Genetic Evaluation of F_1, F_2 and F_3 Crosses of Hariana 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 Hariana (FH), 1/2 Friesian + 1/4 Brown Swiss and 1/4 Hariana (FBH) and 1/2 Friesian + 1/4 Jersey + 1/4 Hariana (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 ± 100.3, 2202 ± 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, 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 × Jersey and Sindhi × 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 Hariana 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 Hariana 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℃ and lowest about 7℃ 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_1, F_2 and F_3 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_1 (32%) to F_2 (55%) and F_3 (50%) in FBH was observed while it was from F_1 (23%) to F_2 (60%) and F_3 (61%) FJH genetic grade. This indicated the higher proportion of animals producing the more than the population mean observed in F_2 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 excepts 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_1, F_2 and F_3 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_1, F_2 and F_3 crosses in various genetic grades

Lactation traits	FH	FBH	FJH
Milk yield (kg)			
F_1	1,943±100.3	2,014± 76.7	2,005± 87.0
F_2	2,202±120.5	2,264± 91.5	2,414± 94.4
F_3	1,925±123.2	2,096±123.9	2,093±121.1
Peak yield (kg)			
F_1	11.57±0.39	11.48±0.37	11.29±0.36
F_2	12.77±0.47	13.34±0.44	13.81±0.39
F_3	11.63±0.48	2.19±0.59	12.18±0.51
Lactation length (days)			
F_1	320± 8.6	342±5.5	333±6.2
F_2	316±10.4	313±6.5	324±6.8
F_3	315±10.6	321±8.8	307±8.7
Milk yield/day of lactation length (kg)			
F_1	5.55±0.24	5.41±0.20	5.52±0.23
F_2	6.42±0.28	6.81±0.24	6.99±0.25
F_3	5.65±0.29	6.11±0.33	6.27±0.32
Milk yield/day of calving interval (kg)			
F_1	3.91±0.23	3.89±0.20	3.86±0.24
F_2	4.68±0.28	4.95±0.24	5.20±0.26
F_3	4.10±0.29	4.39±0.33	4.28±0.34

No. of observations, FH = 329; F_1 = 202; F_2 = 66; F_3 = 61.
FBH = 225; F_1 = 104; F_2 = 73; F_3 = 48.
FJH = 249; F_1 = 113; F_2 = 80; F_3 = 56.

Table 2. Least-squares means with standard errors for the reproduction traits of F_1, F_2 and F_3 crosses in various genetic grades

Reproduction traits	FH	FBH	FJH
Age at first calving (days)			
F_1	988±30.2	1,113±26.1	1,072±23.7
F_2	1,057±44.5	1,041±30.2	1,002±23.4
F_3	1,069±38.0	1,082±44.0	1,047±32.5
Service perod (days)			
F_1	159±15.1	198±12.3	195±15.3
F_2	163±18.2	142±14.6	176±16.6
F_3	144±18.6	164±19.8	192±21.3
Dry period (days)			
F_1	118±13.4	149±12.1	154±14.2
F_2	131±16.0	124±14.5	136±15.4
F_3	124±16.0	140±19.6	160±19.8
Calving interval (days)			
F_1	438±14.7	491±13.3	487±15.4
F_2	447±17.7	437±15.8	460±16.7
F_3	438±18.0	461±21.4	467±21.4

Lactation milk yield

The lactation milk yield of F_1, F_2 and F_3 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_1 was improved by 13.3, 12.4 and 20.4% in FH, FBH and FJH F_2 crosses, respectively. The performance of F_1 was maintained in FH F_3 crosses, it improved by 4% in FBH and FJH F_3 crosses. The performance of F_2's was improved by 12-20%, because of intensive selection among F_1 bulls (the sires of F_2) as the bulls used to produce F_1 were highly selected and the improvement in herd management practices especially between 1985-90 wherein the large number of F_2 cows (38-82%) were in production as compared to F_1 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_1, F_2 and F_3 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_2 and F_3 animals over the F_1 animals in New South Wales, Australia. This increase was presumably achieved by intense selection among their F_1 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_1, F_2 and F_3. 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_1, F_2 and F_3 crosses of Hariana 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_1	20	2,036.12	1,935-2,128	53.42
F_2	10	2,074.39	1,912-2,158	97.71
F_3	5	1,950.84	1,912-2,075	63.12
FBH	38	2,123.12	1,987-2,295	79.86
F_1	16	2,124.08	1,998-2,295	66.60
F_2	12	2,126.03	1,987-2,229	89.54
F_3	10	2,117.09	1,987-2,228	92.56
FJH	40	2,170.10	2,137-2,238	25.69
F_1	18	2,165.72	2,140-2,211	20.73
F_2	13	2,176.48	2,137-2,238	31.12
F_3	9	2,169.13	2,137-2,238	28.62

Bhatnagar et al. (1981) discussing results from cross-breeding experiment carried out at Karnal, India, observed the decline of 25% in milk yield from F_1 to F_2 crosses of Brown Swiss with Sahiwal. They attributed this to be due to heterosis. The decline in milk yield from F_1 to F_2 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_1 to F_2 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 × Hariana and Friesian × Hariana crosses at Haringhata, India showed 20 -30% lower milk yield in F_2 than in F_1 (Bala and Nagarcenkar 1981; Parmar et al., 1980, 1986).

Lactation length

The lactation lengths were nearly the same for F_1, F_2 and F_3 in FH genetic grade. However, the lactation lengths in F_2 and F_3 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 × Hariana and Friesian × Hariana crosses, respectively. The reduction in lactation lengths by 10 days (3%) in Jersey × Hariana crosses and 20 days (6%) in Brown Swiss × 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 (Hariana), 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 Buvanendran 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.

REFERENCES

Alexander, G. T., G. K. Reason, C. H. Clark. 1984. The development of Australian, Friesian Sahiwal - a tick resistant dairy breed. World Anim. Rev. 51:27-34.

Bala, A. K. and R. Nagarcenkar. 1981. Evaluation of different cattle breed groups in hot humid tropics. Ph. D. project, NDRI, Karnal, India.

Bhatnagar, D. S., R. Nagarcenkar, M. Gurnani and R. C. Sharma. 1981. Crossbreeding of zebu cows with Brown Swiss. National Dairy Research Institute, Karnal, Annual Report, 1980, pp. 134-42.

Bhuvanendran, V. 1977. Production characteristics of Jersey-Sindhi grades in Sri Lanka. Aust. J. Agric. Res., 28:747-753.

Bhuvanendran, V. and P. Mahadevan. 1975. Crossbreeding for milk production in Sri Lanka. World Anim. Rev., 15:7-13.

Chacko, C. T. and P. K. George. 1983. Evolution of a breed - Sunandni. In: Indo-Swiss Project Kerala - for livestock and fodder development. Publication prepared on the occasion of the 20th Anniversary of the Project.

Harvey, W. R. 1990. User's guide for LSMLMW-PC - VERSION-2, Mixed Model Least-Squares and Maximum Likelihood Programme. Mimeograph, Columbus, Ohio, USA.

Hayman, R. H. 1974. The development of the Australian Milking Zebu. World Anim. Rev. 11:31-35.

Majid, M. A., A. I. Talukder and M. Zahiruddin. 1996. Productive performance of pure breeds, F_1, F_2 and F_3 generations cows raised in Central Cattle Breeding and Dairy Farm of Bangladesh. Asian - Australasian Journal of Animal Sciences, 9:461-464.

Mehla, R. K., Satish Kumar and A. K. Gupta. 1988. Effect of inter se mating of zebu × Brown Swiss crossbred on productive and reproductive efficiency. Genome 30. Suppl. 33. 13. 2, p. 33.

Parmar, O. S., D. S. Dev and N. L. Dhar. 1980. Inter se mating among Jersey and Hariana cattle. Indian J. Dairy Sci., 33:465-467.

Parmar, O. S., D. S. Dev and N. L. Dhar. 1986. Effect of inter se mating among Holstein Friesian × Hariana crossbred cattle. Indian J. Dairy Sci., 39:86-88.

Taneja, V. K. and D. S. Chawla. 1978. Heterosis for economic traits in Brown Swiss - Sahiwal crosses. Indian J. Dairy Sci., 31:208-213.

Taneja, V. K., P. N. Bhat and R. C. Garg. 1979. Genetic divergence in various Sahiwal × Holstein crossbred grade. Theor. Appl. Genet., 54(2):69-74.

Taneja, V. K. and P. N. Bhat. 1986. Milk and beef production in tropical environments. Third World Congress on Genetics Applied to Livestock Production, 9:73-91.