"Influence of genetic and non-genetic factors on some economic traits in Hariana and its crosses".

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PUSA (SAMASTIPUR) BIHAR

(Faculty of Post-graduate studies)

In Partial fulfilment of the requirement

For the degree of

MASTER OF VETERINARY SCIENCE

IN

ANIMAL BREEDING AND GENETICS

BY

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REG. NO. M/ABG/100/2000-2001

DEPARTMENT OF ANIMAL BREEDING AND GENETICS

BIHAR VETERINARY COLLEGE

PATNA (BIHAR)

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CERTIFICATE-I

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It is further certified that the assistance and help received during the course of this investigation and preparation of the thesis have been fully acknowledged.

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Dhirendra Kumar.

Date 30.1.04

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CHAPTER - I

INTRODUCTION

INTRODUCTION

Dairy development in India has been recognized as an effective instrument for ameliorating the economic condition of rural family, especially the small and marginal farmers and landless agricultural labourers. Cross-breeding has long been established as the best tool for enhancing the productivity in dairy cattle in the shortest possible time. India has become the highest milk producing country in this globe and the total amount of production has reached to nearly about 74 MT (Paroda, 2001), the credit of which may partly be given to the introduction of exotic germplasm. The cross-breeding of indigenous cattle with the germ plasm of exotic bulls such as Holstein Friesian, Jersey, Brown Swiss, Red Dane etc. is in progress at different places to study the suitability of crossbreds in the different agroclimatic conditions of India. Quantum increase in milk production by crossbreeding with Holstein Friesian has been visualized but the level of exotic inheritance with reference to their adaptability and the best suitability for production traits is to be determined. Apart from these, economic efficiency in dairy animal is governed to a larger extent by their productive performance which further depends upon many genetic and non-genetic factors. Therefore, there is need to exploit such genetic and non-genetic factors for their best performance in the production traits and accordingly the strategies for the improvement in dairy cattle breeding can be formulated.

Besides, the milk constituents such as fat%, SNF% and total solid % are important determiner of market value of milk in the country which further depends upon genetic and non-genetic factors such as season of calving, parity of lactation etc. and require deep investigation for optimum

production. Keeping in view of the above facts, the present study was undertaken in hot-humid climate of North Bihar with the following objectives :

1. To estimate the average value for different production and reproduction traits in Hariana and its crossbred grades with Holstein Friesian and Jersey.
2. To study the effect of genetic and non-genetic factors on production and reproduction traits in Hariana and its crossbred grades with Holstein Friesian and Jersey.
3. To study the average values of milk constituent traits and the effect of genetic and non-genetic factors on them in Hariana and its crosses with Holstein Friesian.
4. To study the relationships among various production and reproduction traits and among milk constituent traits in Hariana and its exotic crossbred grades.

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CHAPTER - II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

300 DAYS OR LESS MILK YIELD (KG) :

Chhilar *et al.* (1979) compared the 300 days milk yield in Hariana and its crosses with Holstein Friesian and reported the average 300 days milk yield in Hariana, ½ Friesian and ¾ Friesian genetic groups to be 1753.46 ± 116.76, 2925.83 ± 80.45 and 3072.58 ± 116.19 respectively.

Panda and Sadhu (1983) compared the milk yield spread over first to sixth lactations of Hariana and Desi Bengal around Haringhata farm. They reported the over all average lactation yield of six lactations in H.F. x Hariana and Jersey x Hariana to be 2609.82 ± 20.92 and 2143.94 ± 17.15 kg respectively.

Duc and Taneja (1984) reported the average first lactation yield (kg) in 305 days) in Hariana, Holstein Friesian x Hariana and Jersey x Hariana to be 1150.70 ± 44.65, 2001.97 ± 54.55 and 1588.24 ± 50.78 respectively.

Raj Kumar (1985) observed the average milk yield in Hariana and J x H (F_1) to be 1066.28 kg and 2110.58 kg respectively.

Parmar *et al.* (1986) observed the average 305 days milk yield (kg) in Hariana and Hariana x Holstein Friesian (F_1) to be 693.2 ± 67.8 and 1933.2 ± 42.1 respectively.

Chopra (1990) compared the performance of halfbreds of H.F., Brown Swiss and Jersey with Hariana and reported the average first lactation milk yield (kg) in ½ Holstein Friesian ½ Hariana and ½ Jersey ½ Hariana to be 2647.3 ± 55.5 kg and 1968.9 ± 68.2 kg respectively.

Raheja (1997) reported the overall average of the first lactation milk yield in Friesian x Hariana and Friesian x Sahiwal halfbreds to be 2432 ± 33.6 kg and 2783 ± 26.6 kg respectively.

Pundir and Raheja (1997) observed the mean 1st lactation 300 days milk yield to be 1132.0 ± 19.5 kg in Hariana cows.

Thakur *et al.* (1999) reported the first lactation or 300 days milk yield to be 1258.3 ± 46.3 kg and 1256.8 + 67.9 kg in half Jersey x half Hariana and > half Jersey x < half Hariana respectively which did not differ significantly.

Dalal *et al.* (2002) reported the average 1st lactation milk yield to be 1081.0 ± 14.21 kg in Hariana.

LACTATION LENGTH :

Raj Kumar (1985) reported the average lactation length in Hariana and J X H (F_1) to be 301.70 days and 315.84 days respectively.

Parmar *et al.* (1986) reported the average lactation length in Hariana and Hariana x Holstein Friesian (F_1) to be 385.3 ± 16.3 and 432.7 ± 10.4 days respectively.

Chopra (1990) compared the performance of halfbreds of Holstein-Friesian, Brown Swiss and Jersey with Hariana and reported the 1st lactation length in ½ HF ½ H and ½ J ½ H to be 344.4 ± 5.3 and 328.3 ± 6.5 days respectively.

Pundir and Raheja (1997) reported the average 1st lactation length to be 336 ± 4.3 days in Hariana cows.

Thakur *et al.* (1999) observed the 1st lactation length to be 314.7 ± 9.9 days and 356.1 ± 14.5 days in ½ J x 1/2 H and > ½ J x < ½ H respectively which differed significantly ($P<0.01$).

PEAK YIELD :

Peak yield is one of the most important traits of economic importance of genetic character, generally taken to evaluate the dairy animals in villages and also as an early measure for selecting the stock. Besides, lactation yield, lactation length and persistency of production are considered to be largely dependent on the peak yield.

Koul *et al.* (1977) observed the average peak yield in ½ HF ½ H and ½ J ½ H to be 10.44 kg and 8.43 kg respectively in 1st lactation and 11.05 kg and 8.92 kg respectively in 2nd lactation.

Raheja (1982) observed the average peak yield (kg) in Hariana, ½ Friesian + ½ Hariana and ½ Jersey + ½ Hariana to be 5.95 ± 0.13, 14.39 ± 0.27 and 12.02 ± 0.44 respectively.

Raheja and Balaine (1982) studied the effect of genetic groups on peak yield and reported the average peak yield in Hariana, ½ HF ½ H and ½ J ½ H to be 5.95 kg, 14.39 kg and 12.02 kg respectively.

Dutt and Bhusan (2001) compared the peak yield (kg) of cows of different genetic grades and reported that the average peak yield (11.09 ± 0.22 kg) of ½ Holstein Friesian + ½ Hariana was significantly ($P<0.01$) higher by 2.20 kg than the average peak yield (8.89 kg) of ½ Jersey + ½ Hariana.

Dalal *et al.* (2002) observed the average 1st peak yield (kg) in Hariana to be 6.16 ± 0.06 kg.

DAYS TO ATTAIN PEAK YIELD :

Koul *et al.* (1977) observed the average days to attain peak yield in ½ HF ½ H and ½ J ½ H to be 41.27 days and 56.26 days respectively in 1st

lactation, whereas the respective values in second lactation were noted as 42.45 days and 71.74 days.

Raheja and Balaine (1982) conducted the exlperiment to study DAPY in different genetic grades of cattle and observed the average DAPY in Hariana, ½ HF ½ H, ½ J ½ H, ½ BS ½ H and ½ Red Dane ½ H to be 42.31 days, 38.64 days, 36.5 days, 36.30 days and 37.41 days respectively.

Bhattacharjya *et al.* (1999) compared the lactation wise dairy performance in Hariana cattle and observed that the shortest days (51.83 ± 2.48) to attain peak yield was found in first lactation.

AVERAGE DAILY MILK YIELD (KG) :

Pander and Chopra (1986) studied the factors affecting the average daily milk yield in cows of different genetic grades and reported the average daily milk yield in halfbreds of Holstein Friesian and Jersey with Hariana to be 9.25 ± 0.41 kg and 7.73 ± 0.53 kg respectively.

Thakur *et al.* (1999) observed the average daily milk yield of first lactation to be 4.46 ± 0.38 kg and 5.08 ± 0.55 kg per lactation length (days) in ½ J x ½ H and > ½ J x < ½ H genetic groups respectively which did not differ significantly.

Dalal *et al.* (2002) reported the average daily milk yield of productive life in Hariana to be 3.10 ± 0.04 kg.

DRY PERIOD :

Raj Kumar (1985) observed the overall average dry period in Hariana and J x H (F_1) to be 169.39 days and 70.93 days respectively.

Parmar *et al.* (1986) investigated the effect of interse mating among Holstein Friesian x Hariana halfbreds and reported the average dry period in

Hariana and Hariana x Holstein Friesian (F_1) to be 181.4 ± 11.9 and 73.2 ± 7.5 days respectively.

Pundir and Raheja (1997) observed the mean 1st dry period to be 228 ± 5.4 days in Hariana.

Thakur *et al.* (1999) observed the average 1st dry period to be 166.8 ± 13.3 days, 158.3 ± 19.9 days in ½ J x ½ H and > ½ J x < ½ H genetic groups respectively which did not differ significantly.

Dalal *et al.* (2002) studied the first lactation and life time performance in Hariana cattle and reported the average first dry period to be 210 ± 3.36 days.

AGE AT 1ST CALVING :

Duc and Taneja (1984) reported the average age at 1st calving in Hariana, Holstein Friesian x Hariana and Jersey x Hariana to be 1514.23 ± 12.40, 1157.79 ± 17.10 and 1051.62 ± 15.66 days respectively.

Raj Kumar (1985) observed the average age at 1st calving to be 1824.64 days and 1321.67 days in Hariana and ½ J ½ H genetic groups respectively.

Parmar *et al.* (1986) observed the average age at 1st calving in Hariana and Hariana x Holstein Friesian (F_1) to be 50.1 ± 0.9 and 35.0 ± 0.6 months respectively.

Koul (1987) studied the age at first calving in Hariana of different cattle farms and reported the range to be 1232.9 to 1570.8 days with an overall average of 1339.13 ± 8.44 days.

Chopra (1990) compared the average age at first calving in different genetic groups and reported the average AFC to be 932.6 ± 13.8 days and

881.8 ± 17.0 days in ½ HF ½ H and ½ J ½ H genetic groups respectively which did not differ significantly.

Raheja (1997) studied the 1st lactation and life time production traits in Friesian x Hariana and Friesian x Sahiwal halfbreds and reported the overall average age at 1st calving to be 33.7 ± 0.18 months and 31.9 ± 0.14 months respectively.

Pundir and Raheja (1997) reported the average age at 1st calving to be 1436 ± 10.7 days in Hariana.

Dalal *et al.* (2002) observed the average age at 1st calving in Hariana cattle to be 1443 ± 7.26 days.

PHENOTYPIC CORRELATION :

MILK YIELD X LACTATION LENGTH :

Pundir and Raheja (1997) studied the genetic parameters for 1st lactation and life time traits in Hariana and estimated the phenotypic correlation between lactation milk yield in 300 days and 1st lactation length to be 0.52.

Dalal *et al.* (2002) reported high positive significant ($P<0.01$) estimate of r_p (0.70 ± 0.03) between 1st lactation milk yield and 1st lactation length in Hariana.

MILK YIELD X PEAK YIELD :

Raheja (1982) reported significant ($P<0.01$) positive estimates of r_p between milk yield and peak yield in Hariana and its crosses with Holstein Friesian and Jersey. The values obtained were 0.76 ± 0.14, 0.68 ± 0.12 and 0.86 ± 0.21 in Hariana, ½ HF ½ H and ½ J ½ H genetic groups respectively.

Bhattacharjya *et al.* (1999) compared lactation wise dairy performance in Hariana cattle and observed that all the phenotypic correlations between

milk yield and peak yield in different lactations were positive, high in magnitude and highly significant (P<0.01). The estimates of r_p between 1st lactation milk yield x 1st peak yield, 2nd lactation milk yield x 2nd peak yield, 3rd lactation milk yield x 3rd peak yield and 4th lactation milk yield x 4th peak yield were obtained as 0.85 ± 0.08, 0.90 ± 0.07, 0.67 ± 0.15 and 0.85 ± 0.15 respectively.

Dutt and Bhusan (2001) reported the significant (P<0.01) estimate of r_p to be 0.682 between milk yield and P.Y. in halfbreds and 3 breed genetic grades of Friesian, Brown Swiss and Jersey with Hariana.

Dalal *et al.* (2002) reported positive, significant (P<0.01) and of high magnitude estimate of co-efficient of correlation (0.76 ± 0.02) between 1st lactation milk yield and 1st peak yield in Hariana.

MILK YIELD X DAYS TO ATTAIN PEAK YIELD :

Singh *et al.* (1993) reported positive and highly significant coefficient (P<0.01) of correlation of 0.30 ± 0.06 between first lactation milk yield and DAPY in Sahiwal and its crosses with Jersey and Red Dane.

Milk yield x Average daily milk yield :

Singh *et al.* (1993) observed the estimate of r_p to be positive, significant (P<0.01) and of moderate magnitude (0.45 ± 0.05) between 1st lactation milk yield and average daily milk yield of lactation length in Sahiwal and its crosses with Jersey and Red Dane.

MILK YIELD X DRY PERIOD :

Pundir and Raheja (1997) reported positive phenotypic correlation of 0.76 value between 1st lactation milk yield in 300 days and 1st dry period in Hariana cattle.

Dalal *et al.* (2002) reported significant (P<0.05) negative co-efficient of correlation between 1st lactation milk yield and 1st dry period in Hariana cattle. They reported the value of r_p to be - 0.10 ± 0.04.

MILK YIELD X AGE AT 1ST CALVING :

Koul (1987) reported the estimate of r_p between age at first calving and 1st, 2nd and 3rd lactation yield to be positive in Hariana cattle. The values of r_p of age at 1st calving with 1st, 2nd and 3rd milk yield were obtained as 0.019 ± 0.035, 0.133 ± 0.042 and 0.199 ± 0.049 respectively which were found to be statistically significant (P<0.01) except the former one.

Dalal *et al.* (2002) estimated significant (P<0.01) positive co-efficient of phenotypic correlation of 0.12 ± 0.04 value between 1st lactation milk yield and age at 1st calving in Hariana cattle.

LACTATION LENGTH X PEAK YIELD :

Raheja (1982) observed the estimates of phenotypic correlation co-efficient between lactation length and peak yield to be positive in Hariana and its crosses with Holstein Friesian and Jersey. The estimates of r_p between lactation length x peak yield in Hariana, ½ Hariana + ½ HF, ½ Hariana + ½ Jersey were obtained as 0.09 ± 0.08, 0.16 ± 0.12 and 0.55 ± 0.17 respectively, of which the latter value was found to be statistically significant (P<0.01).

Bhattacharjya *et al.* (1999) conducted experiment to compare the lactation wise dairy performance in Hariana cattle and reported that the estimates of phenotypic correlation between lactation length and peak yield under different lactations were positive, high in magnitude and highly significant (P<0.01). The estimates of r_p between 1st lactation length x 1st peak yield, 2nd lactation length x 2nd peak yield 3rd lactation length x 3rd peak

yield and 4th lactation length x 4th peak yield were found to be 0.47 ± 0.14 0.70 ± 0.12, 0.59 ± 0.17 and 0.65 ± 0.21 respectively.

Dutt and Bhusan (2001) reported positive but non-significant value (0.197) of phenotypic co-efficient correlation between lactation length and peak yield in halfbreds and three breed genetic grades of Friesian, Brown Swiss and Jersey with Hariana.

Dalal *et al.* (2002) reported significant ($P<0.01$) positive phenotypic co-efficient of correlation of 0.27 ± 0.04 value between 1st lactation length and first peak yield in Hariana cattle.

LACTATION LENGTH X DAYS TO ATTAIN PEAK YIELD :

Singh *et al.* (1993) reported the estimate of r_p between first lactation period and DAPY to be negative in Sahiwal and its crosses with Jersey and Red Dane. However, the estimate of r_p was observed to be statistically non-significant.

LACTATION LENGTH X AVERAGE DAILY MILK YIELD :

Rao and Sundaresan (1982) observed positive and non-significant coefficient of correlation of very low magnitude between L.L. and ADMY up to peak yield in 5/8 HF and ¾ HF crosses with Sahiwal.

Singh *et al.* (1993) reported the estimates of phenotypic correlation between first lactation period and ADMY to be positive but non-significant in Sahiwal and crosses with Jersey and Red Dane.

LACTATION LENGTH X DRY PERIOD :

Pundir and Raheja (1997) observed positive phenotypic correlation of 0.54 magnitude between 1st lactation length and 1st dry period in Hariana.

Dalal *et al.* (2002) reported negative and significant ($P<0.05$) phenotypic co-efficient of correlation of -0.10 ± 0.04 value between 1st lactation length and 1st dry period in Hariana cattle.

LACTATION LENGTH X AGE AT 1ST CALVING :

Dalal *et al.* (2002) observed significant ($P<0.01$) positive value of r_p (0.11 ± 0.04) between first lactation length and AFC in Hariana cattle.

PEAK YIELD X DAYS TO ATTAIN PEAK YIELD :

Raheja (1982) estimated the co-efficient of phenotypic correlation of peak yield with days to attain peak yield in Hariana and its crosses with Holstein Friesian and Jersey. He observed the estimates of r_p in Hariana, ½ Hariana + ½ Friesian and ½ Hariana + ½ Jersey to be 0.09 ± 0.08, - 0.24 ± 0.12 and -0.19 ± 0.20 respectively. However, all these estimates were found to be statistically non-significant.

PEAK YIELD X AVERAGE DAILY MILK YIELD :

Dutt and Bhusan (2001) observed highly significant ($P<0.01$) and positive value (0.748) of r_p between peak yield and average daily milk yield in halfbreds and three-breed genetic grades of Friesian, Brown Swiss and Jersey with Hariana.

PEAK YIELD X DRY PERIOD :

Bhattacharjya *et al.* (1999) studied the association between peak yield and dry period in different lactations of Hariana cattle and reported that estimates of r_p between peak yield x dry period in 1st, 3rd and 4th lactations were negative, whereas it was found to be positive in 2nd lactation. The values of r_p between 1st dry period x peak yield, 2nd dry period x peak yield, 3rd dry period x peak yield and 4th dry period x peak yield were obtained as

-0.16 ± 0.16, 0.21 ± 0.17, – 0.13 ± 0.21 and – 0.27 ± 0.27 respectively. However, all these values were observed to be statistically non-significant.

Dutt and Bhusan (2001) observed negative but non-significant value (-0.075) of phenotypic coefficient of co-relation between peak yield and dry period in halfbreds and three - breed genetic grades of Friesian, Brown Swiss and Jersey with Hariana.

Dalal *et al.* (2002) observed negative phenotypic co-efficient of correlation (-0.07 ± 0.04) between 1st peak yield and 1st dry period in Hariana cattle. However, the estimate of r_p was observed to be non-significant.

PEAK YIELD X AGE AT FIRST CALVING :

Dalal *et al.* (2002) reported the estimates of r_p between 1st peak yield and age at first calving in Hariana to be 0.10 ± 0.04 which was found to be statistically significant ($P<0.01$).

DAYS TO ATTAIN PEAK YIELD X AVERAGE DAILY MILK YIELD :

Singh *et al.* (1993) observed positive but non-significant estimate of r_p between ADMY and DAPY in Sahiwal and its crosses with Jersey and Red Dane.

DAYS TO ATTAIN PEAK YIELD X DRY PERIOD :

Singh *et al.* (1993) reported positive but non-significant estimate of r_p between first dry period and DAPY in Sahiwal and its crosses with Jersey and Red Dane.

AVERAGE DAILY MILK YIELD X DRY PERIOD :

Sing *et al.* (1993) observed negative but significant (P<0.01) estimate of r_p between 1st Dry period and ADMY in Sahiwal and its crosses with Jersey and Red Dane.

DRY PERIOD X AGE AT 1ST CALVING :

Dalal *et al.* (2002) reported the estimate of r_p between 1st dry period and age at 1st calving in Hariana to be 0.13 ± 0.04 which was found to be statistically significant (P<0.01).

GENETIC AND NON-GENETIC FACTORS AFFECTING PRODUCTION AND REPRODUCTION TRAITS :

300 DAYS OR LESS MILK YIELD :

EFFECT OF GENETIC GROUPS :

Chhilar *et al.* (1979) investigated the effect of genetic groups on 300 days milk yield in Hariana and its crosses with Friesian and reported that ½ Friesian and ¾ Friesian had significantly (P<0.01) higher 300 days milk yield by 1172.37 kg and 1319.12 kg respectively than Hariana. However, the milk yield of ½ Friesian and ¾ Friesian did not differ significantly.

Mishra *et al.* (1979) reported that there were significant differences (P<0.05) in the indigenous population consisting of Hariana, Sahiwal, Red Sindhi, Gir and Tharparkar with respect to 300 days or less lactation yield up to 5th lactation. However, they did not find significant breed differences in any of the three lactation among cross-breds consisting of above the mentioned five indigenous breeds x H.F.

Panda and Sadhu (1983) reported the significant (P<0.01) effect of breed on lactation yield and observed that overall lactation yield in Hariana x

AVERAGE DAILY MILK YIELD X DRY PERIOD :

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DRY PERIOD X AGE AT 1ST CALVING :

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Panda and Sadhu (1983) reported the significant (P<0.01) effect of breed on lactation yield and observed that overall lactation yield in Hariana x

H.F. was highest followed by Desi Bengal x H.F., Hariana x Jersey and Desi Bengal x Jersey.

Raj Kumar (1985) reported that J x H (F_1) had significantly ($P<0.01$) higher (nearly double) milk yield than Hariana.

Raheja (1997) reported that Friesian x Sahiwal halfbreds had significantly ($P<0.01$) higher first lactation milk yield than Friesian Hariana x halfbreds.

Thakur *et al.* (1999) studied the effect of level of Jersey inheritance for 1st lactation milk yield in nine genetic groups of Jersey x Zebu crossbreds and reported significant ($P<0.01$) effect of genetic groups on 1st lactation 300 days or less milk yield.

EFFECT OF NON-GENETIC FACTORS :

PERIOD OF CALVING :

Mishra *et al.* (1979) observed that the period of calving (1942-72) significantly ($P<0.01$) affected 300 days or less lactation yield in 1st two lactations of indeginous breed. However, they could not find any significant differences in crossbreds of indeginous breeds x H.F. up to 3 lactations.

Panda and Sadhu (1983) reported the non-significant effect of 3 periods between 1966 to 1975 on 1st lactation milk yield of four groups of the crossbred cows of Hariana and Deshi Bengal, H.F. and Jersey.

Raheja (1997) studied the effect of period (1966-1988) at six military dairy farms on 1st lactation milk yield in halfbreds of Hariana and Sahiwal with H.F. and reported the period effect to be significant ($P<0.01$).

Thakur *et al.* (1999) reported significant ($P<0.05$) effect of period (1980-1994) spread over span of fifteen years on 1st lactation 300 days or less milk yield in nine genetic groups of Jersey x Zebu crossbreds.

SEASON OF CALVING :

Chhilar *et al.* (1979) observed highly significant ($P<0.01$) effect of season of calving on 300 days milk yield in Hariana and its crosses with Friesian. The highest 300 days milk yield was reported to be in cool (December - March) followed by hot dry (March –June), moderate (September-December) and hot humid (June – September) seasons.

Mishra *et al.* (1979) reported that season of calving had no significant effect on lactation yield on any of the breed group consisting of Sahiwal, Red Sindhi, Gir, Tharparkar and Hariana and their crosses with H.F.

Panda and Sadhu (1983) observed that winter calvers produced some more milk followed by rainy and summer calvers in four genetic groups of Hariana and Desi Bengal crossed with H.F. and Jersey. However, analysis of variance revealed the season effect to be non-significant on lactation yield.

Raj Kumar (1985) observed that the winter calvers had more lactation yield than summer calvers. However, he noticed that the differences among different seasons with respect to lactation yield were non-significant.

Raheja (1997) reported that the season had no effect on milk yield in halfbreds of Hariana and Sahiwal with Holstein-Friesian.

Thakur *et al.* (1999) studied the effect of four seasons of calving viz. summer, rainy, autumn and winter on 1st lactation 300 days or less milk yield in nine genetic groups of Jersey x Zebu cross-breds and observed that seasons did not play any significant role on it.

PARITY OF LACTATION :

Chhilar *et al.* (1979) reported that the lactation sequence had highly significant ($P<0.01$) effect on 300 days milk yield in Hariana and its crosses with Friesian.

Panda and Sadhu (1983) studied the effect of parity of lactation on average lactation yield from 1st to 6th lactation in crosses of Hariana and Desi Bengal with Holstein Friesian and Jersey. They reported that the lactation yield gradually increased from 1st lactation and reached to its maximum in 3rd lactation in all the genetic groups except in the H.F. x Deshi where the maximum production was attained at 4th lactation. They further observed that thereafter the lactation yield gradually decreased up to 6th lactation where it was the lowest in all the genetic groups.

Raj Kumar (1985) reported significant ($P<0.01$) effect of sequence of lactation on milk yield in Hariana and its crosses with H.F. and Jersey. He observed that there was gradual rise in milk yield up to third lactation after which the decline followed.

LACTATION LENGTH :

EFFECT OF GENETIC FACTOR :

Mishra *et al.* (1979) observed that variation in lactation period among the indigenous breeds belonging to Sahiwal, Red Sindhi, Gir, Tharparkar and Hariana was not significant in any of the six lactations except the 4th lactation period in Hariana. However, they observed significant ($P<0.01$) differences for lactation length among various cross breds (cross of these indigenous breed with Holstein-Friesian) in both the 1st and 2nd lactations.

Raj Kumar (1985) did not find significant effect of breeds on lactation length in Hariana and J x H (F_1).

Thakur *et al.* (1999) observed significant ($P<0.01$) effect of genetic groups of Jersey x Zebu crossbred on 1st lactation length (days).

EFFECT OF NON-GENETIC FACTORS :

PERIOD OF CALVING :

Mishra *et al.* (1979) observed that period of calving (1942-72) did not affect the lactation length significantly in indigenous breeds of Hariana, Sahiwal, Red Sindhi, Gir and Tharparkar. However, they observed that in the crossbreds of these indigenous breeds with H.F., the period of calving (1963-72) was significant ($P<0.01$) on the 3rd lactation period only.

Thakur *et al.* (1999) observed non-significant effect of years (1980-1994) on 1st lactation length in nine genetic groups of Jersey x Zebu crossbreds.

SEASON OF CALVING :

Mishra *et al.* (1979) reported that season of calving did not effect the lactation period in the indeginous breeds belonging to Hariana, Tharparkar, Gir and Red Sindhi. However, they observed that in the crossbreds of the above mentioned indigenous breeds with H.F., the spring calvers have longer lactation length than winter calvers only in the 1st lactation period.

Raj Kumar (1985) reported that season of calving had no significant influence on lactation length in Hariana and J x H (F_1) cows.

Thakur *et al.* (1999) reported that the four seasons of calving viz. summer, rainy, autumn and winter had no significant role on 1st lactation length in nine genetic groups of Jersey x Zebu cross-breds.

PARITY OF LACTATION :

Singh and Desai (1961) observed that the length of lactation period decreased with first to third lactation in Hariana.

Raj Kumar (1985) reported highly significant ($P<0.01$) effect of sequence of lactation in Hariana and J x H (F_1). He observed that there was gradual decrease in lactation length with increase in sequence of lactation.

Singh and Nagarcenkar (1997) observed significant effect of parity on lactation length of Sahiwal cows.

PEAK YIELD :

EFFECT OF GENETIC GROUP :

Koul *et al.* (1977) reported significant effect of genetic groups on peak yield in crosses of H.F., Brown Swiss and Hariana. The average peak yield in ½ H ½ HF was significantly higher than ½ J ½ H by 2.01 kg and 2.13 kg in 1st and 2nd lactations respectively.

Raheja (1982) reported highest peak yield in ½ H ½ F followed by ½ Red Dane ½ HF, ½ Brown Swiss ½ H, ½ Jersey ½ and Hariana.

Nayak and Raheja (1996) observed significant effect of genetic grades on peak yield in Hariana and its crosses with exotic dairy breeds.

Dutt and Bhusan (2001) conducted experiment on halfbreds and three -breed grades of Holstein Friesian, Brown Swiss and Jersey with Hariana and reported that genetic grades had significant effect on peak yield in halfbreds while it was non-significant in threebreed grades.

EFFECT OF NON-GENETIC FACTORS :

PERIOD OF CALVING :

Dutt and Bhusan (2001) observed that there was no significant effect of period of calving on peak yield in halfbreds of H.F., B.S. and Jersey with Hariana. However, they could observe that season played significant role on peak yield in three-breed grades of the above mentioned breeds.

SEASON OF CALVING :

Dutt and Bhusan (2001) did not find any significant effect of season in halfbreds of Holstein Friesian, Brown Swiss, Jersey with Hariana. However, they could observe that season played significant role on peak yield in three-breed grades of HF, B.S. and Jersey with Hariana.

PARITY OF LACTATION :

Koul *et al.* (1977) observed significant ($P<0.01$) effect of lactational sequence on peak yield in halfbreds of Holstein Friesian, Brown Swiss and Hariana cows. The peak yield in second lactation was observed to be higher than first lactation in all the three genetic groups.

Bhattacharjya *et al.* (1999) could not find any significant effect of parity of lactation on peak yield in Hariana cows.

DAYS TO ATTAIN PEAK YIELD :

EFFECT OF GENETIC FACTOR :

Koul *et al.* (1977) reported significant ($P<0.01$) genetic effect on days to attain peak yield in halfbreds of Friesian, Brown Swiss and Jersey with Hariana cows. The average DAPY in ½ H.F. ½ H was lower than ½ J ½ H by 14.99 days and 29.29 days in 1st and 2nd lactations respectively.

Raheja and Balaine (1982) reported that days to attain peak yield was longest in Hariana purebred i.e. 42.31 ± 0.84 days followed in decending order by Friesian, Red-Dane, Jersey and Brown Swiss halfbreds.

EFFECT OF NON-GENETIC FACTORS :

PERIOD OF CALVING :

Singh *et al.* (1993) could not find the effect of period of calving on DAPY to be significant in Sahiwal and its crosses with Jersey and Red Dane.

SEASON OF CALVING :

Singh *et al.* (1983) reported that there was no significant effect of season of calving on DAPY in Sahiwal and its crosses with Jersey and Red Dane.

PARITY OF LACTATION :

Koul *et al.* (1977) conducted the experiment to find out the effect of genetic groups in halfbreds of Holstein Friesian, Brown Swiss and Jersey with Hariana and reported the effect of genetic group on DAPY to be significant on second lactations.

Bhattacharjya *et al.* (1999) reported that there was no significant effect of parity of lactation on DAPY in Hariana cows.

AVERAGE DAILY MILK YIELD :

EFFECT OF GENETIC GROUP :

Pander and Chopra (1986) reported that there were no significant differences in daily milk yield among various genetic groups consisting of halfbreds of Holstein Friesian, Brown Swiss and Jersey and the triple crosses involving the above breeds with Hariana. However, they observed the highest daily milk yield to be 9.25 kg and 7.75kg in halfbreds of Holstein-Friesian with Hariana and half breds of Jersey with Hariana respectively.

Thakur *et al.* (1999) conducted the experiment to study the effect of indigenous breed involved and level of Jersey inheritance in nine genetic groups of Jersey x Zebu crosses and reported that the genetic groups had significant ($P<0.01$) effect on average daily milk yield of 1st lactation.

EFFECT OF NON-GENETIC FACTORS :

PERIOD OF CALVING :

Dutt *et al.* (1992) observed the significant effect of year on milk yield per cow per day in crossbreds of Hariana with Holstein Friesian, Brown

Swiss and Jersey and reported that the differences between years could be attributed to variations in managemental conditions.

Thakur *et al.* (1999) reported that periods (1980-1994) spread over a span of fifteen years did not play significant role on average daily milk yield of 1st lactation per lactation length in nine genetic groups of Jersey x Zebu crossbreds.

SEASON OF CALVING :

Dutt *et al.* (1992) observed the significant effect of months on milk yield per cow per day in crossbreds of Hariana with Holstein Friesian, Brown Swiss and Jersey and reported that differences could be attributed to variation in availability of quality of green fodder and varing climatic and managemental conditions.

Dutt *et al.* (1993) examined the influence of various climatic variables on milk yield per cow per day in crossbreds of Hariana with Holstein Friesian, Brown Swiss and Jersey and reported negative and highly significant ($P<0.01$) co-efficient of correlation of milk yield/per cow/day with wet bulb temperature and relative humidity. They further observed that temperature and humidity together explained 62.75 percent of variations in milk yield/cow/day which was higher than that explained either by temperature or humidity alone.

Thakur *et al.* (1999) reported that the effect of seasons of calving viz. summer, rainy, autumn and winter was non-significant on average daily milk yield of 1st lactation length in nine genetic groups of Jersey x Zebu crossbreds produced by crossing four indigenous breeds viz. Red Sindhi, Sahiwal Tharparkar and Hariana.

PARITY OF LACTATION :

Pander and Chopra (1986) conducted the experiment on seven genetic groups of Holstein Friesian, Brown Swiss and Jersey crossed with Hariana and reported the effect of lactation order on average daily milk to be non-significant.

DRY PERIOD :

EFFECT OF GENETIC GROUPS :

Raj Kumar (1985) observed highly significant ($P<0.01$) effect of genetic groups on dry period and reported that the dry period of Hariana cows was more than double than that of J X H (F_1) cows.

Thakur *et al.* (1999) studied the effect of level of Jersey inheritance in 9 genetic groups of Jersey x Zebu crossbreds on 1st dry period (days) and reported the significant ($P<0.01$) effect of genetic group on it.

EFFECT OF NON-GENETIC FACTORS :

PERIOD OF CALVINGS :

Thakur *et al.* (1999) reported significant ($P<0.05$) effect of years (1980-1994) on 1st dry period in nine genetic groups of Jersey x Zebu crossbreds produced by crossing four indigenous breeds viz. Red Sindhi, Sahiwal, Tharparkar and Hariana.

SEASON OF CALVINGS :

Raj Kumar (1985) observed non-significant effect of season of calvings in Hariana and J x H (F_1).

Thakur *et al.* (1999) observed that the seasons of calving had no significant role on dry period in nine genetic groups of Jersey x Zebu crossbreds.

PARITY OF LACTATION :

Raj Kumar (1985) studied the effect of sequence of lactation on dry period in Hariana and J x H (F_1) and reported that parity of lactation did not play significant role on dry period.

AGE AT 1ST CALVING :

EFFECT OF GENETIC FACTORS :

Duc and Taneja (1984) reported that genetic factors had highly significant ($P<0.01$) effect on AFC in Hariana and its halfbreds with H.F. and Jersey. They reported that average AFC in ½ HF ½ H and ½ J ½ H were significantly ($P<0.01$) lower than Hariana cattle by 356.44 days and 462.61 days respectively.

Raj Kumar (1985) reported highly significant ($P<0.01$) effect of genetic group on age at 1st calving. He observed that AFC of J x H (F_1) cows was significantly ($P<0.01$) 502.97 days lower than Hariana.

Parmar *et al.* (1986) reported a decrease of 15.1 months in the age at first calving of ½ HF ½ H than Hariana.

Chopra (1990) observed significant ($P<0.05$) effect of genetic group on AFC. He found that ½ J ½ H were earlier maturing animals and reported that the average AFC of ½ HF ½ H and ½ J ½ H were significantly ($P<0.05$) lower by 68.9 days and 119.7 days than that of ½ BS ½ H. However, the average AFC of ½ HF ½ H and ½ J ½ H did not differ significantly.

PERIOD OF CALVING :

Duc and Taneja (1994) observed significant ($P<0.01$) effect of years on AFC in Hariana and its crosses with HF and Jersey.

PARITY OF LACTATION :

Raj Kumar (1985) studied the effect of sequence of lactation on dry period in Hariana and J x H (F_1) and reported that parity of lactation did not play significant role on dry period.

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PERIOD OF CALVING :

Duc and Taneja (1994) observed significant ($P<0.01$) effect of years on AFC in Hariana and its crosses with HF and Jersey.

SEASON OF CALVING :

Duc and Taneja (1994) observed that season of calving had no significant effect on AFC in Hariana and its crosses with H.F. and Jersey.

Raj Kumar (1985) reported non-significant effect of season of calving on AFC in Hariana and J x H (F_1).

Sethi *et al.* (2001) observed the effect of season on birth on AFC to be non-significant in Sahiwal.

PARITY OF LACTATION :

Bhatnagar *et al.* (1979) found that dam's parity had no significant effect in Sahiwal and its crosses with Brown Swiss.

MILK CONSTITUENT TRAITS AVERAGE VALUES :

FAT % :

Fat is one the most variables among the different constituents of milk. The differences in the gene frequencies controlling the quantity and quality of milk components largely account for the average genetic differences among the breed. However, the differences among individuals within a breed are often greater than the average difference among breeds of cattle. According to Webb *et al.* (1974) some Holsteins produce milk containing 5% fat whereas some Jersey may produce as low as Holstein breed average.

Yadav *et al.* (1989) observed the average fat % in halfbreds of Hariana half bred with Holstein Friesian and Jersey to be 4.39 ± 0.02% and 5.18 ± 0.03 % respectively.

Kaushik and Tandon (1979) reported the average fat % in milk of Hariana breed to be 4.35 ± 0.03.

Chopra (1990) reported average milk fat % in ½ HF ½ H, ½ BS ½ H, ½ J ½ H to be 4.34 ± 0.38, 4.55 ± 0.41 and 5.08 ± 0.46 respectively.

Chourasia and Jain (1993) reported the pooled estimate of fat % in milk to be 4.12 ± 0.076, 3.93 ± 0.080, 3.92 ± 0.071 and 3.90 ± 0.053 in four genetic groups of three -breed crosses i.e. ½ J ¼ H.F. ¼ Gir, ½ H.F. ¼ J ¼ G and their respective interse groups constituting group three and four respectively.

TOTAL SOLID % :

Kaushik and Tandon (1979) observed the average total solid percentage of milk of Hariana breed to be 13.40 ± 0.02.

Chourasia and Jain (1993) reported significant ($P<0.05$) effect of genetic group on T.S. % of milk and observed the estimate of total solid in milk to be 13.08 ± 0.10, 13.05 ± 0.11, 13.29 + 0.09 and 12.94 ± 0.06 in pooled estimates of four genetic groups of three-breed crosses i.e. ½ J ¼ H.F. ¼ Gir, ½ H.F. ¼ J ¼ G and their respective interse forming group three and four respectively.

SOLID NOT FAT % :

Kaushik and Tandon (1979) observed the average Solid not fat % in milk of Hariana breed of cattle to be 9.05 ± 0.01.

Chourasia and Jain (1993) observed the average pooled Solid not fat % in milk of three-breed crosses to be 8.97 + 0.046, 9.92 ± 0.049, 9.35 ± 0.043, 9.05 ± 0.032 in ½ J ¼ H.F. ¼ G, ½ H.F. ¼ J ¼ G and their respective interse constituenting groups three and four respectively.

GENETIC AND NON-GENETIC FACTORS AFFECTING FAT % IN MILK :

GENETIC EFFECT :

Yadav *et al.* (1989) studied the effect of breed of halfbreds of Hariana with Jersey, Brown Swiss, Holstein Friesian on fat % in milk and reported

significant (P<0.05) breed difference for this traits. They observed the highest (5.18) fat % in halfbred of Jersey and lowest (4.39) in halfbred of Holstein Friesian.

Chopra (1990) observed significant (P<0.05) effect of genetic group involving half-breds of HF, BS and Jersey with Hariana on milk fat %.

Chourasia and Jain (1993) observed non-significant differences for fat % in milk in three-breed crosses consisting of four genetic groups i.e. is ½ J ¼ HF ¼ G, ½ HF ¼ J ¼ G and their respective interse forming groups three and four.

NON-GENETIC EFFECT :

EFFECT OF SEASON ON FAT% :

Kaushik and Tandon (1979) reported significant (P<0.01) effect of season on butter fat % in Hariana cattle.

Yadav *et al.* (1989) studied the effect of seasons on average fat % of milk in halfbreds of Hariana with Jersey, Brown Swiss and Holstein Friesian and reported that seasons played significant (P<0.05) role on average fat % in milk. They further observed that the average fat % was maximum in summer calvers and minimum in winter calvers in all the genetic groups.

Yadav *et al.* (1991) reported the significant (P<0.01) effect of seasons on average fat % in milk of halfbreds of Hariana with Jersey, Brown Swiss and Holstein Friesian. They observed the average fat % to be maximum (5.98 ± 0.11) in 8^{th} month of lactation of summer calvers in JH followed by BH (4.99 ± 0.08) in the 10^{th} month of lactation of winter calvers and minimum (3.99 ± 0.05) in 2nd month of lactation of summer calvers in FH genetic groups.

Chourasia and Jain (1993) reported the pooled estimate of fat % in milk to be 4.12 ± 0.076, 3.93 ± 0.080, 3.92 ± 0.071 and 3.90 ± 0.053 in four genetic groups of three -breed crosses i.e. ½ J ¼ H.F. ¼ Gir, ½ H.F. ¼ J ¼ G and their respective interse groups constituting group three and four respectively.

TOTAL SOLID % :

Kaushik and Tandon (1979) observed the average total solid percentage of milk of Hariana breed to be 13.40 ± 0.02.

Chourasia and Jain (1993) reported significant ($P<0.05$) effect of genetic group on T.S. % of milk and observed the estimate of total solid in milk to be 13.08 ± 0.10, 13.05 ± 0.11, 13.29 + 0.09 and 12.94 ± 0.06 in pooled estimates of four genetic groups of three-breed crosses i.e. ½ J ¼ H.F. ¼ Gir, ½ H.F. ¼ J ¼ G and their respective interse forming group three and four respectively.

SOLID NOT FAT % :

Kaushik and Tandon (1979) observed the average Solid not fat % in milk of Hariana breed of cattle to be 9.05 ± 0.01.

Chourasia and Jain (1993) observed the average pooled Solid not fat % in milk of three-breed crosses to be 8.97 + 0.046, 9.92 ± 0.049, 9.35 ± 0.043, 9.05 ± 0.032 in ½ J ¼ H.F. ¼ G, ½ H.F. ¼ J ¼ G and their respective interse constituenting groups three and four respectively.

GENETIC AND NON-GENETIC FACTORS AFFECTING FAT % IN MILK :

GENETIC EFFECT :

Yadav *et al.* (1989) studied the effect of breed of halfbreds of Hariana with Jersey, Brown Swiss, Holstein Friesian on fat % in milk and reported

significant (P<0.05) breed difference for this traits. They observed the highest (5.18) fat % in halfbred of Jersey and lowest (4.39) in halfbred of Holstein Friesian.

Chopra (1990) observed significant (P<0.05) effect of genetic group involving half-breds of HF, BS and Jersey with Hariana on milk fat %.

Chourasia and Jain (1993) observed non-significant differences for fat % in milk in three-breed crosses consisting of four genetic groups i.e. is ½ J ¼ HF ¼ G, ½ HF ¼ J ¼ G and their respective interse forming groups three and four.

NON-GENETIC EFFECT :

EFFECT OF SEASON ON FAT% :

Kaushik and Tandon (1979) reported significant (P<0.01) effect of season on butter fat % in Hariana cattle.

Yadav *et al.* (1989) studied the effect of seasons on average fat % of milk in halfbreds of Hariana with Jersey, Brown Swiss and Holstein Friesian and reported that seasons played significant (P<0.05) role on average fat % in milk. They further observed that the average fat % was maximum in summer calvers and minimum in winter calvers in all the genetic groups.

Yadav *et al.* (1991) reported the significant (P<0.01) effect of seasons on average fat % in milk of halfbreds of Hariana with Jersey, Brown Swiss and Holstein Friesian. They observed the average fat % to be maximum (5.98 ± 0.11) in 8^{th} month of lactation of summer calvers in JH followed by BH (4.99 ± 0.08) in the 10^{th} month of lactation of winter calvers and minimum (3.99 ± 0.05) in 2nd month of lactation of summer calvers in FH genetic groups.

Chourasia and Jain (1993) observed significant (P<0.01) effect of seasons on fat % of milk in three-breed crosses consisting of four genetic groups i.e. ½ J ¼ HF ¼ G, ½ HF ¼ J ¼ G and their respective interse groups. They observed the average fat % in milk to be higher during summer season than spring in all the four genetic groups.

EFFECT OF PARITY OF LACTATION ON FAT % :

Yadav *et al.* (1989) observed a gradual increase in average fat % in milk during whole lactation, on or upto peak day and on or up to peak week, with the increase in parity among halfbreds of Hariana with Jersey, Brown Swiss and Holstein Friesian. However, the differences were found to be statistically non-significant. They further concluded that whether the differences were significant or not, the winter season calvers had highest fat % in their milk in early stages of lactation in all the groups.

Kaushik and Tandon (1979) observed that lactational sequences had no significant effect on butter fat % in Hariana.

GENETIC AND NON-GENETIC FACTORS AFFECTING TOTAL SOLID% (T.S.%) IN MILK :

GENETIC FACTORS :

Chourasia and Jain (1993) observed significant (P<0.05) effect of genetic groups on total solid % in milk in three-breed crosses consisting of four genetic groups i.e. ½ J ¼ HF ¼ G, ½ HF ¼ J ¼ G and their respective interse constituting groups three and four respectively.

NON-GENETIC FACTORS :

EFFECT OF SEASON :

Kaushik and Tandon (1979) reported highly significant (P<0.01) effect of season on total solid % in milk of Hariana cattle.

Yadav *et al.* (1991) observed significant (P<0.01) effect of season of calving on total solid in milk in halfbreds of Holstein Friesian, Brown Swiss and Jersey with Hariana.

Chourasia and Jain (1993) did not find any significant effect of season on total solid % in milk in four genetic groups of three-breed crosses of Jersey, Holstein Friesian and Gir.

EFFECT OF PARITY OF LACTATION :

Kaushik and Tandon (1979) observed non-significant effect of lactational sequence on T.S. % of milk in Hariana.

GENETIC AND NON-GENETIC FACTORS AFFECTING SOLID NOF FAT% (SNF%) IN MILK :

GENETIC FACTOR :

Chourasia and Jain (1993) observed significant (P<0.05) effect of genetic groups on Solid not fat % in three-breed crosses constituting four genetic groups i.e. ½ J ¼ HF ¼ G, ½ HF ¼ J ¼ G and their respective interse constituting groups three and four respectively.

NON-GENETIC FACTORS :

EFFECT OF SEASON :

Yadav *et al.* (1991) observed significant (P<0.01) effect of seasons on Solid not fat % in halfbreds of Jersey, Brown Swiss and Holstein Friesian with Hariana.

Chourasia and Jain (1993) reported non-significant effect of seasons on S.N.F.% in milk in four genetic groups of three-breed crosses of Jersey, Holstein Friesian and Gir.

EFFECT OF PARITY OF LACTATION :

Kaushik and Tandon (1979) reported significant ($P<0.05$) effect of sequences of lactation on Solid not fat % in Hariana cattle.

PHENOTYPIC CORRELATIONS AMONG DIFFERENT MILK CONSTITUENTS TRAITS :

FAT % X T.S. % :

Kaushik and Tandon (1979) observed the estimates of r_p between butter fat % and total solid % to be positive and high in magnitude (0.947) in Hariana cattle.

Darshanlal and Narayanan (1990) observed significant ($P<0.01$) and positive overall co-efficient of correlation of high magnitude between fat % and total solid % in four different breeds of cattle i.e. Sahiwal, Red Sindhi Tharparkar and Karan Swiss.

FAT % X S.N.F. % :

Kaushik and Tandon (1979) reported a positive phenotypic correlation of 0.039 between butter fat and SNF of milk in Hariana cattle. Darshanlal and Narayanan (1990) observed highly significant ($P<0.01$) and positive overall correlation between fat % and SNF% in four different breeds viz. Sahiwal, Red Sindhi, Tharparkar and Karan Swiss.

S.N.F.% X T.S.% :

Kaushik and Tandon (1979) observed positive phenotypic correlation coefficient of 0.059 between total solid and S.N.F. in Hariana cattle.

Darshanlal and Narayanan (1990) reported positive and significant ($P<0.01$) co-efficient of correlation of high magnitude in four different genetic groups i.e. Sahiwal, Red Sindhi, Tharparkar and Karan Swiss of cattle.

CHAPTER - III

MATERIALS AND METHODS

MATERIALS AND METHODS

The present investigation was conducted on 301 Hariana and its crosses with Holstein Friesian and Jersey cattle maintained at Rajendra Agricultural University Cattle Farm, Pusa, Samastipur for various production and reproduction traits during the period 1980 to 2001.

The various genetic grades of cattle used in the investigation are tabulated in table – 1.

Table – 1 : Genetic grades of cattle and their symbols used for various production and reproduction traits.

Genetic Grades	Symbol used
Hariana Pure	G_1
H.F. < 50 %	G_2
H.F. 50 %	G_3
H.F. 62.5 %	G_4
H.F. 75 %	G_5
Jersey 50 %	G_6

The investigation was carried out to study the effect of genetic and non-genetic factor on production and reproduction traits which are presented in table – 2.

Table – 2 : Various production and reproduction traits along with their symbols used.

	Traits	Symbol used
1.	300 days or less milk yield (kgs)	M.Y.
2.	Lactation length (days)	L.L.
3.	Peak yield (kgs)	P.Y.
4.	Days to attain peak yield (days)	D.A.P.Y.
5.	Average daily milk yield (kgs)	A.D.M.Y.
6.	Dry period (days)	D.R.P.
7.	Age at 1st calving (days)	A.F.C.

The data were obtained from cattle History and Pedigree sheet of Cattle Farm, Pusa and categorized according to genetic groups, periods, seasons of calving and parity of lactation for various production and reproduction traits. The traits measured were as follows :

1. 300 days or less milk yield – The milk yield (kg) up to 300 days or less under each lactation of an individual cow was noted.
2. Lactation length – The lactation length in cow of various genetic groups was calculated in days from the 8th day of calving to the day of cessation of their milk yield under each lactation.
3. Peak yield – Peak yield was noted as the maximum yield attained in a day during the lactation.
4. Days to attain peak yield - It was noted as the day on which the cow yielded first highest milk after colostrum period under each lactation.
5. Average daily milk yield per lactation - It was obtained by dividing total lactation milk yield by the total number of days in milk.

6. Dry period – The dry period was counted in days from the cessation of milk yield to the subsequent parturition for each lactation.
7. Age at first calving – Age at first calving was counted in days from the birth of individuals to their parturition.

The genetic grade –wise number of cattle for different production and reproduction traits has been depicted in Table – 3.

Table – 3. The genetic grade-wise number of cattle for various production and reproduction traits.

Genetic Grade	Production & Reproduction Traits							
	MY	LL	PY	DAPY	ADMY	DRP	AFC	Maximum no. in genetic group
G_1	45	45	42	40	46	39	46	46
G_2	46	58	55	50	57	49	61	61
G_3	21	20	21	20	21	16	-	21
G_4	23	21	26	25	25	16	26	26
G_5	46	50	42	40	52	43	52	52
G_6	83	90	87	80	90	79	95	95
Total	**264**	**284**	**273**	**255**	**291**	**242**	**280**	**301**

Managemental Practices :

The animals were housed at RAU Cattle Farm, Pusa Samastipur in pucca byres. Artificial insemination was practised with semen of Holstein Friesian and Jersey. Standard culling procedures were adopted all along the year for removal of productive, diseased and defective animals. All the

animals were maintained at adequate veterinary aids including regular vaccination and inoculation schedules against Haemorrhagic septicaemia, Black quarter, Foot and mouth disease etc. Proper deworming schedule was followed.

Dry fodder fed to the animals included wheat straw, paddy straw etc. whereas green fodder provided were Berseem, oat, different varieties of Napier grass, sweet jowar, Bajra and seasonal grasses etc.

Besides, Sudha dana, mineral mixture, tisi cake etc were fed to the animals. Apart from these, animals were allowed to graze 3-4 hrs in a day.

Generally two times hand milking at 4.00 am and 3.00 pm was followed. Calves were separated after colostrum feeding after 5-6 days and whole milk feeding up to 2-3 months. Concentrate, roughages and mineral mixture were made available from first month onward according to their body weight and growth requirement as per nutritional standards.

The genetic factors were different genetic groups whereas the non-genetic factors to influence the various production and reproduction traits were :

Sl. No.	Non- genetic factors	Symbol used
1.	Period of calving	PC
2.	Season of calving	SC
3.	Parity of lactation	PL

Period of Calving :

The total period of calving (1980-2001) was divided into six periods which are presented in table -4 :

Table – 4 : Periods of calving along with their symbols used.

Sl. No.	Period of calving	Symbol used
1.	1980-83	PC_1
2.	1984-87	PC_2
3.	1988-91	PC_3
4.	1992-95	PC_4
5.	1996-99	PC_5
6.	2000 – onward	PC_6

The number of observations of various production and reproduction traits under different periods of calving has been depicted in Table – 5.

Table – 5 : Number of observations for various production and reproduction traits during different periods of calving.

Period of calving	MY	LL	PY	DAPY	ADMY	DRP	AFC
PC_1	10	10	10	08	10	08	10
PC_2	29	31	30	28	31	27	32
PC_3	51	61	59	55	63	55	65
PC_4	84	89	87	84	92	82	96
PC_5	78	80	74	69	81	64	69
PC_6	12	13	13	11	14	06	08
Total	**264**	**284**	**273**	**255**	**291**	**242**	**280**

2. Season of calving :

All the years were divided into four seasons of 3 month duration each which are noted as below :

Sl. No.	Seasons	Months	Symbols
1.	Summer	April-June	SC_1
2.	Rainy	July-September	SC_2
3.	Winter	October-December	SC_3
4.	Spring	January-March	SC_4

The number of observations for various production and reproduction traits during different seasons of calving is depicted in Table – 6.

Table – 6 : Number of observations during different seasons of calving.

Season of calving	MY	LL	PY	DAPY	ADMY	DRP	AFC
SC_1	68	72	74	68	74	63	57
SC_2	49	53	51	52	54	50	56
SC_3	71	77	70	63	77	65	80
SC_4	76	82	78	72	86	64	87
Total	**264**	**284**	**273**	**255**	**291**	**242**	**280**

3. Parity of Lactation :

The study was conducted up to a maximum of seven lactations which were denoted as below :

Sl. No.	Number of lactation	Symbol used
1.	First	PL_1
2.	Second	PL_2
3.	Third	PL_3
4.	Fourth	PL_4

5.	Fifth	PL_5
6.	Sixth	PL_6
7.	Seventh	PL_7

The number of observations for various production and reproduction traits under different parity of lactations has been depicted in Table-7.

Table – 7 : Number of observations for various production and reproduction traits under different parity of lactation.

Parity of lactation	MY	LL	PY	DAPY	ADMY	DRP	AFC
PL_1	76	79	82	75	82	64	66
PL_2	58	62	62	57	63	54	60
PL_3	41	47	49	47	50	46	50
PL_4	35	41	38	39	41	36	43
PL_5	24	26	24	23	26	24	30
PL_6	20	20	12	10	20	13	20
PL_7	10	09	06	104	09	05	11
Total	**264**	**284**	**273**	**255**	**291**	**242**	**280**

Milk Constituent Traits :

The present study was also conducted to study the various genetic and non-genetic factors on three milk constituents traits namely : fat %, total solid % (T.S. %) and solid not fat %. The estimates of different milk constituent traits were obtained in the department of Dairy Chemistry at Sanjay Gandhi Institute of Dairy Technology (SGIDT) Patna.

Fat % was estimated as per Gerber's method (Ling, 1954) and total solid % (T.S.%) was estimated using Lactometric method. Solid not fat % was calculated by substracting fat % from total solid%.

The genetic factors affecting the different milk constituent traits were Hariana pure and its different grades with HF. The number of observations under various genetic groups has been presented in Table 8.

Table – 8 : Number of observations for milk constituent traits under different genetic grades.

Sl. No.	Genetic Group	Number	Symbol Used
1.	Hariana Pure	06	G_1
2.	H.F. < 50	28	G_2
3.	H.F. 50 %	32	G_3
4.	H.F. 75%	38	G_4

The non-genetic factors affecting milk constituents traits were :

1. Season
2. Parity of lactation.

Season :

The effect of two seasons : Rainy (S_1) and Winter (S_2) were taken into account to study their effect on milk constituent traits.

The total number of observations obtained from different genetic groups in each season to study their effect on different milk constituents traits was 52.

Parity of lactation :

Altogether eight lactations were considered to study their effect on fat %, T.S. % and SNF %,. The distribution of 104 observations in different parity of lactations has been presented in table – 9.

Table – 9 : Parity-wise distribution of observations of milk constituent traits.

Sl. No.	Lactation No.	No. of observation	Symbol used
1.	First	11	PL_1
2.	Second	25	PL_2
3.	Third	24	PL_3
4.	Fourth	22	PL_4
5.	Fifth	15	PL_5
6.	Sixth	03	PL_6
7.	Seventh	02	PL_7
8.	Eight	02	PL_8

Statistical Analysis :

All the data were analysed by SPECTRUM - 3, FORTAN-IV computer system of DCM at CARI (Central Avian Research Institute), Computer Section, Izzatnagar, Bareilly (U.P.). Some of the minor calculations were also carried out by scientific calculator $CASIO_{fx\text{-}100s}$.

Mean, standard error and co-efficient of variation :

The mean, standard error and coefficient of variation for each trait were computed using the following formulae.

$$\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}$$

$$S.E. = \frac{S}{\sqrt{n}}$$

$$CV\ \% = \frac{S}{\bar{X}} \times 100$$

Where

$$S = \sqrt{\frac{\Sigma X^2_i - \frac{(\Sigma X_i)^2}{n}}{n-1}}$$

$\bar{X}$ = Mean

X_i = Measurement of a trait on i^{th} observation

n = Number of observations.

Correlation Co-efficient :

The simple correlation coefficients on the basis of the phenotypic values among different traits were computed by using the formula given by Snedecor and Cochran (1967).

$$r_{xy} = \frac{\text{Covariance XY}}{Sd_x \, Sd_y}$$

where X = represents one trait

Y = represents another trait

r_{xy} = Coefficient of correlation between X and Y traits.

Sd_x = Standard deviation of trait X.

Sd_y = Standard deviation of trait Y.

n = Paired number of observations.

$$\text{or} \quad r_{xy} = \frac{\Sigma xy - \frac{(\Sigma x)\ (\Sigma y)}{n}}{\sqrt{\left[\Sigma x^2 - \frac{(\Sigma x)^2}{n}\right]\left[\Sigma y^2 - \frac{(\Sigma y)^2}{n}\right]}}$$

The standard error of phenotypic correlation coefficient was calculated by the formula suggested by Goulden (1962).

The correlation coefficients were tested for their significance through 't' test

$$t_{(n-2)df} = \frac{r}{S.E._{(r)}}$$

To study the effect of different genetic and non-genetic factors on various production and reproduction traits, data were subjected to least squares analysis without interaction (Harvey, 1966). The following linear mathematical model was used :

$$\gamma_{ijklm} = \mu + G_i + P_j + S_k + Z_l + e_{ijklm}$$

where

γ_{ijklm} = measurement of m^{th} trait belonging to l^{th} parity of k^{th} season of calving of j^{th} period under i^{th} genetic group.

μ = overall population mean

G_i = effect of i^{th} genetic group (i = 1 ..... 6) for AFC, (i = 1 ..... 5).

P_j = effect of j^{th} period (j = 1 ..... 6)

S_k = effect of k^{th} season of calving (k = 1 ..... 4)

Z_l = effect of l^{th} parity of lactation (l = 1 .....7) and

e_{ijklm} = random error assumed to be normally and independently distributed with mean 0 and variance σ^2_e i.e. NID $(0, \sigma^2_e)$

The statistical significance of various fixed effects were tested by 'F' test. D.M.R.T. as modified by Kramer (1957) was used to examine the pair-wise comparisons among least squares means at 0.05 and 0.01 probability levels, wherever the value was observed to be significant.

The data were subjected to least squares analysis (Harvey, 1966) using the following linear mathematical model to quantify the effect of various genetic and non-genetic factors on milk constituent traits.

$$\gamma_{ijkl} = \mu + G_i + S_j + P_k + e_{ijkl}$$

where

γ_{ijklm} = measurement of l^{th} trait belonging to k^{th} parity of j^{th} season of calving of i^{th} genetic group.

μ = overall population mean

G_i = effect of i^{th} genetic group (i = 1 ..... 4)

S_j = effect of j^{th} season (j = 1 ..... 2)

P_k = effect of k^{th} parity (k = 1 ..... 8)

e_{ijkl} = random error assumed to be normally and independently distributed with mean 0 and variance σ^2_e i.e. NID $(0, \sigma^2_e)$

The statistical significance of various fixed effect was tested by F test. Duncan Multiple Range Test as modified by Kramer (1957) was further used wherever the value of F was observed to be significant to examine the pair-wise comparisons among least squares means at 0.05 and 0.01 levels of probability.

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CHAPTER - IV

RESULTS AND DISCUSSIONS

RESULTS AND DISCUSSIONS

MILK YIELD IN 300 DAY OR LESS (kg) :

Least squares means ± S.E. along with their C.V.% of 300 day or less milk yield (kg) of different genetic groups have been depicted in table -11. The average milk yield of 300 or less days in pure Hariana was observed to be 909.88 kg which falls in the range of 693.2 (Parmer *et al.*, 1986) to 1753.46 kg (Chhilar *et al.* 1979) as reported in the literature. The difference in average milk yield might be attributed to the managemental and environmental variations.

The average 300 days or less milk yield (kg) of H.F. <50% group was found to be 1085.32 kg. However, no information in the literature for this genetic grade could be available to compare the finding of the present study.

In G_3 group i.e. H.F. 50% with Hariana, the average 300 days or less milk yield was observed to be 1836.52 kg. Literature revealed a range of 1933.2 kg (Parmar *et al.*, 1986) to 2925.83 kg (Chhilar *et al.*, 1979) in ½ H.F. + ½ Hariana genetic group.

The finding of the present study is in close agreement with the result obtained by Parmar *et al.* (1986).

The average milk yield in 300 days or less milk yield in HF 62.5% group (G_4) was found to be 860.89 kg in this investigation. However, no information could be available in the literature to compare this finding.

The average 300 days milk yield in HF 75% with Hariana (G_5) was obtained as 1669.58 kg. However, contradictory to this finding, Chhilar *et al.* (1979) reported as high as 3072.58 kg of milk in ¾ Holstein Friesian with Hariana.

In Jersey 50% with Hariana, group (G_6), the average 300 days or less milk yield was observed to be 1740.43 kg. Thakur *et al.* (1999) and Panda and Sadhu (1983) reported a range of overall average to be 1258.3 kg and 2143.94 kg respectively in Jersey x Hariana. However, the finding of the present study is in close proximity with reports of Duc and Taneja (1984).

Table – 10 : Least squares analysis of variance showing the effect of genetic and non genetic factors on Milk Yield (Kg) in 300 days or less.

Source of variation	D.F.	Sum of squares	Mean squares	F
GG	5	32425620.09	6485124.01	16.842**
PC	5	3170490.25	634098.05	1.647 NS
SC	3	1451935.55	483978.51	1.257 NS
PL	6	1088961.46	181493.57	0.471 NS
Remainder (Error)	244	93951825.83	385048.47	--

GG = Genetic group, PC = Period of calving, SC = Season of calving,

PL = Parity of lactation.

** Significant at P< 0.01

NS : Non-significant

Table – 11 : Least squares Means ± S.E. along with C.V.% of 300 days or less milk yield (kg) of different genetic groups of cattle (Crosses of Hariana with Holstein Friesian and Jersey).

Group	Mean ± S.E.	C.V.%
G_1	$909.88^a \pm 150.04$	110.62
G_2	$1085.32^a \pm 69.30$	43.30
G_3	$1836.52^b \pm 78.72$	19.64
G_4	$860.89^a \pm 89.28$	49.73
G_5	$1669.58^b \pm 106.58$	43.29
G_6	$1740.43^b \pm 47.35$	24.79

Means with different superscripts differ significantly ($P<0.05$).

G_1 = Hariana pure, G_2 = H.F< 50% , G_3 = H.F. 50%,

G_4 = H.F. 62.5%, G_5 = H.F. 75% and G_6 = J.50%

Lactation length :

Least squares means along with their standard errors and C.V.% of lactation length in different genetic groups have been depicted in table –13.

The average lactation length in Hariana genetic group was found to be 325. 38 days. Literature revealed a range of 301.70 days (Rajkumar, 1985) to 358.3 days (Parmar *et al.*, 1986) for lactation length in Hariana. The findings obtained in the presents study is in close agreement with the reports of Rajkumar (1985) and Pander and Raheja (1997).

The average lactation length in G_2, G_3, G_4, G_5 and G_6 groups were obtained as 390.74, 334.85, 341.47, 406.98 and 462.69 days respectively. No information could be available for H.F. < 50%, H.F. 62.5% and H.F. 75% with Hariana. Parmar *et al.* (1986) and Chopra (1990) reported the average

lactation length in ½ H F ½ H group to be 432.7 days and 344.4 days respectively. The findings obtained in the present study are in close agreement with the findings of Chopra (1990). However, the average lactation length of Jersey 50% crosses with Hariana was observed to be higher than the findings of Rajkumar (1985), Chopra (1990) and Thakur *et al.* (1999).

Table – 12 : Least squares analysis of variance showing the effect of genetic and non genetic factors on Lactation length (LL) in days.

Sources of variation	D.F.	Sum of squaress	Mean squaress	F
GG	5	635918.27	127183.65	7.650**
PC	5	123556.07	24711.21	1.486 ^{NS}
SC	3	103952.37	34650.79	2.084 ^{NS}
PL	6	140328.36	23388.06	1.407 ^{NS}
Remainder (Error)	264	4388796.36	16624.24	--

GG = Genetic group, PC = Period of calving, SC = Season of calving,

PL = Parity of lactation.

** Significant at P< 0.01

^{NS} : Non-significant

Table – 13 : Least squares Means ± S.E. along with C.V.% of Lactation length (day) of different genetic groups of cattle (Crosses of Hariana with Holstein Friesian and Jersey).

Group	Mean ± S.E.	C.V.%
G_1	$325.38^{b} \pm 13.96$	28.79
G_2	$390.74^{a} \pm 18.30$	35.67
G_3	$334.85^{ab} \pm 18.39$	24.56
G_4	$341.47^{ab} \pm 31.36$	432.09
G_5	$406.98^{a} \pm 18.17$	31.58
G_6	$462.69^{c} \pm 15.44$	31.67

Means with different superscripts differ significantly ($P<0.05$).

G_1 = Hariana pure, G_2 = H.F< 50% , G_3 = H.F. 50%,

G_4 = H.F. 62.5%, G_5 = H.F. 75% and G_6 = J.50%

Peak yield :

The least squares means along with their standard errors and C.V. % of peak yield of milk (kg) in different genetic groups have been shown in table-15.

The average peak yield in G_1, G_2, G_3, G_4, G_5 and G_6 genetic groups were obtained as 5.36 kg, 6.37 kg, 11.02 kg, 5.32 kg, 8.89 kg and 8.56 kg respectively.

Raheja (1982) observed the average peak yield to be 5.95 kg and Dalal *et al.* (2002) reported the average 1st peak yield to be 6.16 kg in Hariana. The finding obtained in the present study is in close agreement with the reports of Raheja (1982). No reformation, however, could be available for G_2, G_4 and G_5 genetic groups for comparison.

Koul *et al.* (1977), Raheja (1982) and Dutt and Bhusan (2001) reported the average peak yield of ½ Holstein Friesian + ½ Hariana to be 10.65 kg 14.39 kg and 11.09 kg respectively. The finding of the present study is in close proximity with the result obtained by Dutt and Bhusan (2001).

Koul *et al.* (1977), Raheja (1982) and Dutt and Bhusan (2001) observed the average peak yield in ½ J + ½ H to be 8.64 kg, 12.02 kg and 8.89 kg respectively. The result obtained in the present investigation is in close agreement with the findings of Koul *et al.* (1977) and Dutt and Bhusan (2001).

Table – 14 : Least squares analysis of variance showing the effect of genetic and non-genetic factors on Peak yield of milk (Kg).

Source of variance	D.F.	Sum of squares	Mean squares	F
GG	5	783.64	156.72	31.606**
PC	5	13.52	2.70	0.545 NS
SC	3	7.58	2.52	0.510 NS
PL	6	37.77	6.29	1.270 NS
Remainder (Error)	253	1254.57	4.95	--

GG = Genetic group, PC = Period of calving, SC = Season of calving,

PL = Parity of lactation.

** Significant at P< 0.01

NS : Non-significant

Table – 15 : Least squares Means ± S.E. along with C.V.% of Peak yield of milk (kg.) of different genetic groups of cattle (Crosses of Hariana with Holstein Friesian and Jersey).

Group	Mean ± S.E.	C.V.%
G_1	$5.36^{d} \pm .22$	26.81
G_2	$6.37^{c} \pm .19$	22.12
G_3	$11.02^{a} \pm .52$	21.61
G_4	$5.32^{cd} \pm .46$	44.53
G_5	$8.89^{b} \pm .52$	38.35
G_6	$8.56^{b} \pm .22$	24.96

Means with different superscripts differ significantly ($P<0.05$).

G_1 = Hariana pure, G_2 = H.F< 50% , G_3 = H.F. 50%,

G_4 = H.F. 62.5%, G_5 = H.F. 75% and G_6 = J.50%

Days to attain peak yield :

The least squares means along with their S.E. and C.V. % of days to attain peak yield of different genetic groups have been presented in table -17. The average days to attain peak yield in G_1, G_2, G_3, G_4, G_5 and G_6 genetic groups were noted as 39.72, 29.80, 30.35, 28.12, 33.80 and 35.35 days respectively. Very little information is available in the literature for comparison for this trait. However, Bhattacharjya *et al.* (1999) in Hariana and Koul *et al.* (1977) in ½ HF ½ H and ½ J ½ H have reported higher average values than the findings of the present study for this trait.

Table – 16 : Least squaress analysis of variance showing the effect of genetic and non genetic factors on Days to attain peak yield (DAPY).

Source of variance	D.F.	Sum of squares	Mean squares	F
GG	5	2871.03	574.20	3.141**
PC	5	2243.30	448.66	2.454*
SC	3	2724.74	908.24	4.968**
PL	6	684.53	114.08	0.624 ^{NS}
Remainder (Error)	235	42959.74	182.80	--

GG = Genetic group, PC = Period of calving, SC = Season of calving,

PL = Parity of lactation.

** Significant at P< 0.01

* Significant at P<0.05

^{NS} : Non-significant

Table – 17 : Least squares Means ± S.E. along with C.V.% of Days to attain peak yield of different genetic groups of cattle (Crosses of Hariana with Holstein Friesian and Jersey).

Group	Mean ± S.E.	C.V.%
G_1	$39.72^{a} \pm 2.32$	36.99
G_2	$26.80^{c} \pm 1.40$	37.16
G_3	$30.35^{bc} \pm 3.41$	50.38
G_4	$28.12^{cd} \pm 1.41$	25.13
G_5	$33.80^{abd} \pm 2.60$	48.70
G_6	$35.35^{ab} \pm 1.78$	45.15

Means with different superscripts differ significantly ($P<0.05$).

G_1 = Hariana pure, G_2 = H.F< 50% , G_3 = H.F. 50%,

G_4 = H.F. 62.5%, G_5 = H.F. 75% and G_6 = J.50%

Table – 17 : Least squares Means ± S.E. along with C.V.% of Days to attain peak yield of different genetic groups of cattle (Crosses of Hariana with Holstein Friesian and Jersey).

Group	Mean ± S.E.	C.V.%
G_1	$39.72^{a} \pm 2.32$	36.99
G_2	$26.80^{c} \pm 1.40$	37.16
G_3	$30.35^{bc} \pm 3.41$	50.38
G_4	$28.12^{cd} \pm 1.41$	25.13
G_5	$33.80^{abd} \pm 2.60$	48.70
G_6	$35.35^{ab} \pm 1.78$	45.15

Means with different superscripts differ significantly ($P<0.05$).

G_1 = Hariana pure, G_2 = H.F< 50% , G_3 = H.F. 50%,

G_4 = H.F. 62.5%, G_5 = H.F. 75% and G_6 = J.50%

Table – 18 : Least squares Means ± S.E. along with C.V.% of Days of attain peak yield under different periods of calving.

Group	Mean ± S.E.	C.V.%
PC_1	$30.13^{ac} \pm 2.57$	24.16
PC_2	$41.86^{a} \pm 3.28$	41.52
PC_3	$38.38^{ab} \pm 2.38$	46.08
PC_4	$31.23^{c} \pm 1.27$	37.27
PC_5	$28.32^{c} \pm 1.46$	43.02
PC_6	$28.91^{bc} \pm 4.24$	48.68

PC_1 = 1980 - 83, PC_2 = 1984 - 87, PC_3 = 1988 - 1991, PC_4 = 1992-94

PC_5 = 1996-99 and PC_6 = 2000-2003.

Means with different superscripts differ significantly ($P<0.05$).

Table – 19 : Least squares Means ± S.E. along with C.V.% of Days to attain peak yield of under different seasons of calving.

Group	Mean ± S.E.	C.V.%
SC_1	$28.90^{b} \pm 1.21$	34.68
SC_2	$32.35^{b} \pm 1.81$	40.42
SC_3	$39.76^{a} \pm 2.59$	51.74
SC_4	$31.49^{b} \pm 1.30$	35.05

S_1 = Summer, S_2 = Rainy, S_3 = Winter and S_4 = Spring

Means with different superscripts differ significantly ($P<0.05$).

Average daily milk yield :

Least squares means ± S.E. and C.V. % of average daily milk yield in different genetic groups have been depicted in table-21.

The average daily milk yield (kgs) of G_1, G_2, G_3, G_4, G_5 and G_6 genetic groups were observed to be 2.75, 3.46, 6.35, 2.82, 4.84 and 5.03 kg respectively. Dalal *et al.* (2002) reported the A.D.M.Y. of productive life in Hariana to be 3.10 kg which is in conformity with the findings of present study. No information could be available in the literature to compare the findings of G_2, G_4 and G_5 genetic groups. However, Pander and Chopra (1986) obtained higher average values for A.D.M.Y. than the findings of the present study for both ½ HF ½ H and ½ J ½ H genetic groups.

The average value of ADMY obtained in this investigation for ½ J ½ H genetic group is in close conformity with the findings of Thakur *et al.* (1999).

Table – 20 : Least squares analysis of variance showing the effect of genetic and non-genetic factors on Average Daily Milk Yield (Kgs).

Source of variance	D.F.	Sum of squares	Mean squares	F
GG	5	305.59	61.11	30.190**
PC	5	22.92	4.58	2.264*
SC	3	11.77	3.92	1.939 NS
PL	6	12.69	2.11	1.045 NS
Remainder (Error)	271	548.63	2.02	--

GG = Genetic group, PC = Period of calving, SC = Season of calving, PL = Parity of lactation. ** Significant at P< 0.01 * Significant at P<0.05

NS : Non-significant

Table – 21 : Least squares Means ± S.E. along with C.V.% of Average Daily Milk yield (kgs) of different genetic groups of cattle (Crosses of Hariana with Holstein Friesian and Jersey).

Group	Mean ± S.E.	C.V.%
G_1	$2.75^{d} \pm 0.13$	33.70
G_2	$3.46^{c} \pm 0.17$	39.18
G_3	$6.05^{a} \pm 0.20$	15.72
G_4	$2.82^{cd} \pm 0.24$	42.89
G_5	$4.84^{b} \pm 0.29$	44.63
G_6	$5.03^{b} \pm 0.14$	27.48

Means with different superscripts differ significantly ($P<0.05$).

G_1 = Hariana pure, G_2 = H.F< 50% , G_3 = H.F. 50%,

G_4 = H.F. 62.5%, G_5 = H.F. 75% and G_6 = J.50%

Table – 22 : Least squares Means ± S.E. along with C.V.% of Average Daily Milk yield (kg) during different periods of calving.

Group	Mean ± S.E.	C.V.%
PC_1	$3.30^{a} \pm 0.17$	16.58
PC_2	$4.57^{ab} \pm 0.35$	43.55
PC_3	$4.69^{b} \pm 0.22$	38.06
PC_4	$3.90^{a} \pm 0.18$	45.14
PC_5	$4.18^{ab} \pm 0.20$	44.39
PC_6	$4.16^{ab} \pm 0.34$	30.77

PC_1 = 1980 - 83, PC_2 = 1984 - 87, PC_3 = 1988 - 1991, PC_4 = 1992-95

PC_5 = 1996-99 and PC_6 = 2000-2003.

Means with different superscripts differ significantly ($P<0.05$).

Dry period :

Least squares means along with their S.E. and C.V. % of dry period in different genetic groups of cattle have been shown in table-24.

Literature revealed the average dry period in Hariana to range from 169.39 days (Raj Kumar, 1985) to 228.0 days (Pundir and Raheja, 1997) in which the finding of the present investigation (201.1 days) also falls. No information could be available for average dry period for G_2, G_4 and G_5 genetic groups for comparison. The average dry period in ½ H F ½ H genetic group was observed to be 121.25 days which is 48.05 days higher than the report of Parmer *et al.* (1986). The average dry period of ½ J ½ H genetic group was obtained as 126.97 days in the present study which falls in the range of 70.93 days (Raj Kumar, 1985) to 166.8 days (Thakur *et al.*, 1999).

Table – 23 : Least squares analysis of variance showing the effect of genetic and non genetic factors on dry period (DRP) in days.

Source of variance	D.F.	Sum of squares	Mean squares	F
GG	5	370802.56	74160.51	8.530**
PC	5	85978.79	17195.76	1.978 NS
SC	3	14502.48	4834.16	0.556 NS
PL	6	21541.28	3590.21	0.413 NS
Remainder (Error)	222	1930038.32	8693.87	--

GG = Genetic group, PC = Period of calving, SC = Season of calving,

PL = Parity of lactation.

** Significant at P< 0.01

NS : Non-significant

Table – 24 : Least squares Means ± S.E. along with C.V.% of dry period (DRP) (days) of different genetic groups of cattle (Crosses of Hariana with Holstein Friesian and Jersey.

Group	Mean ± S.E.	C.V.%
G_1	$201.10^b \pm 20.83$	64.71
G_2	$153.06^c \pm 9.55$	43.69
G_3	$121.25^c \pm 19.76$	65.20
G_4	$264.44^a \pm 34.70$	52.49
G_5	$113.40^c \pm 11.87$	68.70
G_6	$126.97^c \pm 9.47$	66.33

G_1 = Hariana pure, G_2 = HF< 50%, G_3 = H.F. 50%, G_4 = H.F. 62.5%

G_5 = H.F 75% and G_6 = Jersey 50%

Means with different superscripts differ significantly (P<0.05).

Age at 1st calving :

Least squares means ± S.E. and C.V. % of age at 1st calving have been depicted in table-26.

The average age at 1st calving in Hariana was noticed to be 1754.04 days which falls in the range of 1339.13 days (Koul, 1987) to 1824.64 days (Raj Kumar, 1985). Literature did not reveal the average value for this trait in G_2, G_3 and G_4 genetic groups. The average AFC in ½ J ½ H group was found to be 1416.07 days which is higher than the average value reported by Duc and Taneja, (1984), Raj Kumar, (1985) and Chopra (1990). The differences in average AFC as reported by different authors might be attributed to managemental and environmental conditions.

Table – 25 : Least squares analysis of variance showing the effect of genetic and non genetic factors on age at first calving (AFC).

Source of variance	D.F.	Sum of squares	Mean squares	F
GG	4	19894190.05	497354.76	6.033**
PC	5	139815.50	27963.10	0.339^{NS}
SC	3	166088.35	55362.78	0.672^{NS}
PL	6	133438.12	22239.68	0.270^{NS}
Remainder (Error)	261	21515035.42	82433.09	--

GG = Genetic group, PC = Period of calving, SC = Season of calving,

PL = Parity of lactation.

** Significant at P< 0.01

^{NS} : Non-significant

Table – 26 : Least squares Means ± S.E. along with C.V.% of age at 1st calving (AFC) of different genetic groups of cattle (Crosses of Hariana with Holstein Friesian and Jersey.

Group	Mean ± S.E.	C.V.%
G_1	$1754.04^{c} \pm 20.60$	11.44
G_2	$1680.36^{bc} \pm 55.29$	23.72
G_3	$1643.08^{b} \pm 32.24$	15.32
G_4	$1623.39^{b} \pm 31.22$	13.04
G_5	$1416.07^{a} \pm 80.85$	29.11

Means with different superscripts differ significantly (P<0.05).

G_1 = Hariana pure, G_2 = H.F< 50% ,

G_3 = H.F. 62.5%, G_4 = H.F. 75% and G_5 = J.50%

EFFECT OF GENETIC AND NON-GENETIC FACTORS :

Production of milk is the basic economic value of dairy cattle. Basically it is an inherited character which is primarily dependent on breed Since crossbreeding with temperate dairy breed is being utilized as genetic tool for enhancing milk production and productivity potential of indigenous cattle, therefore, to study the effect of level of exotic inheritance on production and reproduction traits in crossbred cows becomes of paramount importance. Besides, various non-genetic factors such as period of calving, season of calving and parity of lactation play very important role in the performance of production and reproduction traits. Variations due to such factors are needed to be quantified for formulating suitable breeding strategy as the overall performance of a dairy animal is the combined effect of genetic and non-genetic factors.

300 DAYS OR LESS MILK YIELD (M.Y.) :

Genetic effect :

Least squares analysis of variance revealed highly significant ($P<0.01$) effect of genetic groups on 300 days or less milk yield (table-10).

Hariana yielded 909.88 kg of milk in 300 or less days which was 48.99 kg more than H.F. 62.5% (G_4) group and 175.44 kg less than H.F. <50 % group (G_2). However, there were no significant differences among G_1, G_2 and G_4 genetic groups with respect to 300 or less days milk yield reflecting that HF < 50% and H.F. 62.5% were not superior to Hariana.

The ½ HF ½ H group (G_3) yielded highest quantity of milk which was significantly ($P<0.05$) higher by 926.64 kg, 751.2 kg and 975.63 kg than G_1, G_2 and G_4 genetic groups respectively. The table further revealed that ½ HF ½ H genetic group had more than double 300 days or less milk yield than

Hariana and HF 62.5% groups. It was further observed that ½ HF ½ H genetic group had 96.09 kg and 166.94 kg more milk than ½ J ½ H and HF 75% groups respectively. However, the average values of HF 50%, HF 75% and Jersey 50% groups did not differ significantly. The ½ J ½ H group yielded second highest 300 days or less milk yield which was higher by 830.55 kgs 655.11 kgs 879.54 kg and 70.85 kg than G_1 G_2, G_4, and G_5 genetic groups respectively.

It was thus concluded that crossbreds G_3, G_5 and G_6 had significant ($P<0.05$) superiority over Hariana. The ½ HF ½ H genetic group was more suitable and top milk yielder followed by ½ J ½ H group in hot – humid climates of north Bihar. Chhilar *et al.* (1979) observed that crossbreds ½ Friesian and ¾ Friesian with Hariana had significant ($P<0.01$) superiority over Hariana with respect to 300 days milk yield. Panda and Sadhu (1983) found that Hariana x H.F. yielded highest milk yield followed by Hariana x Jersey; Raj Kumar (1985) reported J x H (F_1) had significantly ($P<0.01$) nearly double higher milk yield than Hariana and Acharya (1989) concluded that in India Friesian crosses with Indian breeds perform the best for milk production.

The finding obtained in the present study are in conformity with the finding of Chhilar *et al.* (1979), Panda and Sadhu (1983), Raj Kumar (1985) and Aacharya (1989).

Effect of non genetic factors on 300 days or less milk yield :

Period of calving :

Least squares analysis of variance revealed that period of calving did not play significant role on 300 days or less milk yield in Hariana and its crosses with Holstein Friesian and Jersey (table-10). Contrary to the finding

of the present study, Mishra *et al.* (1979), Raheja (1997) and Thakur *et al.* (1999) observed significant period effect on milk yield. However, the finding of present study is in agreement with the result obtained by Panda and Sadhu (1983).

Season of calving :

Least squares analysis of variance reflected that the season of calving had no significant role on 300 days or less milk yield in Hariana and its crosses with Holstein Friesian and Jersey (table-10) which is in conformity with the results obtained by Mishra *et al.* (1979), Panda and Sadhu (1983), Raj Kumar (1985), Raheja (1997) and Thakur *et al.* (1999). However, contrary to the findings of the present study, Chhilar *et al.* (1979) reported highly significant ($P<0.01$) effect of season of calving on 300 day or less milk yield in Hariana and its crosses with Holstein Friesian and Jersey and observed that highest milk was yielded during cool (December – March) season.

Parity of lactation :

Least squares analysis of variance showed that the parity of lactation did not play any significant role on 300 days or less milk yield in Hariana and its crosses with Holstein Friesian and Jersey in the present investigation (table-10). Bhatnagar *et al.* (1979) also reported non-significant effect of dam's parity on first lactation total yield in Sahiwal and its crosses with Brownswiss. However, Chhilar *et al.* (1979), Panda and Sadhu (1983) and Raj Kumar (1985) observed that parity of lactation had significant role on this trait.

Lactation length :

Effect of genetic groups :

Least squares analysis of variance revealed highly significant ($P<0.01$) effect of genetic group on lactation length in Hariana and its crosses with HF and Jersey (table-12).

The least squares means ± S.E. along with C.V. % of lactation length have been depicted in table-13.

An appraisal of table-13. revealed that the highest and lowest lactation lengths (day) were observed in ½ J ½ H and Hariana genetic groups. However, the average lactation length of Hariana did not differ significantly with ½ HF ½ H (G_3) and HF 62.5% (G_4) groups. Group G_2 had significantly ($P<0.05$) higher lactation length by 65.36 days than Hariana. Similarly, G_5 had significantly ($P<0.05$) 81.6 days more lactation length than Hariana. Besides, ½ J ½ H genetic group had significantly ($P<0.05$) more lactation length (day) by 137.37, 71.95, 127.84, 121.22 and 55.71 days than G_1, G_2, G_3, G_4 and G_5 genetic groups respectively. Significant effect of genetic groups obtained in the present study is in conformity with the findings of Mishra *et al.* (1979) and Thakur *et al.* (1999). However, Raj Kumar (1985), contrary to the finding of the present study, did not find significant effect of breeds on lactation length in genetic groups of Hariana and J x H (F_1).

EFFECT OF NON GENETIC FACTORS :

Period of calving :

Least squares analysis of variance (table-12) showed that period of calving did not play significant role on lactation length in Hariana and its crosses with H.F. and Jersey. Mishra *et al.* (1979) in indigenous breed and Thakur *et al.* (1999) in Jersey and Zebu crossbred also reported non-

significant effect of period of calving which are in conformity with the finding of the present study.

Season of calving :

Least squares analysis of variance reflected that season of calving had no significant effect on lactation length in Hariana and its crosses with H.F. and Jersey (table-12).

Mishra *et al.* (1979) in indigenous breed, Raj Kumar (1985) in Hariana and J x H crossbred and Thakur *et al.* (1999) in Jersey x Zebu crossbred also reported that seasons had no influence on lactation length which are in agreement with the finding of present study.

Parity of lactation :

Parity of lactation did not influence the lactation length in Hariana and its crosses with Jersey as revealed by least squares analysis of variance (table-12). However, Singh and Desai (1961) in Hariana, Raj Kumar (1985) in Hariana and J x H (F_1) and Singh and Nagarcenkar (1997) in Sahiwal reported significant effect of parity of lactation on lactation length.

PEAK YIELD :

Effect of genetic groups :

Least squares analysis of variance revealed highly significant ($P<0.01$) effect of genetic group on peak yield (table-14).

Least squares means ± S.E. alongwith C.V.% of peak yield of milk (kg) in different genetic grades have been presented in table-15. The highest peak yield was observed in ½ HF ½ H genetic group (G_3) which was significantly ($P<0.05$) higher by 5.66 kg, 4.65 kg, 5.70 kg, 2.13 kg and 2.46 kg than G_1, G_2, G_4, G_5 and G_6 genetic groups respectively. The second and third highest values of mean peak yield were obtained in G_5 and G_6 genetic

groups respectively which did not differ significantly. Besides, Hariana (G_1) and HF 62.5% with Hariana (G_4) and G_2 and G_4 groups also did not differ significantly.

An appraisal of the table indicated that ½ HF ½ H (G_3) had significantly ($P<0.05$) more peak yield than ½ J ½ H (G_6) which is in conformity with the findings of Koul *et al.* (1977), Raheja (1982) and Raheja and Balaine (1982). Nayak and Raheja also reported significant effect of genetic group on peak yield in halfbreds of Hariana with H.F., Brownswiss and Jersey which are in agreement with the findings of the present study.

Effect of non-genetic factors :

Period of calving :

Least squares analysis of variance (table-14) reflected that period of calving had no significant effect on peak yield in Hariana and its crosses with H.F. and Jersey. Dutt and Bhusan (2001) also reported non-significant effect of period of calving on peak yield in halfbreds of HF, Brown Swiss and Jersey with Hariana, which is in agreement with the findings of the present investigations.

Season of calving :

Least squares analysis of variance depicted in table-14 reflected that season of calving had no significant role on peak yield in Hariana and its crosses with Holstein Friesian and Jersey. Dutt and Bhusan (2001) also reported that season of calving did not play any significant role on peak yield in halfbreds of Hostein Friesian, Brown Swiss and Jersey with Hariana which are similar to the observations noted in this investigation.

Parity of lactation :

Least squares analysis of variance revealed (table-14) that parity of lactation had no significant effect on peak yield in Hariana and its crosses with Holstein Friesian and Jersey, which is in agreement with the findings of Bhattacharjya *et al.* (1999). However, contrary to the finding of the present study, Koul *et al.* (1977) reported that peak yield in second lactation was significantly ($P<0.01$) higher than first lactation in halfbreds of Holstein Friesian and Jersey with Hariana.

DAYS TO ATTAIN PEAK YIELD :

Genetic effect :

Least squares analysis of variance reflected highly significant ($P<0.01$) effect of genetic groups on Days to attain peak yield (table-16).

The average DAPY in different genetic groups ranged from 26.80 days in G_2 group to 39.72 days in Hariana (G_1) group. An appraisal of table-17 indicated that all the crossbreds had lower average DAPY than Hariana. Although, ½ J ½ H had 5.0 days less average DAPY than ½ HF ½ H group, yet there was no significant difference between the two values of average DAPY. Besides, the genetic grades, G_2, G_3 and G_4 did not differ significantly with respect to average DAPY. Raheja and Balaine (1982) observed the highest DAPY in Hariana among Hariana and its half breds of HF, B.S. Jersey and Red Dane which is in agreement with the findings of the present study. Besides, Koul *et al.* (1977) also reported that average DAPY in ½ HF ½ H was lower than that of ½ J ½ H which is in conformity with the findings of the present study.

Effect of non-genetic factors :

Period of calving :

Least squares analysis of variance (table-16) presented significant ($P<0.05$) effect of period of calving on DAPY. Table-18 revealed that the lowest average DAPY was observed during PC_5 periods (1996-99) which was significantly ($P<0.05$) lower by 13.54 days and 10.06 days than PC_2 and PC_3 periods. However, the average DAPY of PC_1, PC_4, PC_5 and PC_6 did not differ significantly. Differences in average DAPY during different periods might be possibly, due to variations in the managemental and natural environmental conditions. However, Singh *et al.* (1993) in Sahiwal and its crosses with Jersey and Red Sindhi did not find any significant effect of period of calving on DAPY.

Season of calving :

Least square analysis of variance (table-16) presented significant ($P<0.05$) effect of season of calving on days to attain peak yield in Hariana and its crosses with HF and Jersey. The least squares means ± S.E. and C.V. % of DAPY during different seasons of calving have been depicted in table-19. The average DAPY in SC_3 group was observed to be highest which was significantly ($P<0.05$) higher by 10.86 days, 7.41 days and 8.27 days than SC_1, SC_2 and SC_4 seasons respectively. However, DMRT revealed that there were no significant differences among SC_1, SC_2 and SC_4 seasons of calvings. Singh *et al.* (1993) also could not find the effect of season on DAPY in Sahiwal and its crosses with Jersey and Red Dane.

Parity of lactation :

Least squares analysis of variance (table-16) presented non-significant effect of parity of lactation on DAPY. However, no information could be

available in literature for parity effect on DAPY in Hariana and its crosses with HF and Jersey for comparison.

Average daily milk yield :

Genetic effect :

Least squares analysis of variance (table-20) reflected highly significant ($P<0.01$) effect of genetic group on average daily milk yield in Hariana and its crosses with Holstein Friesian and Jersey. Least squares means (table-21) indicated the range of ADMY to be 2.75 kg in Hariana to 6.05 kg in ½ HF ½ H genetic groups. The genetic group ½ HF ½ H had the highest ADMY which was significantly ($P<0.05$) higher by 3.3 kg, 2.59 kg, 3.23 kg, 1.21 kg and 1.02 kg than G_1, G_2, G_4, G_5 and G_6 genetic groups respectively.

An appraisal of the table-21 revealed that the lowest ADMY was observed in Hariana which significantly ($P<0.05$) increased with the increase of HF inheritance up to 50%, where it was noted as maximum value. Thereafter, it significantly ($P<0.05$) decreased in HF 62.5% and HF 75% genetic groups. Besides, ½ HF ½ H genetic group had significantly 1.02 kg more ADMY than ½ J ½ H which is in conformity with the result obtained by Pander and Chopra (1986). Apart from these, Thakur *et al.* (1999) also reported significant ($P<0.01$) effect of genetic groups on ADMY which is in agreement with the findings of the present study.

EFFECT OF NON-GENETIC FACTORS :

Period of calving :

Least squares analysis of variance revealed significant ($P<0.05$) effect of period of calving on ADMY in Hariana and its crosses with HF and Jersey (table -20).

available in literature for parity effect on DAPY in Hariana and its crosses with HF and Jersey for comparison.

Average daily milk yield :

Genetic effect :

Least squares analysis of variance (table-20) reflected highly significant ($P<0.01$) effect of genetic group on average daily milk yield in Hariana and its crosses with Holstein Friesian and Jersey. Least squares means (table-21) indicated the range of ADMY to be 2.75 kg in Hariana to 6.05 kg in ½ HF ½ H genetic groups. The genetic group ½ HF ½ H had the highest ADMY which was significantly ($P<0.05$) higher by 3.3 kg, 2.59 kg, 3.23 kg, 1.21 kg and 1.02 kg than G_1, G_2, G_4, G_5 and G_6 genetic groups respectively.

An appraisal of the table-21 revealed that the lowest ADMY was observed in Hariana which significantly ($P<0.05$) increased with the increase of HF inheritance up to 50%, where it was noted as maximum value. Thereafter, it significantly ($P<0.05$) decreased in HF 62.5% and HF 75% genetic groups. Besides, ½ HF ½ H genetic group had significantly 1.02 kg more ADMY than ½ J ½ H which is in conformity with the result obtained by Pander and Chopra (1986). Apart from these, Thakur *et al.* (1999) also reported significant ($P<0.01$) effect of genetic groups on ADMY which is in agreement with the findings of the present study.

EFFECT OF NON-GENETIC FACTORS :

Period of calving :

Least squares analysis of variance revealed significant ($P<0.05$) effect of period of calving on ADMY in Hariana and its crosses with HF and Jersey (table -20).

An appraisal of table-22 indicated that the ADMY ranged from 3.3 kg during PC_1 period to 4.69 kg during PC_3 period. ADMY was observed to be highest in PC_3 period which was significantly ($P<0.05$) higher by 1.39 kg and 0.79 kg than PC_1 and PC_4 periods respectively. However, the ADMY among other periods of calving did not differ significantly. Dutt *et al.* (1992) also reported significant effect of period of calving in crossbreds of Hariana with HF, BS and Jersey which is in agreement with the findings of the present study. Differences in ADMY during various periods might be attributed to variations in the managemental and natural environmental conditions.

Season of calvings :

Least squares analysis of variance (table-20) revealed non-significant effect of season of calving on ADMY in Hariana and its crosses with HF and Jersey which is in conformity with the findings of Thakur *et al.* (1999). Contrary to the findings of the present study, Dutt *et al.* (1992) observed that season played important role in determining ADMY in crosses of Hariana and Jersey.

Parity of lactation :

Least squares analysis of variance (table-20) indicated that parity of lactation did not play any significant role on ADMY in Hariana and its crosses with HF and Jersey which is in conformity with the finding of Pander and Chopra (1986).

DRY PERIOD :

Effect of Genetic Groups :

Least squares analysis of variance (table-23) presented that genetic groups had highly significant ($P<0.01$) effect on dry period in Hariana and

its crosses with HF and Jersey. An appraisal of table-24 revealed that dry period in Hariana was almost double than the dry periods of ½ HF ½ H, ½ J ½ H and ¾ HF ¼ H genetic groups. However, the dry periods of G_2, G_3, G_5 and G_6 genetic groups did not differ significantly. Raj Kumar (1985) and Thakur *et al.* (1999) observed significant ($P<0.01$) effect of genetic groups on dry periods which are similar to the findings of the present study. Besides, Raj Kumar (1985) reported the dry period of Hariana to be about double than the dry period of J x H (F_1) which is in conformity with the findings of the present study.

EFFECT OF NON-GENETICS FACTOR :

Period of calving :

Least squares analysis of variance (table-23) revealed that there was no significant effect of period of calving on dry period. Bhatnagar *et al.* (1979) also reported non-significant effect of period of calving on first dry period in Sahiwal and its crosses with Brown Swiss. However, Thakur *et al.* (1999), contrary to the finding of the present study, reported significant effect of period of calving on dry period in Jersey x Zebu crossbreds.

Season of calving :

Least squares analysis of variance (table-23) revealed non-significant effect of season of calving on dry period in Hariana and its crosses with HF and Jersey which is in conformity with the findings of Raj Kumar (1985) and Thakur *et al.* (1999).

Parity of lactation :

Least squares analysis of variance of (table-23) presented non-significant effect of parity of lactation on dry period in Hariana and its crosses with HF and Jersey. Raj Kumar (1985) reported non-significant

effect of sequence of lactation on dry period in Hariana and J x H (F_1) which is similar to the finding of the present study.

Age at 1st calving :

Effect of genetic group :

It was revealed through least squares analysis of variance that genetic group had highly significant ($P<0.01$) effect on AFC in Hariana and its crosses with HF and Jersey (table-25). An appraisal of table-26 revealed that Hariana had highest AFC whereas ½ J ½ H had the lowest. ½ J ½ H had significantly ($P<0.05$) lower AFC than Hariana G_1, G_2, G_3 and G_4 genetic groups by 337.97 days, 264.29 days, 227.01 days and 207.32 days respectively. Besides, G_3 and G_4 groups had significantly ($P<0.05$) 110.96 days and 130.65 days less AFC than Hariana respectively. However, the average AFC of G_2, G_3 and G_4 genetic groups did not differ significantly.

Duc and Taneja (1984) observed significant ($P<0.01$) decline in average AFC of ½ HF ½ H and ½ J ½ H from Hariana. Raj Kumar (1985) reported that the average AFC of J x H (F_1) was significantly ($P<0.01$) lower than Hariana. Parmar *et al.* (1986) reported significant ($P<0.05$) decline in AFC of ½ HF ½ H from Hariana. The finding of the present study is in agreement with the reports of the above authors.

EFFECT OF NON-GENETIC FACTORS :

Period of calving :

Least squares analysis of variance (table-25) presented non-significant effect of period of calving on AFC in Hariana and its crosses with HF and Jersey. However, contrary to the finding of the present study Duc and Taneja (1994) reported significant effect of years on AFC.

Season of calving :

Least squares analysis of variance (table-25) revealed that season of calving did not play significant role in Hariana and its crosses with HF and Jersey.

Raj Kumar (1985) in Hariana and J x H (F_1), Duc and Taneja (1994) in Hariana and its crosses with HF and Jersey and Sethi *et al.* (2001) in Sahiwal observed non-significant effect of seasons on AFC which are in agreement with the findings of the present study.

Parity of lactation :

Least squares analysis of variance (table-25) presented that there was no significant effect of parity of lactation on AFC in Hariana and its crosses with HF and Jersey. Bhatnagar *et al.* (1979) also reported non-significant effect of dam's parity on AFC in Sahiwal which is similar to the finding of the present study. However, Raj Kumar (1985) reported significant effect of parity of lactation on AFC in Hariana and J X H (F_1).

PHENOTYPIC CORRELATION COEFFICIENTS (r_p) :

MY x LL :

The overall estimates of co-efficient of $r_p \pm$ S.E. between MY and LL was observed to be positive (0.001) but of very low magnitude and non-significant (table-27) in Hariana and its crosses with HF and Jersey. Positive but significant ($P<0.01$) estimates of r_p between first MY and first LL in Hariana have also been reported by Pander and Raheja (1997) and Dalal *et al.* (2002).

Table – 27 : Overall estimates of $r_p \pm$ S.E. among various production and reproduction traits in Hariana and its crosses with HF and Jersey.

Traits	LL	PY	DAPY	ADMY	DRP	AFC
MY	0.001^{NS} ± 0.062 (256)	0.642** ± 0.038 (243)	0.022^{NS} ± 0.067 (222)	0.774** ± 0.025 (261)	-0.375** ± 0.059 (212)	0.150* ± 0.049 (243)
LL	–	0.099^{NS} ± 0.006 (262)	0.042^{NS} ± 0.064 (243)	-0.062^{NS} ± 0.059 (282)	-0.140* ± 0.064 (234)	0.073^{NS} ± 0.061 (264)
PY	–	–	0.044^{NS} ± 0.063 (249)	0.758** ± 0.026 (268)	-0.270** ± 0.062 (222)	0.157* ± 0.064 (233)
DAPY	–	–	–	0.047^{NS} ± 0.063 (250)	0.067^{NS} ± 0.068 (213)	0.313** ± 0.059 (233)
ADMY	–	–	–	–	-0.336** ± 0.058 (236)	0.132* ± 0.060 (270)
DRP	–	–	–	–	–	-0.338** ± 0.059 (225)

MY = Milk yield (kg), LL = Lactation length (days), PY = Peak yield (kg), DAPY = Days to attain peak yield, ADMY = Average daily milk yield (kg), DRP= Dry period (days) and AFC = Age at first calving,

* Significant at (P<0.05), ** Significant at (P<0.01),

NS :Non-significant.

Figures in parentheses indicate paired number of observations.

MY x PY :

The overall estimate of r_p between MY and PY in Hariana and its crosses with HF and Jersey was found to be 0.642 ± 0.038 which was statistically highly significant (P<0.01). Raheja (1982) in Hariana and its crosses with HF and Jersey, Bhattacharjya *et al.* (1999) in Hariana, Dutt and Bhusan (2001) in three-breed genetic grades of HF, BS and Jersey with Hariana and Dalal *et al.* (2002) in Hariana also reported positive, significant and of high magnitude estimate of co-efficient of phenotypic correlations between MY and PY which are in agreement with the findings of the present study.

Positive, significant and high magnitude estimate of r_p between MY and PY suggests that improvement in one of the traits would lead to simultaneous improvement in other trait. Besides, the low magnitude of S.E. of r_p is indicative of high precision of the estimate.

MY x DAPY :

The overall estimate of phenotypic correlation between MY and DAPY in Hariana and its crosses with HF and Jersey was found to be positive but non-significant. No information about the estimate of r_p between these traits could be available in these genetic groups. However, Singh *et al.* (1993) also reported positive but significant (P<0.01) estimate of r_p between 1st MY and 1st DAPY in Sahiwal and its crosses with Jersey and Red Dane. Positive estimate of r_p between MY and DAPY obtained in the present study is similar to the finding of Singh *et al.* (1993).

MY x ADMY :

The overall estimate of phenotypic correlation between MY and ADMY in Hariana and its crosses with HF and Jersey was obtained as 0.774

± 0.025 which was highly significant (P<0.01) (table-27). Singh *et al.* (1993) also reported positive and significant estimate of r_p in MY x ADMY in Sahiwal and its crosses with Jersey and Red Dane which is similar to the finding of the present study. The significant (P<0.01), positive and high magnitude estimate of r_p might suggest that selection in one of the traits would lead to improvement in other trait.

MY x DRP :

The overall phenotypic coefficient of correlation between MY and DRP in Hariana and its crosses with HF and Jersey was found to be negative, significant (P<0.01) and of moderate magnitude (-0.375 ± 0.059) (table-27). Dalal *et al.* (2002) also reported negative and significant (P<0.01) estimate of r_p between MY and DRP in Hariana which is in agreement with the finding of the present study.

MY x AFC :

The overall estimate of r_p between MY and AFC in Hariana and its crosses with HF and Jersey was found to be positive, significant (P<0.05) and of low magnitude (0.150 ± 0.049). Koul (1987) in 2nd and 3rd lactations and Dalal *et al.* (2002) in 1st lactation between MY x AFC in Hariana also observed positive, significant and of low magnitude estimates of r_p which are in agreement with findings of the present study.

LL x PY :

The overall estimate of phenotypic coefficient of correlation between LL and PY in Hariana and its crosses with HF and Jersey was found to be positive but non-significant (table-27). Raheja (1982) in Hariana and its crosses with HF and Jersey and Dutt and Bhusan (2001) in half-breds and 3 breed genetic grades of HF, BS and Jersey with Hariana also reported

positive but non-significant estimate of r_p between LL and PY which are in conformity with the finding of the present study. Besides, the trend of positive r_p between LL and PY obtained by Bhattacharjya *et al.* (1999) and Dalal *et al.* (2002) is also in agreement with the finding of the present study.

LL x DAPY :

The overall estimate of $r_p \pm$ S.E. between LL and DAPY was observed to be 0.042 ± 0.064 in Hariana and its crosses with HF and Jersey (Table -27). However, this value of r_p was found to be statistically non-significant. Singh *et al.* (1993) also reported non-significant estimate of r_p in LL x DAPY in Sahiwal and its crosses with Jersey and Red Dane.

LL x ADMY :

The overall estimate of phenotypic correlation between LL and ADMY was found to be negative, non-significant and of very low magnitude (-0.062 ± 0.059) in the present study. Rao and Sundersan (1982) in 5/8 HF and ¾ HF crosses with Sahiwal and Singh *et al.* (1993) in crosses of Sahiwal with Jersey and Red Dane observed positive, non-significant and of very low magnitude estimate of r_p between LL and ADMY. The trend of non-significant estimate of r_p obtained in this study is similar to the trend reported by the above mentioned authors.

LL x DRP :

The overall estimate of co-efficient of correlation between LL and DRP was observed to be negative (-0.140 ± 0.064) and significant ($P<0.05$) in the present investigation (table-27). Dalal *et al.* (2002) also observed negative and significant ($P<0.05$) estimate of r_p in 1st LL x 1st DRP in Hariana which is in conformity with the finding of the present study.

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However, contrary to this finding, Pundir and Raheja (1997) observed positive estimate of r_p between 1st LL x 1st DRP in Hariana.

LL x AFC :

The overall estimate of r_p between LL and AFC was found to be positive but non-significant (0.073 ± 0.061) in the present study (table-27). Dalal *et al.* (2002) also reported the estimate of r_p between 1st LL and AFC to be positive and of low magnitude (0.11). The trend of positive direction obtained in the present study is similar to the trend observed by Dalal *et al.* (2002).

PY x DAPY :

The overall estimate of phenotypic co-efficient of correlation between PY and DAPY was observed to be positive but non-significant (0.044 ± 0.063) in the present study (table-27). Raheja (1982) also reported positive and non-significant estimate of r_p in Hariana which is similar to the finding of the present study. However, he observed negative but also non-significant estimates of r_p between PY and DAPY in ½ HF ½ H and ½ J ½ H genetic groups.

PY x ADMY :

The overall estimate of r_p between PY and ADMY was observed to be positive, highly significant ($P<0.01$) and of high magnitude (0.758 ± 0.026) in the present investigation (table-27). Dutt and Bhusan (2001) also reported positive, highly significant ($P<0.01$) and of high magnitude (0.748) estimate of r_p between PY and ADMY in halfbreds and 3 breed-genetic grades of HF, BS and Jersey with Hariana, the trend of which is similar to the trend obtained in the present study. Positive, significant and high magnitude

estimate of r_p suggested that selection for improvement in one of the traits would also result in improvement in other correlated trait.

PY x DRP :

The overall estimate of r_p between PY and DRP in Hariana and its crosses with HF and Jersey was observed to be negative (-0.270) and highly significant ($P<0.01$) (table-27). Bhattacharjya *et al.* (1999) in 1st, 3rd and 4th lactations of Hariana, Dutt and Bhusan (2001) in halfbreds and three-breed genetic grades of HF, BS and Jersey with Hariana and Dalal *et al.* (2002) in Hariana also reported the estimates of r_p between PY and DRP to be negative, the trend of which is similar to the trend obtained in the present study.

PY x AFC :

The overall estimate of r_p between PY and AFC was obtained as 0.157 $\pm$ 0.064 which was statistically significant ($P<0.05$) in this study. Dalal *et al.* (2002) also reported positive and significant estimate of r_p (0.10 $\pm$ 0.04) between first peak yield and AFC in Hariana, the trend of which is similar to the trend obtained in the present investigation.

DAPY x ADMY :

The overall estimate of r_p between DAPY and ADMY was observed to be positive (0.047 $\pm$ 0.063) but non-significant in this study (table-27). Singh *et al.* (1993) also reported positive but non-significant estimate of r_p between DAPY and ADMY in Sahiwal and its crosses with Jersey and Red Dane, the trend of which is similar to the finding of the present study.

DAPY x DRP :

Table-27 revealed positive, non-significant and of low magnitude (0.067 $\pm$ 0.068) estimate of r_p between DAPY and DRP in this investigation.

Singh *et al.* (1993) also reported positive but non-significant estimate of r_p between DAPY and 1st DRP in Sahiwal and its crosses with Jersey and Red Dane, the trend of which is similar to the trend obtained in the present investigation.

DAPY x AFC :

The overall estimate of coefficient of phenotypic correlation between DAPY and AFC was found to be positive (0.313 ± 0.059), highly significant (P<0.01) and of moderate magnitude in Hariana and its crosses with HF and Jersey (table-27). However, no information could be available for comparison of the estimate of this trait in these genetic grades.

ADMY x DRP :

Table-27 revealed negative, highly significant (P<0.01) and of moderate magnitude (-0.336 ± 0.058) estimate of coefficient of phenotypic correlation between ADMY and DRP in Hariana and its crosses with HF and Jersey. Singh *et al.* (1993) also reported negative and highly significant (P<0.01) estimate of r_p between ADMY and 1st DRP in Sahiwal and its crosses with Jersey and Red Dane, the trend of which is in conformity with the trend obtained in the present finding.

ADMY x AFC :

The overall estimate of r_p between ADMY and AFC in Hariana and its crosses with HF and Jersey was found to be positive, significant (P<0.05) and of low magnitude (0.132 ± 0.060). However, no information in the literature could be available for comparison of this traits in these genetic groups.

DRP x AFC :

Table 27. revealed the overall estimate of r_p between DRP and AFC in Hariana and its crosses with HF and Jersey to be negative, significant ($P<0.01$) and of moderate magnitude (-0.338 ± 0.059). However, contrary to the present finding, Dalal *et al.* (2002) observed positive and significant estimate of r_p between 1st DRP and AFC in Hariana.

MILK CONSTITUENT TRAITS :

Average Values :

FAT % :

Least squares means ± S.E. along with C.V. % of fat % in Hariana and its crosses with Holstein-Friesian have been depicted in Table - 29).

The average fat % ranged from 3.763 in ¾ HF ¼ H genetic group to 4.740 in pure Hariana. Literature revealed range of fat % from 3.90 (Chourasi and Jain 1993) to 5.18 % (Yadav *et al.* 1989) in Hariana and its crosses with HF and Jersey in which the finding of the present study also falls. Differences in fat % might be attributed to differences in genetic groups, managemental and environmental effect.

Table – 28 : Least squares analysis of variance showing the effect of genetic and non genetic factors on fat %.

Source of variance	D.F.	Mean squares	F
GG	3	2.15268	9.4206**
PL	7	0.2546	1.1143^{NS}
SE	1	1.6668	7.2943**
Remainder (Error)	92	0.2285	--

GG = Genetic groups, PL = Parity of lactations, SE = Seasons.

** Significant at P< 0.01

NS : Non-significant

Table – 29 : Least squares Means ± S.E. along with C.V.% of FAT % of milk of different genetic groups (Crosses of Hariana with Holstein Friesian).

Groups	Mean ± S.E.	C.V.%
G_1	$4.740^a \pm 0.22$	11.630
G_2	$4.288^b \pm 0.11$	14.191
G_3	$4.132^b \pm 0.10$	14.785
G_4	$3.763^c \pm 0.11$	18.347

G_1 = Pure Hariana, G_2 = H.F. < 50%, G_3 = H.F. 50% and G_4 = H.F. 75%

Means with different superscripts differ significantly (P<0.05).

Table – 30 : Parity-wise least squares Means ± S.E. along with there C.V.% of fat% in different genetic groups.

Groups	Mean ± S.E.	C.V.%
P_1	4.1664 ± 0.3636 (11)	28.9440
P_2	4.0994 ± 0.2873 (25)	35.0417
P_3	4.3389 ± 0.2835 (24)	32.0095
P_4	4.0257 ± 0.2903 (22)	33.8233
P_5	4.2609 ± 0.3216 (15)	29.2332
P_6	4.5177 ± 0.5728 (3)	21.9607
P_7	4.0912 ± 0.7949 (2)	27.4774
P_8	4.3484 ± 0.6899 (2)	22.4373

Figures in parentheses indicate number of observations.

Total Solid % :

Least squares means along with their S.E. and C.V. % of total solid % of milk in different genetic groups have been presented in table – 32. The table revealed a range of 12.156 % of T.S. in ¾ HF ¼ H genetic group to 13.160 in Hariana pure. The literature reported a range of 12.94% (Chourasia

and Jain 1993) to 13.40 % (Kaushik and Tandon 1979) in Hariana and crosses of indigenous breeds with exotic dairy breeds.

All the values of T.S. % except the value of ¼ H ¾ HF group obtained in the present study fall in the range mentioned in the literature. Variations in T.S. % of milk might be attributed to the differences in genetic groups, managemental, climatic and other environmental conditions.

Table – 31 : Least squares analysis of variance showing the effect of genetic and non genetic factors on Total Solid (TS) %.

Source of variance	D.F.	Mean squares	F
GG	3	5.003	6.178**
PL	7	0.737	0.911^{NS}
SE	1	8.749	10.804**
Remainder (Error)	92	0.809	--

GG = Genetic group, PC = Period of calving, SC = Season of calving,

PL = Parity of lactation.

** Significant at P< 0.01, * Significant at P<0.05

NS : Non-significant

Table – 32 : Least squares Means ± S.E. along with C.V.% of total solid % (TS%) of milk of different genetic groups (Crosses of Hariana with Holstein Friesian).

Groups	Mean ± S.E.	C.V.%
G_1	$13.160^a \pm 0.42$	7.891
G_2	$12.969^a \pm 0.21$	8.813
G_3	$12.989^a \pm 0.20$	8.840
G_4	$12.156^b \pm 0.21$	10.649

G_1 = Pure Hariana, G_2 = H.F. < 50%, G_3 = H.F. 50% and G_4 = H.F. 75%

Means with different superscripts differ significantly ($P<0.05$).

Table – 33 : Parity-wise least squares Means ± S.E. along with there C.V.% of total solid % in Hariana and its crosses with H.F.

Groups	Mean ± S.E.	C.V.%
P_1	13.0237 ± 0.3485 (11)	8.8749
P_2	12.7743 ± 0.2528 (25)	9.8949
P_3	12.8331 ± 0.2411 (24)	9.2039
P_4	12.4022 ± 0.2533 (22)	9.5796
P_5	13.0670 ± 0.2911 (15)	8.6280
P_6	13.0531 ± 0.5936 (3)	7.8766
P_7	12.5788 ± 0.8046 (2)	9.0459
P_8	12.8194 ± 0.6845 (2)	7.5513

Figures in parentheses indicate number of observations.

S.N.F. % -

Least squares means of S.N.F. % along with their S.E. and C.V.% in Hariana and its crosses with Holstein Friesian have been depicted in table 34.

The table revealed the range 8.419% in ¾ HF ¼ H to 8.421% in Hariana. Literature revealed a range of 8.97% to 9.92% (Chourasia and Jain, 1993) of SNF % in Hariana and other crossbreds of indigenous breeds with exotic dairy breeds. The differences in average S.N.F. % might be attributed to genetic, managemental, climatic and other environmental factors.

Table – 34 : Least squares analysis of variance showing the effect of genetic and non genetic factors on Solid not FAT %.

Source of variance	D.F.	Mean squares	F
GG	3	0.795	1.496^{NS}
PL	7	0.494	0.926^{NS}
SE	1	1.093	2.056^{NS}
Remainder (Error)	92	0.531	--

GG = Genetic group, PC = Period of calving, SC = Season of calving,

PL = Parity of lactation.

** Significant at P< 0.01, * Significant at P<0.05

NS : Non-significant

Table – 35 : Least squares Means ± S.E. along with C.V.% of Solid Not Fat % (SNF%) of milk of different genetic groups (Crosses of Hariana with Holstein Friesian).

Groups	Mean ± S.E.	C.V.%
G_1	$8.421^a \pm 0.34$	15.68
G_2	$8.700^a \pm 0.17$	9.48
G_3	$8.793^a \pm 0.16$	9.54
G_4	$8.419^a \pm 0.17$	6.27

G_1 = Pure Hariana, G_2 = H.F. < 50%, G_3 = H.F. 50% and G_4 = H.F. 75%

Means having common superscripts indicate non-significant differences between the groups.

EFFECTS OF GENETIC AND NON-GENETIC FACTORS ON MILK CONSTITUENT TRAITS :

FAT %

Effect of genetic factors :

Least squares analysis of variance presented highly significant (P<0.01) effect of genetic group on fat % (table –28).

Least squares means along with their S.E. & C.V.% of fat% in milk have been depicted in table-29. The average fat% in milk was observed to be highest in Hariana which was significantly (P<0.05) higher by 0.452%, 0.608% and 0.977% than HF < 50%, ½ HF ½ H and ¾ HF ¼ H genetic groups. HF < 50% group had significantly (P<0.05) 0.525% higher fat % than ¾ HF ¼ H genetic group. However, the average fat % of HF < 50% did not differ significantly with the mean fat% of ½ HF ½ H genetic group. Besides, the mean fat % of milk in ½ HF ½ H genetic group had also

significantly (P<0.05) 0.369% more fat% than that of ¾ HF ¼ H genetic group.

An appraisal of this table clearly reflected that fat % in milk was highest in pure Hariana which significantly decreased with increase in the inheritance of Holstein Friesian. As such HF < 50% had significantly higher fat % in milk than ½ HF ½ H group and also ½ HF ½ H genetic group had significantly (P<0.05) higher fat % than ¾ HF ¼ H genetic group.

Yadav *et al.* (1989) and Chopra (1990) have also reported the significant effect of genetic groups on milk fat % in crosses of Hariana with exotic dairy breeds. However, Chourasia and Jain (1993) did not find any significant differences in fat % of three-breed crosses of four genetic groups involving HF, Jersey and Gir.

NON-GENETIC FACTORS AFFECTING MILK FAT % :

Effect of Seasons :

Least squares analysis of variance revealed highly significant effect (P<0.01) of season on milk fat % (table-28).

The average fat percentages of milk in rainy (S_1) and winter (S_2) were observed to be 4.101 and 4.362 respectively. Winter seasons had significantly (P<0.01) 0.261% higher milk fat % than rainy seasons in this study. Yadav *et al.* (1989), Yadav *et al.* (1991) and Chourasia and Jain (1993) also reported significant effect of season on milk fat%. Differences in fat% in different seasons may be attributed to variations in feeding regime, managemental practices and climatic conditions. Yadav *et al.* (1989) concluded that winter season calvers had highest fat % in their milk in all the genetic groups which is similar to the findings of the present study.

Effect of Parity of Lactation :

Least squares analysis of variance of fat% in different parity ranged from 4.0257 in P_4 to 4.5177 in P_6 parity (table-30). However, the average value obtained in different parity did not differ significantly (table-28) which revealed that parity of lactation had no significant effect on fat %. Kaushik and Tandon (1979) and Yadav *et al.* (1989) also reported non-significant effect of parity of lactation on milk fat% which is in conformity with the finding of the present study.

Total Solid % :

Analysis of variance presented highly significant ($P<0.01$) effect of genetic groups on total solid% in Hariana and its crosses with Holstein Friesian (table-31). The least squares means along with their S.E. and C.V.% of total solid% of milk of different genetic groups have been depicted in table-32.

The T.S.% ranged from 12.156 in ¾ HF ¼ H genetic group to 13.160 in pure Hariana.

An appraisal of table –32 revealed that the T.S. % of Hariana, < 50% HF and ½ H ½ HF genetic groups were significantly ($P<0.01$) higher by 1.004%, 0.813% and 0.833% than ¾ HF ¼ H genetic group. However, the T.S.% of G_1, G_2 and G_3 groups did not differ significantly. Besides, the T.S % of all the crossbreds of Hariana were lower than Hariana pure. Kaushik and Tandon (1979) reported the average T.S. % of milk of Hariana to be 13.40 which is very close to the finding of the present study. Besides, Chourasia and Jain (1993) also reported significant ($P<0.05$) effect of breed crosses on T.S. % which is similar to the finding of the present investigation.

EFFECT OF NON-GENETIC FACTORS :

EFFECT OF SEASONS :

Least squares analysis of variance revealed (table-31) highly significant ($P<0.01$) effect of season on T.S. % of milk in Hariana and its crosses with Holstein Friesian. The average T.S.% in S_1 and S_2 seasons were observed to be 12.5197 and 13.1180 respectively. Winter season had 0.5983% significantly ($P<0.01$) higher T.S.% than rainy. Kaushik and Tandon (1979) in Hariana and Yadav *et al.* (1991) in halfbreds of HF, BS and Jersey with Hariana also observed significant effect of season on T.S. % which are in agreement with the finding of the present study. However, Chourasia and Jain could not find significant effect of T.S.% of milk in four genetic groups of crossbreds. The differences in T.S.% in various seasons might be attributed to feeding regime, managemental practices and other environmental climatic conditions.

Effect of Parity of Lactation :

Least squares analysis of variance (table-31) presented non-significant effect of parity of lactation on T.S. % in Hariana and its crosses with Holstein Friesian. The least squares means ± S.E. along with C.V.% in different parity have been presented in table-33 which ranged from 12.4022% in P_4 to 13.067% in P_5 parity. However, the average value of T.S.% in different parity did not differ significantly. Kaushik and Tandon (1979) also observed non-significant effect of lactational sequance of T.S.% in Hariana which is in conformity with the finding of the present study.

SOLID NOT FAT % :

GENETIC FACTOR :

Least squares analysis of variance presented non-significant effect of genetic groups on SNF % in Hariana and its crosses with Holstein Friesian (table-34).

The least squares means ± S.E. and C.V.% of SNF % have been shown in table-35 which ranged from 8.419 in G_4 group to 8.793 in G_3 group. The SNF % of HF < 50% and ½ HF ½ H genetic groups were higher by 0.279% and 0.372% than Hariana respectively. Besides, G_2 and G_3 groups had also higher SNF% by 0.281% and 0.374% than G_4 genetic group. But none of these average values differed significantly. However, Chourasia and Jain (1993) observed significant effect ($P<0.05$) of genetic groups in crossbred dairy cattle.

NON-GENETIC FACTORS :

Effect of Season : Least squares analysis of variance (table-34) presented non-significant effect of seasons on SNF % in Hariana and its crosses with HF.

The average SNF% in S_1 and S_2 seasons were found to be 8.4779% and 8.6894% respectively. Although, the average SNF % of winter season was higher by 0.2115% than rainy season, yet, the average values did not differ significantly. Chourasia and Jain (1993) also observed non-significant effect of season among cross-breds, the trend of which is similar to the trend obtained in the present study. However, contrary to this trend, Yadav *et al.* (1991) reported significant effect of season on SNF % in halfbreds of Jersey, BS and HF with Hariana.

Groups	Mean ± S.E.	C.V.%
P_1	8.8230 ± 0.3558 (11)	13.3748
P_2	8.6172 ± 0.2699 (25)	15.6605
P_3	8.4933 ± 0.2623 (24)	15.1296
P_4	8.3063 ± 0.2717 (22)	15.3424
P_5	8.8564 ± 0.3061 (15)	13.3860
P_6	8.5601 ± 0.5838 (3)	11.8126
P_7	8.4823 ± 0.8000 (2)	13.3380
P_8	8.5304 ± 0.6741 (2)	11.1756

Figures in parentheses indicate number of observations.

PHENOTYPIC CORRELATIONS AMONG MILK CONSTITUENT TRAITS :

Fat % x T.S. % :

The estimates of r_p alongwith their S.E. between fat % and T.S.% in different genetic grades have been depicted in table-37.

An appraisal of table-37 revealed that the estimate of r_p ranged from 0.584 in G_4 to 0.876 in G_1 genetic groups whereas the pooled estimate was found to be 0.659. Thus, the table reflected that there was positive, highly significant ($P<0.01$) and high magnitude of r_p between fat% and T.S.% of milk. Kaushik and Tandon (1979) in Hariana cattle and Darashanlal and Narayanan (1990) in different breeds of dairy cattle also reported positive, significant and high magnitude of the estimates of phenotypic correlation coefficient between fat% and T.S. % which are in conformity with the finding of the present study.

Positive, significant ($P<0.01$) and high magnitude estimates of r_p might suggest that selection for Fat % would also lead to improvement in T.S. % of milk and vice-versa through correlated responses.

Table – 37 : Phenotypic co-relation co-efficient among milk constituents traits of various grades of cattle.

Genetic Grade	Fat % X T.S. %	Fat % X S.N.F%	T.S.% X S.N.F.%
G_1	0.876** ± 0.248	0.466^{NS} ± 0.442	0.835* ± 0.274
G_2	0.591** ± 0.158	0.006^{NS} ± 0.196	0.810** ± 0.115
G_3	0.652** ± 0.138	0.108^{NS} ± 0.181	0.746** ± 0.121
G_4	0.584** ± 0.135	0.293^{NS} ± 0.160	0.870** ± 2.957
Pooled	0.659** ± 0.074	0.180^{NS} ± 0.097	0.804** ± 0.058

G_1 = Hariana pure G_2 = HF < 50%

G_3 = HF 50% G_4 = HF 75%

* Significant at P<0.05,

** Significant at P<0.01

NS : Non-significant

Fat % x S.N.F. % :

The genetic grade-wise pooled estimates of r_p along with S.E. between Fat % and S.N.F.% have been presented in table-37. The pooled estimates of r_p between Fat % and SNF% was found to be 0.180, whereas it ranged from 0.006 in G_2 to 0.466 in G_1 genetic groups. It was observed that all the five values of r_p were positive but non-significant. Kaushik and Tandon (1979) also reported positive but low magnitude (0.039) of r_p between butter fat % and SNF % in Hariana cattle. Darshanlal and Narayanan (1990) also observed positive and highly significant (P<0.01) overall estimates of r_p in four different breeds of dairy cattle. The trend and direction of the estimates of r_p obtained in the findings of the present study are in agreement with the trend and direction reported by the above authors.

SNF % x T.S. % :

The overall and genetic grade wise estimate of r_p along with their S.E. between SNF% and T.S.% have been depicted in table-37.

The table-37 revealed that all the five values of estimates of r_p between T.S.% and SNF% of milk were positive and significant either at $P<0.05$ or $P<0.01$ levels of significance.

The pooled estimate of r_p between T.S. % and SNF % was observed to be 0.804 whereas in different genetic groups it ranged from 0.746 in G_3 to 0.870 in G_4 genetic groups. Thus, the table-37 very clearly indicate that there is positive, significant and high magnitude of phenotypic correlation between T.S. % and SNF % of milk. Besides, the low values of standard error of r_p reflect its high precision. Kaushik and Tandon (1979) reported positive estimates of r_p in Hariana cattle and Darshanlal and Narayanan (1990) in four different genetic groups of dairy cattle also observed positive, significant ($P<0.01$) and high magnitude of estimates of r_p between T.S. % and SNF % of milk which are in conformity with the finding of the present study.

Positive, significant ($P<0.01$) and high magnitude estimate of r_p between T.S. % and SNF % of milk might suggest that selection for T.S. % would also lead to improvement in SNF % and vice-versa through correlated responses.

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CHAPTER - V

SUMMARY AND CONCLUSION

SUMMARY

The present investigation was conducted on 301 Hariana and its crosses with Holstein Friesian and Jersey maintained at Rajendra Agricultural University Cattle Farm, Pusa, Samastipur, Bihar for various production and reproduction traits during the period 1980 to 2001. The various genetic groups for these traits were Hariana pure, HF < 50%, HF 50%, HF 62.5%, HF 75% and Jersey 50%. The different production and reproduction traits studied in this experiment were :

1. 300 days or less milk yield (kg)
2. Lactation length (days)
3. Peak yield (kgs)
4. Days to attain peak yield
5. Average daily milk yield (kgs)
6. Dry period (days)
7. Age at 1st calving (days)

The effect of various genetic and non-genetic factors on these traits were studied. The gentic factors were various genetic groups, whereas the non-genetic factors included period of calving, season of calving and parity of lactation.

Besides, this study was also conducted on 104 Hariana and its crosses with Holstein Friesian for milk constituent traits such as fat%, total solid % and solid not fat %. The genetic factors were various genetic groups, whereas the non-genetic factors included season and parity of lactation on these traits.

The investigation was planned with the following objectives :

1. To estimate the average value for different production and reproduction traits in Hariana and its crossbred grades with Holstein Friesian and Jersey.
2. To study the effect of genetic and non-genetic factors on production and reproduction traits in Hariana and its crossbred grades with Holstein Friesian and Jersey.
3. To study the average values of milk constituent traits and the effect of genetic and non-genetic factors on them in Hariana and its crosses with Holstein Friesian.
4. To study the relationships among various production and reproduction traits and among milk constituent traits in Hariana and its exotic crossbred grades.

The lowest (909.88 kg) and the highest (1836.52kg) 300 days or less milk yield were observed in Hariana and ½ HF ½ H genetic groups. Genetic group had significant ($P<0.01$) effect on 300 days or less milk yield. The ½ HF ½ H group yielded highest quantity of milk which was significantly ($P<0.05$) higher by 926.64 kg, 751.2 kg and 975.63 kg than Hariana, HF<50% and HF 62.5% genetic groups respectively. The ½ HF 1/2H genetic group, thus, had more than double 300 days or less milk yield than Hariana and HF 62.5% groups. Further, the ½ HF 1/2H genetic group had 96.09 kg and 166.94 kg more milk than ½ J ½ H and HF 75% groups respectively. The ½ J ½ H group yielded second highest 300 days or less milk yield which was higher by 830.55kg, 655.11kg, 879.54 kg and 70.85 kg than Hariana, HF < 50%, HF 62.5% and HF 75% genetic groups respectively.

The period of calving, season of calving and parity of lactation had no significant effect on 300 days or less milk yield.

The highest (462.69 days) and lowest (325.38 days) lactation lengths were observed in ½ J ½ H and Hariana genetic groups. The genetic group had significant ($P<0.01$) effect on lactation length (days). The ½ J ½ H genetic group had significantly ($P<0.05$) more lactation length by 137.37 and 71.95, 127.84, 121.22 and 55.71 days than Hariana, HF < 50% HF 50%, HF 62.5% and HF 75% genetic groups respectively.

The period of calving, season of calving and parity of lactation did not influence the lactation length significantly.

The highest (11.02 kg) average peak yield was observed in ½ HF ½ H genetic group, whereas the lowest (5.32kg) value was noted in HF 62.5% group. Genetic group had significant effect on peak yield. The ½ HF ½ H genetic group had significantly ($P<0.05$) higher peak yield by 5.66 kg, 4.65 kg, 5.70 kg, 2.13 kg and 2.46 kg than Hariana, HF < 50%, HF 62.5% HF 75% and J 50% genetic groups respectively. The second and third highest values of mean peak yield were found in HF 75% and J 50% genetic groups respectively which did not differ significantly.

The period of calving, season of calving and parity of lactation had no significant influence on peak yield.

The average days to attain peak yield ranged from 26.80 days in HF < 50% group to 39.72 days in Hariana. All the crossbreds had lower average DAPY than Hariana. Although, ½ J ½ H genetic group had 5.0 days less average DAPY than ½ HF ½ H group, yet there was no significant difference between these two values of average DAPY. Besides, the genetic grade HF <

%, HF 50% and HF 62.5% group did not differ significantly with spect to average DAPY.

Period of calving had significant (P<0.05) effect on DAPY. The west average DAPY was observed during 1996-99 which was significantly P<0.05) lower by 13.54 days and 10.06 days than 1984-87 and 1988-91 periods respectively.

Season of calving had significant (P<0.05) effect on DAPY. The verage DAPY in winter season was observed to be highest which was significantly (P<0.05) higher by 10.86 days, 7.41 days and 8.27 days than summer, rainy and spring seasons. However, average DAPY of summer, rainy and spring seasons did not differ significantly.

The parity of lactation had no significant effect on DAPY. The highest (6.05 kg) and lowest (2.75 kg), average daily milk yield were observed in ½ HF ½ H and Hariana genetic groups respectively. Genetic factors significantly affected the ADMY. The genetic group ½ HF ½ H had significantly (P<0.05) higher ADMY by 3.3 kg 2.59 kg, 3.23 kg, 1.21 kg, 1.02 kg than Hariana, HF < 50%, HF 62.5%, HF 75% and J 50% genetic groups respectively. The lowest ADMY was observed in Hariana which significantly (P<0.05) increased with the increase of HF inheritance up to 50% where it was observed to be maximum. Thereafter, it significantly (P<0.05) decreased in HF 62.5% and HF 75% genetic groups.

The period of calving had significant (P<0.05) effect on ADMY (P<0.05). The ADMY was observed to be highest (4.69kg) in 1988-91 which was significantly (P<0.05) higher by 1.39 kg and 0.79 kg than 1980-83 and 1992-95 periods respectively. However, the other periods of calving did not differ significantly with respect to ADMY.

The season of calving and parity of lactation had no significant effect on ADMY.

The highest (201.10 days) and lowest (113.40 days) average dry periods were observed in Hariana and HF 75% genetic groups respectively. The average dry period in Hariana was almost double than the average dry period of ½ HF ½ H, ½ J ½ H and ¾ HF ¼ H genetic groups. However, the mean dry periods of HF < 50%, HF 50%, HF 75% and J 50% genetic groups did not differ significantly.

The period of calving, season of calving and parity of lactation did not affect the dry period significantly.

The age at 1st calving ranged from 1416.07 days in J 50% group to 1754.04 days in Hariana. The ½ J ½ H group had significantly ($P<0.05$) lower AFC than Hariana, HF < 50%, HF 62.5% and HF 75% by 337.91 days, 264.29 days, 227.01 days and 207.32 days respectively. Besides, HF 62.5% and HF 75% had also significantly ($P<0.05$) 110.96 days and 130.65 days less AFC than Hariana, respectively.

The period of calving, season of calving and parity of lactation had no significant effect on age at first calving.

On overall basis, the 300 days or less milk yield was observed to be positively correlated with lactation length, peak yield, days to attain peak yield, average daily milk yield and age at 1st calving, whereas it was significantly ($P<0.01$) negatively correlated with dry period.

The lactation length had positive phenotypic correlations with peak yield and days to attain peak yield and age at 1st calving and negative correlations with lactation length and average daily milk yield.

50%, HF 50% and HF 62.5% group did not different significantly with respect to average DAPY.

Period of calving had significant (P<0.05) effect on DAPY. The lowest average DAPY was observed during 1996-99 which was significantly (P<0.05) lower by 13.54 days and 10.06 days than 1984-87 and 1988-91 periods respectively.

Season of calving had significant (P<0.05) effect on DAPY. The average DAPY in winter season was observed to be highest which was significantly (P<0.05) higher by 10.86 days, 7.41 days and 8.27 days than summer, rainy and spring seasons. However, average DAPY of summer, rainy and spring seasons did not differ significantly.

The parity of lactation had no significant effect on DAPY. The highest (6.05 kg) and lowest (2.75 kg), average daily milk yield were observed in ½ HF ½ H and Hariana genetic groups respectively. Genetic factors significantly affected the ADMY. The genetic group ½ HF ½ H had significantly (P<0.05) higher ADMY by 3.3 kg 2.59 kg, 3.23 kg, 1.21 kg, 1.02 kg than Hariana, HF < 50%, HF 62.5%, HF 75% and J 50% genetic groups respectively. The lowest ADMY was observed in Hariana which significantly (P<0.05) increased with the increase of HF inheritance up to 50% where it was observed to be maximum. Thereafter, it significantly (P<0.05) decreased in HF 62.5% and HF 75% genetic groups.

The period of calving had significant (P<0.05) effect on ADMY (P<0.05). The ADMY was observed to be highest (4.69kg) in 1988-91 which was significantly (P<0.05) higher by 1.39 kg and 0.79 kg than 1980-83 and 1992-95 periods respectively. However, the other periods of calving did not differ significantly with respect to ADMY.

However, all these estimates mere statistically non-significant. But the negative estimate of r_p between lactation length and dry period was found to be statistically significant.

The peak yield was positively and significantly ($P<0.01$) correlated with days to attain peak yield, average daily milk yield and age at 1st calving and negatively correlated with dry period.

The days to attain peak yield had positive but non-significant estimate of r_p with average daily milk yield and dry period. However, it had significant ($P<0.01$) phenotypic correlation with age at 1st calving.

The average daily milk yield had significant ($P<0.01$) negative correlation with dry period but significant ($P<0.05$) positive correlation with age at 1st calving.

Dry period was observed to be significantly ($P<0.01$) negatively correlated with age at 1st calving.

The significant, positive and high magnitude estimate of r_p between two traits might suggest that selection in one of traits would lead to improvement in other trait.

The average fat % ranged from 3.763 in ¾ HF ¼ H to 4.740 in Hariana. Genetic group had significant ($P<0.01$) effect on fat%. The fat % in milk was highest in pure Hariana which significantly ($P<0.05$) decreased with increase in inheritance of Hostein Friesian.

Season played significant role in determining the fat %. Winter season had significantly ($P<0.01$) 0.261% higher milk fat% than rainy reason.

The parity of lactation had no significant effect on fat %.

The average total solid % ranged from 12.156% in ¾ HF ¼ H genetic group to 13.160 in Hariana. Genetic group had significant effect on total

solid %. The total solid % of Hariana, < 50 HF, ½ HF ½ H genetic groups were significantly (P<0.01) higher by 1.001%, 0.813% 0.833% than ¾ HF 1/4H genetic group respectively. However, T.S.% of Hariana, < 50 % HF and ½ HF ½ H genetic groups did not differ significantly.

Seasons had highly significant (P<0.01) effect on total solid % of milk in Hariana and its crosses with Holstein Friesian. Winter season had 0.5983% significantly (P<0.01) higher total solid % than rainy.

The parity of lactation, however, had no significant effect on total solid %.

The average solid not fat % ranged from 8.419% in ¾ HF ¼ H group to 8.421 % in Hariana. However, both genetic and non-genetic factors did not affect the solid not fat% significantly.

There were positive, highly significant (P<0.01) and of high magnitude estimates of phenotypic correlation between fat % and total solid % with low estimates of standard error in all the genetic groups.

The estimates of r_p between fat % and solid not fat % in all the genetic groups were observed to be positive but non-significant.

There were positive, significant (P<0.05 or P<0.01) and of high magnitude estimates of phenotypic correlations between total solid% and solid not fat % in all the genetic groups.

In general, all these three milk constituent traits were positively correlated. Positive, significant and high magnitude estimates of r_p among these traits might suggest that selection for any of these milk constituent traits would also lead to improvement in other traits through correlated responses. Thus it may be concluded that selection should be based on fat%, since it is easily estimatable and it would also lead to gain in total solid and solid not fat percentages.

CONCLUSION

1. The ½ HF ½ H genetic group i.e. HF 50% had the highest 300 days or less milk yield followed by ½ J ½ H genetic group.
2. The ½ HF ½ H genetic group had highest peak yield and average daily milk yield among all the genetic groups.
3. All the crossbreds had lower days to attain peak yield than Hariana.
4. The ½ HF ½ H, HF < 50%, HF 75% and ½ J ½ H groups had significantly lower dry period than Hariana.
5. The age at 1st calving of all the crossbreds were lower than Hariana.
6. The 300 days or less milk yield was positively correlated with lactation length, peak yield, average daily milk yield and age at 1st calving and negatively correlated with dry period.
7. Fat % was observed to be highest in Hariana which decreased with the increase in inheritance of Hostein Friesion.
8. Winter season had significantly higher fat and total solid percentages than rainy season.
9. There were positive phenotypic correlations among fat %, total solid % and solid not fat % in all the genetic groups.
10. On the basis of 300 days or less milk yield, peak yield, lactation length and average daily milk yield, it may be concluded that ½ HF ½ H genetic group is most suitable in hot and humid agro-climatic region of Bihar.
11. Since fat %, total solid % and solid not fat% were positively correlated, therefore, selection should be based on fat % as it is easily estimatable and it would also lead to improvement in total solid and solid not fat % through correlated responses.

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