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Effect of Multiplicative Multifactor Adjustment on the Performance of Holstein-Friesian x Sahiwal Crosses*

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ABSTRACT

Multiplicative adjustment factors were derived by using least squares estimates obtained from the data on 1736 higher and 743 lower crosses of Holstein-Friesian with Sahiwal, maintained at Military Dairy Farm of Southern Command (Pimpri, Bangalore and Secunderabad).

Records were simultaneously adjusted for significant effects (mostly farm, group of sires and year). The adjustment in higher crosses was found to be efficient in reducing the standard error of mean and coefficient of variation, without disturbing the general mean significantly. On the contrary, sample size of lower crosses appeared to be too small to derive effective adjustment factors. Because use of such factors tended to inflate the sample variability hence the multiplicative multifactor adjustment would be more effective if the factors are derived from the larger sample size like that of higher crosses.

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INTRODUCTION

The adjustment of nongenetic effects either by developing factors or including them in the model would increase the efficiency of genetic analysis, which in turn would improve the interpretation of genetic experiment. Various studies had indicated the need for adjusting age, period, year, season of calving (Gupta *et al.*, 1979 and Chacko *et al.*, 1984), farm (Ganpule *et al.*, 1984) and lactation number (Tajane and Gurnani, 1984).

Most of the earlier studies (Deb *et al.*, 1981; Tajane and Gurnani, 1984 and Tandon and Harvey, 1984) developed age and lactation correction factors. It was, therefore, felt necessary to derive the adjustment factors for other important nongenetic effects too.

MATERIALS AND METHODS

Data pertained to the performance records on 1736 and 743 crossbred daughters of Holstein-Friesian (HF) and Sahiwal sires, respectively, maintained at Military Dairy Farms of Southern Command (Pimpri, Secunderabad and Bangalore) and born during 1970 to 1983. The HF x Sahiwal crossbreds of HF and Sahiwal sires were termed as higher and lower crosses, respectively.

*Based on the data from the Ph.D. thesis of first author.

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Multiplicative adjustment factors were derived by using least squares estimates of general mean and nongenetic effect (Tandon and Harvey, 1984) as :

F_{ij} = U/ (U + E_{ij})

Where F_{ij} = Adjustment factor for i^{th} nongenetic effect of jth group,

U = Least squares estimate of general mean,

E_{ij} = Least squares estimates of ith nongenetic effect of jth group.

Multilinear least squares model included farm, group of sires used in different periods, year and season for birth weight (BW), age at first calving (AFC) and body weight at first calving (BFC). For first lactation length (FLL), yield (FLY) and peak yield (FLPY), two additional effects (age and weight groups) were included in the model.

These records were adjusted simultaneously for significant effects only as :

$$Y_i = Xi \left(\prod_{j=1} F_{ij}\right)$$

TABLE 1

Multiplicative adjustment factors for farm, group and year in higher crosses of Holstein Friesian with Sahiwal.

Effect		*Age at first calving*	*Body weight at first calving*	*First lactation length*	*First lactation yield*	*First lactation peak yield*
Farm	1	0.945	1.024	—	1.179	1.123
	2	1.040	0.988	—	0.831	0.900
	3	1.020	0.989	—	1.054	1.001
Group of sires	1	1.039	0.977	1.053	1.105	1.113
	2	0.992	0.989	0.992	0.972	0.985
	3	0.972	1.037	0.960	0.938	0.919
Year	1	0.973	1.050	0.954	1.068	1.010
	2	0.919	1.055	0.910	0.914	0.945
	3	0.968	1.053	0.908	0.995	1.048
	4	0.913	0.950	0.946	0.961	1.002
	5	0.922	0.989	0.978	0.829	0.850
	6	1.042	0.940	1.053	1.004	0.973
	7	1.047	0.982	1.024	1.046	1.042
	8	1.097	0.970	1.058	0.982	1.016
	9	0.951	0.992	1.064	0.946	0.945
	10	0.910	1.042	1.071	1.138	1.017
	11	1.012	0.976	1.031	1.046	1.052
	12	1.071	1.027	1.046	1.167	1.160
	13	1.137	1.016	0.998	—	—

Where Y_i and X_i are adjusted and unadjusted records, respectively of a cow belonging to j^{th} subgroup of ith nongenetic main group. The different analytical criteria (Tajane and Gurnani, 1978) were estimated to judge the effectiveness of the adjustment.

RESULTS AND DISCUSSION

Multiplicative adjustment factors were developed only for the effects, found significant (Tajane and Rai 1989a and 1989b) and presented in Table 1, 2 and 3. Accordingly, adjusment for farm, group of sire and year was needed in almost all traits of both the crosses. The FLY and FLPY of both the crosses were to be adjusted for body weight effects, while seasonal correction was to be done in FLPY of both the crosses and in birth weight of lower crosses. However, there was no need of adjusting BW and FLL in higher crosses for all and farm effects, respectively. In general, the factors were greater for farm-1, group 1, later years, and younger body weight groups in higher and lower crosses. Exceptionally, in lower crosses the adjustment factors for group-2 were comparatively greater than those for gruop-1 (Table- 2) with exception of BW and FLPY.

TABLE 2

Multiplicative adjustment factors for farm, group and year in lower crosses of Holstein Friesian with Sahiwal.

Effects		*Birth weight*	*Age at first calving*	*Body weight at first calving*	*First lactation length*	*First lactation length*	*First lactaion peak yield*
Farm	1	1.003	1.019	1.005	1.022	1.159	1.102
	2	0.983	0.997	1.022	0.954	0.943	1.007
	3	1.015	0.984	0.975	1.027	0.929	0.910
Group of sires	1	1.001	0.940	0.983	0.984	1.023	0.983
	2	0.999	1.068	1.017	1.017	0.978	1.018
Year	1	0.955	1.027	1.031	1.019	0.953	1.019
	2	1.116	1.091	0.976	0.898	0.189	0.931
	3	1.027	1.078	0.978	1.010	0.866	0.940
	4	0.972	1.053	0.967	0.965	0.855	0.871
	5	0.997	1.015	1.014	0.938	0.981	1.015
	6	0.989	0.958	1.022	0.987	1.055	1.011
	7	1.012	0.889	1.001	0.936	1.125	1.035
	8	0.944	0.919	0.985	1.370	1.800	1.264
	9	1.008	1.008	1.030	—	—	—

The effect of adjustment on following analytical criteria was studied to judge its effectiveness.

(a) Estimates of mean, standard error and co-effecient of variation

Estimates of general mean for adjusted records may differ from that of unadjusted accords to the extent of approximation error. From the present results (Table-1), this error appeared to be random. Because, the adjustment had reduced the means' of some traits, while it increased the means of other traits. Statistically, the error was almost zero as there were no significant differences between adjusted and unadjusted means of all the traits. Similar results were also reported for lactation adjustment by least squares constants in Sahiwal (Deb *et al.*, 1981).

In genetic analysis adjustment is mainly to reduce or remove the variability associated with the nongenetic effects. Consequently, the population is supposed to be more homogenous with the lower co-efficient of variation after adjustment. Similarly, the precision of estimate of population mean would be increased through the reduction in the standard error of mean. Based on this analogy, the multiplicative multifactor adjustment was found to be efficient in reducing standard error of mean and co-efficient of variation for all the performance traits in higher crosses (Table 4). On the contrary, this adjustment in lower crosses seemed to be less efficient as it tended to slightly increase standard error of mean and coefficient of variation (Table 4). Probably small size might have inflated the random error, thereby increasing the variability in sample population

TABLE 3

Multiplicative adjustment factors for seasons and body weight groups in Holstein-Friesian x Sahiwal crosses.

Effects	*Higher crosses*		*Lower crosses*		
	First lactation yield	*First lactation peak yield*	*First lactation yield*	*First lactation peak yield*	*Birth weight*
Body weight groups					
1	1.242	1.241	1.274	1.248	—
2	1.108	1.095	1.058	1.084	—
3.	1.019	1.019	0.985	1.003	—
4.	0.910	0.927	0.961	0.950	—
5.	0.825	0.818	0.824	0.815	—
Seasons					
1	—	0.996	—	0.955	1.011
2	—	0.989	—	1.058	0.995
3	—	1.015	—	0.993	0.994

TABLE 4

Effect of adjustment on the estimates of means, standard errors and co-efficient of variations of performance traits in Holstein- Friesian X Sahiwal crosses.

	Traits	*Lower crosses*			*Higher crosses*		
		n	*Unadjusted*	*Adjusted*	*n*	*Unadjusted*	*Adjusted*
1.	Birth weight (kg)	743	26.01 ± 0.10 (10.69)	25.90 ± 0.12 (12.67)	1736	26.18 ± 0.25 (39.51)	26.18 ± 0.25 (39.51)
2.	Age at first calving (days)	743	156.4 ± 7.74 (22.06)	957 ± 9.16 (26.08)	1736	933.4 ± 4.23 (18.86)	936 ± 2.11 (12.94)
3.	Body weight at first calving (kg)	743	356.1 ± 1.182 (13.92)	356 ± 2.37 (18.15)	1736	359.9 ± 2.31 (26.79)	361 ± 1.30 (13.83)
4.	First lactation length (days)	575	279.6 ± 2.31 (19.81)	283 ± 2.67 (22.62)	1494	311.9 ± 1.41 (17.53)	308 ± 1.11 (12.81)
5.	First lactation yield (kg)	575	2466 ± 38.0 (37.96)	2435 ± 45.7 (45.00)	1494	2843 ± 24.6 (33.51)	2810 ± 12.8 (12.83)
6.	First lactation peak yield (kg)	575	11.97 ± 0.14 (27.84)	11.75 ± 0.05 (9.56)	1494	14.04 ± 0.10 (26.35)	13.88 ± 0.06 (15.01)

Figures in parentheses are per cent co-efficient of variation.

of lower crosses. The present findings, thus, confirmed the earlier reports (Tajane and Gurnani, 1978, 1984 and Tajane and Siddiquee, 1985).

(b) Differences between crosses

Improved genetic analysis through adjustment would ensure better comparison between crosses. Keeping this in view, the mean squares due to crosses and error with their relative contribution to total variability (R^2%) were estimated (Table 5). The mean sum of squares between crosses were slightly reduced for all the traits except BW. The reduction was to the extent of approximated error that was also common in disturbing the estimates of general mean (Table 1). The estimates of error mean squares and its relative contribution (R^2%) were also reduced as expected. However, there was no much anticipated increase in the variability associated with crosses (R^2 values for crosses) owing to the reduction in mean squares between crosses. Hence, the adjustment could not induce much improvement in the level of significance, while testing the differences between the performances of crosses (Table 5).

Perusal of all the criteria indicated that multiplicative multifactor adjustment would be effective if the factors are derived from the larger sample size like that of higher crosses. The adjustment would be erroneous if the sample size is too small like that of lower crosses.

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