and all between-months covariances were assumed to be zero -"random month" model (Chauhan, 1987b). The criteria used for comparisons were:

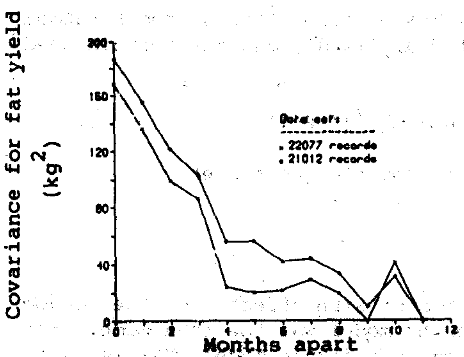

Fig. 1. The trends amongst different months apart covariances for fat yield from British data

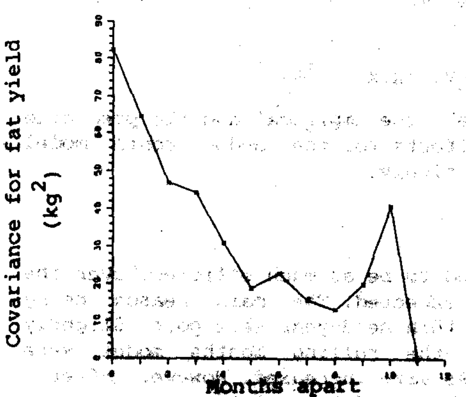

Fig. 2. The trends amongst different months apart covariances for fat yield from Swiss data

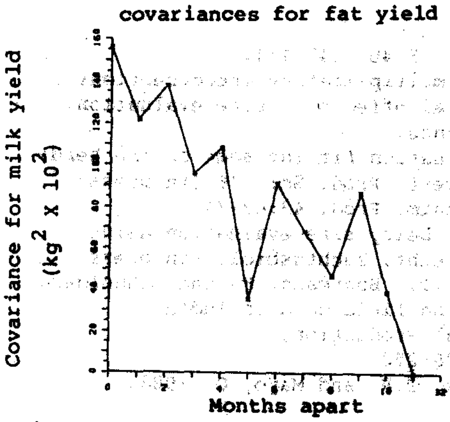

Fig. 3. The trends amongst different months apart covariances for milk yield from Indian data

(1) Empirical variance of the estimates of sire effects from 8 random subsets of data of proven sires (fitted as fixed), and the formula used is given below:

$$\text{Empirical variance for sire } i = [\sum_{j=1}^{P} (u_{ij}-\bar{u}_i)^2]/(P-1)$$

where:

u_{ij} = sire effect for the ith sire from the jth subset,

$\bar{u}_i = [\sum_{j=1}^{P} u_{ij}]/P$

P = number of subsets of data.

(2) Predicted variances of the estimates of sire effects for the random month model given that the rolling months model was the true model. For example, let each record be represented by a simple model ($Y=Xt+e$) with co(variances) of t equal to $(X'V_1^{-1}X)^{-1}$ when the model is incorrect (m1), and $(X'V_2^{-1}X)^{-1}$ when it is true (m2).

Then:

$$Var(t_{m2}|m2) = (X'V_2^{-1}X)^{-1}$$

$$Var(t_{m1}|m2) = (X'V_1^{-1}X)^{-1}X'V_1^{-1}V_2V_1^{-1}X(X'V_1^{-1}X)^{-1}$$

Compared to the rolling months model, the empirical and the predicted variances of the estimates of sire effects for the random month model were larger by 2.19 and 3.95%, respectively.

CONCLUSIONS

The rolling months model was not found to be as much efficient over the random month model as was originally expected. The main reason being that the connections among months within herd-year were poor. Slightly larger gains in the efficiency of the rolling months model were observed as the herd-year subclass size increased. However, after a herd-year size of about 10 the gains appeared to asymptote.

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