CROSSBREEDING EFFECTS IN FRIESIAN, JERSEY AND SAHIWAL CROSSES IN PAKISTAN

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ABSTRACT

Data on 4023 lactation records on purebred Sahiwal cows and 2391 lactation records of Holstein Friesian X Sahiwal (FS) and Jersey X Sahiwal (JS) crossbreds from Livestock Production Research Institute (LPRI) Bahadurnagar, District Okara and Qadirabad District Sahiwal for the period 1973-1995, in Punjab, Pakistan were analysed. Crossbreeding effects were studied for production and reproduction traits: lactation milk yield (LMY), calving interval (CI), milk yield per day of calving interval (MCI), days open and days dry. Heterosis effects were significant ($P< .01$) and in a favourable direction for all production and fertility traits in all groups. Compared with the mid-parent mean, the F_1 would increase LMY by 31 % in FS and by 41 % in JS crosses. The MCI would be increased in these crosses, by 49 % and 51 %, respectively. For reproduction traits there was a decrease in days open: 35 and 60 %; days dry: 41 and 72 % and CI: 15 and 20 % for FS and JS crosses, respectively. Heterosis effects were larger than breed additive effects. Additive breed effects for FS crosses were larger than for JS crosses, and FS crossbreds were superior to JS crossbreds in LMY and MCI. The recombination effects were found significant ($P < .01$) for most of the traits in this study.

Keywords: *Bos indicus*, *Bos taurus*, Crossbreeding, Heterosis, Recombination loss.

INTRODUCTION

The Sahiwal breed is considered more productive among indigenous species (Khan *et al.* 1992). The improvement in genetic potential through within breed selection is very slow. Van Vleck *et al.* (1986) reported that efficient breeding programme even under optimal conditions in temperate areas may produce changes in genetic merit for milk from 1 to 2 per cent per year. Such rates are insufficient to improve production from indigenous breeds for a fast growing human population in the country. A possible solution is crossbreeding by combining the desired characteristics of two species; milk production from Bos taurus (*BT*) and adaptability from *Bos indicus* (*BI*: indigenous) cattle. For developing a dairy programme in Pakistan, Sahiwal/ local cattle could be used for crossbreeding with *Bos taurus* (*BT*: Friesian or Jersey) breeds. Cunningham and Syrstad (1987) noted that the improvement in genetic potential in *BT* X *BI* crossbreeding could be equal to 100 years of selection. The present investigation was undertaken to calculate the crossbreeding effects in Friesian X Sahiwal and Jersey X Sahiwal crosses in Pakistan. These parameters would be needed to predict the possible improvement made in crossbreds with respect to various production, reproduction and fitness traits and would help to assess the potential for crossbreeding programmes.

MATERIALS AND METHODS

The data set included 4023 lactation records (parity 1 to 5) on 1172 purebred Sahiwal cows, 2182 lactation records on 748 Friesian crossbreds and 209 records on 76 Jersey crossbreds for the period 1973-1995, from LPRI Bahadurnagar and Qadirabad in Punjab, Pakistan. Five economically important traits: lactation milk yield (LMY), calving interval (CI), milk yield per day of calving interval (MCI), days open and days dry were included in this study. Data were split in two sets, one for Sahiwal and its crossbreds with Holstein Friesian (FS) and another for Sahiwal and its crossbreds with Jersey (JS). Two models were compared: a regression model where additive breed, heterosis and epistatic (recombination loss) effects were fitted as regression coefficients, and a breed group model. The term heterosis is defines as the superiority of the crossbred individual over the means of its parents, whereas recombination is defined as deviation from linear relation of performance with heterosis, such that " the coefficient of recombination describes the average fraction of indipendently segregating pairs of loci in gametes from both parents which are expected to be non-parental combinations. Fixed effects of herd-year-season, parity, and calving age within parity were common in both models. These models were fitted using ASREML (Gilmour and Thompson, 1998).

In mathematically terms the regressin model is written as under:

y_{ijkl} = $\mu + hys_i + parity_j + b_1 age(parity)_{ijk} + b_2A_1 + b_3A_2 + b_4H_{13} + b_5H_{23} + b_6R_{13} + b_7R_{23} + e_{ijkl}$ Where,

μ = Overall population mean,

hys_i = i^{th} herd-year-season interaction,

$Parity_j$ = $_j$th parity,

$age(parity)_{ijk}$ = Calving age within parity,

b_1 = Regression coefficient of age at calving within parity,

b_2 = Additive genetic effect of Friesian breed (relative to Sahiwal),

b_3 = Additive genetic effect of Jersey breed (relative to Sahiwal),

b_4 = Heterotic effect of F_1 cross of Friesian and Sahiwal breeds,

b_5 = Heterotic effect of F_1 cross of Jersey and Sahiwal breeds,

b_6 = Epistatic effect of F_1 cross of Friesian and Sahiwal breeds,

b_7 = Epistatic effect of F_1 cross of Jersey and Sahiwal breeds,

A_1, A_2 = Breed coefficients of the trait (calculated as percentage of genes from friesian and Jersey breeds,

H_{13}, H_{23} = Heterosis coefficients of the trait (calculated as percentage of heterozy- gous loci as b_{Het}).

R_{13}, R_{23} = Recombination coefficients of the trait as b_{Rec}

The breed group in mathematically terms can be written as under:

$y_{ijkl} = \mu + hys_i + parity_j + bg_k + b_1 age(parity)_{ijkl} + e_{ijkl}$ All the other terms are already explained except, bg = Breed groups, The breed group representation is given in Table 1.

RESULTS

Heterosis effects were significant ($P < .01$) for all traits of Sahiwals crosses with Friesian and Jersey (Table 2). Additive genetic differences between Sahiwal and Jersey were not significant for any of the traits but between Holstein and Sahiwal they were significant for most of the traits. Generally, heterosis effects were larger than breed differences, especially for Jersey crosses. The effects of recombination was also significant for both crosses except for production traits in JS crosses (Table 2). The regression model and the breed group model were compared for MCI, having the highest level of heterosis (49 %) in Friesian crossbreds. The predicted least squares means for this trait in Friesian crosses from both models is given in Fig. 1. This figure shows that predicted means for both models were reasonably similar.

Differences with the least square estimates obtained from breed group model were larger for Jersey (Fig. 2). An explanation is that breed group estimates from the regression model were inaccurate due to the fact that regression coefficients in Jersey crossbreds had very high standard errors and some genetic groups had a small number of observations. Least squares means indicate that almost all crossbreds were superior to Sahiwals for having shorter CI, less days dry and days open. MCI was also improved in all the crossbreds. LMY was better in crosses having ≥ 50 % *BT* in case of FS crosses. In case of JS crosses there was an improvement in LMY only in F_1 crosses. FS crosses were superior to JS crosses for production and MCI but JS were better for reproduction traits.

DISCUSSION

In our study, heterosis effects were larger than additive breed effects, indicating that a 50 % composite breed would outperform purebred Friesians. This might be typical for harsh tropical environments. Martinez *et al.* (1988) reported higher estimates for the additive genetic than for the heterosis effects in farms where management practices appeared to support higher level of production (>2800kg /lactation). The substantial milk depression observed in the F_2 relative to F_1 (indicated as recombination) has been well documented by others (McDowell, 1985 and Syrstad, 1989). Syrstad (1989) attributes this decline to a reduction in the epistatic effects. An F_2 cross would retain only 50 % of the heterosis and have an additional loss due to recombination effects. Significant recombination effects would have a negative effects on composites. However, such losses might be recovered by a selection program within the composite. Talbott *et al.* (1994) also studied additive and heterosis effects for Friesian X Sahiwal and Jersey X Sahiwal crossbred cattle (with different model and data set) in Punjab, Pakistan. Their study showed lower estimates for additive effects in some traits in both crossbreds but their estimates for

Table 1: Different breed groups and their non-additive genetic effects

Breed groups	% BT*	Percent heterosis	Percent Recomb	No. of records Friesian x Sahiwal	No. of records Jersey x Sahiwal
3/4	75	50	25	61	21
5/8	62.5	50	44	113	8
F1	50	100	0	934	138
F2	50	50	50	465	12
F3	50	50	50	300	-
F4	50	50	50	75	-
3/8	37.5	50	44	43	5
1/4	25	50	25	91	25
Sahiwal	0	0	0	4023	4023

* BT = *Bos taurus* (Friesian or Jersey breeds).

Table 2 : Additive and non-additive breed effects for Friesian X Sahiwal and Jersey X Sahiwal crosses

Trait	Sahiwal Means	Estimates ± Standard error		
		Additive	Heterosis	Recombination
Friesian X Sahiwal Crosses				
LMY (kg)	1770	783.0 ± 200.0**	670.0 ± 110.0**	-650.0 ± 143.0**
CI (days)	482	32.3 ± 24.0	-76.9 ± 11.4**	-93.7 ± 10.7**
MCI (kg)	3.94	1.52 ± 0.48**	2.32 ± 0.26**	-0.46 ± 0.35**
Days open	196	60.7 ± 25.8*	-80.4 ± 14.0**	-98.1 ± 19.3**
Days dry	209	11.4 ± 26.4	-88.0 ± 14.2*	-80.4 ± 19.5**
Jersey X Sahiwal Crosses				
LMY (kg)	1770	379.0 ± 422.0	813.0 ± 230.0**	-560.0 ± 484.0**
CI (days)	482	-42.4 ± 68.0	-94.1 ± 36.0**	-136.0 ± 81.0**
MCI (kg)	3.94	1.9 ± 1.12	2.50 ± 0.60**	-1.47 ± 1.25**
Days open	196	3.0 ± 69.0	-118.0 ± 37.0**	-138.0 ± 81.0**
Days dry	209	11.4 ± 771.0	-154 ± 41.0**	-150.0 ± 92.0**

** P < .01 * P < .05

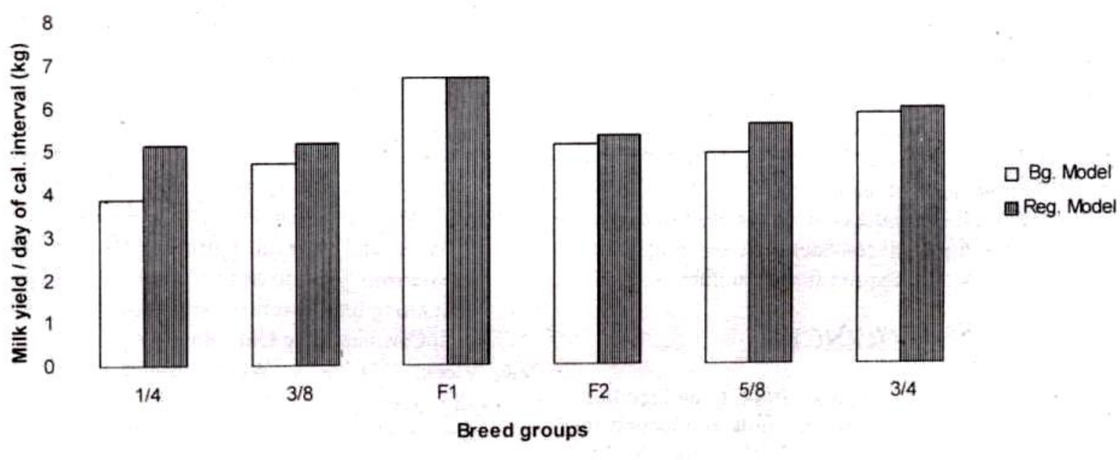

Fig. 1: Comparison of two models for prediction of MCI in Friesian crossbreds

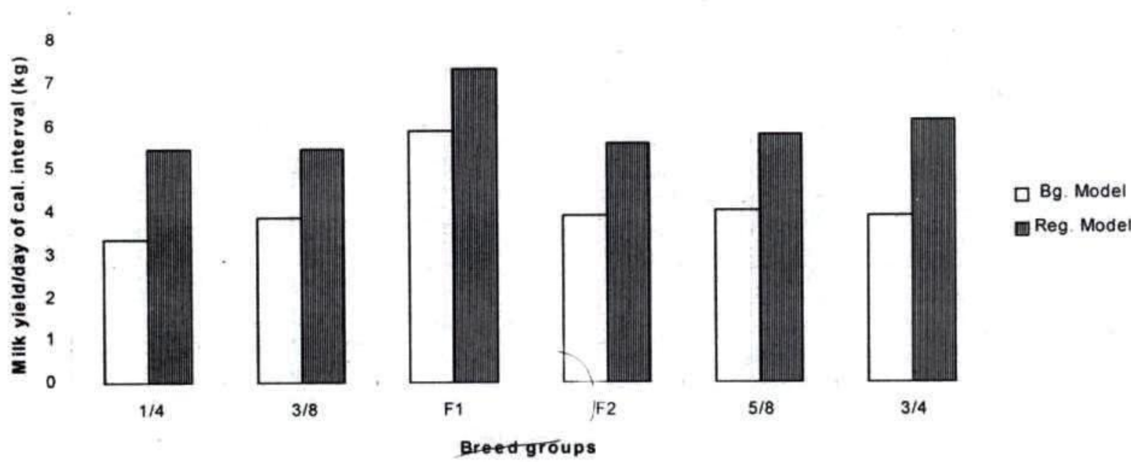

Fig. 2: Comparison of two models for prediction of MCI in Jersey crossbreds

heterosis were larger in Friesian X Sahiwal crossbreds than the estimates of the present study, especially for lactation milk yield but they did not counted for recombination loss.

CONCLUSIONS

This study emphasises the importance of developing a breeding strategy that maintains a high level of heterosis to maximise both milk production and fitness in sub tropical environment of Pakistan, where inputs are limited. Heterosis effects were significant and in a favourable direction for all traits, whereas additive effects from *Bos Taurus* were smaller. Continuously producing F_1 crosses is practically not optimal because producers have to constantly rely on external sources to purchase replacements. The development of two breed composite, for example a Friesian-Sahiwal composite, may be a more practical way for improvement of dairy stock in the country. Feasibility of such an endeavour under resource poor small farmer set up and consideration of indigenous genetic resources would require further studies.

REFERENCES

Cunningham, E.P. and O. Syrstad, 1987. Crossbreeding Bos indicus and Bos taurus for milk production in the tropics. FAO Anim. prod. health paper No.68, Rome, Italy.

Gilmour, A.R. and R. Thompson, 1998. Modelling variance parameters in ASREML for repeated measures data. Proceed. Of 6th World Cong. GALP. Vol.27: 453 - 454 Armidale, NSW, Australia.

Khan, U.N., A. Olsson, and J. Philipsson, 1992. Sahiwal breed development in Pakistan. Animal Production and Rural Development. 6th AAAP Anim.Sci. Cong. Bangkok Vol.I: 171-178,.

Martinez, M.L., A.J. Lee, and C.Y. Lyn, 1988. Age and Zebu-Holstein additive and heterotic effects on lactation performance and reproduction in Brazil. J. Dairy Sci. , 71: 80.

McDowell, R.E., 1985. Crossbreeding in tropical areas with emphasis on milk, health and fitness. J. Dairy Sci. , 68: 2418.

Syrstad, O., 1989. Dairy cattle crossbreeding in the tropics: performance of secondary crossbred populations. Livest. Prod. Sci. , 23: 97.

Talbott, C.W., M.Z. Chaudhury, R.E. McDowell, B.T. McDaniel and O.W. Robinson, 1994. Potential to increase milk yield in tropical countries: A case for maintaining high levels of heterosis. Ph. D. Thesis. North Carolina State Uni., Raleigh, NC.

Van Vleck, L.D., R.A. Westell and J.C. Schneider, 1986. Genetic changes in milk yield estimated from simultaneous genetic evaluation of bulls and cows. J. Dairy Sci. , 69: 2963.