

## Genetic Evaluation of $F_1$ , $F_2$ and $F_3$ Crosses of Haryana with Friesian, Brown Swiss and Jersey

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**ABSTRACT:** Data on the first lactation performance traits of  $F_1$ ,  $F_2$  and  $F_3$  crosses covering the period from 1972 to 1995 of a total of 803 dairy cows of three genetic grades maintained at Livestock Production Research Farm, Indian Veterinary Research Institute, Izatnagar were analysed. Three genetic grades were 1/2 Friesian+1/2 Haryana (FH), 1/2 Friesian+1/4 Brown Swiss and 1/4 Haryana (FBH) and 1/2 Friesian+1/4 Jersey+1/4 Haryana (FJH). Age at first calving increased by 7% and 8% in  $F_2$  and  $F_3$ , respectively, over the  $F_1$  in FH. The reduction in age at first calving at  $F_2$  and  $F_3$  levels by 2-7% over the  $F_1$  was observed in FBH and FJH. The lactation milk yield of  $F_1$ ,  $F_2$  and  $F_3$  crosses was  $1,943 \pm 100.3$ ,  $2,202 \pm 120.5$  and  $1,925 \pm 123.2$  kg in FH;  $2,014 \pm 76.7$ ,  $2,264 \pm 91.5$  and  $2,096 \pm 123.9$  kg in FBH and  $2,005 \pm 87.0$ ,  $2,414 \pm 94.4$  and  $2,093 \pm 121.1$  kg in FJH, respectively. The

lactation milk yield improved by 12-20% in  $F_2$  crosses in various genetic grades. The performance of  $F_1$  was, however, maintained in FH  $F_3$  crosses, it improved by 4% in FBH and FJH  $F_3$  crosses. The lactation lengths and calving intervals were nearly the same for  $F_1$ ,  $F_2$  and  $F_3$  crosses in FH while lactation lengths and calving intervals were reduced by 3-11% in  $F_2$  and  $F_3$  crosses in FBH and FJH genetic grades. The milk yield/day of lactation length and milk yield/day of calving interval increased by 16-35% in  $F_2$  and 2-14% in  $F_3$  over the  $F_1$  in various genetic grades. It is recommended that a sufficiently large effective population size of these three genetic grades be maintained by inter se matings and rigorous selection of sires so for developing a genetic base population for new breed development.

(Key Words: First Lactation Traits, Crossbreds, Dairy Cow)

### INTRODUCTION

Crossbreeding with European/temperate dairy breeds has been widely undertaken for improving the milk production potential in tropical cattle. Crossbreds have performed better than the native stock in almost all cases and were generally well adapted to local conditions. However, inter se mating among the first generation crosses gave variable and often contradictory results. A decline in milk yield was observed in the second generation crossbreds in some experiments (Bhuvanendran and Mahadevan, 1975; Bhatnagar et al., 1981; Parmar et al., 1986; Majid et al., 1996). Hayman (1974), however, reported an increase in yield in Sahiwal  $\times$  Jersey and Sindhi  $\times$  Jersey  $F_2$  animals over the  $F_1$  animals by selecting for milk yield in the  $F_1$  generation. Alexander et al. (1984) reported non-significant differences in milk production in  $F_1$ ,  $F_2$  and  $F_3$  crosses of Sahiwal and Friesians in tropical Australia.

A number of dairy cattle strains/breeds like Taylor, Jersind, Jamaica Hope (JH), Australian Milking Zebu

(AMZ), Australian Friesian Sahiwal (AFS), Karan Swiss, Karan Fries and Sunandni have been evolved from crossbred foundations in hot and humid environments. Most of the crossbred strains/breeds evolved have existed only in small numbers in organised farms barring AMZ, AFS, JH and Sunandni. The  $F_1$ ,  $F_2$  and  $F_3$  crosses of three genetic grades, from Haryana females mated with Friesian, Brown Swiss and Jersey males, generated at Livestock Production Research Farm of the Indian Veterinary Research Institute, Izatnagar are under performance testing. These genetic grades are proposed to be used as a base for developing new high yielding strains of crossbred cattle. The purpose of this article is to evaluate the performance of  $F_1$ ,  $F_2$  and  $F_3$  crosses of Haryana with Friesian, Brown Swiss and Jersey.

### MATERIALS AND METHODS

Data on the first lactation performance traits of  $F_1$ ,  $F_2$  and  $F_3$  crosses covering the period from 1972 to 1995 of a total of 803 dairy cows of three genetic grades maintained at the Livestock Production Research Farm,

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Indian Veterinary Research Institute, Izatnagar were analysed. These cows were progenies of 113 sires and sire progeny group size ranged between 3 and 64. The farm is situated 170 m above the mean sea level on 28° 22' north latitude and 79° 24' east longitude. The average highest ambient temperature during summer was 38°C and lowest about 7°C winter. The average rainfall was around 85 mm, most of which was received during July to September. Three genetic grades were 1/2 Friesian + 1/2 Hariana (FH), 1/2 Friesian + 1/4 Brown Swiss + 1/4 Hariana (FBH) and 1/2 Friesian + 1/4 Jersey and 1/4 Hariana (FJH). Cows with abnormal and incomplete records due to sickness or abortions were excluded from the study. Data on the entire period were divided into 5 periods in FH and 4 periods in FBH and FJH genetic grades, comprised of 5 years each, where differences would be sizable enough to be detected. The year was delineated into 5 seasons based on prevalent climatic conditions viz. winter (December, January), spring (February, March), summer (April, May), rainy (June-September) and Autumn (October, November) seasons. First lactation traits included in the study were age at first calving, lactation milk yield, peak yield, lactation length, service period, dry period, calving interval, milk yield/day of lactation length and milk yield/day of calving interval. Data were analysed by using the least-squares and maximum likelihood programme of Harvey (1990). Model for age at first calving contained fixed effects of generation, season and period of birth. The other production and reproduction traits were analysed by a model containing generation, season and period of calving as fixed effects and age at first calving as linear covariable. The estimates of breeding values of sires for first lactation milk yield were computed by the Best Linear Unbiased Prediction (BLUP) procedures.

The distribution of first lactation milk yield in various generations indicated that the proportions of animals producing milk yield more than the population mean were 40, 59 and 44% in F<sub>1</sub>, F<sub>2</sub> and F<sub>3</sub> FH genetic grade, respectively. Similar trend was observed in other two genetic grades where the increase in proportion of animals producing more than their population mean from F<sub>1</sub> (32%) to F<sub>2</sub> (55%) and F<sub>3</sub> (50%) in FBH was observed while it was from F<sub>1</sub> (23%) to F<sub>2</sub> (60%) and F<sub>3</sub> (61%) FJH genetic grade. This indicated the higher proportion of animals producing the more than the population mean observed in F<sub>2</sub> generation of various genetic grades.

## RESULTS AND DISCUSSION

The results on the effects of generation, season of

birth/calving, period of birth/calving for various lactation and reproduction traits in different genetic grades revealed that the effect of generation and season of birth/calving was non significant for various traits in FH crosses. The effect of period of birth/calving was significant for all lactation and reproduction traits, except calving interval and service period in FH crosses. In FBH crosses, the effect of generation was significant for all lactation and reproduction traits except lactation milk yield and dry period. The period of birth/calving significantly affected all the traits in FBH crosses. The generation effect was significant for all lactation traits except lactation length, while it was non significant for all reproduction traits in FJH crosses. The season of calving affected milk yield, peak yield, milk yield/day of calving interval and service period significantly while period of calving also significantly affected all lactation traits in FJH crosses.

The least-squares means with standard errors for various first lactation and reproduction traits of F<sub>1</sub>, F<sub>2</sub> and F<sub>3</sub> crosses in various genetic grades are presented in tables 1 and 2, respectively.

**Table 1.** Least-squares means with standard errors for the first lactation traits of F<sub>1</sub>, F<sub>2</sub> and F<sub>3</sub> crosses in various genetic grades

Lactation traits	FH	FBH	FJH
<b>Milk yield (kg)</b>			
F <sub>1</sub>	1,943 ± 100.3	2,014 ± 76.7	2,005 ± 87.0
F <sub>2</sub>	2,202 ± 120.5	2,264 ± 91.5	2,414 ± 94.4
F <sub>3</sub>	1,925 ± 123.2	2,096 ± 123.9	2,093 ± 121.1
<b>Peak yield (kg)</b>			
F <sub>1</sub>	11.57 ± 0.39	11.48 ± 0.37	11.29 ± 0.36
F <sub>2</sub>	12.77 ± 0.47	13.34 ± 0.44	13.81 ± 0.39
F <sub>3</sub>	11.63 ± 0.48	2.19 ± 0.59	12.18 ± 0.51
<b>Lactation length (days)</b>			
F <sub>1</sub>	320 ± 8.6	342 ± 5.5	333 ± 6.2
F <sub>2</sub>	316 ± 10.4	313 ± 6.5	324 ± 6.8
F <sub>3</sub>	315 ± 10.6	321 ± 8.8	307 ± 8.7
<b>Milk yield/day of lactation length (kg)</b>			
F <sub>1</sub>	5.55 ± 0.24	5.41 ± 0.20	5.52 ± 0.23
F <sub>2</sub>	6.42 ± 0.28	6.81 ± 0.24	6.99 ± 0.25
F <sub>3</sub>	5.65 ± 0.29	6.11 ± 0.33	6.27 ± 0.32
<b>Milk yield/day of calving interval (kg)</b>			
F <sub>1</sub>	3.91 ± 0.23	3.89 ± 0.20	3.86 ± 0.24
F <sub>2</sub>	4.68 ± 0.28	4.95 ± 0.24	5.20 ± 0.26
F <sub>3</sub>	4.10 ± 0.29	4.39 ± 0.33	4.28 ± 0.34

No. of observations, FH = 329; F<sub>1</sub> = 202; F<sub>2</sub> = 66; F<sub>3</sub> = 61.  
 FBH = 225; F<sub>1</sub> = 104; F<sub>2</sub> = 73; F<sub>3</sub> = 48.  
 FJH = 249; F<sub>1</sub> = 113; F<sub>2</sub> = 80; F<sub>3</sub> = 56.

**Table 2.** Least-squares means with standard errors for the reproduction traits of F<sub>1</sub>, F<sub>2</sub> and F<sub>3</sub> crosses in various genetic grades

Reproduction traits	FH	FBH	FJH
Age at first calving (days)			
F <sub>1</sub>	988 ± 30.2	1,113 ± 26.1	1,072 ± 23.7
F <sub>2</sub>	1,057 ± 44.5	1,041 ± 30.2	1,002 ± 23.4
F <sub>3</sub>	1,069 ± 38.0	1,082 ± 44.0	1,047 ± 32.5
Service period (days)			
F <sub>1</sub>	159 ± 15.1	198 ± 12.3	195 ± 15.3
F <sub>2</sub>	163 ± 18.2	142 ± 14.6	176 ± 16.6
F <sub>3</sub>	144 ± 18.6	164 ± 19.8	192 ± 21.3
Dry period (days)			
F <sub>1</sub>	118 ± 13.4	149 ± 12.1	154 ± 14.2
F <sub>2</sub>	131 ± 16.0	124 ± 14.5	136 ± 15.4
F <sub>3</sub>	124 ± 16.0	140 ± 19.6	160 ± 19.8
Calving interval (days)			
F <sub>1</sub>	438 ± 14.7	491 ± 13.3	487 ± 15.4
F <sub>2</sub>	447 ± 17.7	437 ± 15.8	460 ± 16.7
F <sub>3</sub>	438 ± 18.0	461 ± 21.4	467 ± 21.4

### Lactation milk yield

The lactation milk yield of F<sub>1</sub>, F<sub>2</sub> and F<sub>3</sub> crosses were 1,943 ± 100.3, 2,202 ± 120.5 and 1,925 ± 123.2 kg in FH; 2,014 ± 76.7, 2,264 ± 91.5 and 2,096 ± 123.9 kg in FBH and 2,005 ± 87.0, 2,414 ± 94.4 and 2,093 ± 121.1 kg in FJH genetic grade, respectively. These results revealed that the performance of F<sub>1</sub> was improved by 13.3, 12.4 and 20.4% in FH, FBH and FJH F<sub>2</sub> crosses, respectively. The performance of F<sub>1</sub> was maintained in FH F<sub>3</sub> crosses, it improved by 4% in FBH and FJH F<sub>3</sub> crosses. The performance of F<sub>2</sub>'s was improved by 12-20%, because of intensive selection among F<sub>1</sub> bulls (the sires of F<sub>2</sub>) as the bulls used to produce F<sub>1</sub> were highly selected and the improvement in herd management practices especially between 1985-90 wherein the large number of F<sub>2</sub> cows (38-82%) were in production as compared to F<sub>1</sub> cows (0-18%) in various genetic grades. Results on average breeding values of sires for first lactation milk yield revealed that the breeding values of sires used to produce F<sub>1</sub>, F<sub>2</sub> and F<sub>3</sub> crosses in various genetic grades were nearly the same (table 3). These findings were consistent with those of Hayman (1974) who observed an increase in milk yield in Sahiwal × Jersey and Red Sindhi × Jersey F<sub>2</sub> and F<sub>3</sub> animals over the F<sub>1</sub> animals in New South Wales, Australia. This increase was presumably achieved by intense selection

among their F<sub>1</sub> sires. Alexander et al. (1984), discussing results from crossbreeding experiment of Sahiwal with Friesian at Ayr Research Station in Queensland, showed non-significant differences in milk production in F<sub>1</sub>, F<sub>2</sub> and F<sub>3</sub>. The average lactation milk yield of the base generation (2,367 kg) was close to the yield of animals from inter se mating (2,357 kg) of 5/8 Brown Swiss crosses at the Indo-Swiss Project in Kerala, India (Chacko and George, 1983).

**Table 3.** Average expected breeding values (EBV) of first lactation milk yield for various groupings of sires used to produce F<sub>1</sub>, F<sub>2</sub> and F<sub>3</sub> crosses of Haryana with Friesian, Brown Swiss and Jersey

Genetic grade	No. of sire	Average EBV of sires (kg)	EBV range (kg)	S.D. (kg)
FH	35	2,027.47	1,912-2,158	72.23
F <sub>1</sub>	20	2,036.12	1,935-2,128	53.42
F <sub>2</sub>	10	2,074.39	1,912-2,158	97.71
F <sub>3</sub>	5	1,950.84	1,912-2,075	63.12
FBH	38	2,123.12	1,987-2,295	79.86
F <sub>1</sub>	16	2,124.08	1,998-2,295	66.60
F <sub>2</sub>	12	2,126.03	1,987-2,229	89.54
F <sub>3</sub>	10	2,117.09	1,987-2,228	92.56
FJH	40	2,170.10	2,137-2,238	25.69
F <sub>1</sub>	18	2,165.72	2,140-2,211	20.73
F <sub>2</sub>	13	2,176.48	2,137-2,238	31.12
F <sub>3</sub>	9	2,169.13	2,137-2,238	28.62

Bhatnagar et al. (1981) discussing results from crossbreeding experiment carried out at Karnal, India, observed the decline of 25% in milk yield from F<sub>1</sub> to F<sub>2</sub> crosses of Brown Swiss with Sahiwal. They attributed this to be due to heterosis. The decline in milk yield from F<sub>1</sub> to F<sub>2</sub> was 33-42% in Friesian × Sinhala, Jersey × Sinhala and Jersey × Sindhi crosses in Sri Lanka (Bhuvanendran and Mahadevan, 1975). Taneja and Bhat (1986), studying data from Karnal, found that large decline in milk production from F<sub>1</sub> to F<sub>2</sub> was due to poor quality of crossbred bulls used and not due to decline in heterosis. Similar situation could explain the results of the experiment in Sri Lanka. Similar analysis of the records on Jersey × Haryana and Friesian × Haryana crosses at Haringhata, India showed 20-30% lower milk yield in F<sub>2</sub> than in F<sub>1</sub> (Bala and Nagarcenkar 1981; Parmar et al., 1980, 1986).

### Lactation length

The lactation lengths were nearly the same for F<sub>1</sub>, F<sub>2</sub> and F<sub>3</sub> in FH genetic grade. However, the lactation lengths in F<sub>2</sub> and F<sub>3</sub> reduced by 9-29 days (3-9%), over

the  $F_1$  in FBH and FJH genetic grades. Bala and Nagarcenkar (1981) and Parmar et al. (1986) reported the almost similar lactation lengths for  $F_1$  and  $F_2$  in Jersey  $\times$  Hariana and Friesian  $\times$  Hariana crosses, respectively. The reduction in lactation lengths by 10 days (3%) in Jersey  $\times$  Hariana crosses and 20 days (6%) in Brown Swiss  $\times$  Sahiwal crosses from  $F_1$  to  $F_2$  were observed by Parmar et al. (1980) and Bhatnagar et al. (1981).

#### Milk production efficiency traits

The milk yield/day of lactation length increased by 16-27% in  $F_2$  and 2-14% in  $F_3$  over the  $F_1$  in various genetic grades. The performance of milk yield/day of calving interval of  $F_1$  was improved by 20-35% in  $F_2$  and 5-13% in  $F_3$  crosses of various genetic grades. The increase in efficiency traits of milk production in  $F_2$  and  $F_3$  was possibly because of intensive selection among crossbred bulls and improvement in herd management practices during the period of 1985-90. Results of crossbreeding experiment, carried out at Karnal, revealed the decline in milk yield/day of calving interval by 20% in  $F_2$  and  $F_3$  over the  $F_1$  Brown Swiss and Sahiwal crosses (Mehla et al., 1988). This reduction in milk yield/day of first calving interval from  $F_1$  to  $F_2$  was due to poor quality of sires used to produce  $F_2$  crosses (Taneja and Bhat, 1986).

#### Age at first calving

Age at first calving in  $F_2$  and  $F_3$  crosses increased by 69 (7%) and 81 days (8%), respectively, over the  $F_1$  cross in FH genetic grade. The reduction in age at first calving at the  $F_2$  and  $F_3$  levels by 25-72 days (2-7%) over the  $F_1$  was observed in FBH and FJH genetic grades. Age at first calving in  $F_2$  increased nearly by 4 months over the  $F_1$  in a crossbreeding experiment of Brown Swiss and Sahiwal, carried out at the National Dairy Research Institute, Karnal (Haryana), India (Taneja and Chawla, 1978). Parmar et al. (1980) also observed an increase in age at first calving by 1.9 months (6%) in  $F_2$  Jersey and Hariana crosses in Haringhata, India. Age at first calving was nearly the same for  $F_1$  and  $F_2$  Jersey and Red Sindhi crosses in Sri Lanka (Bhuvanendran, 1977). However, Parmar et al. (1986) reported from another crossbreeding experiment of Friesian and Hariana, a reduction in age at first calving by 1.8 months (5%) from  $F_1$  to  $F_2$ .

#### Calving interval

The calving intervals of the  $F_1$ ,  $F_2$  and  $F_3$  FH grade were nearly similar while the reduction in calving intervals by 20-54 days (4-11%) in  $F_2$  and  $F_3$  over the  $F_1$  was observed in FBH and FJH genetic grades. The calving intervals of  $F_1$  and  $F_2$  Brown Swiss and Sahiwal

crosses were observed to be similar (Bhatnagar et al., 1981). The reduction in calving intervals by 21 days (5%) from  $F_1$  to  $F_2$  Friesian and Sinhala crosses was also reported by Bhuvanendran and Mahadevan (1975). However, Parmar et al. (1986) and Bala and Nagarcenkar (1981) observed longer calving intervals by 31-127 days (6-27%) in  $F_2$  than  $F_1$  crosses of Hariana with Friesian and Jersey, presumably due to reduction in quality of managements.

In conclusion, the lactation milk yield of  $F_1$  improved by 12-20% in various genetic grades. This supports the view of Taneja et al. (1979) that when two segregating populations of cattle are crossed, the subsequent generation do not show segregation pattern of drop in productivity. The performance of  $F_1$  was maintained and even improved in  $F_3$  generations. The lactation lengths and calving intervals were nearly the same for  $F_1$ ,  $F_2$  and  $F_3$  in FH grade while the reduction in lactation lengths and calving intervals in  $F_2$  and  $F_3$  over the  $F_1$  was observed in FBH and FJH genetic grades. The milk production efficiency traits of  $F_1$  improved by 16-35% in  $F_2$  and 2-14% in  $F_3$  crosses in various genetic grades. It is recommended that a sufficiently large effective population size of these three genetic grades be maintained by inter se matings and rigorous selection of sires so for developing a genetic base population for new breed development.

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