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**STUDIES ON PERFORMANCE OF FRIESIAN X SAHIWAL GRADES
WITH SPECIAL REFERENCE TO FUNCTIONS OF TEMPERATURE,
HUMIDITY AND MILK YIELD UNDER PENINSULAR INDIA**

BY

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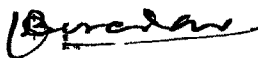
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CERTIFICATE I

Shri Umakant Gangappa Biradar has satisfactorily prosecuted his course of research for a period of not less than four semesters and that the dissertation entitled " STUDIES ON PERFORMANCE OF FRIESIAN x SAHIVAL GRADES WITH SPECIAL REFERENCE TO FUNCTIONING OF TEMPERATURE, HUMIDITY AND MILK YIELD UNDER PENINSULAR INDIA " submitted by him is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the dissertation or part thereof has not been previously submitted by him for a degree of any University.

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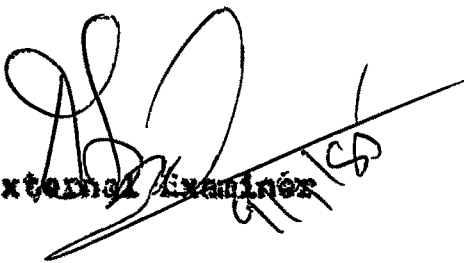
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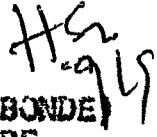
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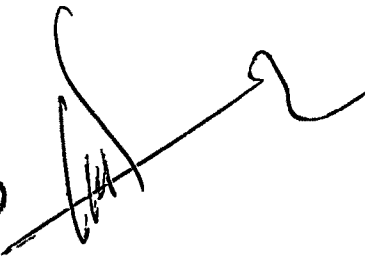
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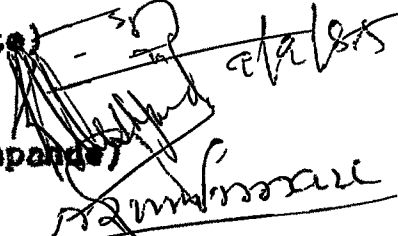

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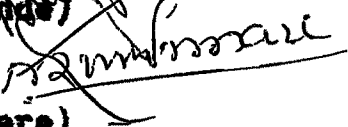

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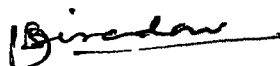
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CONTENTS

<u>Chapter</u>		<u>Page</u>
1.	INTRODUCTION	1-5
2.	REVIEW OF LITERATURE	6-34
3.	MATERIALS AND METHODS	35-52
4.	RESULTS	53-129
5.	DISCUSSION	130-155
6.	SUMMARY AND CONCLUSIONS	156-167
	LITERATURE CITED	1-xviii
	APPENDICES	1-xxviii

1. INTRODUCTION

1. INTRODUCTION

Our national economy to a large extent is dependent on the livestock among which cattle occupy the pivotal position. Though, India has the largest number of cattle, the country produces only 6 per cent of the world's milk production. The availability of milk per capita per day comes down to 100 g by 1969-70 as against 150 g during 1950-51. Owing to sustained efforts for improvement of cattle by the country during the last 10 years, the availability of milk at present is around 126 g inspite of the enormous population growth. During 1979-80, milk production in the country was around 30 million tons against a projected demand of 50 million tons for 1980, with a deficit of about 20 million tons.

The genesis of low productivity associated with our cattles has been a prolonged effect of breeding and management followed through ages. The development of present day indigenous breeds of cattle is imbibed in the ecological assortment of their utility. Therefore, a breed to breed variation in their characters has arisen as a result of slow genetic transformation from generation to generation. It is needless to emphasize on usage of our cattle in agriculture as a motive power. There has been a general trend among the breeders to develop animals with better

draft capacity suitable to a specific ecological situation. There are 26 well recognized cattle breeds in our country. Irrespective of the ecological classification of our cattle their importance as milch, dual and draft purpose breeds has been realized at the national level. Sahiwal, Gir, Red Sindhi, Tharparkar breeds of cattle are recognized for milk production. Whereas, Mariana, Dooni, Kankrej, Ongole and Kathi are categorised as dual purpose. The draft purpose type includes Khillar, Amrit Mahal, Hallikar, Kangayam, Malvi etc. Of late, till 1918 not much attention was paid to improve the productivity. Importance of cattle from milk production point of view was recognized in the beginning of the 1st world war and thereafter.

The indigenous cattle breeds are low producers, they mature late and have a delayed conception coupled with long calving intervals. They are hardy and better adapted to tropical climate. Though, enough genotic variability is available in these breeds, but their improvement through selective breeding happen to be slow rewarding. Keeping in view our limited land resources increase in the productivity per animal would lead to increased returns per unit area. It can be accomplished slowly through selection and rather rapidly through introduction of superior inheritance from potential exotic dairy breeds.

Early efforts for introducing productive genes from European cattle through crossbreeding of indigenous stock were made by European planters, missionaries and administrators in various hill stations and cantonments. Organized efforts for crossbreeding were initiated by the military dairy farm authorities through breeding Sahiwal and Red Sindhi cattle with Holstein Friesian sires. In 1964 the Government of India decided to adopt a policy of crossbreeding on a wide scale to promote milk production. Accordingly the crossbreeding of indigenous cattle with exotic dairy breed was reported through organized sectors i.e. military dairy farms and Government cattle breeding farms etc. A systematic approach for improving the productivity of our cattle has been resorted through five year plans. Some of the important activities like Key Village Scheme, Goushala Development Scheme, Intensive Cattle Development Project, establishment of Cattle Breeding Farms, Co-ordinated Research Projects and massive crossbreeding programme on field scale are the efforts worth mentioning. Extensive application of artificial insemination technique, use of frozen semen technology have become the popular tools to augment quick improvement. Thus an effort for slow transformation of existing genetic material into a more productive type has been the major goal of five year plan.

Use of exotic germplasm of dairy breeds namely Friesian, Jersey, Brown Swiss and Red Dane on indigenous cattle has been resorted. As a result of cross breeding large number of cross progeny have been produced. The performance records on production and reproduction traits are now available. The production and reproduction records are made by the cross progeny in the environment of their breeding tracts.

The Agro-climatic condition are so diverse that a particular type of animal which proves to be economical producer in one region may turn out to be uneconomical in another. The climate, agricultural practices, nature of crops and grasslands may support some good animals in one part, the same animals when raised in different environment may find it difficult to survive and perform reasonably.

Environment play an important but deceptive role in the expression of quantitative traits. Milk production is the end result of a long chain of events caused by manifold complex physiological functionings. It means that genes, gene interactions and genotype-environmental interaction have played their role. Environmental factors such as temperature, solar radiation, humidity and wind velocity affect animal performance. Decreasing trend in milk and fat yield under high environmental

temperature have been reported (Johnson, 1976; McDowell et al., 1976 and Moody et al., 1967). Rodriguez et al. (1977) found that the relative humidity and maximum and minimum temperatures accounted for significant amount of variability (1 to 16 per cent) in milk yield and percentage of milk constituents.

The objectives of this study were-

- 1) To identify the extent of influence of various factors on monthly and total yield of Friesian x Sahiwal grades.
- 2) To estimate the genetic and phenotypic correlations, heritability of various characters in Friesian x Sahiwal grades.
- 3) To assess the relationship of temperature and humidity with monthly milk yield in Friesian x Sahiwal grades.

...

2. REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

2.1 Lactation period

The average lactation length of 338 days in 1/2 Kerry x Punganur cows was reported by Venkatarathan and Venkayya (1964). The lactation length of 327 and 255 days was observed in 1/2 Holstein Friesian F_1 and F_2 respectively by Zurita and De'Alba (1967). The 1st lactation length for Sahiwal cows was reported as 297.3 ± 78.5 days by Kushwaha and Miera (1969). First, 2nd and 3rd lactation lengths were 328, 314 and 325 days for Sahiwal, 304, 294 and 285 days for Red Sindhi, 388, 289 and 257 days for Brown Swiss crosses, respectively as reported by Chopra et al. (1973). Gangwar et al. (1973) recorded the average 1st lactation length as 271, 274, 285 and 264 days in 1/3, 1/4, 3/4 and 5/8 bred Holstein Friesians, respectively. The lactation periods of 277, 295, 286 and 289 days were reported by Kassab et al. (1976) in 1/2, 3/4, 7/8 and 15/16 Friesian x Janubi crossbreds, respectively. The average 1st lactation length of 299.73 days was observed in Holstein Friesian x Sahiwal crossbreds by Katpatal et al. (1979). The lactation length of 298.8 days in Friesian x Zebu cows was recorded by Rao and Nagarcenkar (1979). The 1st mean lactation length 332.98 ± 7.21 days in Friesian x Local cows was reported by Sewlikar et al. (1979). The average lactation length of 353.60 ± 5.70 days

for Friesian x Sahiwal crossbred cows was reported by Gurcharan Singh et al. (1960). Subanendran et al. (1961) concluded that the lactation length was longer by 41 days in 7/8 bred than 1/2 Friesian x White Fulani. Lad et al. (1962) reported average lactation period in 1/2 bred Friesian x Deoni cows for 1st and 2nd lactations as 312.04 ± 6.63 and 292.70 ± 9.63 days. The corresponding figures for 3/4 Friesian x 1/4 Deoni were 337.75 ± 23.98 and 300.57 ± 30.77 days. The mean lactation period in 1/2 bred Friesian x Deoni and Jersey x Deoni cows were observed as 304.14 ± 4.91 and 289 ± 5.80 days by Sarode (1982). Bonde et al. (1983) reported the lactation period in 1/2 bred Friesian x Deoni as 310.27 ± 7.01 , 310.57 ± 8.57 and 299.37 ± 7.94 in 1/2 bred Jersey x Deoni as 266.1 ± 21.19 , 299.16 ± 12.19 and 270.50 ± 20.5 in 3/4 bred Friesian x Deoni as 365.00 ± 20.00 , 363.14 ± 43.44 and 392.00 ± 23.59 days for 1st, 2nd and 3rd lactations, respectively.

2.1.1 Grade effect

Non-significant effect of grades on lactation length has reported by Gandhu et al. (1973) for Sahiwal and its crosses with Friesian. Non-significant differences on lactation length of different Friesian x Sahiwal grades such as 1/8, 1/4, 1/2, 5/8 and 3/4 have been reported by Verma et al. (1973). Lal (1975) reported that the

lactation period was significantly influenced by the level of Friesian inheritance. 1/4 and 1/2 breeds had significantly shorter lactation period than 5/8 and 3/4 Friesians which however, did not differ from each other. The lactation length averaged as 277, 295, 286 and 289 days for crossbred Janubi cows with 1/2, 3/4, 7/8 and 15/16 Friesian inheritance (Kassab *et al.*, 1976).

Pandey *et al.* (1978) did not observe significant differences in lactation periods of various grades namely 1/8, 1/4, 3/8 and 1/2 Friesian x Red Sindhi cross progeny. Non-significant effect of grade on lactation length in Friesian x Sahiwal crossbreds was reported by Katpatal *et al.* (1979).

2.1.2 Farm effect

The least squares analysis of variance showed significant effect due to farms on lactation length in Sahiwal and its crosses with Friesian as reported by Sandhu *et al.* (1973). Bhat *et al.* (1978) stated that farm had significant effect on lactation length in Sahiwal x Friesian crossbreds. Significant effect of farms on lactation length in Friesian x Zebu crossbreds was reported by Rao and Nagarcenkar (1979).

2.1.3 Period effect

Balaine *et al.* (1971) observed that period of calving had significant effect on lactation length in Mariane cows.

Lactation length was significantly affected by periods as reported by Sandhu et al. (1973) in Sahiwal and its crosses with Friesian. Bhat et al. (1978) recorded significant effect due to period of calving on lactation length in Sahiwal x Friesian crossbreds.

2.1.4 Age at first calving effect

Kushwaha and Misra (1969) reported that the age at first calving had highly significant effect on lactation length of Sahiwal cows.

2.2 Dry period

Venkataratnam and Venkayya (1964) reported a dry period of 89 days in 1/2 Kerry x Punganur cows. The average first dry period of 196.10 ± 98.40 days in Sahiwal cows was reported by Kushwaha and Misra (1969). Dry periods of 187.10, 64.10 and 79.60 days were observed in Mariana, Friesian x Mariana and Jersey x Mariana, respectively by Parmar (1976). Average dry period of 176.30 ± 7.50 days for 1/2 bred Gir x Friesian crosses was observed by D'Souza et al. (1978). Dry periods of 52, 51 and 54 days in Friesian x Tharparkar, Jersey x Tharparkar and Brown Swiss x Tharparkar cross progeny were reported by Nagarcenkar et al. (1978). D'Souza et al. (1979) observed dry periods of 85.00 and 74.70 days in Friesian x Red Gindhi and Red Dane x Red Sindhi, respectively.

The average dry period of 119.40 ± 8.20 days with a range of 90 to 130 days for different lactations in Friesian x Sahiwal crossbred cows was observed by Gurcharan Singh et al. (1980). The mean dry periods of 108.14 ± 11.76 and 113.34 ± 12.07 for 1/2 bred and 164.25 ± 47.30 and 103.00 ± 32.41 days for 3/4 bred Friesian x Deoni cows in 1st and 2nd lactations, respectively have been reported by Lad et al. (1982). For Friesian x Deoni and Jersey x Deoni crossbred cows the dry period averaged as 73.90 ± 7.79 and 82.21 ± 12.47 days, respectively (Sarode, 1982). Bonde et al. (1983) observed the average dry period of 112.38 ± 9.44 , 112.10 ± 9.49 and 97.00 ± 12.5 for 1/2 bred and 130.00 ± 48.49 , 102.20 ± 30.92 and 80.00 ± 33.66 days for 3/4 bred, Friesian x Deoni crossbred cows in 1st, 2nd and 3rd lactations respectively.

2.2.1 Grade effect

Genetic grades had significant influence on dry period in Friesian x Sahiwal crossbreds (Choudhary et al., 1977). Dhat et al. (1978) reported highly significant effect of grades (4/64 to 63/64 Friesian inheritance, on dry period in Friesian x Sahiwal crossbreds. Study on Friesian x Red Sindhi cows with 1/8, 1/4, 3/8 and 1/2 Friesian inheritance revealed non-significant effect of grade on dry period as reported by Pandey et al. (1978).

Basu and Ghai (1978) concluded that the dry period of cows having >75 per cent. Friesian inheritance was significantly shorter than that of < 50 per cent Friesian inheritance.

2.2.2 Farm effect

The effect due to farms was highly significant on 1st dry period in case of pure Sahiwal and Sahiwal x Friesian crossbreds as reported by Bhat et al. (1978).

2.2.3 Period effect

Chaudhary et al. (1977) observed non-significant effect of period on dry period in Friesian x Sahiwal crossbreds. Significant effect of period on dry period was reported by Bhat et al. (1978) in Friesian x Sahiwal crossbred cows. Similar findings were also reported by Basu and Ghai (1980) for Friesian x Sahiwal crossbred cows.

2.2.4 Age at first calving

Kushwaha and Miera (1969) reported that age at 1st calving had non-significant effect on 1st dry period for Sahiwal cows. The age at 1st calving had no influence on dry period in Friesian x Sahiwal crossbreds as observed by Chaudhary et al. (1977).

2.3 Intercalving period

Singh and Choudhary (1961) reported 484.40 days of intercalving period in Sahiwal cows. The average 1st

calving interval of 498.10 ± 124.20 days for Sahiwal cows was recorded by Kushwaha and Misra (1969). The calving interval of 391 to 420 days in Friesian x Janubi cows was observed by Kassab et al. (1976). The calving interval of 539.80, 468.90 and 434.20 days in Mariana, Friesian x Mariana and Jersey x Mariana crossbreds, respectively was observed by Parnar (1976). Narain and Garg (1979) reported 1st calving interval which averaged 442 days for Sahiwal or Friesian x Sahiwal cows. The average inter-calving period for Friesian x Sahiwal crossbreds was 462 days (Gurcharan Singh et al., 1980). The mean intercalving period of 387.70 ± 10.13 and 372.42 ± 15.77 days for Friesian x Deoni and Jersey x Deoni cows was reported by Sarode (1982).

2.3.1 Grade effect

Non-significant difference among the grades in respect of calving interval was noted by Verma et al. (1973) in Friesian x Sahiwal crossbreds. Non-significant difference between 1/2 Friesian + 1/2 Sahiwal, 1/2 Friesian, + 1/2 , Mariana, 3/4 Friesian, + 1/4 Mariana and 1/2 Friesian + 1/2 Tharparkar for intercalving periods were reported by Taneja (1974). Similar trend was also observed by Bhat et al. (1978) in pure bred Sahiwal and Sahiwal x Friesian crossbreds. The differences among crossbred

groups were non-significant for calving interval in Friesian x Red Sindhi cows with $1/8$, $1/4$, $3/8$ and $1/2$ Friesian inheritance as observed by (Pandey et al., 1978). Grade had non-significant influence on 1st calving interval of Brown Swiss x Sahiwal crossbreds (Dhatnagar et al., 1979). Narain and Garg (1979) reported significant difference due to grade in calving interval of Friesian x Sahiwal crossbreds. Similar results was also reported by Rao and Nagarcenkar (1979) in Friesian x Zebu crossbred. Non-significant differences among genotypes namely $1/2$, $5/8$ and $3/4$ bred Friesians in respect of 1st calving interval were observed by Narayanaswamy (1981). Anand and Salaine (1981) reported that genetic groups viz; Friesian, Friesian x Mariana, Brown Swiss x Mariana, Red Dane x Mariana had highly significant effect on calving interval. However, grade did not affect calving interval in Friesian x White Fulani cows as observed by Euvanendran et al. (1981).

2.3.2 Farm effect

Significant effect of farm on 1st calving interval in pure bred Sahiwal and Sahiwal x Friesian crossbreds was observed by Bhat et al. (1978). Narain and Garg (1979) reported the 1st calving interval which was unaffected by farm in Sahiwal and Friesian x Sahiwal cows. Non-significant effect of farms on calving interval was reported by Rao and Nagarcenkar (1979) in Friesian x Sahiwal crossbreds.

2.3.3 Period effect

Chat et al. (1978) reported significant effect of periods on first calving interval for Sahiwal and Sahiwal x Friesian crossbreds. Period was reported to have highly significant effect on calving interval for Friesian x Sahiwal crossbreds (Sahota, 1978). The first calving interval was unaffected by period in Sahiwal and Friesian x Sahiwal cows as observed by Narain and Garg (1979). Rao and Nagarcenthor (1979) reported non-significant effect of period on calving interval of Friesian x Sahiwal crossbreds.

2.3.4 Age at first calving effect

Kushwaha and Misra (1969) reported that age at first calving had significant effect on first calving interval in Sahiwal cows.

2.4 Service period

The average service period of 195.54 ± 67.20 days in Sahiwal cows was reported by Malik and Sandhu (1968). Chopra et al. (1973) recorded the average service period of 188, 150 and 102 days in Sahiwal, Red Sindhi and Brown Swiss F_1 crosses, respectively. Lal (1975) observed longest service period of 123.76 days in Sahiwal and shortest of 108.25 days in 1/2 bred Friesian x Sahiwal. Service period of 90 and 71 days in Friesian x Red Sindhi

and Red Dane x Red Sindhi crossbreds was observed by D'Souza et al. (1979). Average service period of 164.70 ± 9.90 days was recorded by Gurcharan Singh et al. (1930) in Friesian x Sahiwal crossbred cows. Deshpande and Bonde (1983) reported the average first service period as 154.39 ± 5.32 days for Friesian x Sahiwal crossbreds.

2.4.1 Grade effect

Sandhu et al. (1973) observed significant effect of grade on service period in Friesian x Sahiwal crossbreds. Non-significant effect of grade on service period was recorded by Verma et al. (1973), Chaudhary et al. (1977) and Bhat et al. (1978). Highly significant effect of grade was observed by Sahota (1978) in Friesian x Sahiwal crossbreds. Dangl et al. (1980) reported non-significant effect of grade on service period in Friesian x Sahiwal crossbreds. Genetic group had a highly significant effect on service period as concluded by Anand and Dalaine (1981) in Friesians, Friesian x Mariana, Brown Swiss^{SS} Mariana and Red Dane x Mariana cows.

2.4.2 Farm effect

Non-significant effect of farm on service period in Friesian x Sahiwal crossbreds was reported by Sandhu et al. (1973). Chaudhary et al. (1977) and Bhat et al. (1978) recorded significant effect of farm

on service period for Friesian x Sahiwal crossbreds. Non-significant effect of farm on service period in Friesian x Sahiwal crossbreds was observed by Sahota (1978) and Dangl et al. (1980). Deshpande and Sondo (1983) observed highly significant effect of farm on the length of the first service period in Friesian x Sahiwal crossbreds.

2.4.3 Period effect

Significant effect of period on service period was observed in Friesian x Sahiwal by Sandhu et al. (1973). Non-significant effect of period on service period of Friesian x Sahiwal crossbred was reported by Chaudhary et al. (1977). Significant effect of period was observed by Bhat et al. (1978) in Friesian x Sahiwal crossbreds. Similar observations were also made by Sahota (1978) in Friesian x Sahiwal crossbreds. Non-significant effect of periods on service period in Friesian x Sahiwal cows was recorded by Dangl et al. (1980).

2.4.4 Age at first calving

Chaudhary et al. (1977) reported that age at first calving had non-significant effect on service period in Friesian x Sahiwal crossbreds.

2.5 Monthly milk yield

Moxely (1966) reported the significant effect of age at first calving on monthly lactation yield in Friesian herds. Pradhan (1974) studied weekly milk yield in Kankrej cows and observed a linear form of declination from 7th to 41st weeks. The weekly milk yield of Mariana cows was significantly affected by season of calving for 2 to 44 weeks of production (Basant Singh et al., 1979).

2.6 300 day milk yield

First lactation 305 day milk yield in F_1 Brown Swiss x Sahiwal and Brown Swiss x Red Sindhi cows was reported as 2979 ± 89 kg and 2009 ± 93 kg respectively, by Bhatnagar et al. (1969). The milk yield of 305 day from Jersey, Sahiwal x Jersey and Red Sindhi x Jersey cows was recorded as 4536, 4649 and 2694 kg respectively by Hayman (1972). The first lactation 300 day performance of $1/2$ Friesian + $1/2$ Sahiwal, $1/2$ Friesian + $1/2$ Mariana, $3/4$ Friesian + $1/4$ Mariana and $1/2$ Friesian + $1/2$ Tharparkar crossbred was 2213, 2373, 2431 and 2643 kg as recorded by Jeneja (1974). For non-descript Zebu, Red Sindhi, Brown Swiss x non-descript and Brown Swiss x Red Sindhi cows, the 300 days first lactation milk yield averaged as 793.00, 1072.80, 1611.40 and 1037.60 litres respectively as reported by Nair and Lalath (1977).

D'Souza et al. (1978) observed the first 300 day lactational yield as 2154.20 ± 106.30 kg for 1/2 bred, Gir x Friesian crossbreds. The average 305 day first lactational yield of the herd was 2767 litres in Red Dane x Sahiwal crossbreds as reported by Gill et al. (1978). The average milk yield of 305 day in Friesian x Local and Jersey x Local was 2022.89 and 1856.53 kg respectively as reported by Gurcharan Singh et al. (1980).

2.6.1 Grade effect

Bhatnagar et al. (1969) observed that first lactation 305 day milk yield was non-significant in F_1 Brown Swiss x Sahiwal and Brown Swiss x Red Sindhi crossbreds. The 300 day lactation yield in Friesian x Sahiwal crossbreds was significantly affected by level of exotic inheritance. Pandey and Desai (1973) reported that the 300 day milk yield increased significantly as the proportion of Friesian blood increased. Taneja (1974) reported that 1/2 Friesian + 1/2 Tharparkar gave highest and 1/2 Friesian + 1/2 Sahiwal gave lowest milk yield. The milk yield of 305 day in 1/2 Ayrshire + 1/2 Sahiwal and 3/4 Ayrshire + 1/4 Sahiwal was significantly affected by grade as observed by Kimenye (1970). Performance of 3/8 to 5/8 Friesian x Sahiwal cows was significantly better, than the lower blood levels in respect of 300 day milk yield (Tomar and Tomar, 1982).

2.6.2 Farm effect

Khanna and Bhat (1972) reported significant effect due to farm on 300 day milk yield in Sahiwal x Friesian crossbreds.

2.6.3 Period effect

Khanna and Bhat (1972) reported significant effect of period on 300 day milk yield in Sahiwal x Friesian crossbreds. Similar results was also reported by Koley *et al.* (1981) in Jersey x Mariana crossbreds.

2.6.4 Age at first calving effect

Chawla and Mishra (1979) reported significant effect of age at first calving on first lactation yield in Sahiwal, Brown Swiss x Sahiwal, Friesian x Sahiwal, Sahiwal x Friesian-Sahiwal crossbreds.

2.7 Total milk yield

Matson (1937) reported the average lactation yields of Sahiwal and 1/8, 1/2, 5/8, 3/4 and 7/8 Friesian grades were 1870, 3122, 3277, 2946 and 3210 kg in respective average lactation periods of 296, 310, 326, 323 and 239 days, respectively. Nagpal and Acharya (1971) studied the milk yield of Sahiwal cows in different lactations and recorded a range of 1596.96 ± 21 to 2092 ± 34 kg. The first lactation milk yield was 1287.30kg for Tharparkor dams Vs 2087.70 for their F_1 daughters from Jersey cross

and the 2nd and 3rd lactation yields were 1246.50 Vs. 2378.30, 1283.80 Vs. 2495.80 kg as recorded by Nagarcenkar (1969). Chopra et al. (1973) reported average milk yield of first 3 lactations in Sahiwal cows were 2136, 2398, 2546 and in Brown Swiss x Sahiwal F_1 cross were 3018, 2910, 2187 kg respectively. The average first lactation milk yields in 1/4, 1/8, 3/4 and 5/8 bred were 2015, 1572, 1990 and 1900 litres as reported by Gangwar et al. (1973). Singh et al. (1973) recorded the average first lactation milk yield in Sahiwal cows as 1595.34 ± 465.76 kg. Nagarcenkar (1970) reported total milk yield in the first lactation as 3027, 3258 and 3833 kg in Friesian x Tharparkar, Jersey x Tharparkar and Brown Swiss x Tharparkar, respectively. Gurcharan Singh et al. (1980) recorded the average lactation milk yield of 4324.10 ± 79.10 kg in Friesian x Sahiwal crossbreds.

2.7.1 Grade effect

Ganpule (1971) reported significant influence of Friesian inheritance on the milk yield of crossbreds. Milk yield in first lactation increased with increased Friesian inheritance up to 20-23/32 grade in Northern region and 17-19/32 grade in Southern region. Lactation yield in Friesian x Sahiwal crossbred was significantly affected by level of exotic inheritance. Milk yield

of Sahiwal and 1/4 Friesian was significantly lesser than those of 1/2, 5/8 and 3/4 Friesian which did not differ from each other as observed by Jain (1974). Taneja and Bhat (1974) reported that the first lactational yield of Sahiwal x Friesian cows increased with increasing Friesian inheritance up to 30/64 Friesian and thereafter no definite trend was observed. However, milk yield of 63/64 Friesian cows was non-significantly higher than that of all grades. Ahmed et al. (1971) reported significant grade differences in first lactation milk yield of 1/4, 1/2, 5/8 and 3/4 Friesian x Sahiwal crossbred cows. Further it was concluded that 1/2 brood Friesian inheritance with Sahiwal was the most suitable for milk production under tropical situation in India. Bhat et al. (1976) reported first lactation milk yield in 63/64 grade as highest and for 5/64 grade as lowest in Friesian x Sahiwal crossbreds, the grade differences being significant. Arora and Desai (1979) concluded that between group, the differences in milk yield were significant for Friesian x Sahiwal crossbred with ≤ 50 per cent and ≥ 50 per cent Friesian inheritance. Grade had significant effect on milk yield in Friesian x Mariana crossbred. Milk yield of 1/4 Friesians was significantly lower than those of 1/2, 3/4 and 7/8 Friesians, which however did not differ

significantly from one another as reported by Chowdhary and Barhat (1979). Narayanswamy (1991) recorded significant differences among grades (Friesian x Sahiwal crossbreds $1/2$, $5/8$ and $3/4$ Friesian) for total milk yield. The order of superiority was generally $1/2 > 5/8 > 3/4$ Friesian inheritance. Deshpande and Londe (1982) reported that milk yield were highly significantly different in $< 1/8$, $1/8$, $1/4$, $3/8$, $1/2$, $5/8$, $3/4$ and $7/8$ Friesian x Sahiwal crossbreds. The performance of $3/8$ to $5/8$ Friesian x Sahiwal cows which was significantly better than the lower blood levels in first lactation milk yield was observed by Tomar and Tomar (1982).

2.7.2 Farm effect

Khanna and Bhat (1971) studied the Sahiwal cows stationed at military farms of Ambala, Lucknow and Meerut and reported non-significant differences in milk yield due to farms. Farm had non-significant effect on milk production of Sahiwal cows as observed by Nagpal and Acharya (1971). Khanna and Bhat (1972) recorded significant effect of farm on lactation yield in Sahiwal x Friesian crosses. Significant effect due to farm on milk yield was observed by Sandhu et al. (1973). Taneja and Bhat (1974) reported significant effect due to farm on first lactation yield of Friesian x Sahiwal crossbred cows. Non-significant effect of farms on milk production

of Friesian x Sahiwal crosses was recorded by Chaudhary and Chaudhary (1977). The significant effect of farm on first lactation milk yield in Friesian x Sahiwal crossbreds was reported by Bhat et al. (1978). Deshpande and Bonde (1982) reported that the milk production was highly significantly affected by farm in Friesian x Sahiwal crossbreds.

2.7.3 Period effect

Period of calving had significant effect on first lactation milk yield as reported by Nagpal and Acharya (1971) in Haryana. Similar observations were made in Friesian x Sahiwal by Khanna and Bhat (1972); Jain and Dhillon (1975); Raheja and Balaine (1977). Chowdhary and Barhat (1979) reported significant effect of period on milk yield in Friesian x Haryana crossbreds. Narain and Garg (1979) stated that lactation yield of Friesian x Sahiwal crossbreds was unaffected by period. However, highly significant effect of period on milk yield was reported by Deshpande and Bonde (1982).

2.7.4 Age at first calving effect

The age at first calving had highly significant effect on first lactation milk yield in Sahiwal cows (Kushwaha and Misra, 1969). Nagpal and Acharya (1971) recorded that age at calving had significant effect on milk production in first lactation of Sahiwal cows.

Significant effect of age at first calving on milk production of Friesian x Sahiwal crossbred was noted by Chaudhary and Chaudhary (1977). Basu and Ghai (1977) reported that age at first calving had a non-significant effect on first lactation yield of Friesian x Sahiwal crossbreds. Significant effect of age at first calving on first lactation yield was observed in Sahiwal, Brown Swiss x Sahiwal, Friesian x Sahiwal and Sahiwal x Friesian- Sahiwal crossbreds (Chawla and Mishra, 1979).

2.8 Genetic and phenotypic correlations

2.8.1 Lactation period

Bhasin (1967) in Dewati cows reported that the lactation period was positively and significantly correlated with calving interval. Hargrove et al. (1969) recorded the phenotypic correlation as $r = 0.43$ between first lactation period and milk yield of first lactation. The phenotypic correlation between first lactation length and first lactation production for 305 days or less was significant (Gurnani et al., 1971). Tomar et al. (1972) in Mariana cows recorded positive significant phenotypic correlations of lactation length with service period. Correlation of lactation length with lactation yield was positive and highly significant (0.56). Chopra et al. (1973) in Brown Swiss crossbreds recorded highly significant and positive correlation of lactation period

with dry period and service period. Sandhu *et al.* (1973) reported positive and highly significant genotypic and phenotypic correlation of lactation length with first service period for most of Friesian x Sahiwal genetic groups. Kassar *et al.* (1976) observed significant correlation between lactation length and milk yield ($r = 0.71$) in Friesian x Janubi crossbreeds. Sahota (1978) in Friesian x Sahiwal reported highly significant and positive genetic and phenotypic correlation between lactation period and dry period, calving interval and service period. Deshpande (1981) observed highly significant and negative genetic correlation of lactation period with dry period, intercalving period, service period, whereas phenotypic correlation was highly significant and positive.

2.8.2 Dry period

Bhasin (1969) in Mariana cows reported highly positive genetic correlation of dry period with service period. Sahota (1978) in Friesian x Sahiwal reported genetic and phenotypic correlation of dry period with calving interval and service period was positive and highly significant. Whereas, genetic and phenotypic correlation of dry period with 300 day milk yield and total yield was negatively highly significant.

Patil et al. (1980) observed positive and significant correlation between dry period and service period. Deshpande (1981) in Friesian x Sahiwal observed highly significant and positive genetic correlation of dry period with calving interval, service period, 300 day milk yield and total yield. Whereas, highly significant and positive phenotypic correlation with calving interval, service period, negative non-significant with 300 day milk yield and positive non-significant with total yield was reported by him.

2.8.3 Intercalving period

Bhasin (1967) reported that the intercalving period was highly correlated with service period in Dewati cow. Genetic correlation of intercalving period with service period was highly significant in Friesian x Sahiwal (Sahota, 1978). Deshpande (1981) in Friesian x Sahiwal observed highly significant and positive genetic and phenotypic correlation with total yield.

2.8.4 Service period

Sandhu et al. (1973) in Friesian x Sahiwal observed the genetic correlation between the first service period and first total yield and was very high for most of the genetic groups. The phenotypic correlation between first service period and first total yield was positive for all the genetic groups except 3/4 bred where the correlation was negative and low.

2.8.5 Monthly milk yield

Sikka and Jeneja (1981) reported the genetic correlation of lactation yield with monthly yields up to 5th month in Sahiwal cattle as 0.90 ± 0.13 to 0.97 ± 0.02 .

2.8.6 300 day milk yield

Sahota (1978) in Friesian x Sahiwal recorded positive phenotypic correlations with all the traits except dry period. Deshpande (1981) reported that 300 day milk yield had highly significant and positive genetic and phenotypic correlations with all the traits studied except dry period where phenotypic correlation was negative and non-significant.

2.8.7 Total yield

The phenotypic correlation of lactation yield with lactation period was positive and highly significant as reported by Chopra *et al.* (1973). Kassab *et al.* (1976) in Friesian x Janubi observed significant correlation between milk yield and lactation length. Deshpande (1981) in Friesian x Sahiwal observed highly significant and positive genetic and phenotypic correlations with all the traits except dry period where phenotypic correlation was non-significant and positive.

2.9 Heritability

2.9.1 Lactation period

Narayankhedkar (1973) reported the heritability estimate of 0.01 ± 0.01 in Sahiwal. Taneja *et al.* (1978) in Friesian x Sahiwal reported the heritability estimates of 0.08 ± 0.06 and 0.15 ± 0.07 for 4-30/64 and 36-63/64 genetic groups. Deshpande (1981) in Friesian x Sahiwal recorded 0.015 ± 0.010 heritability.

2.9.2 Dry period

Tajena *et al.* (1978) in Friesian x Sahiwal reported the heritability estimates of 0.11 ± 0.07 , 0.24 ± 0.12 for 4-30/64 and 36-63/64 genetic groups. Basu and Ghai (1978) in Friesian x Sahiwal recorded the heritability estimates of 0.06, 0.03 for 1/2 and 3/4 breeds. Deshpande (1981) in Friesian x Sahiwal observed 0.075 ± 0.012 heritability.

2.9.3 Inter-calving period

Taneja (1974) in Sahiwal recorded the heritability estimate of -0.454. Sahota (1978) observed the heritability estimate of 0.033 in Friesian x Sahiwal. The heritability estimate for calving interval was not significantly different from zero as observed by Basu and Ghai (1980). Deshpande (1981) in Friesian x Sahiwal recorded the heritability estimate of 0.029 ± 0.011 .

2.9.4 Service period

Tomar et al. (1972) reported the heritability estimate of -0.07 in Mariana. Chopra et al. (1973) in Sahiwal, Sahiwal x Brown Swiss observed -0.094 ± 0.20 and 0.036 ± 0.404 heritability. Taneja et al. (1978) in Friesian x Sahiwal recorded heritability estimate of 0.21 ± 0.09 , 0.23 ± 0.12 in 30/60 and 63/64 genetic groups. Doshpande and Bonde (1983) in Friesian x Sahiwal recorded heritability estimate near to zero in Friesian x Sahiwal.

2.9.5 Monthly milk yield

Sikka and Taneja (1981) estimated heritability in Sahiwal as 0.37 ± 0.13 and 0.42 ± 0.19 for 3rd and cumulative monthly milk yield up to first 90 days.

2.9.6 300 day milk yield

The heritability estimates for 300 day milk yield were 0.65 ± 0.63 in Friesian x Sahiwal crossbreds (Misra et al., 1979). Koley et al. (1981) in Jersey x Mariana reported the heritability estimate as 0.34 ± 0.07 . Doshpande (1981) recorded heritability estimate as 0.386 ± 0.022 .

2.9.7 Total milk yield

Chopra et al. (1973) in Friesian x Sahiwal observed 0.18 ± 0.01 heritability. Bonde et al. (1978) in

Friesian x Non-descript reported the heritability estimate of 0.02 ± 0.01 . Taneja et al. (1978) recorded heritability estimates for first lactation yield as 0.17 ± 0.17 , 0.07 ± 0.08 in Friesian x Sahiwal. Deshpande (1981) reported the heritability estimates of 0.384 ± 0.042 .

2.10 Saturation deficit coefficient

Significance of physical environment in dairy cattle production in tropics is well recognized. The ambient temperature, atmospheric humidity, solar radiation and wind velocity are some of principle climatic factors, which determine the stress on livestock, as these factors affect the feed intake, efficiency of feed utilization and production (Payne and Hancock, 1957 and McDowell et al., 1969).

2.10.1 Effect of temperature

A sharp decline in milk yield from 13.05 to 7.65 kg per day was observed by Hegan and Richardson (1930) in Holstein, Jersey and Guernsey cows when the temperature was increased from 4 to 35 °C. Rick and Lee (1948 a) working with Jersey cows in the temperature range of 29-43 °C, did not observe a decrease in milk yield. However, Horsteli and Brody (1953) observed declination in milk yield from Jersey, Holstein and Brown Swiss cows on exposure to a temperature above 29 °C and that in



Brahman cows above 35 °C. The optimal temperature for milk production was considered to be around 10 °C. A rise in temperature above 10 °C being much more detrimental to milk production than below 10 °C as reported by Ragsdale et al. (1949). A temperature cycle of 21-38 °C depressed milk yields of Holstein cows by about 20 per cent and that of Jersey cows by about 8 per cent. But after the first week under these conditions the magnitude of the depression became smaller indicating a acclimatization has occurred as reported by Brody et al. (1955). The milk production of Holsteins was not significantly affected by temperatures in the range of -12 to 24 °C. Above 24 °C milk production declined rapidly and heat stress caused animal discomfort as observed by Yeck and Stewart (1959). The high milk yield of early lactation was more depressed by heat stress than the low milk yield of late lactation, namely 3.555 kg/day as compared with 1.125 kg/day at 32 °C was recorded by Johnson et al. (1960). Johnson et al. (1962) noted that the response of milk yield to high temperature which was dependent on heat tolerance and on the level of milk production. Nees (1964) in Tasmania found that constant temperatures above 28 °C depressed milk yield in cows of various European breeds, but that temperature cycles stimulating hot day conditions (32-38 °C) for

5½ hours and cooler night conditions (24-29 °C) for 15½ hours remained without effect on milk yield. The decline in animal productivity during high environment temperature were due to the reduction in feed intake (Moody et al., 1967). Milk yield and milk solids-not-fat were significantly decreased by thermal stress (Roussel et al., 1969). Milk production reduced by heat stress was related to the temperature humidity index (THI) as reported by Hahn and Osburn (1969). Reduced feed consumption is partially responsible for reduced milk production under heat stress was reported by Albright and Alliston (1971). Longer exposure to excess heat reduces feed consumption and milk production (Thompson, 1973). Non-significant difference was found by Gizbrekht (1974) between lactation milk yield and type of thermoregulatory (heat production) response on exposure to unseasonal temperature in winter and summer calving of Russian Black Pied cows. In autumn, winter, spring and summer the average daily milk yield was studied by Petkov (1977). In summer rise in average temperature above the seasonal norm resulted in a decrease in the average daily yield whereas below normal resulted in an increase in the daily milk yield. The average daily environmental temperature ranged from 5 to 20 °C. When the maximum daily temperature rose from 22.8 to 25.8 °C daily maximum yield per female fell by 0.4 litres. The maximum

variation in daily yield was 0.6 litres (Lange, 1978). Daily ambient temperature ranged from 22 to 29 °C in September and from 20 to 25 °C in December. Average daily temperature humidity index values for September and December were 70 and 75. Mean daily milk yields of shaded and non-shaded cows were 18.5 and 14.5 kg, the difference was significant as reported by Ingraham *et al.* (1979). Thanindratan (1978) noted that the effect of weather was small with lowered production of ≤ 0.5 kg/day. Only 3 per cent of all weather patterns studied caused changes ≥ 0.1 kg in daily milk yield. Environmental temperatures of -4 °C to +4 °C had an adverse effect on milk yield and temperature of 17-24 °C had a beneficial effect. Ordonez (1980) noted that milk yield decreased by 0.86 kg for Friesian and 0.21 kg for Brown Swiss cows for each 1 °C increase in temperature over 19 °C. Yields of Friesian cows were markedly superior to those of Brown Swiss.

2.10.2 Effect of humidity

Effects of high humidity on milk yield become pronounced only at temperature above 24 °C. At a temperature of 29 °C the milk yields of Holstein, Jersey and Brown Swiss cows were only 97, 93 and 93 per cent of the norm when the relative humidity was 40 per cent but were only 69, 75 and 83 per cent of the norms, when the

relative humidity was 90 per cent (Yeck and Stewart, 1959). From experiments made under a variety of temperature humidity combinations, it was concluded that changes in milk yield were in most animals not complete until about 10 days after the change of the environmental conditions (Johnson et al., 1960). Milk yields of 40 Holstein cows were seriously depressed by high humidity only above air temperature of 27 °C as reported by Johnson et al. (1963). In Jersey x native crosses Kassab et al. (1977) recorded that cows yield more milk in winter and spring than summer and autumn. Some environmental factors affecting milk yield of crossbred cows was studied by Kassab et al. (1977). Milk yield averaged 6.084 kg in Jersey x native crosses. Mean ambient temperature was 16-25 °C in spring, 27.1-28.7 °C in summer, 17.1-24.9 °C in autumn and 11.9-13.8 °C in winter; RH ranged from 29.5 per cent in May to 57.5 per cent in January cows yield more milk in the winter (6.583 kg/day respectively) and spring 6.844 kg respectively than in summer (5.899 kg) or autumn 5.008 kg.

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3. MATERIALS AND METHODS

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3.1 Location

The data for the study entitled "Performance of Friesian x Sahiwal grades with special reference to the functions of temperature, humidity and milk yield under Peninsular India" were obtained from the pedigree and history sheets and breeding records of crossbred progeny maintained at Indian Military Dairy Farms viz; Secunderabad, Bangalore, Belgaum, Pimpri and Devlali under the control of southern command. These farms are situated in tropical region of northern hemisphere at latitudes ranging from 13° to 20° , longitude ranging from 74° to 79° at a mean sea level of 423 to 921 meters. The southern zone receives annual rainfall with maximum precipitation during June, July, August and September. These military dairy farms experience climatic changes round the year with occasional extremes. Marked variation in climate of the year has set out four seasons. Winter season covers December, January, February; summer season March, April and May; south-west monsoon during June, July, August, September and post-monsoon from October to November (Crops and weather Report, 1980).

3.2 The data

The military dairy farms maintain various grades of Friesian x Sahiwal crossbreds. Systematic records in

respect of performance characters of individual animal is maintained. The data on age at first calving, milk yield, lactation period, dry period, service period and intercalving period in respect of individual cows with $1/2$, $3/4$, $5/8$ and $7/8$ Friesian grades covering a period from 1968 to 1982 were collected from breeding and performance records. The information as regards to monthly milk yield were obtained from monthly milk yield records. In all 447 crossbred progeny from 6 sires comprising 1752 lactations have been considered in this study.

Table 1: Farm-wise and grade-wise distribution of the Friesian x Sahiwal crossbred progeny.

Grade Farm	1/2	3/4	5/8	7/8	Total
Secunderabad	19	21	54	23	117
Bangalore	19	19	05	01	44
Belgaum	12	21	24	04	61
Pimpri	18	38	63	12	131
Devleli	13	33	32	16	94
Total:	81	132	178	56	447

The distribution on incomplete lactations due to various reasons were not considered and deleted from the study. A minimum of 37 number of cows per sire with complete lactation information have been considered for the study.

3.3 Management

Feeding and management of dairy animals at the military dairy farms were according to the fixed schedule. The management of lactating, pregnant and dry herd is separately done. Cows after parturition are included in the milking herd and are fed and cared in accordance of the standard schedule prescribed for the military dairy farms under southern command. Uniform pattern of feeding was practiced at Indian Military Dairy Farms, feeding standards according to the age group, considering the maintenance, growth and production requirements. The feeding schedule is given in Appendix I. Concentrate feeding to dairy animals at all these farms is done at the time of milking. Dry and green roughages are allowed at morning and evening meals. All dairy cows are stall fed but they are allowed exercise about one hour. Watering is done three times daily. Well constructed housing facilities are provided to dairy animals as well as to other categories of animals. Twice milking a day is followed at all the farms except at Bangalore where, the

milking is done 3 times a day at equal intervals. At the time of milking music is run at Secunderabad farm because this farm is near to air-port where flying of aeroplane is common. The milk recording is started from 4th day onwards after calving.

3.4 Methodology

The data collected from the farms did not provide equal or proportionate number of observations. With the disproportionate sub-class number various types of effect such as grade, period, farm and age at first calving can not be separated by ordinary method of analysis of variance. In this situation the least squares method outlined by Harvey (1966) was employed. The principle of this technique is to minimise the error sum of squares and sum of squared differences between observed and expected values, called the residual sum of squares. The following mathematical model was employed.

$$Y_{ijklm} = \mu + G_i + P_j + F_k + A_l + e_{ijklm}$$

Where,

Y_{ijklm} is the record of the cow from l^{th} age at first calving obtained from j^{th} period at K^{th} farm and belonging to i^{th} grade.

μ is the population mean common to all observations.

G_i is the effect of i^{th} grade (1,2...4)

P_j is the effect of j^{th} period (1,2,3)

F_k is the effect of k^{th} farm (1,2...5)

A_1 is the effect of 1st age at first calving (1,2...8)

e_{ijklm} = random error assumed with NID $(0, \sigma^2 e)$

3.4.1 Least squares analysis of data

The following procedure was adopted.

Setting-up of normal equations: From the mathematical model a system of normal equations were set up which are presented in Table 2. To estimate the 21 unknown constants, 21 normal equations were formed and these were 1 for u 4 for grades, 3 for periods, 5 for farms and 8 for age at first calving. These equations were then set-up in the form of matrix.

3.4.2 Imposing the restrictions

The normal equations so developed are not independent. Therefore, an unique solution could not be obtained. For obtaining the estimates of constants following restriction were imposed.

$$\sum_1 G_1 = \sum_j P_j = \sum_k F_k = \sum_1 A_1 = 0$$

By imposing the restrictions on the estimates of constants, it is possible to compute the G_1 , P_j , F_k and A_1 . The

Table 2: Set of normal equations.

Model:	Y_{ijklm}	μ	G_i	P_j	F_k	A_l	ϵ_{ijklm}
		μ	G_i	P_j	F_k	A_l	RHM
μ		$n_{...}$	$n_{i..}$	$n_{.j}$	$n_{..k}$	$n_{...l}$	$Y_{.....}$
G_i		$n_{i....}$	$n_{i...}$	$n_{ij..}$	$n_{i.k}$	$n_{i..l}$	$Y_{i....}$
P_j		$n_{.j...}$	$n_{ij..}$	$n_{.j..}$	$n_{.jk.}$	$n_{.j.l}$	$Y_{.j...}$
F_k		$n_{..k..}$	$n_{i.k.}$	$n_{.jk.}$	$n_{..k.}$	$n_{..kl}$	$Y_{..k..}$
A_l		$n_{...l.}$	$n_{i..l}$	$n_{.j.l}$	$n_{..kl}$	$n_{...l}$	$Y_{...l.}$

restrictions were imposed in the following manner.

3.4.3 Imposing restrictions for the main effect

Since there are four grades n_{ij} values in the column corresponding to four grades, were subtracted from n_{ij} values of previous columns i.e. (one). In the row-wise reduction also n_{ij} values in second row were subtracted from n_{ij} values of all previous rows. Similar, procedure was adopted for imposing restrictions on period, farm and age at first calving. Thus the 3rd period, 5th farm, 8th age at first calving were suppressed.

3.4.4 Reduction of RHM (column vectors)

The procedure adopted in columnwise reduction of n_{ij} matrix was followed for RHM also. The μ element was left undisturbed and manipulations were made in coefficients of main effects.

3.4.5 Estimation of constants

The reduced n_{ij} matrix is symmetrical about its main diagonal and is of the dimension of 17 x 17 of rows and columns made up of 1 row and column for u 3 for grades, 2 for period, 4 for farms and 7 for age at first calving. Similarly, reduced RHM is a column vector of 17 rows. Least squares constants were obtained from the inverse of reduced matrix and RHM of the equation in the following way.

Reduced n_{ij} matrix $\times$ constants = Reduced RHM

$$17 \times 17 \quad 17 \times 1 = 17 \times 1$$

i.e. constants = reduced n_{ij} matrix⁻¹ $\times$ Reduced RHM

The estimates corresponding to the suppressed elements during reduction were obtained by the following relationships.

$$G_4 = - (G_1 + G_2 + G_3)$$

$$P_3 = - (P_1 + P_2)$$

$$F_5 = - (F_1 + F_2 + F_3 + F_4)$$

$$A_8 = - (A_1 + A_2 + A_3 + A_4 + A_5 + A_6 + A_7)$$

3.4.6 Least squares analysis of variance

Computation of sum of squares (SS)

a) Total uncorrected sum of squares (TSS)

$\sum_i \sum_j \sum_k \sum_l \sum_m \sum_{ijklm}^2 Y_{ijklm}$ was obtained for each character by usual method.

b) Sum of squares for main effects were obtained by using the values of constants and the values of variance and covariance matrix.

$$\text{c) Error SS} = \sum_i \sum_j \sum_k \sum_l \sum_m \sum_{ijklm}^2 Y_{ijklm} - R (\mu, G_i, P_j, F_k, A_l)$$

where, 'R' is the RHM element corresponding to the constants i.e. μ, G_i, P_j, F_k, A_l .

- d) Sum of squares due to main effects were obtained by using the following expressions.

$$SS \text{ for the } i^{\text{th}} \text{ set of main effects} = A_1^1 Z_1^{-1} A_1$$

Where,

A_1 is the column vector for the constants for i^{th} set of main effects.

A_1^1 is the transpose of A_1 i.e. row vector, Z_1^{-1} is the inverse of the segment of the variance, covariance matrix corresponding to the row and column for i^{th} set of constants. Having obtained the values of total SS, error SS and main effect SS. The analysis of variance was run as shown in the Table 3.

Table 3: Pattern of analysis of variance.

Source	df	SS	MSS	F
Grade	i-1	$A_1^1 Z_1^{-1} A_1$	SS/df	MSS/MSSE
Period	j-1	$A_j^1 Z_j^{-1} A_j$	SS/df	MSS/MSSE
Farm	k-1	$A_k^1 Z_k^{-1} A_k$	SS/df	MSS/MSSE
Age at first calving	1-1	$A_1^1 Z_1^{-1} A_1$	SS/df	MSS/MSSE
Error	residual ijklm	$\sum_{i=1}^2 \sum_{j=1}^2 \sum_{k=1}^2 \sum_{l=1}^2 \sum_{m=1}^2$ $Y_{ijkl} - R$ $(\mu, G_i, P_j, F_k, A_l)$	SS/df	
Total	n.....-1	$\sum_{i=1}^2 \sum_{j=1}^2 \sum_{k=1}^2 \sum_{l=1}^2 \sum_{m=1}^2$ Y_{ijkl}	SS/df	

The mean squares were obtained by dividing the sum of squares of each effect by corresponding degrees of freedom. The ratio of mean squares for each of the effects and that for error provided the 'F' value for testing the significance of different effects. Standard error for least squares means of main effects were obtained from the values of error mean squares σ_e^2 , and the elements of variance and covariance matrix viz;

$$\text{S.E. } \mu = \sqrt{(C_{\mu\mu})}$$

$$\text{S.E. } (\mu + a_i) = \sqrt{(C_{\mu\mu} + C_{ii} + C_{\mu i}) \sigma_e^2}$$

Where,

$C_{\mu\mu}$ = element of variance and covariance matrix corresponding to μ row and μ column.

C_{ii} = elements of i^{th} effect by row and column.

$C_{\mu i}$ = element in the μ^{th} row and i^{th} column.

3.4.7 Duncan's Multiple Range Test (DMRT)

After analysis of variance the significant effects were further analysed to have all the pairwise comparisons using the DMRT as modified by Kramer (1957). The test was performed in the following manner (Harvey, 1966).

- a) The least squares means for particular effects under study were arranged in descending order, largest to the left and smallest to the right.

- b) $(\bar{Y}_a - \bar{Y}_b)$ values were estimated

where,

$\bar{Y}_a$ = Least squares mean for treatment a.

$\bar{Y}_b$ = Least squares mean for treatment b.

$$c) \left[(\bar{Y}_a - \bar{Y}_b) \left(\sqrt{\frac{2}{C_{aa} + C_{bb} - 2 C_{ab}}} \right) \right]$$

was then estimated where,

C_{aa} , C_{bb} are the diagonal elements of variance and covariance matrix corresponding to a and b respectively, while C_{ab} is the element corresponding to ath row and bth column.

- d) The value of $(\sigma \cdot Z_{pn2})$ was determined by Z_{pn2} from the table given for significant studentized range (Table A-7, Steel and Torrie, 1960) and

$$\sigma = \sqrt{\text{Error MSS}}$$

p = number of means in the range chosen.

n_2 = number of degrees of freedom for error.

- e) If the value of

$$\left[(\bar{Y}_a - \bar{Y}_b) \left(\sqrt{\frac{2}{C_{aa} + C_{bb} - 2C_{ab}}} \right) \right]$$

was greater than $(\sigma \cdot Z_{pn2})$ the difference between least squares means a and b were considered significant.

Estimation of values in variance and covariance matrix corresponding to the absorbed elements that were suppressed.

For all possible comparisons among least squares means it was necessary to obtain the diagonal element and off-diagonal elements of all the effects including those that were suppressed. These values were estimated from the available values of variance and covariance matrix in the following way.

$$C_{\mu\mu} + G_4 = \frac{(C_{\mu\mu} + CG_4G_4 + 2(C_{\mu G_4})\sigma_e^2)}{1}$$

Where,

$C_{\mu\mu}$ = the value of variance and covariance matrix corresponding to μ row and column.

$$C_{G_4G_4} = -(CG_1, G_2, G_3, G_4)$$

Where,

$C_{G_1G_2G_3G_4} = (C_{\mu\mu} + G_1)$ using the same procedure, values of variance and covariance matrix corresponding to other suppressed elements were obtained.

3.5 Correction of the data

Records were corrected for the effects for each character using the relationship.

$$C Y_{ijklm} = Y_{ijklm} - C.F.$$

Where,

C Y_{ijklm} = corrected record.

Y_{ijklm} = uncorrected record.

C.F. = correction factor.

3.6 Estimation of genetic and phenotypic parameters

Heritabilities, genetic and phenotypic correlations gradewise for various traits were estimated from the corrected data.

Estimation of genetic components of variance and covariance was done by using the following generalized model.

$$Y_{ij} = \mu + S_i + e_{ij}$$

Where,

Y_{ij} = j^{th} observation of i^{th} sire.

μ = overall mean.

S_i = effect due to i^{th} sire common to all its progeny.

e_{ij} = random error which is NID $(0, \sigma_e^2)$

Assumptions, $E(S_i) = E(e_{ij}) = 0$

$$E(S_i)^2 = \sigma^2_s \text{ and } E(e_{ij})^2 = \sigma_e^2$$

Heritabilities were estimated by paternal half-sib correlation method as outlined by Hazel and Terill (1943).

The estimated sire component of variance was used as an estimate of one fourth of the additive genetic variance. The analysis of variance for heritability estimate is given below.

Table 4: Analysis of variance for estimation of heritability.

Source	df	MSS	Component
Sires	S-1	MS _s	$\sigma^2_e + \bar{K} \sigma^2_s$
Error	N-1	MS _e	σ^2_e

$$\sigma^2_s = \frac{MS_s - MS_e}{\bar{K}}$$

$\bar{K}$ = average number of progeny per sire and is estimated by the following formula.

$$\bar{K} = \frac{(\sum K)^2 - \sum K^2}{\sum K (S-1)}$$

$$h^2 = \frac{4 \times s}{\sigma^2_s + \sigma^2_e}$$

The standard error of heritability was estimated by the method given by Dickerson (1960) and also Swiger et al. (1964).

$$s = \sqrt{\frac{2}{K^2} \cdot \frac{(MS)_s}{n_s} + \frac{(MS)_w}{n_w}}$$

Where,

K = coefficient of sire component.

$(MS)_s$ = mean squares for sire component.

$(MS)_w$ = mean squares for errors.

n_s = degree of freedom for sire components.

n_w = degrees of freedom for error components.

Swiger's formula:
$$S.E. = \frac{2 (N-1) (1-t)^2 (1 + (K + ij)^2)}{K^2 (N-S) (S-1)}$$

3.7 Genetic correlations

The components of covariance of two traits were computed from analysis of variance to obtain genetic correlations. The cross products of values of two character for each individual were summed and the total sum of cross products were partitioned according to the sources of variation. The genetic correlation coefficient (r_G) was estimated by the following formula.

$$r_{Gij} = \frac{\text{Cov. } S_i S_j}{\sqrt{\sigma_{S_i} \sigma_{S_j}}}$$

Where,

$\text{Cov. } S_i S_j$ = covariance component between sire group for traits i and j .

S_i = sire variance for i^{th} trait.

S_j = sire variance for j^{th} trait.

Standard error for genetic correlation was estimated after Robertson (1959).

$$SE r_G = \frac{1 - r_G^2}{\sqrt{2}} \cdot \sqrt{\frac{(hx^2) \cdot (hy^2)}{h_x^2 \times h_y^2}}$$

where,

r_G = genetic correlation between character x and y,
 h^2_x and h^2_y is the heritability of character x and y respectively.

3.8. Phenotypic correlations

The phenotypic correlations were estimated by the method described by Searle (1961).

$$r_{P_1P_j} = \frac{\text{Cov. } (T_1 T_j)}{(\sigma^2 T_1) \cdot (\sigma^2 T_j)}$$

where,

$\text{Cov. } T_1 T_j$ = Total component of covariance of i^{th} and j^{th} character.

$\sigma^2 T_1, \sigma^2 T_j$ = Total components of variance of i^{th} and j^{th} characters, respectively.

$r_{P_1P_j}$ = Phenotypic correlation between i^{th} and j^{th} characters.

The S.E. of phenotypic correlation was calculated according to the formula given by Fance and Sukhatme (1967).

$$S.E. (r_{P_1 P_2}) = \frac{1 - r_{P_1 P_2}^2}{\sqrt{N-2}}$$

where,

N = Total number of animals.

3.9 Milk yield and environmental components viz: temperature and humidity

The data on atmospheric temperature and relative humidity were collected from the meteorological observatories, Government of India located near the dairy farm. The meteorological weekly data of maximum and minimum temperature ($^{\circ}\text{C}$) and relative humidity (%) were taken from the records maintained at the observatories. The mean temperature and relative humidity for every week was calculated according to usual procedure. The air humidity affects the temperature. The saturation vapour pressure as a function of mean air temperature and is expressed as vapour pressure deficit ($e_a - e_d$).

where,

e_a = saturation vapour pressure as a function of mean

($\mu = \frac{T_{\max} + T_{\min}}{2}$) air temperature which is

obtained by referring standards given by FAO

(FAO, crop water requirement, 1977).

$$e_d = \frac{e_s \times RH}{100}$$

The saturation deficit coefficient = $(e_s - e_d)$.

The saturation deficit coefficients were computerised from the 4th day of calving of cow onwards. The simple average of saturation deficit was obtained by addition of saturation deficit coefficients of constants^{is} four weeks and dividing the sum by four to get the average. The monthly milk yield of cows and its corresponding monthly saturation deficit coefficients thus obtained were plotted. The saturation deficit coefficient being the functions of temperature and humidity has a fluctuating behaviour being its property and was given independent status to understand its functional relationship with milk yield. The following functions were tried.

Exponential	$\hat{Y} = ae^{bx}$
Linear	$\hat{Y} = a + bx$
Quadratic	$\hat{Y} = a + bx + cx^2$
Cobb-Douglas	$\hat{Y} = ax^b$

Where,

$\hat{Y}$ = estimated milk yield

a = pure constant intercept.

b = regression coefficient of linear term.

x = saturation deficit coefficient.

c = regression coefficient of quadratic term.

...

RESULTS

4. RESULTS

Manipulation of hereditary material through systems of mating and selection to develop genotypes better adaptive to a system of environment and at the same time maintain productivity has been the aim of breeder. Cross breeding of indigenous breed like Sahiwal, Red Sindhi, Gir, Tharparkar, etc. with exotic breeds like Friesian, Jersey, Brown Swiss and Red Dane has been practised in our country. Genotypes from such mating have made their records in respect of production and reproduction traits under the environment of tropical situation. Evaluation of production and reproduction traits of cross progeny with reference to non-genetic factors including few environmental elements like temperature and humidity was aimed at in the present investigation. The data on Friesian and Sahiwal crossbreds from the five military dairy farms under the southern command was considered. The data on 447 crossbred cows with 1758 lactations in respect of lactation period, dry period, intercalving period, service period, monthly milk yield, 300 day milk yield and total yield were obtained from breeding and performance records maintained on these farms. The data on weekly temperature and humidity were obtained from the meteorological observatories in the vicinities of the farm except Belgaum and Davlali. The meteorological data in

case of Belgaum and Devlali farm were obtained from the meteorological observatories at Charwar and Niphad, respectively. To understand the effect of grade, period, farm and age at first calving the information obtained from the record was considered. Four grades namely $1/2$, $3/4$, $5/8$ and $7/8$ were coded as G_1 , G_2 , G_3 and G_4 . Three periods namely 1968-72, 1973-77 and 1978-82 were coded as P_1 , P_2 and P_3 . Five farms namely Secunderabad, Bangalore, Belgaum, Pimpri and Devlali were coded as F_1 , F_2 , F_3 , F_4 and F_5 , respectively. The age at first calving ranged from 684 to 1665 days. Eight levels of age at first calving were coded as A_1 for below 700 days to A_8 as 1301 days and above days with a class interval of 100 days. The lactation period ranged from 116 to 554 days. The dry period ranged from 41 to 643 days. The intercalving period ranged from 302 to 1071 days. The service period ranged from 22 to 793 days. The 300 day milk yield ranged from 1427 to 7666 kg. The total yield ranged from 912 to 9731 kg and saturation deficit coefficient ranged from 4.31 to 50.06 per cent. The data was subjected to statistical analysis by the least squares method of analysis outlined by Harvey (1966), to assess the extent of influence of fixed effects. Similarly, the random effect due to sire was also estimated. The least squares means with standard errors for the traits are

presented in Tables 5, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23 and 24. The least squares analysis of variance for the factors affecting various traits are presented in Appendices II to XVII. Genetic, phenotypic correlations and heritability for the traits studied in respect of 1/2, 3/4, 5/8 and 7/8 broods are presented in Tables 6, 7, 8 and 9. The corrected data on monthly milk yield were plotted with the corresponding saturation deficit coefficient to develop the functional relationship. Four functions were tried. The results are presented in the following paras.

4.1 Effect of various factors on lactation period

The least squares means with standard errors for various factors affecting lactation period in Friesian x Sahiwal cross progeny are presented in Table 5.

The general mean for lactation period was 312.97 ± 2.80 days. The grade effect was non-significant. Grade G_3 (315.13 ± 3.52 days) recorded the highest lactation length followed by G_4 (313.01 ± 5.25 days), G_1 (312.05 ± 4.03 days) and G_2 (311.60 ± 3.65 days), respectively. Duncan's Multiple Range Test (DMRT) revealed non-significant differences amongst grades. The period effect was highly significant. The highest period of 331.77 ± 3.78 days was recorded in P_3 followed by P_2 (300.19 ± 2.52 days);

Table 5: Least squares means and standard errors for the factors affecting lactation period.

Source	Code	Mean	S.E.
μ	-	312.97	2.80
Grade	G ₁	312.05 ^a	4.05
	G ₂	311.60 ^a	3.65
	G ₃	315.13 ^a	3.32
	G ₄	313.01 ^a	5.25
Period	P ₁	299.05 ^c	5.60
	P ₂	308.10 ^{bc}	2.52
	P ₃	331.77 ^a	3.78
Farm	F ₁	312.38 ^a	3.66
	F ₂	313.31 ^a	5.76
	F ₃	308.62 ^a	4.73
	F ₄	312.81 ^a	3.70
	F ₅	317.74 ^a	4.07
AFC	A ₁	320.21 ^a	10.43
	A ₂	307.23 ^a	4.73
	A ₃	311.67 ^a	3.84
	A ₄	305.85 ^a	3.72
	A ₅	311.60 ^a	3.80
	A ₆	311.58 ^a	4.74
	A ₇	316.47 ^a	6.31
	A ₈	319.17 ^a	7.84

Means with similar superscripts are not significantly different.

and P_1 (297.05 ± 5.60 days), respectively. Period P_3 and P_2 differ significantly. Whereas, P_1 and P_2 were at par with each other as revealed by DMRT. The effect due to farm was non-significant. The lactation period of 317.74 ± 4.07 days was recorded at F_3 followed by F_2 (313.31 ± 5.76 days), F_4 (312.81 ± 3.70 days), F_1 (312.30 ± 3.66 days) and F_3 (308.62 ± 4.73 days), respectively. DMRT revealed non-significant differences amongst the farms. The age at first calving had non-significant effect. The lactation period from various age groups ranged from 305.35 ± 3.72 to 320.21 ± 10.43 days. Among the different age at first calving the lactation length did not differ significantly as revealed by DMRT.

The lactation length in 1/2 breeds (Table 6), had highly significant and positive genetic correlations with dry period, intercalving period, service period, monthly milk yield, 300 day milk yield and total yield. Highly significant and positive phenotypic correlations of lactation period with dry period, intercalving period, service period, monthly milk yield of 6th to 9th month, 300 day milk yield and total yield was observed. Whereas, positive non-significant with monthly milk yield of 1st to 5th and 10th month.

Table 6 Genetic and phenotypic correlations amongst various economic traits in Friesian x Sahiwal crossbreds (1/2 bred).

Str	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 Lactation period	0.037 0.011	0.202 0.037	0.620 0.037	0.520 0.037	0.001 0.037	0.004 0.037	0.027 0.037	0.046 0.037	0.054 0.037	0.115 0.020	0.153 0.065	0.177 0.042	0.134 0.022	0.062 0.075	0.262 0.037	0.474 0.038
2 Dry period	0.800 0.025	-0.026 0.008	0.883 0.025	0.885 0.025	-0.067 0.025	-0.079 0.025	-0.108 0.025	-0.105 0.025	-0.098 0.025	-0.113 0.025	-0.094 0.052	-0.099 0.053	-0.094 0.065	-0.154 0.085	-0.099 0.025	-0.025 0.058
3 Inter-calving period	>1 0.000	>1 0.000	-0.0002 0.009	0.998 0.000	-0.059 0.000	-0.064 0.000	-0.076 0.000	-0.067 0.000	-0.058 0.000	-0.041 0.005	-0.070 0.008	-0.008 0.021	-0.026 0.051	-0.112 0.087	0.040 0.000	0.196 0.036
4 Service period	>1 0.005	-0.820 0.005	>1 0.005	0.006 0.009	-0.052 0.005	-0.056 0.005	-0.071 0.005	-0.051 0.005	-0.051 0.005	-0.033 0.001	-0.003 0.003	-0.003 0.017	-0.022 0.047	-0.109 0.088	0.046 0.005	0.203 0.037
5 1st month milk yield	>1 0.178	0.440 0.178	>1 0.178	>1 0.178	0.178 0.021	0.951 0.178	0.926 0.178	0.919 0.178	0.878 0.178	0.816 0.186	0.783 0.194	0.647 0.197	0.517 0.164	0.392 0.171	0.840 0.178	0.780 0.159
6 2nd month milk yield	>1 0.159	0.506 0.126	>1 0.159	>1 0.159	>1 0.159	0.159 0.020	0.956 0.159	0.940 0.159	0.900 0.159	0.835 0.165	0.807 0.159	0.663 0.170	0.524 0.139	0.338 0.161	0.855 0.159	0.312 0.148
7 3rd month milk yield	>1 0.142	0.575 0.142	>1 0.142	>1 0.142	0.996 0.142	>1 0.142	0.142 0.018	0.969 0.142	0.938 0.142	0.878 0.151	0.847 0.169	0.694 0.186	0.560 0.165	0.395 0.150	0.884 0.142	0.819 0.132
8 4th month milk yield	>1 0.141	0.320 0.141	>1 0.141	>1 0.141	0.999 0.141	>1 0.141	>1 0.141	0.141 0.018	0.956 0.141	0.908 0.155	0.871 0.172	0.715 0.188	0.586 0.162	0.447 0.143	0.898 0.141	0.836 0.146
9 5th month milk yield	>1 0.133	0.601 0.133	>1 0.133	>1 0.133	>1 0.133	>1 0.133	>1 0.133	0.990 0.133	0.950 0.133	0.936 0.134	0.911 0.160	0.765 0.176	0.639 0.155	0.511 0.165	0.915 0.133	0.844 0.124
10 6th month milk yield	>1 0.129	0.883 0.129	>1 0.129	>1 0.129	>1 0.129	>1 0.129	>1 0.129	0.982 0.129	0.988 0.129	0.988 0.129	0.953 0.170	0.833 0.194	0.723 0.175	0.586 0.171	0.927 0.129	0.854 0.150
11 7th month milk yield	>1 0.142	0.633 0.142	>1 0.142	>1 0.142	0.906 0.142	0.785 0.142	0.922 0.142	0.871 0.142	0.962 0.142	0.994 0.142	0.942 0.018	0.836 0.175	0.723 0.160	0.650 0.140	0.925 0.141	0.862 0.124
12 8th month milk yield	>1 0.182	0.529 0.182	>1 0.182	>1 0.182	0.874 0.182	0.767 0.182	0.927 0.182	0.888 0.182	0.962 0.182	>1 0.182	>1 0.182	0.182 0.022	0.915 0.115	0.690 0.109	0.845 0.182	0.780 0.169
13 9th month milk yield	>1 0.15	0.512 0.145	>1 0.145	>1 0.145	0.626 0.145	0.464 0.145	0.727 0.145	0.671 0.145	0.850 0.145	0.904 0.145	0.998 0.145	>1 0.145	0.145 0.021	0.763 0.112	0.738 0.145	0.681 0.035
14 10th month milk yield	0.794 0.227	0.369 0.227	0.549 0.227	0.608 0.227	0.503 0.227	0.175 0.227	0.471 0.227	0.361 0.227	0.578 0.227	0.806 0.227	0.927 0.227	>1 0.227	>1 0.227	0.227 0.034	0.590 0.227	0.534 0.038
15 11th month milk yield	>1 0.219	0.823 0.219	>1 0.219	>1 0.219	0.957 0.219	0.949 0.219	0.965 0.219	0.922 0.219	0.976 0.219	>1 0.199	>1 0.251	0.983 0.256	0.923 0.182	0.748 0.164	0.219 0.024	0.945 0.195
16 Total yield	>1 0.201	-0.009 0.201	0.693 0.201	0.687 0.201	0.974 0.201	0.982 0.201	0.986 0.201	0.983 0.201	0.998 0.201	>1 0.180	>1 0.177	0.990 0.185	0.800 0.105	0.173 0.094	>1 0.201	0.202 0.022

* Significant at $P < 0.01$ * Significant at $P < 0.05$

Note: Figures on the diagonal are heritabilities, off diagonal are phenotypic correlations, and below diagonal are genetic correlations

The heritability estimate for lactation length in 1/2 bred progeny was 0.037 ± 0.011 .

In case of 3/4 breeds (Table 7), the genetic correlations of lactation length with intercalving period, service period, monthly milk yield of 1st to 10th month and 300 day milk yield were negative and highly significant. Whereas, positive and highly significant with dry period and total yield. Highly significant and positive phenotypic correlations of lactation period with dry period, intercalving period, service period, monthly milk yield of 1st, 6th to 10th month, 300 day milk yield and total yield were observed. Whereas, positive and significant with monthly milk yield of 4th and 5th month; positive but non-significant with milk yield of 2nd and 3rd month.

The heritability estimate for lactation length in 3/4 bred progeny was -0.014 ± 0.004 .

In case of 5/8 breeds (Table 8), lactation length had highly significant and positive genetic correlations with intercalving period, service period, monthly milk yields of 5th, 6th, 7th, 9th, 10th month, 300 day milk yield and total yield. Significant positive genetic correlation of lactation period with dry period was observed. Highly significant negative genetic correlation of lactation period with monthly milk yield of 1st, 2nd, 3rd, 4th month were

Table 7: Genetic and phenotypic correlations amongst various economic traits in Friesian x Sahiwal crossbred (3/4 bred).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1) Lactation period	-0.014 ±0.004	0.115 ±0.014	0.656 ±0.014	0.641 ±0.014	0.083 ±0.014	0.066 ±0.014	0.066 ±0.009	0.066 ±0.009	0.091 ±0.009	0.083 ±0.022	0.116 ±0.030	0.165 ±0.029	0.229 ±0.027	0.219 ±0.031	0.092 ±0.018	0.304 ±0.014	** 0.516 ±0.072
2) Dry period	0.622 ±0.026	-0.026 ±0.003	0.775 ±0.026	0.813 ±0.026	-0.148 ±0.026	-0.150 ±0.026	0.045 ±0.027	-0.045 ±0.027	-0.146 ±0.027	-0.144 ±0.023	-0.134 ±0.018	-0.117 ±0.018	-0.093 ±0.017	-0.056 ±0.023	-0.077 ±0.027	-0.114 ±0.026	-0.052 ±0.027
3) Interval-viring period	-0.118 ±0.001	>-1 ±0.105	0.001 ±0.004	0.965 ±0.001	-0.038 ±0.001	-0.049 ±0.001	-0.048 ±0.003	-0.048 ±0.003	-0.032 ±0.003	-0.036 ±0.001	-0.014 ±0.001	0.013 ±0.001	0.061 ±0.002	0.073 ±0.014	-0.028 ±0.020	0.107 ±0.001	** 0.278 ±0.029
4) Service period	-0.123 ±0.015	-0.735 ±0.015	>-1 ±0.015	-0.015 ±0.004	-0.058 ±0.015	-0.069 ±0.015	-0.070 ±0.013	-0.070 ±0.013	-0.053 ±0.013	-0.056 ±0.017	-0.032 ±0.017	0.006 ±0.012	0.059 ±0.013	0.075 ±0.028	-0.014 ±0.027	-0.089 ±0.015	0.255 ±0.023
5) 1st month milk yield	>-1 ±0.103	-0.770 ±0.103	>-1 ±0.103	>-1 ±0.103	0.103 ±0.010	0.933 ±0.103	0.924 ±0.097	0.924 ±0.097	0.912 ±0.097	0.386 ±0.109	0.856 ±0.107	0.802 ±0.107	0.699 ±0.123	0.639 ±0.162	0.529 ±0.198	0.846 ±0.103	** 0.756 ±0.088
6) 2nd month milk yield	>-1 ±0.141	-0.822 ±0.141	>-1 ±0.141	>-1 ±0.141	0.992 ±0.141	0.142 ±0.012	0.968 ±0.134	0.968 ±0.134	0.942 ±0.134	0.909 ±0.144	0.866 ±0.141	0.797 ±0.140	0.696 ±0.149	0.527 ±0.179	0.494 ±0.200	0.861 ±0.141	** 0.761 ±0.106
7) 3rd month milk yield	>-1 ±0.143	0.204 ±0.143	>-1 ±0.143	>-1 ±0.143	>-1 ±0.143	>-1 ±0.143	0.143 ±0.012	0.143 ±0.012	0.979 ±0.143	0.951 ±0.161	0.912 ±0.156	0.850 ±0.154	0.745 ±0.188	0.684 ±0.226	0.552 ±0.267	0.895 ±0.143	** 0.802 ±0.112
8) 4th month milk yield	>-1 ±0.131	-0.726 ±0.131	>-1 ±0.131	>-1 ±0.131	>-1 ±0.131	0.995 ±0.131	0.999 ±0.131	0.999 ±0.131	0.132 ±0.012	0.970 ±0.257	0.934 ±0.154	0.881 ±0.152	0.785 ±0.178	0.713 ±0.229	0.584 ±0.269	0.914 ±0.131	** 0.825 ±0.105
9) 5th month milk yield	>-1 ±0.194	-0.863 ±0.194	>-1 ±0.194	>-1 ±0.194	>-1 ±0.194	0.998 ±0.194	1.000 ±0.194	1.000 ±0.194	>-1 ±0.194	0.195 ±0.016	0.957 ±0.198	0.911 ±0.194	0.824 ±0.221	0.752 ±0.276	0.640 ±0.291	0.922 ±0.194	** 0.836 ±0.176
10) 6th month milk yield	-0.774 ±0.199	>-1 ±0.199	>-1 ±0.199	>-1 ±0.199	0.999 ±0.199	0.934 ±0.199	0.950 ±0.199	0.950 ±0.199	0.971 ±0.199	0.983 ±0.199	0.199 ±0.015	0.936 ±0.188	0.849 ±0.215	0.787 ±0.279	0.681 ±0.315	0.920 ±0.199	** 0.843 ±0.192
11) 7th month milk yield	-0.850 ±0.162	-0.900 ±0.162	>-1 ±0.162	>-1 ±0.162	0.989 ±0.162	0.883 ±0.162	0.910 ±0.162	0.910 ±0.162	0.937 ±0.162	0.955 ±0.162	0.936 ±0.162	0.162 ±0.014	0.912 ±0.194	0.837 ±0.248	0.728 ±0.318	0.922 ±0.162	** 0.859 ±0.163
12) 8th month milk yield	>-1 ±0.166	>-1 ±0.166	>-1 ±0.166	>-1 ±0.166	>-1 ±0.166	0.969 ±0.166	0.974 ±0.166	0.974 ±0.166	0.993 ±0.166	>-1 ±0.166	>-1 ±0.166	>-1 ±0.166	0.167 ±0.014	0.901 ±0.237	0.764 ±0.313	0.885 ±0.166	** 0.840 ±0.144
13) 9th month milk yield	-0.751 ±0.129	-0.945 ±0.129	>-1 ±0.129	-0.836 ±0.129	>-1 ±0.129	>-1 ±0.129	>-1 ±0.129	>-1 ±0.129	>-1 ±0.129	>-1 ±0.129	>-1 ±0.129	>-1 ±0.129	>-1 ±0.129	0.129 ±0.013	0.841 ±0.244	0.824 ±0.129	** 0.786 ±0.154
14) 10th month milk yield	>-1 ±0.799	-0.443 ±0.079	>-1 ±0.079	-0.567 ±0.079	0.996 ±0.079	0.893 ±0.079	0.935 ±0.079	0.935 ±0.079	0.919 ±0.079	0.969 ±0.079	>-1 ±0.079	>-1 ±0.079	0.967 ±0.079	0.936 ±0.079	0.080 ±0.013	0.723 ±0.079	** 0.692 ±0.093
15) 300 day milk yield	>-1 ±0.102	-0.791 ±0.102	>-1 ±0.102	>-1 ±0.102	>-1 ±0.102	0.941 ±0.102	0.964 ±0.102	0.964 ±0.102	0.993 ±0.102	>-1 ±0.124	>-1 ±0.132	0.997 ±0.128	>-1 ±0.149	>-1 ±0.233	0.937 ±0.291	0.102 ±0.010	** 0.941 ±0.102
16) Total yield	0.187 ±0.106	-0.709 ±0.106	-0.422 ±0.106	-0.267 ±0.106	0.921 ±0.106	0.733 ±0.106	0.733 ±0.110	0.733 ±0.110	0.743 ±0.110	0.813 ±0.119	0.888 ±0.122	0.973 ±0.101	>-1 ±0.097	0.971 ±0.169	>-1 ±0.265	0.983 ±0.106	** 0.106 ±0.011

** Significant at $P < 0.01$ * Significant at $P < 0.05$

Note: Figures on the diagonal are heritabilities, off diagonal are phenotypic correlations, and below diagonal are genetic correlations.

Table 8: Genetic and phenotypic and correlations amongst various economic traits in Friesian x Sahiwal crossbred (5/8 bred).

Str No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Lactation period	0.015 ±0.003	0.112 ±0.015	0.641 ±0.015	0.631 ±0.015	0.136 ±0.015	0.140 ±0.016	0.150 ±0.016	0.168 ±0.016	0.163 ±0.022	0.180 ±0.024	0.191 ±0.019	0.293 ±0.016	0.289 ±0.252	0.255 ±0.050	0.336 ±0.015	0.535 ±0.057
2. Dry period	0.095 ±0.017	-0.017 ±0.003	0.775 ±0.017	0.800 ±0.017	-0.147 ±0.017	-0.136 ±0.018	-0.146 ±0.018	-0.146 ±0.018	-0.145 ±0.023	-0.128 ±0.025	-0.111 ±0.030	-0.093 ±0.028	-0.091 ±0.018	-0.066 ±0.062	-0.144 ±0.017	-0.067 ±0.009
3. Inter-calving period	0.618 ±0.025	0.813 ±0.025	0.026 ±0.003	0.939 ±0.025	-0.020 ±0.025	-0.010 ±0.025	-0.010 ±0.025	-0.002 ±0.025	-0.007 ±0.024	0.016 ±0.024	0.037 ±0.029	0.094 ±0.023	0.083 ±0.016	0.082 ±0.054	0.095 ±0.025	0.263 ±0.026
4. Service period	0.703 ±0.016	0.835 ±0.016	0.886 ±0.016	0.017 ±0.003	-0.021 ±0.016	-0.010 ±0.016	-0.013 ±0.016	-0.005 ±0.016	-0.006 ±0.016	0.015 ±0.016	0.036 ±0.022	0.098 ±0.019	0.097 ±0.017	0.097 ±0.056	0.094 ±0.016	0.262 ±0.016
5. 1st month milk yield	>1 ±0.002	>1 ±0.002	>1 ±0.002	>1 ±0.002	-0.002 ±0.002	0.955 ±0.003	0.931 ±0.003	0.925 ±0.003	0.892 ±0.005	0.876 ±0.006	0.832 ±0.005	0.738 ±0.002	0.667 ±0.004	0.530 ±0.017	0.875 ±0.002	0.827 ±0.008
6. 2nd month milk yield	>1 ±0.002	>1 ±0.002	>1 ±0.002	>1 ±0.002	-0.504 ±0.002	-0.003 ±0.002	0.973 ±0.002	0.962 ±0.002	0.927 ±0.001	0.908 ±0.001	0.860 ±0.001	0.765 ±0.003	0.677 ±0.002	0.519 ±0.002	0.895 ±0.002	0.855 ±0.001
7. 3rd month milk yield	>1 ±0.001	>1 ±0.001	>1 ±0.001	>1 ±0.001	>1 ±0.001	0.424 ±0.001	-0.001 ±0.002	0.968 ±0.001	0.938 ±0.001	0.921 ±0.002	0.877 ±0.003	0.788 ±0.002	0.698 ±0.007	0.545 ±0.001	0.903 ±0.001	0.864 ±0.001
8. 4th month milk yield	-0.405 ±0.009	>1 ±0.009	>1 ±0.009	>1 ±0.009	-0.804 ±0.009	0.679 ±0.009	>1 ±0.009	0.010 ±0.003	0.969 ±0.010	0.958 ±0.008	0.917 ±0.006	0.823 ±0.003	0.736 ±0.005	0.581 ±0.002	0.924 ±0.009	0.887 ±0.013
9. 5th month milk yield	0.104 ±0.018	>1 ±0.018	>1 ±0.018	>1 ±0.018	-0.375 ±0.018	0.819 ±0.018	>1 ±0.018	>1 ±0.018	0.019 ±0.003	0.973 ±0.015	0.939 ±0.011	0.853 ±0.008	0.771 ±0.008	0.627 ±0.001	0.928 ±0.018	0.881 ±0.023
10. 6th month milk yield	0.483 ±0.007	>1 ±0.007	>1 ±0.007	>1 ±0.007	>1 ±0.007	>1 ±0.007	-0.185 ±0.007	0.870 ±0.007	>1 ±0.007	0.008 ±0.002	0.964 ±0.002	0.883 ±0.002	0.806 ±0.018	0.673 ±0.020	0.936 ±0.007	0.897 ±0.008
11. 7th month milk yield	0.682 ±0.022	>1 ±0.022	>1 ±0.022	>1 ±0.022	>1 ±0.022	>1 ±0.022	-0.599 ±0.022	0.485 ±0.022	0.751 ±0.022	>1 ±0.022	-0.023 ±0.003	0.916 ±0.006	0.831 ±0.021	0.705 ±0.028	0.926 ±0.022	0.882 ±0.025
12. 8th month milk yield	-0.0004 ±0.009	>1 ±0.009	>1 ±0.009	>1 ±0.009	>1 ±0.009	>1 ±0.009	>1 ±0.009	0.161 ±0.009	0.475 ±0.009	0.499 ±0.009	>1 ±0.009	0.010 ±0.003	0.880 ±0.019	0.740 ±0.029	0.897 ±0.009	0.875 ±0.018
13. 9th month milk yield	0.591 ±0.010	>1 ±0.010	>1 ±0.010	>1 ±0.010	>1 ±0.010	>1 ±0.010	>1 ±0.010	-1 ±0.010	>1 ±0.010	>1 ±0.010	>1 ±0.010	>1 ±0.010	-0.011 ±0.003	0.816 ±0.029	0.841 ±0.008	0.836 ±0.007
14. 10th month milk yield	>1 ±0.004	>1 ±0.004	>1 ±0.004	>1 ±0.004	>1 ±0.004	>1 ±0.004	>1 ±0.004	-0.473 ±0.004	>1 ±0.004	-0.989 ±0.004	-0.694 ±0.004	-0.732 ±0.004	-0.616 ±0.004	0.005 ±0.005	0.713 ±0.005	0.709 ±0.001
15. 300 day milk yield	0.112 ±0.017	>1 ±0.017	>1 ±0.017	>1 ±0.017	-0.791 ±0.017	0.279 ±0.016	>1 ±0.016	>1 ±0.016	>1 ±0.016	>1 ±0.015	>1 ±0.009	0.102 ±0.001	>1 ±0.018	>1 ±0.004	0.018 ±0.003	0.942 ±0.025
16. Total yield	0.771 ±0.027	>1 ±0.027	>1 ±0.027	>1 ±0.027	-0.575 ±0.027	-0.771 ±0.026	0.872 ±0.026	0.973 ±0.026	>1 ±0.026	>1 ±0.026	0.929 ±0.022	0.668 ±0.017	>1 ±0.008	>1 ±0.008	>1 ±0.027	0.027 ±0.003

** Significant at $P < 0.01$ * Significant at $P < 0.05$
 NOTE: Figures on the diagonal are heritabilities, off diagonal are phenotypic correlations, and below diagonal are genetic correlations.

observed. Whereas, non-significant and negative genetic correlation was observed with 8th months milk yield. The lactation length had highly significant and positive phenotypic correlation with dry period, intercalving period, service period, monthly milk yield of 1st to 10th month, 300 day milk yield and total yield were observed.

The heritability estimate for lactation period in 5/8 bred progeny was 0.015 ± 0.003 .

In case of 7/8 breeds (Table 9), lactation length had highly significant and positive genetic correlations with dry period, intercalving period, service period, monthly milk yields of 1st, 5th, 8th, 10th and total yield. Highly significant negative genetic correlations of lactation length with monthly milk yield of 2nd, 3rd, 4th, 7th and 9th month were observed. Non-significant and positive genetic correlation with 6th month milk yield was observed. Non-significant and negative genetic correlation of lactation length with 300 day milk yield was recorded. The lactation length had highly significant and positive phenotypic correlations with dry period, service period, intercalving period, monthly milk yield from 1st to 10th month, 300 day milk yield and total yield.

The heritability estimate for lactation period in 7/8 bred progeny was 0.081 ± 0.022 .

Table 9. Genetic and phenotypic correlations amongst various economic traits in Friesian x Sahiwal crossbred (7/8 bred).

St. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 Lactation period	0.081 ±0.022	>1** ±0.080	0.610 ±0.080	0.642 ±0.080	0.113 ±0.080	0.178 ±0.080	0.178 ±0.080	0.201 ±0.080	0.215 ±0.080	0.239 ±0.080	0.216 ±0.080	0.216 ±0.078	0.281 ±0.002	0.203 ±0.080	0.334 ±0.080	0.594 ±0.312
2 Dry period	0.790 ±0.050	-0.050 ±0.013	0.799 ±0.050	0.813 ±0.050	-0.089 ±0.050	-0.075 ±0.050	-0.044 ±0.050	-0.025 ±0.050	-0.020 ±0.050	-0.005 ±0.050	-0.022 ±0.055	0.036 ±0.067	0.049 ±0.055	-0.047 ±0.078	-0.005 ±0.050	0.041 ±0.016
3. Inter-calving period	>1** ±0.160	0.226 ±0.160	0.160 ±0.029	0.971 ±0.160	-0.001 ±0.160	0.036 ±0.160	0.055 ±0.160	0.083 ±0.160	0.091 ±0.160	0.110 ±0.160	0.082 ±0.139	0.173 ±0.152	0.154 ±0.118	0.033 ±0.109	0.165 ±0.160	0.341 ±0.386
4 Services period	>1** ±0.068	0.041 ±0.068	>1** ±0.068	0.069 ±0.210	0.009 ±0.068	0.056 ±0.068	0.078 ±0.068	0.107 ±0.060	0.118 ±0.068	0.141 ±0.068	0.116 ±0.045	0.206 ±0.055	0.187 ±0.002	0.081 ±0.054	0.195 ±0.068	0.374 ±0.280
5 1st month milk yield	>1** ±0.002	>1** ±0.002	>1** ±0.002	>1** ±0.002	0.002 ±0.016	0.897 ±0.002	0.902 ±0.002	0.881 ±0.002	0.848 ±0.002	0.839 ±0.002	0.821 ±0.026	0.706 ±0.037	0.550 ±0.028	0.494 ±0.035	0.804 ±0.002	0.763 ±0.057
6 2nd month milk yield	-0.534 ±0.026	-0.461 ±0.026	-0.623 ±0.026	-0.529 ±0.026	-0.484 ±0.026	0.025 ±0.018	0.976 ±0.026	0.944 ±0.026	0.894 ±0.026	0.885 ±0.025	0.860 ±0.047	0.767 ±0.050	0.560 ±0.063	0.529 ±0.058	0.836 ±0.026	0.825 ±0.059
7 3rd month milk yield	-0.443 ±0.027	-0.112 ±0.027	-0.262 ±0.027	-0.084 ±0.027	0.929 ±0.027	0.957 ±0.027	0.027 ±0.018	0.979 ±0.027	0.930 ±0.027	0.927 ±0.027	0.895 ±0.042	0.805 ±0.048	0.604 ±0.070	0.536 ±0.117	0.869 ±0.027	0.844 ±0.062
8 4th month milk yield	-0.355 ±0.050	0.216 ±0.050	-0.065 ±0.050	0.156 ±0.050	>1** ±0.050	0.839 ±0.050	0.978 ±0.050	0.050 ±0.020	0.949 ±0.050	0.950 ±0.050	0.910 ±0.065	0.829 ±0.075	0.655 ±0.088	0.549 ±0.131	0.875 ±0.050	0.860 ±0.019
9 5th month milk yield	0.313 ±0.067	0.796 ±0.060	-0.575 ±0.060	0.900 ±0.060	>1** ±0.060	0.584 ±0.060	0.745 ±0.060	0.895 ±0.060	0.061 ±0.021	0.942 ±0.060	0.916 ±0.077	0.638 ±0.093	0.690 ±0.090	0.583 ±0.001	0.878 ±0.060	0.852 ±0.071
10 6th month milk yield	0.026 ±0.086	0.584 ±0.086	-0.241 ±0.086	0.540 ±0.086	>1** ±0.086	0.777 ±0.086	0.856 ±0.086	0.909 ±0.026	>1** ±0.086	0.087 ±0.023	0.958 ±0.107	0.888 ±0.125	0.751 ±0.132	0.635 ±0.085	0.902 ±0.086	0.874 ±0.105
11 7th month milk yield	-0.183 ±0.109	0.477 ±0.109	0.120 ±0.109	0.442 ±0.109	>1** ±0.109	0.854 ±0.109	0.923 ±0.109	0.979 ±0.109	>1** ±0.109	>1** ±0.109	0.109 ±0.025	0.921 ±0.130	0.780 ±0.152	0.688 ±0.111	0.916 ±0.109	0.870 ±0.141
12 8th month milk yield	0.752 ±0.103	0.807 ±0.103	0.901 ±0.103	>1** ±0.103	>1** ±0.103	0.488 ±0.103	0.598 ±0.103	0.685 ±0.103	>1** ±0.103	0.876 ±0.103	0.850 ±0.103	0.130 ±0.025	0.850 ±0.139	0.751 ±0.037	0.896 ±0.103	0.972 ±0.125
13 9th month milk yield	-0.409 ±0.171	0.792 ±0.171	0.545 ±0.171	>1** ±0.171	>1** ±0.171	0.785 ±0.171	0.755 ±0.171	0.908 ±0.171	>1** ±0.171	>1** ±0.171	>1** ±0.171	>1** ±0.171	0.172 ±0.035	0.626 ±0.019	0.762 ±0.171	0.757 ±0.439
14 10th month milk yield	0.106 ±0.108	0.103 ±0.108	0.261 ±0.180	-0.134 ±0.108	>1** ±0.108	>1** ±0.108	-0.965 ±0.108	-0.883 ±0.108	>1** ±0.108	-0.884 ±0.108	0.875 ±0.108	>1** ±0.108	>1** ±0.024	0.109 ±0.024	0.631 ±0.021	0.757 ±0.171
15 300 day milk yield	-0.051 ±0.061	>1** ±0.061	0.466 ±0.061	0.833 ±0.061	>1** ±0.061	0.283 ±0.061	0.545 ±0.061	0.821 ±0.061	>1** ±0.061	>1** ±0.061	>1** ±0.062	0.982 ±0.103	>1** ±0.125	>1** ±0.047	0.062 ±0.021	0.906 ±0.175
16 Total yield	0.917 ±0.042	>1** ±0.242	0.904 ±0.242	0.997 ±0.242	0.510 ±0.242	0.880 ±0.242	0.942 ±0.242	0.961 ±0.242	>1** ±0.242	>1** ±0.242	0.968 ±0.266	>1** ±0.294	>1** ±0.229	>1** ±0.058	0.943 ±0.242	0.242 ±0.171

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

Note: >1 or the diagonal are heritabilities, off diagonal are phenotypic correlations, and below diagonal are genetic correlations

4.2 Effect of various factors on dry period

The least squares means with standard errors for various factors affecting dry period in Friesian x Sahiwal cross progeny are presented in Table 10.

The general mean for dry period was 129.00 ± 3.90 days. The grade effect was non-significant. Grade G_2 recorded the (136.23 ± 5.09 days) longest dry period followed by G_4 (130.56 ± 7.32 days), G_3 (129.65 ± 4.63 days) and G_1 (122.69 ± 5.62 days), respectively. DMRT revealed non-significant differences amongst dry periods of various grades. The period effect was non-significant. The highest period of 134.63 ± 7.21 days was recorded in P_1 followed by P_2 (132.34 ± 3.51 days) and P_3 (122.41 ± 5.26 days), respectively. DMRT revealed non-significant differences amongst the dry periods in different periods. The effect due to farm was highly significant. The highest dry period of 133.69 ± 5.67 days was recorded at F_5 followed by F_1 (136.95 ± 5.10 days), F_3 (124.01 ± 6.50 days), F_4 (121.32 ± 5.16 days) and F_2 (113.00 ± 0.03 days). DMRT revealed non-significant differences amongst the dry periods of the cows at F_2 , F_3 and F_4 ; F_1 and F_3 . The dry period of the cows at F_5 farm was significantly different from others. F_2 is significantly different from F_1 and F_5 .

Table 10: Least squares means and standard errors
for the factors affecting dry period.

Source	Code	Mean	S.E.
μ	-	129.80	3.90
Urade	G ₁	122.69 ^a	5.62
	G ₂	136.28 ^a	5.09
	G ₃	129.63 ^a	4.63
	G ₄	130.56 ^a	7.32
Period	P ₁	134.63 ^a	7.81
	P ₂	132.34 ^a	3.51
	P ₃	122.41 ^a	5.26
Farm	F ₁	136.95 ^{bc}	5.10
	F ₂	113.00 ^a	8.03
	F ₃	124.01 ^{cde}	6.58
	F ₄	121.32 ^{de}	5.16
	F ₅	153.69 ^a	5.67
AFC	A ₁	137.34 ^a	14.53
	A ₂	130.18 ^a	6.59
	A ₃	134.91 ^a	5.35
	A ₄	125.99 ^a	5.18
	A ₅	122.64 ^a	5.29
	A ₆	130.50 ^a	5.60
	A ₇	131.55 ^a	9.48
	A ₈	125.24 ^a	10.92

Means with similar superscripts are not
significantly different.

The age at 1st calving had non-significant effect. The dry period from various age groups ranged from 122.64 ± 5.29 to 137.34 ± 14.53 days. Amongst the different age at 1st calving the dry period did not differ significantly as revealed by DART.

The dry period in 1/2 breeds (Table 6), had highly significant and positive genetic correlations with the trait studied except intercalving period and service period for which, it was negative and highly significant and that with total yield negative non-significant. Highly significant and positive phenotypic correlation of dry period with intercalving period and service period was observed. It was negatively highly significant with milk yield of 3rd, 4th, 5th, 6th, 8th, 10th months and 300 day milk yield. Negative significant correlation of dry period with milk yield of 2nd, 7th and 9th months were observed and negative non-significant with 1st month and total yield.

The heritability estimate for dry period in 1/2 bred progeny was -0.026 ± 0.008 .

In case of 3/4 breeds (Table 7), the genetic correlations of dry period with the traits studied were negatively highly significant except milk yield of 3rd month, in which case it was positive and highly significant

The phenotypic correlations of dry period with inter-calving period and service period was positively highly significant, and negatively highly significant with milk yields of 1st, 2nd, 4th, 5th, 6th, 7th months and 300 day milk yield. The phenotypic correlation of dry period with 3rd month yield was positive but non-significant; negatively non-significant with 9th month milk yield and total yield and negatively significant with 8th and 10th months milk yield.

The heritability estimate for dry period in 3/4 bred progeny was -0.026 ± 0.003 .

In case of 5/8 breeds (Table 3), the genetic correlations of dry period with the traits studied were positive and highly significant. The phenotypic correlations of dry period with intercalving period and service period was positive and highly significant. It was negative and highly significant with 1st, 2nd, 3rd, 4th, 5th, 6th, 7th months and 300 day milk yield. The phenotypic correlations of dry period with milk yield of 8th and 9th months were negatively significant. Whereas, milk yield of 10th month and total yield were negative but non-significant.

The heritability estimate for dry period in 5/8 bred progeny was -0.017 ± 0.003 .

In case of 7/8 breeds (Table 9), the genetic correlations of dry period with intercalving period, milk yield of 1st, 4th, 5th, 6th, 7th, 8th, 9th, 10th months, 300 day milk yield and total yield was positive and highly significant. It was negative and highly significant with milk yield of 2nd, 3rd months and positive but non-significant with service period. The phenotypic correlations of dry period with intercalving period and service period was highly significant. It was negatively significant with milk yield of 1st month and negative but non-significant with monthly milk yield from 2nd to 7th and also with 10th month, 300 day milk yield and positive with 8th, 9th months and total yield.

The heritability estimate for dry period in 7/8 bred progeny was -0.050 ± 0.013 .

4.3 Effect of various factors on intercalving period

The least squares means with standard errors for various factors affecting intercalving period in Friesian x Sahiwal cross progeny are presented in Table 11.

The general mean for intercalving period was 439.73 ± 5.14 days. The grade effect was non-significant. Highest intercalving period of 443.66 ± 6.70 days was recorded in grade G_2 followed by G_1 (433.97 ± 7.41 days), G_3 (440.77 ± 6.10 days) and G_4 (440.50 ± 5.64 days), respectively.

Table 11: Least squares means and standard errors
for the factors affecting intercalving period.

Source	Code	Mean	S.E.
μ		439.73	5.14
Grade	G ₁	433.97 ^a	7.41
	G ₂	443.66 ^a	6.70
	G ₃	440.77 ^a	6.10
	G ₄	440.50 ^a	9.64
Period	P ₁	427.93 ^c	10.28
	P ₂	437.13 ^{bc}	4.62
	P ₃	454.12 ^a	6.93
Farm	F ₁	448.43 ^{bc}	6.71
	F ₂	422.97 ^e	10.57
	F ₃	431.56 ^{cde}	8.67
	F ₄	426.26 ^{de}	6.79
	F ₅	409.41 ^a	7.46
AFC	A ₁	454.51 ^a	19.14
	A ₂	436.70 ^a	8.68
	A ₃	442.04 ^a	7.05
	A ₄	432.83 ^a	6.81
	A ₅	435.04 ^a	6.97
	A ₆	432.09 ^a	8.69
	A ₇	444.98 ^a	12.48
	A ₈	439.62 ^a	14.38

Means with similar superscripts are not significantly different.

DWMT revealed non-significant differences amongst the intercalving period exhibited by various grades. The period effect was significant. The highest intercalving period of 454.12 ± 6.93 days was recorded in P_3 followed by P_2 (437.13 ± 4.62 days) and P_1 (427.93 ± 10.28 days). The intercalving period in period P_3 was significantly different from P_1 and P_2 . The intercalving periods from period P_1 and P_2 did not differ significantly amongst them as revealed by DWMT. The effect due to farm was highly significant. The highest intercalving period of 469.41 ± 7.46 days was recorded at F_5 followed by F_1 (448.43 ± 6.71 days), F_3 (431.96 ± 8.67 days), F_4 (426.26 ± 6.79 days) and F_2 (422.97 ± 10.37 days), respectively. DWMT revealed non-significant differences amongst the intercalving period exhibited at F_2 , F_3 and F_4 ; F_1 and F_3 . Whereas, the intercalving period at farm F_5 was significantly different from rest of the farms. The intercalving period at farm F_2 was significantly different from F_1 and F_3 . The age at 1st calving had non-significant effect. The intercalving period from various age groups ranged from 432.09 ± 8.69 to 454.51 ± 19.14 days. The intercalving period from various age group did not differ significantly from each other as revealed by DWMT.

The intercalving period in 1/2 breeds (Table 6), had highly significant and positive genetic correlations with

the traits studied. Positive significant phenotypic correlations of intercalving period with service period and total yield were observed; whereas, negative non-significant correlations of intercalving period with monthly milk yield from 1st, 2nd, 4th to 9th months; and negatively highly significant correlation of intercalving period with milk yield of 10th month were recorded. Negative significant correlation of intercalving period with milk yield of 3rd month and positive non-significant with 300 day milk yield were observed.

The heritability estimate for intercalving period in 1/2 bred progeny was -0.0002 ± 0.009 .

In case of 3/4 breds (Table 7), the genetic correlations of intercalving period with the traits studied were negative and highly significant. The phenotypic correlations of intercalving period with service period, 300 day milk yield and total yield have been positive and highly significant. Negative non-significant with milk yield of 1st, 2nd, 3rd, 4th, 5th, 6th and 10th months; and that with 7th, 8th, and 9th months milk yield positive non-significant.

The heritability estimate for intercalving period in 3/4 bred progeny was 0.001 ± 0.004 .

In case of 5/8th breeds (Table 8), the intercalving period had positive and highly significant genetic correlations with the traits studied. The phenotypic correlations of intercalving period with service period and total yield were highly significant; that with 8th to 10th months, 300 day milk yield were positive and significant, positive and non-significant with 6th and 7th months milk yield; and negative but non-significant with monthly milk yield of 1st to 5th months were observed.

The heritability estimate for intercalving period in 5/8 bred progeny was 0.026 ± 0.003 .

In case of 7/8 breeds (Table 9), the intercalving period had positive and highly significant genetic correlations with service period, monthly milk yield of 1st, 7th, 8th, 9th, 10th months, 300 day milk yield and total yield; whereas, negative highly significant with monthly milk yields of 2nd, 3rd, 5th and 6th months; negative non-significant with 4th month. The phenotypic correlations of intercalving period with service period, monthly milk yield of 6th, 8th, 9th months, 300 day milk yield and total yield were positive highly significant. The phenotypic correlation of intercalving period with monthly milk yield of 4th, 5th and 7th were positive and significant that with monthly milk yield of 2nd, 3rd and

10th months were positive non-significant and with 1st month it was negative non-significant.

The heritability estimate for intercalving period in 7/8 bred progeny was 0.160 ± 0.029 .

4.4 Effect of various factors on service period

The least squares means with standard errors for various factors affecting lactation period in Friesian x Sahiwal cross progeny are presented in Table 12.

The general mean for service period was 152.13 ± 3.05 days. The grade effect was non-significant. The highest service period of 162.41 ± 9.47 days was observed in grade G_4 , followed by G_2 (162.01 ± 6.56 days), G_3 (160.79 ± 5.99 days) and G_1 (151.36 ± 7.28 days), respectively. DMRT revealed non-significant differences amongst the service period of cows from various grades. The period effect was non-significant. The highest service period of 169.79 ± 8.61 days was recorded in P_3 followed by P_2 (156.50 ± 4.55 days) and P_1 (151.02 ± 10.10 days), respectively. DMRT revealed non-significant differences amongst periods. The effect due to farm was highly significant. The service period of 188.47 ± 7.33 days was recorded in the cows at farm F_5 followed by F_1 (169.90 ± 6.60 days), F_4 (151.09 ± 6.67 days), F_3 (149.12 ± 6.52 days) and F_2 (141.49 ± 10.39 days),

Table 12: Least squares means and standard errors for the factors affecting service period.

Source	Code	Mean	S.E.
μ		159.13	5.05
Grade	G ₁	151.36 ^a	7.28
	G ₂	162.01 ^a	6.58
	G ₃	160.75 ^a	5.99
	G ₄	162.41 ^a	9.47
Period	P ₁	151.02 ^a	10.10
	P ₂	156.58 ^a	4.55
	P ₃	169.79 ^a	6.81
Farm	F ₁	165.50 ^{bcd}	6.60
	F ₂	141.49 ^e	10.39
	F ₃	149.12 ^{de}	8.52
	F ₄	151.09 ^{cde}	6.67
	F ₅	188.47 ^a	7.33
AFC	A ₁	177.75 ^a	18.81
	A ₂	153.81 ^a	8.53
	A ₃	162.50 ^a	6.93
	A ₄	147.62 ^a	6.70
	A ₅	153.61 ^a	6.85
	A ₆	153.94 ^a	8.55
	A ₇	165.72 ^a	12.27
	A ₈	159.11 ^a	14.13

Means with similar superscripts are not significantly different.

respectively. DMRT revealed non-significant differences amongst the service period exhibited by the cows at F_1 , F_2 , F_3 and F_4 farms. The service period in cows from farm F_5 was significantly different from rest of the farms. The age at 1st calving had non-significant effect. The service period from various age groups ranged from 147.62 ± 6.70 to 177.75 ± 18.81 days. The service period from various age groups did not differ significantly amongst each other as revealed by DMRT.

The service period in 1/2 breeds (Table 6), had highly significant and positive genetic correlations with the traits studied. Highly significant and positive phenotypic correlation was observed with total yield. Highly significant and negative phenotypic correlation was observed with milk yield of 10th month. Non-significant and negative phenotypic correlations of service period with monthly milk yield of 1st to 9th months were observed. Non-significant and positive phenotypic correlation of service period with 300 day milk yield was observed.

The heritability estimate for service period in 1/2 bred progeny was 0.006 ± 0.009 .

In case of 3/4 breeds (Table 7), the genetic correlations of service period with the traits studied were negative and highly significant. The phenotypic correlation of service period with total yield was positive

and highly significant. It was negative but non-significant with monthly milk yield of 1st to 6th and 10th months. The phenotypic correlations of service period with 7th, 8th and 9th months milk yield were positive but non-significant and with 300 day milk yield it was negative and significant.

The heritability estimate for service period in 3/4 bred progeny was -0.013 ± 0.004 .

In case of 5/8 breeds (Table 8), service period had positive and highly significant genetic correlations with the traits studied. Highly significant and positive phenotypic correlations were observed with 8th month milk yield and total yield. Positive significant phenotypic correlations of service period with monthly milk yield of 9th, 10th and 300 day milk yield were observed. Negative non-significant phenotypic correlations of service period with monthly milk yield of 1st, 2nd, 3rd, 4th and 5th months were observed. Whereas, positive but non-significant with milk yields from 6th and 7th months.

The heritability estimate for service period in 5/8th bred progeny was 0.017 ± 0.003 .

In case of 7/8 breeds (Table 9), the service period had positive and highly significant genetic correlations

with monthly milk yield of 1st, 4th to 9th months, 300 day milk yield and total yield. Whereas, negative highly significant correlations with monthly milk yield of 2nd and 10th month and negative significant with milk yield of 3rd month. The phenotypic correlations of service period with monthly milk yield of 4th to 9th, 300 day milk yield and total yield were positive and highly significant; that with monthly milk yield of 3rd and 10th month the correlations were positive significant and with 1st and 2nd monthly milk yield positive non-significant.

The heritability estimate for service period in 7/8 bred progeny was 0.069 ± 0.210 .

4.5 Effect of various factors on milk yield of 1st month

The least squares means with standard error for factors affecting milk yield of 1st month in Friesian x Saniwal cross progeny are presented in Table 13.

The general mean for 1st month milk yield was 406.11 ± 4.74 kg. The grade effect was highly significant. The milk yield of grade G_1 was highest (433.52 ± 6.64 kg) followed by G_3 (407.55 ± 5.63 kg), G_2 (404.29 ± 6.18 kg) and G_4 (379.36 ± 8.89 kg), respectively. Significant differences existed amongst each other except for G_2 and G_3 which were at par as revealed by LSD. The period effect

Table 13: Least squares means and standard errors for the factors affecting milk yield of 1st month.

Source	Code	Mean	S.E.
μ	-	406.11	4.74
Grade	G ₁	433.32 ^a	6.84
	G ₂	404.29 ^c	6.18
	G ₃	407.55 ^{bc}	5.63
	G ₄	379.36 ^d	8.89
Period	P ₁	338.03 ^c	9.49
	P ₂	393.72 ^b	4.27
	P ₃	486.57 ^a	6.40
Farm	F ₁	421.25 ^b	6.20
	F ₂	459.70 ^a	9.76
	F ₃	401.73 ^{cd}	8.00
	F ₄	352.24 ^e	6.27
	F ₅	395.62 ^d	6.89
AFC	A ₁	380.01 ^c	17.66
	A ₂	389.00 ^{bc}	8.01
	A ₃	401.66 ^{abc}	6.50
	A ₄	406.50 ^{abc}	6.29
	A ₅	406.06 ^{abc}	6.44
	A ₆	417.30 ^{ac}	8.03
	A ₇	414.54 ^{abc}	11.52
	A ₈	433.78 ^a	13.27

Means with similar superscripts are not significantly different.

on milk yield was highly significant. The highest milk yield of 426.57 ± 6.40 kg was recorded in period P_3 followed by P_2 (393.72 ± 4.27 kg) and P_1 (338.03 ± 9.49 kg), respectively. The DMIT revealed significant differences amongst the milk yield in different periodicities. The effect due to farm was highly significant. The highest milk yield of 459.70 ± 9.76 kg was recorded at farm F_2 followed by F_1 (421.25 ± 6.20 kg), F_3 (401.73 ± 8.00 kg), F_5 (395.62 ± 6.89 kg) and F_4 (332.24 ± 6.24 kg), respectively. DMIT revealed significant differences amongst yields from different farms. Non-significant differences were observed in the yields from F_3 and F_5 farms. The age at 1st calving had non-significant effect. The milk yield of cows from various age groups ranged from 380.01 ± 17.66 to 433.78 ± 13.27 kg. The DMIT revealed that the milk yield from A_8 age group was significantly different from rest of the age groups. Whereas, non-significant differences were observed amongst other age groups in respect of milk yield.

The genetic correlations of 1st month milk yield in 1/2 breeds (Table 6), were highly significant and positively correlated with the traits studied. Similarly the phenotypic correlations were also positive and highly significant.

The heritability estimate for 1st month milk yield in 1/2 bred progeny was 0.174 ± 0.021 .

In case of 3/4 breeds (Table 7), the genetic and phenotypic correlations of milk yield in 1st month with the traits studied were positive and highly significant.

The heritability estimate for milk yield of 1st month in 3/4 bred progeny was 0.103 ± 0.010 .

In case of 5/8 breeds (Table 8), the genetic correlations of milk yield in 1st month were negative and highly significant with the traits studied. The phenotypic correlations were positive and highly significant.

The heritability estimate for milk yield of 1st month in 5/8 bred progeny was -0.002 ± 0.002 .

In case of 7/8 breeds (Table 9), the genetic correlations of milk yield of 1st month were positive and highly significant with 3rd to 9th months and also with total yield. Negative and non-significant with monthly milk yield of 2nd, 10th and 300 day milk yield have been observed. Highly significant and positive phenotypic correlation of 1st month milk yield with the traits studied was observed.

The heritability estimate for milk yield of 1st month in 7/8 bred progeny was 0.002 ± 0.016 .

4.6 Effect of various factors on milk yield of 2nd month

The least squares means with standard errors for factors affecting milk yield of 2nd month in Frisian x Sahiwal cross progeny are presented in Table 14.

The general mean for 2nd month milk yield was 426.75 ± 4.76 kg. The grade effect was highly significant. The highest milk yield of 459.12 ± 6.87 kg was recorded in cows of G_1 grade followed by G_2 (427.69 ± 6.21 kg), G_3 (425.11 ± 5.56 kg) and G_4 (375.00 ± 6.94 kg), respectively. D.M.T. revealed significant differences amongst the milk yield from various grades except G_2 and G_3 . The milk yield from G_2 and G_3 were non-significantly different from each other. The period effect was highly significant. The highest milk yield of 517.00 ± 6.43 kg was recorded in period P_3 followed by P_2 (411.10 ± 4.29 kg) and P_1 (352.15 ± 9.54 kg), respectively. The D.M.T. revealed significant differences amongst milk yield in different periodicities. The effect due to farm was highly significant. The highest milk yield of 474.63 ± 9.50 kg was recorded at F_2 farm followed by F_1 (451.51 ± 6.22 kg), F_3 (416.55 ± 8.04 kg), F_5 (412.34 ± 6.92 kg) and F_4 (375.72 ± 6.30 kg), respectively. Non-significant differences were observed amongst the milk yields at

Table 14: Least squares means and standard errors for the factors affecting milk yield of 2nd month.

Source	Code	Mean	S.E.
μ	-	426.75	4.76
Grade	G ₁	459.12 ^a	6.87
	G ₂	427.69 ^{bc}	6.21
	G ₃	425.11 ^c	5.66
	G ₄	395.08 ^d	8.94
Period	P ₁	352.15 ^c	9.54
	P ₂	411.10 ^b	4.29
	P ₃	517.00 ^a	6.43
Farm	F ₁	451.51 ^a	6.22
	F ₂	474.63 ^a	9.80
	F ₃	416.55 ^{bc}	8.04
	F ₄	375.72 ^d	6.30
	F ₅	412.34 ^c	6.92
AFC	A ₁	402.97 ^d	17.75
	A ₂	409.52 ^{cd}	8.05
	A ₃	421.23 ^{bcd}	6.54
	A ₄	426.46 ^{abcd}	6.32
	A ₅	425.88 ^{abcd}	6.47
	A ₆	442.46 ^{abd}	8.07
	A ₇	429.79 ^{abcd}	11.58
	A ₈	455.69 ^a	13.37

Means with similar superscripts are not significantly different.

F_1 and F_2 farm; and F_3 and F_5 farm. The milk yield from farm F_4 was significantly different from others as revealed by DMIT. The age at 1st calving had non-significant effect. The milk yield of various age groups ranged from 402.97 ± 17.75 to 450.69 ± 13.37 kg. DMIT revealed the non-significant differences amongst first seven age groups and also amongst last five age groups. A_3 age group was significantly different from A_1 , A_2 and A_3 .

The milk yield in 1/2 breeds (Table 6), had highly significant and positive genetic and phenotypic correlations with the traits studied.

The heritability estimate for 2nd month yield in 1/2 bred progeny was 0.139 ± 0.020 .

In case of 3/4 breeds (Table 7), the genetic and phenotypic correlations of milk yield in 2nd month with the traits studied were positive and highly significant.

The heritability estimate for yield of 2nd month in 3/4 bred progeny was 0.142 ± 0.012 .

In case of 5/3 breeds (Table 8), the genetic correlations of milk yield in 2nd month with milk yield during 3rd, 4th and 5th months, 330 day milk yield were positive and highly significant. Negative and highly significant with milk yield during 6th, 7th, 8th, 9th,

10th months and total yield. The phenotypic correlations of milk yield in 2nd month with traits studied were positive and highly significant.

The heritability estimate for yield of 2nd month in 5/8 bred progeny was -0.003 ± 0.002 .

In case of 7/8 broods (Table 9), the genetic correlations of milk yield during 2nd month with the traits studied were positive and highly significant except with the milk yield of 10th month which was negative and highly significant. The phenotypic correlation of milk yield in 2nd month was positive and highly significant with the traits studied.

The heritability estimate for 2nd month milk yield in 7/8 bred progeny was 0.025 ± 0.018 .

4.7 Effect of various factors on milk yield of 3rd month

The least squares means with standard errors for factors affecting milk yield of 3rd month in Friesian x Sahiwal cross progeny are presented in Table 15.

The general mean for 3rd month milk yield was 403.54 ± 4.65 kg. The grade effect was highly significant. The 3rd months milk yield from grade G_1 was highest (431.35 ± 6.70 kg) followed by G_2 (405.54 ± 5.06 kg), G_3 (402.82 ± 5.52 kg) and G_4 (374.43 ± 8.72 kg), respectively.

Table 13: Least squares means and standard errors for the factors affecting milk yield of 3rd month.

Source	Code	Mean	S.E.
μ_1	-	403.54	4.65
Grade	G ₁	431.35 ^a	6.70
	G ₂	405.54 ^{bc}	5.06
	G ₃	402.82 ^c	5.52
	G ₄	374.43 ^d	8.72
Period	P ₁	332.61 ^c	9.30
	P ₂	389.92 ^b	4.18
	P ₃	488.08 ^a	6.27
Farm	F ₁	430.06 ^a	6.08
	F ₂	450.81 ^a	9.56
	F ₃	393.17 ^{bc}	7.84
	F ₄	354.42 ^d	6.14
	F ₅	369.21 ^c	6.75
AFC	A ₁	305.41 ^a	17.31
	A ₂	386.40 ^{ca}	7.85
	A ₃	395.63 ^{bca}	6.38
	A ₄	403.00 ^{abc}	6.17
	A ₅	403.44 ^{abc}	6.31
	A ₆	415.02 ^{ab}	7.87
	A ₇	400.88 ^{abc}	11.29
	A ₈	430.45 ^a	13.00

Means with similar superscripts are not significantly different.

DART revealed significant differences amongst milk yield from various grades except G_2 and G_3 . The yields from G_2 and G_3 were non-significant. The period effect was highly significant. The milk yield in 3rd month from period P_3 was the highest (400.00 ± 6.27 kg) followed by P_2 (369.92 ± 4.10 kg) and P_1 (332.61 ± 9.30 kg), respectively. DART revealed significant differences amongst different periodicities. The farm effect was highly significant. The highest milk yield of 450.31 ± 9.56 kg was recorded at F_2 farm followed by F_1 (430.06 ± 6.08 kg), F_3 (393.17 ± 7.34 kg), F_4 (394.42 ± 6.14 kg) and F_5 (389.21 ± 6.75 kg), respectively. DART revealed significant differences amongst yields from different farms except for F_1 and F_2 ; F_3 and F_5 , which were at par. The age at 1st calving had non-significant effect. The milk yield of various age groups ranged from 385.41 ± 17.31 to 415.09 ± 7.67 kg. DART revealed non-significant differences amongst different age groups.

In case of 1/2 breeds (Table 6), the genetic and phenotypic correlations of milk yield of 3rd month with the traits studied were positive and highly significant.

The heritability estimate for 3rd month milk yield in 1/2 bred progeny was 0.142 ± 0.016 .

In case of 3/4 breeds (Table 7), the genetic and phenotypic correlations of milk yield during 3rd month with the traits studied were positive and highly significant.

The heritability estimate for milk yield during 3rd month in 3/4 breed was 0.143 ± 0.012 .

In case of 5/8 breeds (Table 8), the genetic correlations of milk yield in 3rd month with milk yield of 6th to 10th months were negative and highly significant. Positive and highly significant genetic correlations of milk yield in 3rd month with milk yield of 4th, 5th, 300 day milk yield and total yield have been observed. Positive and highly significant phenotypic correlations of milk yield during 3rd month with the traits studied were observed.

The heritability estimate for milk yield of 3rd month in 5/8 breeds was -0.001 ± 0.002 .

In case of 7/8 breeds (Table 9), the genetic correlations of milk yield of 3rd month with 4th to 9th months milk yield, 300 day milk yield and total yield were positive and highly significant. Whereas, it was negative and highly significant with milk yield of 10th month. Highly significant and positive phenotypic correlations of 3rd month milk yield with traits studied were observed.

The heritability estimate for yield of 3rd month in 7/8 breeds was 0.027 ± 0.018 .

4.8 Effect of various factors on milk yield of 4th month

The least squares means with standard errors for factors affecting milk yield of 4th month in Friesian x Sahiwal cross progeny are presented in Table 16.

The general mean for milk yield in 4th month was 373.83 ± 4.46 kg. The grade effect was highly significant. Grade G_1 recorded the highest milk yield of 405.57 ± 6.44 kg followed by G_2 (379.38 ± 5.82 kg), G_3 (378.49 ± 5.30 kg) and G_4 (351.69 ± 8.35 kg), respectively. DMRT revealed significant differences amongst the milk yield except G_2 and G_3 . The milk yield from G_2 and G_3 were at par. The period effect was highly significant. The highest milk yield of 455.63 ± 6.03 kg was recorded in period P_3 followed by P_2 (367.21 ± 4.02) and P_1 (313.65 ± 6.94 kg), respectively. DMRT revealed significant differences amongst different periodicities. The farm effect was highly significant. The highest milk yield of 424.49 ± 9.19 kg was recorded at farm F_2 followed by F_1 (399.07 ± 5.84), F_3 (372.47 ± 7.53 kg), F_4 (363.83 ± 6.49 kg) and F_5 (334.30 ± 9.20 kg), respectively. DMRT revealed significant differences amongst yields of different farms. Milk yield from farm F_3 and F_5 were at par. The age at 1st calving had non-significant effect. The milk yield of various age groups ranged from 363.54 ± 7.55 to 401.35 ± 12.50 kg. The DMRT revealed that A_2 was significantly

Table 16: Least squares means and standard errors for the factors affecting milk yield of 4th month.

Source	Code	Mean	S.E.
μ	-	376.83	4.46
Grade	G ₁	405.57 ^a	6.44
	G ₂	379.38 ^{bc}	5.82
	G ₃	378.49 ^c	5.30
	G ₄	351.89 ^d	8.38
Period	P ₁	313.65 ^c	8.94
	P ₂	367.21 ^b	4.02
	P ₃	455.63 ^a	6.03
Farm	F ₁	399.07 ^b	5.84
	F ₂	424.49 ^a	9.19
	F ₃	372.47 ^{cd}	7.53
	F ₄	334.30 ^e	5.90
	F ₅	363.83 ^d	6.49
AFC	A ₁	364.39 ^{ab}	16.64
	A ₂	363.54 ^b	7.55
	A ₃	371.41 ^{ab}	6.13
	A ₄	377.33 ^{ab}	5.93
	A ₅	378.48 ^{ab}	6.07
	A ₆	392.24 ^a	7.56
	A ₇	381.92 ^{ab}	10.85
	A ₈	401.35 ^a	12.50

Means with similar superscripts are not significantly different.

different from A_6 and A_8 age groups.

In case of 1/2 breeds (Table 6), the genetic correlations of milk yield during 4th month were positive and highly significant with the traits studied. Similar was the trend in respect of phenotypic correlations.

The heritability estimate for yield of 4th month in 1/2 breed progeny was 0.142 ± 0.018 .

In case of 3/4 breeds (Table 7), the genetic and phenotypic correlations of milk yield during 4th month was highly significant and positive with the traits studied.

The heritability estimate for milk yield of 4th month in 3/4 breeds was 0.132 ± 0.012 .

In case of 5/8 breeds (Table 8), the genetic correlations of milk yield during 4th month were positive and highly significant with monthly milk yield for 5th to 6th months, 300 day milk yield and total yield. Negative and highly significant genetic correlations with monthly milk yields of 9th and 10th month have been observed. The phenotypic correlations were positive and highly significant with the traits studied.

The heritability estimate for milk yield during 4th month in 5/8 breeds was 0.010 ± 0.003 .

in case of 7/8 breeds (Table 9), the genetic correlations of milk yield during 4th month were positive and highly significant with monthly yield for 5th to 9th months, 300 day milk yield and total yield. Negative and non-significant genetic correlations with milk yield of 10th month was observed. Highly significant and positive phenotypic correlations between yield of 4th month and with the traits studied were observed.

The heritability estimate for milk yield of 4th month in 7/8 breeds was 0.053 ± 0.020 .

4.9 Effect of various factors on milk yield of 5th month

The least squares means with standard errors for factors affecting milk yield of 5th month in Friesian x Sahiwal cross progeny are presented in Table 17.

The general mean for 5th month milk yield was 353.93 ± 4.29 kg. The grade effect was highly significant. The highest milk yield of 375.84 ± 6.19 kg was recorded in cows from G_1 grade followed by G_2 (357.16 ± 5.61 kg), G_3 (355.90 ± 5.10 kg) and G_4 (327.21 ± 8.06 kg), respectively. DART revealed significant differences amongst grades except G_2 and G_3 grades which were non-significantly different. The period effect was highly significant. The highest milk yield of 423.89 ± 5.80 kg

Table 17: Least squares means and standard errors for the factors affecting milk yield of 5th month.

Source	Code	Mean	S.E.
μ .		353.93	4.29
Grade	G ₁	375.84 ^a	6.19
	G ₂	357.16 ^{bc}	5.61
	G ₃	355.50 ^c	5.10
	G ₄	327.21 ^d	8.06
Period	P ₁	294.40 ^c	3.59
	P ₂	343.50 ^b	3.87
	P ₃	423.89 ^a	5.80
Farm	F ₁	370.62 ^b	5.62
	F ₂	401.64 ^a	6.86
	F ₃	348.81 ^{cd}	7.25
	F ₄	308.22 ^e	5.68
	F ₅	340.36 ^d	6.24
AFC	A ₁	344.68 ^{ab}	16.00
	A ₂	336.31 ^b	7.26
	A ₃	347.37 ^{ab}	5.90
	A ₄	350.32 ^{ab}	5.71
	A ₅	351.35 ^a	5.83
	A ₆	370.02 ^a	7.27
	A ₇	357.88 ^{ab}	10.43
	A ₈	373.50 ^a	12.02

Means with similar superscripts are not significantly different.

was recorded in period P_3 followed by P_2 (343.50 ± 3.87 kg) and P_1 (294.40 ± 8.59 kg), respectively. D.M.T revealed significant differences amongst different periodicities. The effect due to farm was highly significant. The highest milk yield of 401.64 ± 3.86 kg was recorded at F_2 farm followed by F_1 (373.62 ± 5.62 kg), F_3 (340.81 ± 7.25 kg), F_5 (340.36 ± 6.24 kg) and F_4 (300.22 ± 5.63 kg), respectively. D.M.T revealed significant differences amongst the yields from cows at different farms except for F_3 and F_5 . The milk yield from cows at farm F_3 and F_5 were at par. Non-significant effect of age at 1st calving on milk yield of 5th month was observed. The yields from various age groups ranged from 336.31 ± 7.26 to 373.59 ± 12.02 kg. D.M.T revealed that A_2 was significantly different from A_3 , A_6 and A_8 age groups.

In case of 1/2 breeds (Table 6), the genetic and phenotypic correlations of milk yield during 5th month were highly significant and positive with the traits studied.

The heritability estimate for milk yield during 5th month in 1/2 bred progeny was 0.133 ± 0.018 .

In case of 3/4 breeds (Table 7), the genetic and phenotypic correlations of milk yield during 5th month were positive and highly significant with the traits studied.

The heritability estimate for milk yield during 5th month in 3/4 breeds was 0.195 ± 0.016 .

In case of 5/8 breeds (Table 3), the genetic correlations of milk yield during 5th month with milk yield during 6th, 7th and 8th months, 300 day milk yield and total yield were positive and highly significant. But negative and highly significant with 9th and 10th months milk yield. Phenotypic correlations were positive and highly significant with the traits studied.

The heritability estimate for milk yield during 5th month in 5/8 breeds was 0.019 ± 0.003 .

In case of 7/8 breeds (Table 9), the genetic correlations from 5th month milk yield with monthly milk yield of 6th to 9th months, 300 day milk yield and total yield were positive and highly significant. Negative and highly significant genetic correlation with 10th month milk yield was observed. Phenotypic correlations were positive and highly significant with the traits studied.

The heritability estimate for milk yield during 5th month in 7/8 breeds was 0.061 ± 0.021 .

4.10 Effect of various factors on milk yield of 6th month

The least squares means with standard errors for the factors affecting milk yield of 6th month in Friesian x Sahiwal cross progeny are presented in Table 10.

Table 18: Least squares means and standard errors for the factors affecting milk yield of 6th month.

Source	Code	Mean	S.E.
μ	-	330.04	4.18
Grade	G ₁	349.68 ^a	6.03
	G ₂	331.84 ^c	5.45
	G ₃	332.05 ^{bc}	4.96
	G ₄	306.59 ^d	7.84
Period	P ₁	276.13 ^c	8.36
	P ₂	320.51 ^b	3.76
	P ₃	393.47 ^a	5.66
Farm	F ₁	341.85 ^{bc}	5.46
	F ₂	377.11 ^a	8.63
	F ₃	327.43 ^{cd}	7.05
	F ₄	285.27 ^e	5.53
	F ₅	318.53 ^d	6.06
AFC	A ₁	325.51 ^a	15.56
	A ₂	316.90 ^b	7.07
	A ₃	325.88 ^a	5.75
	A ₄	328.34 ^a	5.55
	A ₅	326.80 ^a	5.68
	A ₆	344.46 ^a	7.08
	A ₇	330.22 ^a	10.15
	A ₈	342.20 ^a	11.69

Means with similar superscripts are not significantly different.

The general mean for 6th month milk yield was 330.04 ± 4.10 kg. The grade effect was highly significant. G_1 recorded the highest (349.68 ± 6.03 kg) milk yield followed by G_3 (332.03 ± 4.96 kg), G_2 (331.84 ± 5.45 kg) and G_4 (306.59 ± 7.84 kg), respectively. Significant differences were observed amongst grades except for G_2 and G_3 , which were at par as revealed by DMRT. The period effect was highly significant. The highest milk yield of 393.47 ± 5.66 kg was recorded in period P_3 followed by P_2 (320.51 ± 3.76 kg) and P_1 (276.13 ± 8.36 kg), respectively. DMRT revealed significant differences amongst different periodicities. The effect due to farm was highly significant. The highest milk yield of 377.11 ± 6.63 kg was recorded at farm F_2 followed by F_1 (341.65 ± 5.46 kg), F_3 (327.43 ± 7.05 kg), F_5 (316.53 ± 6.06 kg) and F_4 (265.27 ± 5.53 kg), respectively. DMRT revealed significant differences amongst yields from different farms except F_1 and F_3 ; F_3 and F_5 farms were at par. The age at 1st calving had non-significant effect. The milk yield from various age groups ranged from 316.90 ± 7.07 to 343.46 ± 7.08 kg. DMRT revealed non-significant differences existed amongst different age groups except A_2 , which was significantly different from rest of the age groups.

The genetic and phenotypic correlations (Table 6), of 6th month milk yield with the traits studied were positive and highly significant in case of 1/2 bred progeny.

The heritability estimate for 6th month milk yield in 1/2 bred progeny was 0.130 ± 0.017 .

In case of 3/4 breeds (Table 7), the genetic and phenotypic correlations of milk yield during 6th month with the traits studied were positive and highly significant.

The heritability estimate for milk yield of 6th month in 3/4 bred progeny was 0.199 ± 0.015 .

In case of 5/8 breeds (Table 8), the genetic correlations of milk yield during 6th month were positive and highly significant with monthly milk yield of 7th and 8th months, 300 day milk yield and total yield. Whereas, negative and highly significant genetic correlation with 9th and 10th months milk yield. The phenotypic correlations of milk yield were positive and highly significant with the traits studied.

The heritability estimate for milk yield of 6th month in 5/8 bred progeny was 0.008 ± 0.002 .

In case of 7/8 breeds (Table 9), the genetic correlations of milk yield during 6th month with 7th, 8th, 9th months, 300 day milk yield and total yield were positive

and highly significant. Negative but highly significant genetic correlation with 10th month milk yield was recorded. The phenotypic correlations were highly significant.

The heritability estimate for milk yield of 6th month in 7/8 bred progeny was 0.067 ± 0.023 .

4.11 Effect of various factors on milk yield of 7th month

The least squares means with standard errors for factors affecting milk yield of 7th month in Friesian x Sahiwal cross progeny are presented in Table 19.

The general mean for 7th month milk yield was 304.35 ± 4.08 kg. The grade effect was highly significant. The milk yield of 7th month from cows of G_1 grade recorded the highest milk yield (321.54 ± 5.89 kg) followed by G_3 (307.27 ± 4.54 kg), G_2 (303.49 ± 5.32 kg) and G_4 (285.17 ± 7.67 kg), respectively. Significant differences existed amongst the milk yield from various grades except for G_2 and G_3 . The milk yield from cows of grade G_2 and G_3 were at par as revealed by DMRT. The period effect was highly significant. The highest milk yield of 363.14 ± 5.55 kg was recorded in period P_3 followed by P_2 (297.03 ± 3.67 kg) and P_1 (252.88 ± 8.14 kg), respectively. DMRT revealed significant differences amongst different periodicities.

Table 19: Least squares means and standard errors for the factors affecting milk yield of 7th month.

Source	Code	Mean	S.E.
μ	-	304.35	4.08
Grade	G ₁	321.54 ^a	5.89
	G ₂	303.40 ^c	5.32
	G ₃	307.27 ^{bc}	4.84
	G ₄	285.17 ^d	7.67
Period	P ₁	252.88 ^c	8.14
	P ₂	297.03 ^b	3.67
	P ₃	363.14 ^a	5.55
Farm	F ₁	311.33 ^{bc}	5.32
	F ₂	350.95 ^a	8.43
	F ₃	305.52 ^{cd}	6.89
	F ₄	260.57 ^e	5.40
	F ₅	293.37 ^d	5.93
AFC	A ₁	304.25 ^a	15.14
	A ₂	289.90 ^{ac}	6.92
	A ₃	300.97 ^a	5.61
	A ₄	298.12 ^{ab}	5.41
	A ₅	302.08 ^a	5.55
	A ₆	316.72 ^a	6.91
	A ₇	304.80 ^a	9.88
	A ₈	317.95 ^a	11.45

Means with similar superscripts are not significantly different.

The farm effect was highly significant. The highest milk yield of 330.95 ± 8.43 kg was recorded at farm F_2 followed by F_1 (311.33 ± 5.32 kg), F_3 (305.92 ± 6.69 kg), F_5 (293.37 ± 5.93 kg) and F_4 (260.57 ± 5.40 kg), respectively. DART revealed significant differences amongst yields from different farms. Non-significant differences were observed in F_1 and F_3 ; F_3 and F_5 farms. The age at 1st calving had non-significant effect. The milk yield from various age groups ranged from 259.90 ± 6.92 to 317.95 ± 11.45 kg. DART revealed non-significant differences among different age groups. Age group A_2 and A_4 were different from each other in respect of milk yield of 7th month.

The genetic and phenotypic correlations of 7th month milk yield in $1/2$ breeds (Table G), were highly significant and positive with the trait studied.

The heritability estimate for 7th month milk yield in $1/2$ bred progeny was 0.142 ± 0.018 .

In case of $3/4$ breeds (Table 7), the genetic and phenotypic correlations of 7th month milk yield with the traits studied were positive and highly significant.

The heritability estimate for 7th month milk yield in $3/4$ bred progeny was 0.162 ± 0.014 .

In case of 5/8 breeds (Table 8), the genetic correlations of milk yield of 7th month with milk yield of 8th month, 300 day milk yield and total yield were positive and highly significant. Whereas, they were negative and highly significant with 9th and 10th months milk yield. Phenotypic correlations of milk yield during 7th month with the traits studied were positive and highly significant.

The heritability estimate for 7th month milk yield in 5/8 bred progeny was -0.023 ± 0.003 .

In case of 7/8 breeds, the genetic and phenotypic correlations (Table 9) of milk yield during 7th month was highly significant and positively correlated with the traits studied.

The heritability estimate for milk yield of 7th month in 7/8 bred progeny was 0.109 ± 0.025 .

4.12 Effect of various factors on milk yield of 8th month

The least squares means with standard errors for factors affecting milk yield of 8th month in Friesian x Sahiwal cross progeny are presented in Table 20.

The general mean for 8th month milk yield was 274.55 ± 4.12 kg. The grade effect was highly significant. The highest milk yield of 293.16 ± 5.97 kg was recorded in cows

Table 20: Least squares means and standard errors for the factors affecting milk yield of 8th month.

Source	Code	Mean	S.E.
μ	-	274.55	4.12
Grade	G ₁	293.16 ^a	5.97
	G ₂	272.68 ^{cd}	5.39
	G ₃	277.12 ^{bc}	4.91
	G ₄	255.24 ^d	7.74
Period	P ₁	230.25 ^c	8.25
	P ₂	265.75 ^b	3.69
	P ₃	327.66 ^a	5.61
Farm	F ₁	278.16 ^{bcd}	5.39
	F ₂	317.04 ^a	8.50
	F ₃	275.73 ^{cd}	7.02
	F ₄	235.14 ^e	5.45
	F ₅	266.69 ^d	5.97
AFC	A ₁	264.69 ^a	15.15
	A ₂	265.99 ^a	7.05
	A ₃	275.37 ^a	5.70
	A ₄	267.14 ^a	5.46
	A ₅	271.60 ^a	5.61
	A ₆	283.90 ^a	6.97
	A ₇	276.99 ^a	10.05
	A ₈	290.74 ^a	11.53

Means with similar superscripts are not significantly different.

grade G_1 followed by G_3 (277.12 ± 4.91 kg), G_2 (272.68 ± 5.39 kg) and G_4 (255.24 ± 7.74 kg), respectively. DMRT revealed significant differences amongst grades except G_2 and G_3 ; G_2 and G_4 which were non-significantly different. The period effect was highly significant. The highest milk yield was recorded in period P_3 (327.66 ± 3.61 kg) followed by P_2 (265.75 ± 3.69 kg) and P_1 (230.25 ± 6.25 kg), respectively. DMRT revealed significant differences amongst different periodicities. The effect due to farm was highly significant. The highest milk yield of 317.04 ± 8.50 kg was recorded at farm F_2 followed by F_1 (278.16 ± 5.33 kg), F_3 (273.73 ± 7.02 kg), F_5 (266.69 ± 5.97 kg) and F_4 (235.14 ± 5.45 kg), respectively. The yields at farm F_2 and F_4 were significantly different from other farms. Non-significant differences existed amongst the yields at F_1 , F_3 and F_5 farms. The age at 1st calving had non-significant effect. The milk yield of various age groups ranged from 264.69 ± 15.15 to 290.74 ± 11.53 kg. DMRT revealed non-significant differences amongst them.

The genetic and phenotypic correlations of 9th month milk yield were positive and highly significant with the traits studied in 1/2 breeds (Table 6).

The heritability estimate for 8th month yield in 1/2 bred progeny was 0.102 ± 0.022 .

In case of 3/4 breeds (Table 7), the genetic and phenotypic correlations of milk yield of 8th month with the traits studied were positive and highly significant.

The heritability estimate of 8th month yield in 3/4 bred progeny was 0.167 ± 0.014 .

In case of 5/8 breeds (Table 8), the genetic correlation of milk yield of 8th month with 300 day milk yield and total yield were positive and highly significant. It was negative and highly significant with the milk yield of 9th and 10th month. The phenotypic correlations were positive and highly significant with the traits studied.

The heritability estimate for yield of 8th month in 5/8 bred progeny was 0.010 ± 0.003 .

In case of 7/8 breeds (Table 9), the genetic correlations of milk yield during 8th month with 9th month, 300 day milk yield and total yield were positive and highly significant. Negative and highly significant genetic correlation with milk yield of 10th month was observed. Phenotypic correlations were highly significant and positive correlation with the traits studied.

The heritability estimate for milk yield of 8th month in 7/8 bred progeny was 0.103 ± 0.025 .

4.13 Effect of various factors on milk yield of 9th month

The least squares means with standard errors for factors affecting milk yield of 9th month in Friesian x Sahiwal cross progeny are presented in table 21.

The general mean for 9th month milk yield was 247.05 ± 4.33 kg. The grade effect was highly significant. The cows from grade G_1 recorded the highest milk yield (263.05 ± 6.24 kg) followed by G_3 (248.80 ± 5.22 kg), G_2 (245.07 ± 5.65 kg) and G_4 (231.28 ± 8.14 kg), respectively. DMRT revealed that grade G_1 significantly differed from G_2 and G_4 and was at par with G_3 . Non-significant differences were observed amongst the milk yield of cows from G_2 and G_3 , G_2 and G_4 . The period effect was highly significant. The highest milk yield of 290.42 ± 5.80 kg was recorded in period P_3 followed by P_2 (241.59 ± 3.91 kg) and P_1 (209.14 ± 0.75 kg), respectively. Significant differences amongst the yields from different periodicities were observed as revealed by DMRT. The farm effect was highly significant. The milk yield of 280.20 ± 0.86 kg was recorded at farm F_2 , followed by F_3 (247.93 ± 7.44 kg), F_1 (246.92 ± 5.73 kg), F_5 (240.40 ± 6.32 kg) and F_4 (211.79 ± 5.71 kg), respectively. DMRT revealed significant differences amongst the yields from different farms except F_1 and F_3 farms which were

Table 21: Least squares means and standard errors for the factors affecting milk yield of 9th month.

Source	Code	Mean	S.E.
μ	-	247.05	4.33
Grade	G ₁	263.05 ^a	6.24
	G ₂	245.07 ^{bc}	5.65
	G ₃	248.80 ^{ab}	5.22
	G ₄	231.28 ^c	8.14
Period	P ₁	209.14 ^c	8.75
	P ₂	241.59 ^b	3.91
	P ₃	290.42 ^a	5.80
Farm	F ₁	246.92 ^{cd}	5.73
	F ₂	288.20 ^a	8.86
	F ₃	247.95 ^{bcd}	7.44
	F ₄	211.79 ^e	5.71
	F ₅	240.40 ^d	6.32
AFC	A ₁	246.99 ^a	16.38
	A ₂	237.19 ^a	7.46
	A ₃	244.64 ^a	5.96
	A ₄	241.78 ^a	5.79
	A ₅	244.95 ^a	5.94
	A ₆	255.71 ^a	7.43
	A ₇	249.23 ^a	10.42
	A ₈	255.91 ^a	11.74

Means with similar superscripts are not significantly different.

at par with each other. Non-significant effect of age at 1st calving was observed. The milk yields from various age groups ranged from 237.19 ± 7.46 kg to 255.91 ± 11.74 . The DMRT revealed non-significant differences amongst the milk yield of cows from different age groups.

The genetic and phenotypic correlations of 9th month milk yield with the traits studied were positive and highly significant in 1/2 breeds (Table 6).

The heritability estimate for 9th month milk yield in 1/2 bred progeny was 0.146 ± 0.021 .

In case of 3/4 breeds (Table 7), the genetic and phenotypic correlations of 9th month milk yield with the traits studied were positive and highly significant.

The heritability estimate for 9th month milk yield in 3/4 bred progeny was 0.129 ± 0.013 .

In case of 5/8 breeds (Table 8), the genetic correlations of 9th month milk yield with the traits studied were negative and highly significant. Phenotypic correlations were positive and highly significant with the traits studied.

The heritability estimate for milk yield of 9th month in 5/8 bred progeny was -0.011 ± 0.003 .

In case of 7/8 breeds (Table 9), the genetic correlations were positive and highly significant with 300 day milk yield and total yield. Whereas, it was negative and highly significant with 10th month milk yield. Phenotypic correlations were positive and highly significant with the traits studied.

The heritability estimate for milk yield of 9th month in 7/8 bred progeny was 0.172 ± 0.035 .

4.14 Effect of various factors on milk yield of 10th month

The least squares means with standard errors for factors affecting milk yield of 10th month in Friesian x Sahiwal cross progeny are presented in Table 22.

The general mean for milk yield in 10th month was 211.71 ± 4.75 kg. The grade effect was highly significant. The highest milk yield of 217.42 ± 6.60 was recorded in G_1 followed by G_2 (212.20 ± 6.27 kg), G_3 (211.02 ± 5.62 kg) and G_4 (206.18 ± 8.76 kg), respectively. DMRT revealed non-significant differences amongst the milk yield from cows of different grades. The period effect was highly significant. The highest yield of 241.55 ± 6.04 kg was recorded in period P_3 followed by P_2 (209.92 ± 4.20 kg) and P_1 (183.64 ± 9.70 kg), respectively. Significant differences amongst the yields from different periodicities were observed as revealed by DMRT. The farm effect was

Table 22: Least squares means and standard errors for the factors affecting milk yield of 10th month.

Source	Code	Mean	S.E.
μ	-	211.71	4.75
Grade	G ₁	217.42 ^a	6.60
	G ₂	212.20 ^a	6.27
	G ₃	211.02 ^a	5.62
	G ₄	206.18 ^a	8.76
Period	P ₁	183.64 ^c	9.70
	P ₂	209.92 ^b	4.20
	P ₃	241.55 ^a	6.04
Farm	F ₁	213.51 ^{cd}	6.17
	F ₂	249.05 ^a	9.77
	F ₃	216.31 ^{bcd}	8.14
	F ₄	176.04 ^e	5.99
	F ₅	203.63 ^d	6.74
AFC	A ₁	227.67 ^a	17.81
	A ₂	205.39 ^a	8.08
	A ₃	208.07 ^a	6.51
	A ₄	208.87 ^a	6.21
	A ₅	207.86 ^a	6.31
	A ₆	209.68 ^a	7.81
	A ₇	214.84 ^a	10.98
	A ₈	211.29 ^a	12.20

Means with similar superscripts are not significantly different.

highly significant. The highest milk yield of 249.05 ± 9.77 kg was recorded at farm F_2 followed by F_3 (216.31 ± 8.14 kg), F_1 (213.51 ± 6.17 kg), F_5 (203.63 ± 6.74 kg) and F_4 (176.04 ± 5.92 kg). M/R revealed significant differences among the yields from different farms except F_1 , F_3 and F_5 which were at par amongst them. Non-significant effect of age at 1st calving was observed. The yields from various age groups ranged from 205.39 ± 8.06 to 227.67 ± 17.81 kg. M/R revealed non-significant differences amongst the yields from different age groups.

In case of 1/2 breeds (Table 6), the genetic and phenotypic correlations of milk yield during 10th month with traits studied were highly significant and positive.

The heritability estimate for milk yield of 10th month in 1/2 bred progeny was 0.227 ± 0.034 .

In case of 3/4 breeds (Table 7), the genetic and phenotypic correlations of milk yield during 10th month with the other traits studied were positive and highly significant.

The heritability estimate for milk yield of 10th month in 3/4 bred progeny was 0.060 ± 0.013 .

In case of 5/8 breeds (Table 8), the genetic correlations of milk yield from 10th month with the traits studied were negative and highly significant. Phenotypic

correlations were positive and highly significant with the traits studied.

The heritability estimate for milk yield of 10th month in 5/8 bred progeny was 0.005 ± 0.005 .

In case of 7/8 broods (Table 9), the genetic correlations were negative and highly significant with 300 day milk yield and total yield. Phenotypic correlations were positive and highly significant with the traits studied.

The heritability estimate for milk yield of 10th month in 7/8 bred progeny was -0.109 ± 0.024 .

4.15 Effect of various factors on 300 day milk yield

The least squares means with standard errors for factors affecting milk yield of 300 day in Friesian x Sahiwal cross progeny are presented in Table 23.

The general mean for milk yield of 300 day was 3210.13 ± 41.13 kg. The grade effect was highly significant. The highest milk yield of 3440.24 ± 59.32 kg was recorded in G_1 followed by G_3 (3220.15 ± 48.84 kg), G_2 (3193.36 ± 53.64 kg) and G_4 (2964.28 ± 77.19 kg). The differences amongst the yields from various grade were significant except G_2 and G_3 which were at par as revealed by LSD. The period effect was highly significant. The highest yield of 3556.37 ± 55.32 kg was recorded in period F_3 followed by P_2 (3113.66 ± 37.04 kg) and P_1 (2658.37 ± 82.33 kg), respectively.

Table 23: Least squares means and standard errors for the factors affecting 300 day milk yield.

Source	Code	Mean	S.E.
μ	-	3210.13	41.13
Grade	G ₁	3440.24 ^a	59.32
	G ₂	3195.86 ^c	53.64
	G ₃	3220.15 ^{bc}	40.84
	G ₄	2984.28 ^d	77.19
Period	P ₁	2658.37 ^c	82.33
	P ₂	3115.66 ^b	37.04
	P ₃	3656.37 ^a	55.52
	P ₄	3630.24 ^a	84.66
Farm	F ₁	3337.38 ^b	53.77
	F ₂	3630.24 ^a	84.66
	F ₃	3166.31 ^{cd}	69.41
	F ₄	2800.53 ^e	54.39
AFC	F ₅	3108.21 ^d	59.76
	A ₁	3116.69 ^{ab}	153.27
	A ₂	3054.58 ^b	69.52
	A ₃	3168.51 ^{ab}	56.47
	A ₄	3162.63 ^{ab}	54.58
	A ₅	3184.80 ^{ab}	55.88
	A ₆	3296.59 ^a	69.64
	A ₇	3262.55 ^{ab}	99.97
	A ₈	3414.71 ^a	115.15

Means with similar superscripts are not significantly different.

D.M.T. revealed significant differences amongst the yields from different periodicities. The farm effect was highly significant. Farm F_2 was recorded the highest yield of 3638.24 ± 84.66 kg followed by F_1 (3337.30 ± 53.77), F_3 (3166.31 ± 69.41 kg), F_5 (3108.21 ± 52.76) and F_4 (2800.53 ± 54.39 kg), respectively. D.M.T. revealed significant differences amongst the yields from different farms except F_3 and F_5 which were at par amongst each other. Non-significant effect of age at 1st calving was observed. The yields from various age groups ranged from 3034.58 ± 69.52 to 3414.71 ± 115.15 kg. D.M.T. revealed non-significant differences amongst different age groups except A_2 which was different from age group A_6 and A_3 .

The genetic and phenotypic correlations of 300 day milk yield with total yield was positive and highly significant in case of 1/2 bred progeny (Table 6).

The heritability estimate for 300 day milk yield in 1/2 bred progeny was 0.219 ± 0.024 .

In case of 3/4 breeds (Table 7), the genetic and phenotypic correlations of 300 day milk yield with total yield was positive and highly significant.

The heritability estimate for 300 day milk yield in 3/4 bred progeny was 0.102 ± 0.010 .

In case of 3/8 broods (Table 8), genetic and phenotypic correlations of 300 day milk yield with total yield were positive and highly significant.

The heritability estimate for 300 day milk yield in 5/8 bred progeny was 0.018 ± 0.003 .

The genetic and phenotypic correlations in case of 7/8 bred progeny (Table 9) for 300 day milk yield with total yield was positive and highly significant.

The heritability estimate for 300 day milk yield in 7/8 bred progeny was 0.062 ± 0.021 .

4.16 Effect of various factors on total yield

The least squares means with standard errors for factors affecting total yield in Friesian x Sahiwal cross progeny are presented in Table 24.

The general mean for total yield was 3405.24 ± 47.00 kg. The grade effect was highly significant. G_1 recorded the highest yield (3629.02 ± 67.49 kg) followed by G_3 (3442.42 ± 55.21 kg), G_2 (3352.15 ± 61.53 kg) and G_4 (3197.38 ± 90.44 kg), respectively. D.F. revealed non-significant differences between the total milk yield of cows from grade G_2 and G_3 , similarly between G_2 and G_4 . However, the total yield from cows of grade G_1 was significantly different from rest of the grades.

Table 24: Least squares means and standard errors for the factors affecting total yield.

Source	Code	Mean	S.E.
μ	-	3405.24	47.00
Grade	G ₁	3629.02 ^a	67.49
	G ₂	3352.15 ^{cd}	61.53
	G ₃	3442.42 ^{bc}	55.21
	G ₄	3197.38 ^d	90.44
Period	P ₁	2747.41 ^c	92.71
	P ₂	3272.60 ^b	42.37
	P ₃	4195.72 ^a	65.30
Farm	F ₁	3560.47 ^b	60.90
	F ₂	3866.60 ^a	90.14
	F ₃	3334.47 ^{cd}	79.37
	F ₄	2960.03 ^e	62.91
	F ₅	3304.63 ^d	68.60
AFC	A ₁	3427.24 ^{abc}	171.47
	A ₂	3188.67 ^c	79.23
	A ₃	3360.87 ^{abc}	64.12
	A ₄	3290.09 ^{bc}	64.36
	A ₅	3375.12 ^{abc}	64.26
	A ₆	3507.28 ^a	79.47
	A ₇	3493.81 ^{abc}	115.31
	A ₈	3598.87 ^a	129.77

Means with similar superscripts are not significantly different.

The period effect was highly significant. The highest yield of 4195.72 ± 65.30 kg was recorded in P_3 followed by P_2 (3272.60 ± 42.37 kg) and P_1 (2747.41 ± 92.71 kg), respectively. DMRT revealed significant differences amongst different periodicities. The effect due to farm was highly significant. The highest milk yield of 3866.60 ± 98.14 kg was recorded at farm F_2 followed by F_1 (3560.47 ± 60.90 kg), F_3 (3334.49 ± 79.37 kg), F_5 (3304.63 ± 68.60 kg) and F_4 (2960.03 ± 62.91 kg), respectively. Significant differences amongst the total yields from different farm were observed. However, the yields from F_3 and F_5 farms were non-significantly different as revealed by DMRT. The age at 1st calving had significant effect. The milk yield from various age groups ranged from 3188.67 ± 73.23 to 3598.87 ± 129.77 kg. DMRT revealed that A_2 was significantly different from A_6 and A_8 age groups. Non-significant differences were observed amongst the milk yield from first five and A_7 age groups.

The heritability estimate of total yield in 1/2 bred progeny (Table 6) was 0.202 ± 0.022 .

The heritability estimate of total yield in 3/4 bred progeny was (Table 7) 0.106 ± 0.011 .

The heritability estimate of total yield in 5/8 bred progeny was (Table 8) 0.027 ± 0.003 .

The heritability estimate of total yield in 7/8 bred progeny was (Table 9) 0.242 ± 0.041 .

The effect of change in temperature and humidity on monthly milk yield in Friesian x Sahiwal crossbred cows have been studied. The data on average saturation deficit coefficient (the function of temperature and humidity), the milk yield of corresponding month was plotted. The study was done in respect of overall uncorrected and corrected data. Four functions viz; exponential, linear, quadratic and Cobb-Douglas were tried. The result are present in foregoing paras.

Overall uncorrected and corrected data

The functional relationship between the saturation deficit coefficient and overall uncorrected data on monthly milk yield are presented in Tables 25 and 26.

The mean monthly milk yield was $\bar{Y} = 331.84$ kg under each type of function with corresponding means for saturation deficit coefficient $\bar{X} = 5.724$ per cent under exponential, linear, quadratic and Cobb-Douglas, respectively. The regression coefficient under each function have been -0.0002 , -0.234 , 0.667 and 0.002 respectively. They were non-significant. Similarly, coefficient of determination (R^2) was smaller.

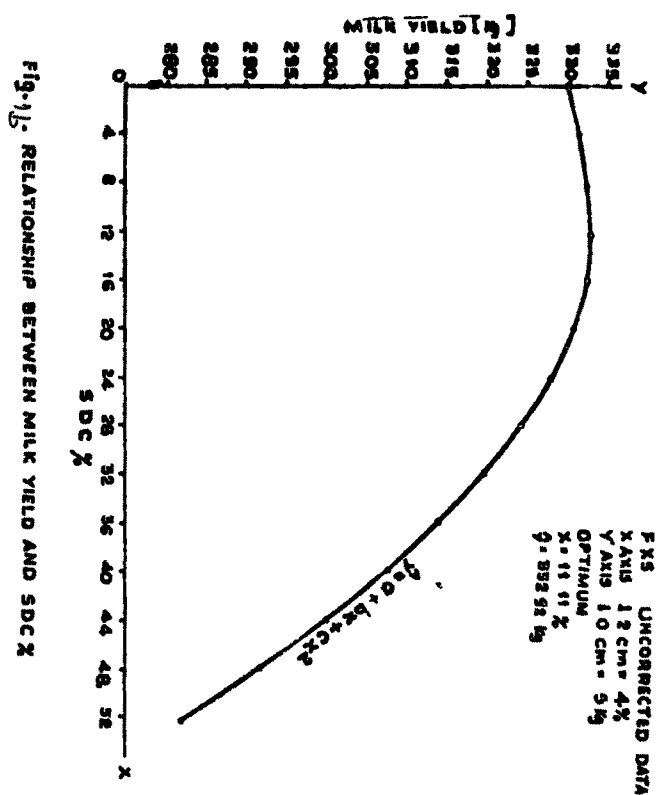
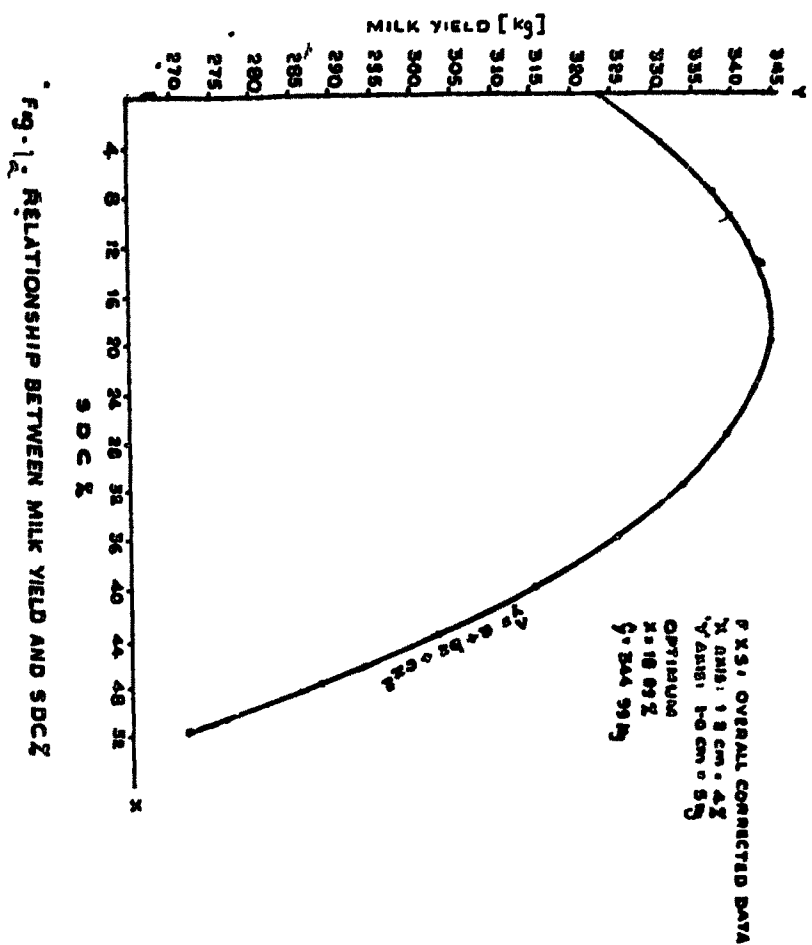
Table 25: Milk production functions in response to saturation deficit coefficient (uncorrected data)

Sr. No.	Functions Values	Exponential $\hat{Y} = ae^{bx}$	Linear $\hat{Y} = a+bx$	Quadratic $\hat{Y}=a+bx+cx^2$	Cobb-Douglas $\hat{Y}= ax^b$
<u>a) Uncorrected data</u>					
1)	a	5.726	334.692	329.228	5.718
2)	b	-0.0002	-0.234	0.667	0.002
3)	c	-	-	-0.030	-
4)	SE _b	0.0005	0.167	0.809	0.007
5)	SE _c	-	-	0.026	-
6)	t _b	0.315	1.395	0.825	0.334
7)	t _c	-	-	1.138	-
8)	R ²	0.000006	0.0001	0.00019	0.00007
9)	N	16424	16424	16424	16424
10)	F	-	-	1.56	-
11)	Optima	-	-	11.11	-
		$\bar{Y} = 331.840$	$\bar{Y} = 331.840$	$\bar{Y} = 331.840$	$\bar{Y} = 331.840$
		$\bar{X} = 5.724$	$\bar{X} = 5.724$	$\bar{X} = 5.724$	$\bar{X} = 5.724$
<u>b) Overall corrected data</u>					
1)	a	5.736	333.168	321.078	5.692
2)	b	0.002**	0.537**	2.532**	0.028**
3)	c	-	-	-0.067*	-
4)	SE _b	0.0005	0.156	0.752	0.655
5)	SE _c	-	-	0.025	-
6)	t _b	3.619	3.451	3.368	4.285
7)	t _c	-	-	2.712	-
8)	R ²	0.0006	0.0007	0.0012	0.0011
9)	N	16413	16413	16413	16413
10)	F	-	-	9.035	-
11)	Optima	-	-	18.89	-
		$\bar{Y} = 339.720$	$\bar{Y} = 339.720$	$\bar{Y} = 339.720$	$\bar{Y} = 339.720$
		$\bar{X} = 5.759$	$\bar{X} = 5.759$	$\bar{X} = 5.759$	$\bar{X} = 5.759$

* P < 0.05; ** P < 0.01

Table 26: Relationship between milk yield and saturation deficit coefficient.

$\hat{Y} = a + bx + cx^2$ Quadratic	$\hat{Y} = a + bx + cx^2$ Quadratic
a) Uncorrected data $\hat{Y}$ = Estimated value a = Pure constant intercept b = Regression coefficient c = Partial regression coefficient x = Levels of SDC (4,8,12.....52)	b) Overall corrected data $\hat{Y}$ = Estimated value a = Pure constant intercept b = Regression coefficient c = Partial regression coefficient x = Levels of SDC (4,8,12.....52)
$\hat{Y}_1 = 331.40$ $\hat{Y}_2 = 332.63$ $\hat{Y}_3 = 332.90$ $\hat{Y}_4 = 332.21$ $\hat{Y}_5 = 330.36$ $\hat{Y}_6 = 327.94$ $\hat{Y}_7 = 324.37$ $\hat{Y}_8 = 319.84$ $\hat{Y}_9 = 314.35$ $\hat{Y}_{10} = 307.90$ $\hat{Y}_{11} = 300.48$ $\hat{Y}_{12} = 292.11$ $\hat{Y}_{13} = 282.78$	$\hat{Y}_1 = 330.13$ $\hat{Y}_2 = 337.04$ $\hat{Y}_3 = 341.01$ $\hat{Y}_4 = 344.43$ $\hat{Y}_5 = 344.92$ $\hat{Y}_6 = 343.24$ $\hat{Y}_7 = 339.44$ $\hat{Y}_8 = 333.49$ $\hat{Y}_9 = 325.39$ $\hat{Y}_{10} = 315.15$ $\hat{Y}_{11} = 302.76$ $\hat{Y}_{12} = 288.24$ $\hat{Y}_{13} = 271.57$



Therefore, the variation in milk yield shared by SDC was very meagre to that of total. It did not explain a quantum of share due to the effect of saturation deficit coefficient.

The functional relationship between saturation deficit coefficient and monthly milk yield (overall corrected data) is presented in Tables 25 and 26. It was observed that the mean monthly milk yield have $\bar{Y} = 337.72$ kg with corresponding saturation deficit coefficient of $\bar{X} = 5.759$ per cent under exponential, linear, quadratic and Cobb-Douglas. The 'b' values were highly significant for the four functions. The 'c' value for quadratic function was significant but negative. The coefficient of determination R^2 value for quadratic function was 0.0012 and superior to rest of the functions studied. The quadratic function was more appropriate. Therefore, it has been choiced to explain the production of milk under the effect of saturation deficit coefficient.

From the quadratic type of function it was observed that the partial regression coefficient 'b' value attached to linear term (x) was highly significant and positive, explaining thereby an upward movement of parabola. The partial regression coefficient 'C' value attached to quadratic term was negative. The optimum value for the

curvature at which the curve shapes down was estimated by equating $dy/dx = 0$ and $X = \frac{b}{2c} = 18.99$ per cent

which happened to be the optimum limit of tolerance.

The monthly milk yield in Friesian x Sahiwal crossbreds went on increasing at a decreasing rate till the tolerance limit was achieved and thereafter, there happened to be an down-ward movement in the yield.

At the tolerance limit, optima was recorded as

$Y_{opt} = 344.99$ kg of milk yield with corresponding saturation deficit coefficient of 18.99 per cent. The coefficient of determination (r^2) value explained that the variation in monthly milk yield due to saturation deficit coefficient was of the order of 0.12 per cent. Though numerically it was smaller value but significant.

The grade-wise corrected data

1/2 bred Friesian x Sahiwal cross progeny

The functional relationship between the monthly milk yield and the corresponding saturation deficit coefficient (corrected data) was assessed and the results are presented in Tables 27 and 28.

It was observed that the mean monthly milk yield was $\bar{Y} = 339.356$ kg with corresponding mean saturation deficit coefficient $\bar{X} = 5.759$ per cent, each under exponential, linear, quadratic and Cobb-Douglas functions,

Table 27: Milk production functions in response to saturation deficit coefficient.

Sr. No.	Functions Values	Exponential $\hat{Y} = acbx$	Linear $\hat{Y} = a + bx$	Quadratic $\hat{Y} = a + bx + cx^2$	Cobb-Douglas $\hat{Y} = ax^b$
a) 1/2 bred corrected data					
1)	a	5.706	324.466	329.237	5.642
2)	b	0.004**	1.275**	0.467	0.049**
3)	c	-	-	0.028	-
4)	SE _b	0.001	0.373	1.718	0.015
5)	SE _c	-	-	0.057	-
6)	t _b	3.477	3.422	0.272	3.195
7)	t _c	-	-	0.482	-
8)	R ²	0.0040	0.0039	0.0040	0.003
9)	N	2976	2976	2976	2976
10)	F	-	-	5.97	-
11)	Minima	-	-	0.34	-
	$\bar{Y} = 339.356$	$\bar{Y} = 339.356$	$\bar{Y} = 339.356$	$\bar{Y} = 339.356$	$\bar{Y} = 339.356$
	$\bar{X} = 5.759$	$\bar{X} = 5.759$	$\bar{X} = 5.759$	$\bar{X} = 5.759$	$\bar{X} = 5.759$
b) 3/4 bred corrected data					
1)	a	5.716	329.718	317.187	5.645
2)	b	0.003**	0.823**	2.920*	0.046**
3)	c	-	-	-0.071	-
4)	SE _b	0.001	0.309	1.453	0.013
5)	SE _c	-	-	0.048	-
6)	t _b	3.063	2.664	2.010	3.515
7)	t _c	-	-	1.477	-
8)	R ²	0.002	0.001	0.002	0.003
9)	N	4546	4546	4546	4546
10)	F	-	-	4.55	-
11)	Optima	-	-	20.56	-
	$\bar{Y} = 339.646$	$\bar{Y} = 339.646$	$\bar{Y} = 339.646$	$\bar{Y} = 339.646$	$\bar{Y} = 339.646$
	$\bar{X} = 5.756$	$\bar{X} = 5.756$	$\bar{X} = 5.756$	$\bar{X} = 5.756$	$\bar{X} = 5.756$

* P < 0.05; ** P < 0.01

Table 2a: Relationship between milk yield and saturation deficit coefficient.

$\hat{Y} = a + bx + cx^2$ Quadratic	$\hat{Y} = a + bx + cx^2$ Quadratic
a) <u>1/2 bred corrected data</u>	b) <u>3/4 bred corrected data</u>
$\hat{Y}$ = Estimated value	$\hat{Y}$ = Estimated value
a = Pure constant intercept	a = Pure constant intercept
b = Regression coefficient	b = Regression coefficient
c = Partial regression coefficient	c = Partial regression coefficient
x = Levels of SDC (4, 8, 12, ..., 52)	x = Levels of SDC (4, 8, 12, ..., 52)
$\hat{Y}_1 = 331.09$	$\hat{Y}_1 = 328.03$
$\hat{Y}_2 = 334.75$	$\hat{Y}_2 = 336.00$
$\hat{Y}_3 = 338.86$	$\hat{Y}_3 = 342.00$
$\hat{Y}_4 = 343.87$	$\hat{Y}_4 = 345.73$
$\hat{Y}_5 = 349.77$	$\hat{Y}_5 = 347.18$
$\hat{Y}_6 = 356.56$	$\hat{Y}_6 = 346.37$
$\hat{Y}_7 = 364.25$	$\hat{Y}_7 = 343.28$
$\hat{Y}_8 = 372.84$	$\hat{Y}_8 = 337.92$
$\hat{Y}_9 = 382.33$	$\hat{Y}_9 = 330.29$
$\hat{Y}_{10} = 392.71$	$\hat{Y}_{10} = 320.38$
$\hat{Y}_{11} = 403.98$	$\hat{Y}_{11} = 308.21$
$\hat{Y}_{12} = 416.15$	$\hat{Y}_{12} = 293.76$
$\hat{Y}_{13} = 429.22$	$\hat{Y}_{13} = 277.04$

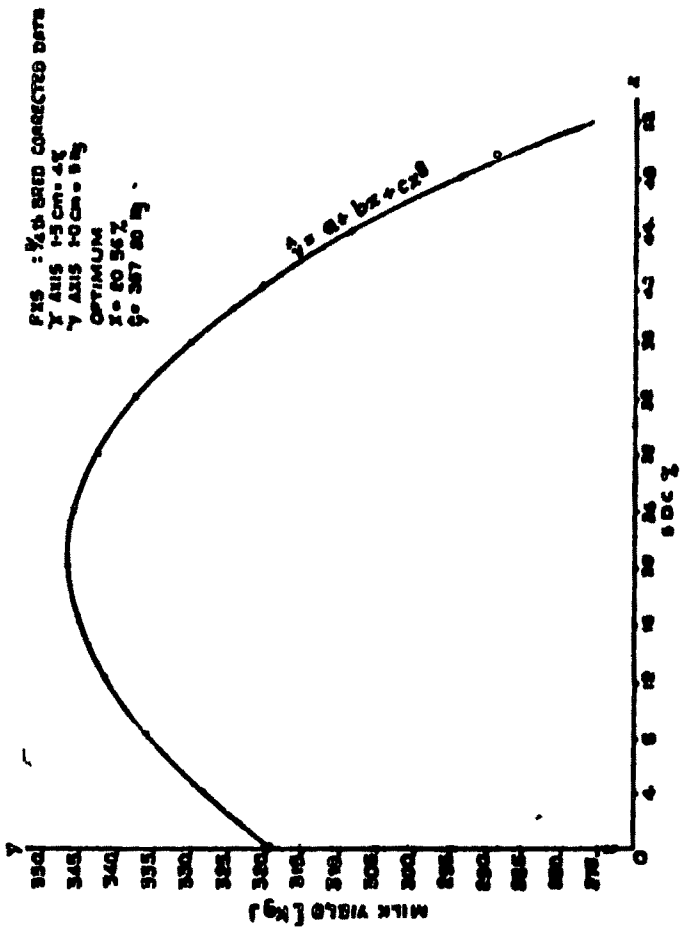
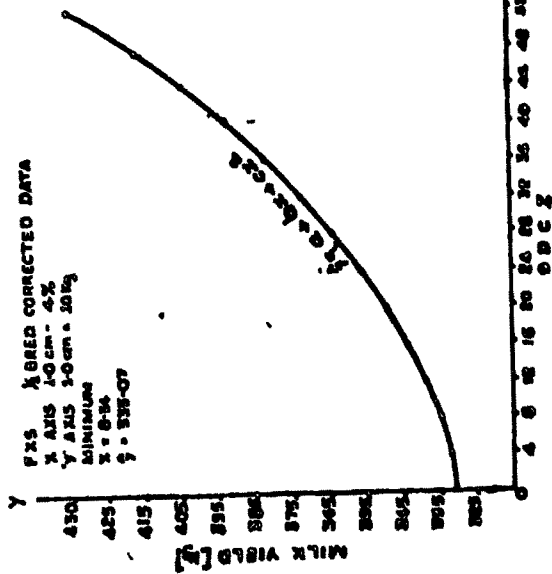


FIG 2.3. RELATIONSHIP BETWEEN MILK YIELD AND SDC 2

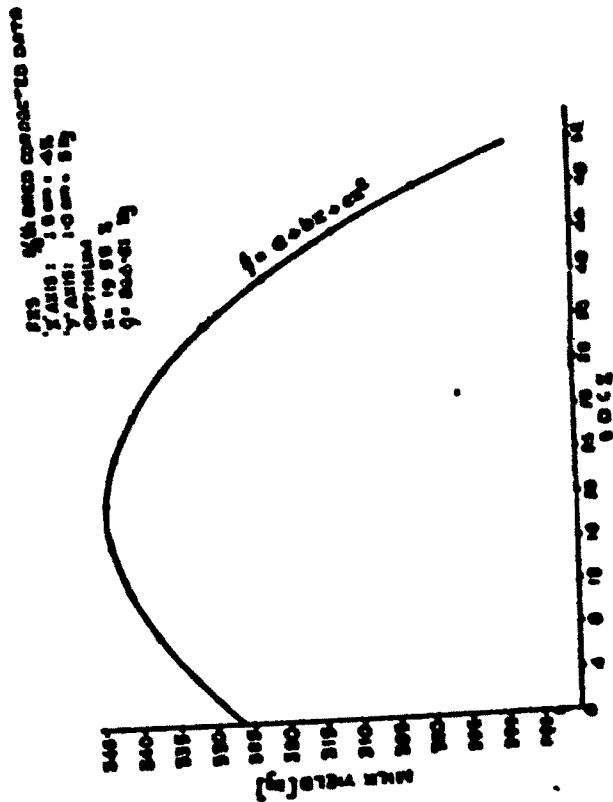
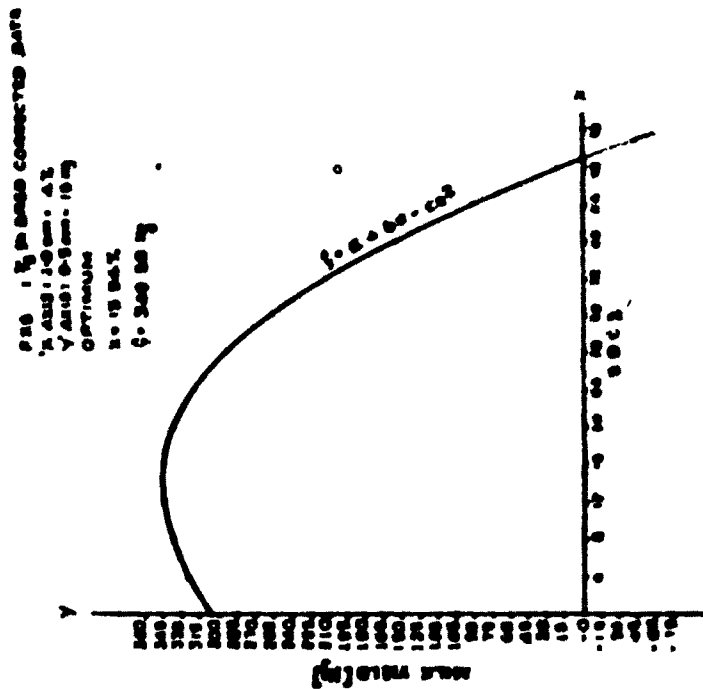


FIG 2.5. RELATIONSHIP BETWEEN MILK YIELD AND SDC 2



respectively. The regression coefficient 'b' value attached to linear term under exponential, linear and Cobb-Douglas functions have been highly significant. Whereas, under quadratic function it was non-significant. In addition, the 'c' value attached to quadratic term was non-significant but positive. The production trend exhibited a linearity throughout. In biological system normally it is not expected. The data therefore, did not agree with the application of these type of functions. Perhaps it might need some another type of approach.

3/4 bred Friesian x Sahiwal cross progeny

The functional relationship between monthly milk yield and corresponding saturation deficit coefficient in 3/4 bred Friesian x Sahiwal are presented in Tables 27 and 28. It was observed that the mean monthly milk yield in 3/4 bred was $\bar{Y} = 339.646$ kg with corresponding saturation deficit coefficient $\bar{X} = 5.756$ per cent under exponential, linear, quadratic and Cobb-Douglas type of functions. The regression coefficient 'b' value attached to linear term (X) was significant under all the four type of functions. The partial regression coefficient attached to quadratic term under quadratic type of function was negative and non-significant. The coefficient of determination (R^2) value was 0.2 per cent.

Indicating thereby the total variation in monthly milk yield of 0.2 per cent variation was shared by saturation deficit coefficient. Though the value of 0.2 per cent numerically smaller, but was significant. From the regression coefficient attached to quadratic term, it was revealed that the milk yield went on increasing at a decreasing rate till the tolerance limit and thereafter declination started. Hence, the optimum value for the curvature at which curve shape downward was estimated by $X = \frac{b}{2c} = 20.56$ per cent saturation deficit coefficient. At the level of tolerance limit of 20.56 per cent, the optimum yield was estimated as 357.20 kg.

5/8 bred Friesian x Sahiwal cross progeny

The functional relationship between monthly milk yield and corresponding saturation deficit coefficient in 5/8 breeds are presented in Tables 29 and 30.

It was observed that the mean monthly milk yield was $\bar{Y} = 340.01$ kg with corresponding saturation deficit coefficient of $\bar{X} = 5.762$ per cent each under exponential, linear, quadratic and Cobb-Douglas type of functions, respectively. The regression coefficient 'b' value attached to linear term under exponential and quadratic functions have been significant. That under Cobb-Douglas, it was

Table 29: Milk production functions in response to saturation deficit coefficient.

Sr. No.	Functions Values	Exponential $\hat{Y} = ae^{bx}$	Linear $\hat{Y} = a+bx$	Quadratic $\hat{Y} = a+bx+cx^2$	Cobb-Douglas $\hat{Y} = ax^b$
a) 5/8 bred corrected data					
1)	a	5.739	334.209	324.341	5.686
2)	b	0.002*	-0.466	2.073*	0.031**
3)	c	-	-	-0.053	-
4)	SE _b	0.0007	0.233	1.132	0.009
5)	SE _c	-	1.998	0.036	-
6)	t _b	2.339	-	1.831	3.221
7)	t _c	-	-	1.450	-
8)	R ²	0.0007	0.0005	0.0009	0.001
9)	N	6948	6948	6948	6948
10)	F	-	-	3.12	-
11)	Optima	-	-	19.55	-
		$\bar{Y} = 340.01$	$\bar{Y} = 340.01$	$\bar{Y} = 340.01$	$\bar{Y} = 340.01$
		$\bar{X} = 5.762$	$\bar{X} = 5.762$	$\bar{X} = 5.762$	$\bar{X} = 5.762$
b) 7/8 bred corrected data					
1)	a	5.805	351.255	300.237	5.839
2)	b	-0.003*	-0.949*	7.339**	-0.0313**
3)	c	-	-	-0.275**	-
4)	SE _b	0.0015	0.439	2.239	0.019
5)	SE _c	-	-	0.073	-
6)	t _b	2.254	2.157	3.277	1.647
7)	t _c	-	-	3.773	-
8)	R ²	0.0026	0.0023	0.0096	0.0014
9)	N	1943	1943	1943	1943
10)	F	-	-	9.40	-
11)	Optima	-	-	13.34	-
		$\bar{Y} = 339.599$	$\bar{Y} = 339.599$	$\bar{Y} = 339.599$	$\bar{Y} = 339.599$
		$\bar{X} = 5.783$	$\bar{X} = 5.783$	$\bar{X} = 5.783$	$\bar{X} = 5.783$

* $P \angle 0.05$; ** $P \angle 0.01$

Table 30: Relationship between milk yield and saturation deficit coefficient.

$\hat{Y} = a + bx + cx^2$ Quadratic	$\hat{Y} = a + bx + cx^2$ Quadratic
a) <u>5/8 corrected data</u>	b) <u>7/8 bred corrected data</u>
$\hat{Y}$ = Estimated value	$\hat{Y}$ = Estimated value
a = Pure constant intercept	a = Pure constant intercept
b = Regression coefficient	b = Regression coefficient
c = Partial regression coefficient	c = Partial regression coefficient
x = Levels of SDC (4, 8, 12, ..., 52)	x = Levels of SDC (4, 8, 12, ..., 52)
$\hat{Y}_1 = 331.79$	$\hat{Y}_1 = 325.18$
$\hat{Y}_2 = 337.53$	$\hat{Y}_2 = 341.34$
$\hat{Y}_3 = 341.58$	$\hat{Y}_3 = 348.69$
$\hat{Y}_4 = 343.94$	$\hat{Y}_4 = 347.25$
$\hat{Y}_5 = 344.60$	$\hat{Y}_5 = 337.01$
$\hat{Y}_6 = 343.57$	$\hat{Y}_6 = 317.96$
$\hat{Y}_7 = 340.83$	$\hat{Y}_7 = 290.12$
$\hat{Y}_8 = 336.40$	$\hat{Y}_8 = 253.47$
$\hat{Y}_9 = 330.27$	$\hat{Y}_9 = 208.03$
$\hat{Y}_{10} = 332.46$	$\hat{Y}_{10} = 153.79$
$\hat{Y}_{11} = 312.94$	$\hat{Y}_{11} = 90.74$
$\hat{Y}_{12} = 301.73$	$\hat{Y}_{12} = 18.90$
$\hat{Y}_{13} = 288.81$	$\hat{Y}_{13} = -61.74$

highly significant. The partial regression coefficient 'c' value attached to quadratic term (X^2) was negative and non-significant. The coefficient of determination (R^2) value for quadratic function was 0.09 per cent indicating thereby that the total variation in monthly milk yield 0.09 per cent was shared by the effect of saturation deficit coefficient. The optimum tolerance by the relationship $X = \frac{b}{2c} = 19.55$ per cent. The milk yield went on increasing at the decreasing rate till the point of optimum tolerance i.e. 19.55 per cent of saturation deficit coefficient and thereafter, declination started. At the level of tolerance of 19.55 per cent the limit optimum yield was estimated as 344.61 kg.

7/8 bred Friesian x Sahiwal cross progeny

The functional relationship between monthly milk yield in 7/8 breeds and the corresponding saturation deficit coefficient are presented in Tables 29 and 30.

It was observed that the mean monthly milk yield was $\bar{Y} = 339.599$ kg with corresponding saturation deficit coefficient of $\bar{X} = 5.783$ per cent each under exponential, linear, quadratic and Cobb-Douglas functions. The partial regression coefficient 'b' value attached to linear

term (X) and the 'C' value attached to quadratic term (X^2) have been highly significant. The 'C' value was negative. The coefficient of determination of (R^2) for quadratic function was 0.96 per cent. Explaining thereby 0.96 per cent of total variation in monthly milk yield was shared by saturation deficit coefficient. The optimum tolerance limit for saturation deficit coefficient was estimated by the relationship $X = \frac{b}{2c}$ 13.34 per cent, saturation deficit coefficient at which the optimum yield was estimated as 349.20 kg. The milk yield went on increasing at a decreasing rate till the optimum tolerance limit of 13.34 per cent saturation deficit coefficient and thereafter curve shapes downward.

...

5. DISCUSSION

5. DISCUSSION

To augment superior performance of dairy animal under varied climatic conditions had been the goal of breeders and of the breeding plans. The genotype environment interaction in respect of various production and reproduction traits had been the subject of study and investigation for the breeders. Adopting a selection strategy and developing superior genotype is a continuous process of dairy cattle improvement.

The least squares means for lactation period in the present study was 312.97 ± 2.80 days, which is slightly higher to that of standard lactation period of 300 days. Kushwaha and Misra (1969) reported the lactation period of 293.30 ± 78.50 days in pure Sahiwal. Gangwar *et al.* (1973) observed the 1st lactation length of 271, 274, 285 and 264 days in 1/8, 1/4, 3/4 and 5/8 bred Friesians, respectively. Kassab *et al.* (1976) reported lactation period of 277, 295, 286 and 289 days in 1/2, 3/4, 7/8 and 15/16 Friesian x Janubi crosses. Katpatal *et al.* (1979) observed the lactation period of 299.73 days in Friesian x Sahiwal. Rao and Nagarconkar (1979) reported a lactation length of 298.80 days in Friesian x Debu. The above referred observations by various authors on lactation period have been on lower side to those observed in the present investigation. However, Gurcharan Singh *et al.* (1980)

in Friesian x Sahiwal reported the lactation length 333.60 ± 5.70 days. Sowliker *et al.* (1979) reported a lactation period of 332.90 ± 7.21 days in Friesian x Local cows. Bonde *et al.* (1983) observed the lactation period of 310 days in 1/2 and 3/4 bred Friesian x Deoni cows. Longer lactation period than standard leads to increase the calving interval.

The grade effect on lactation length was non-significant. DDMT has revealed that lactation length of various grades did not differ. A maximum lactation length of 315.13 ± 3.32 days and the minimum of 311.50 ± 3.65 days was observed in the present study. Sandhu *et al.* (1973) in Friesian x Sahiwal, Verma *et al.* (1973) in various grades of Friesian x Sahiwal and Pandey *et al.* (1978) in various grades of Friesian x Red Sindhi observed similar trend of non-significant effect of grade. The period effect on lactation length was significant. It appears that there had been constant persuation in improvement of this trait at these farms during the period from 1968-82. DDMT revealed that the lactation length during period P_3 and P_2 differ significantly. The lactation length in P_1 and P_2 were at par. Sandhu *et al.* (1973) in Friesian x Sahiwal, Dhat *et al.* (1978) in Sahiwal/Friesians and Misra *et al.* (1979) in Friesian x Sahiwal and Friesian x

Red Sindhi recorded the similar trend of period effect on lactation length. The selection of appropriate genotype and their use in production of progenies from period 1 to 2 and from period 2 to 3 might have been the effect on lactation period. The effect due to farm on lactation length was non-significant. There had been a difference in lactation length amongst the farms but it happens to be non-significant as revealed by DMRT. The lactation period ranged from 308.62 ± 4.73 to 317.74 ± 4.07 days. This lactation period at these farms though little bit higher than standard but appears to be not far away from the observed general mean of 312.97 ± 2.80 days. Sandhu et al. (1973) in Friesian x Sahiwal, Bhat et al. (1978) in Sahiwal x Friesian, Rao and Nagarcenkar (1979) in Friesian x Zebu recorded the significant farm effect on lactation length. The study carried out by these authors was mostly on northern military dairy farms. In the present study the effect due to age at 1st calving on lactation length was non-significant. The age at 1st calving had a range of 684 to 1665 days. It was expected to have significant effect of age at 1st calving with such a range but the tendency of non-significant effect indicated that there was a scope to control this trait further and reduce the age at 1st calving to a suitable level without adversely affecting other traits.

Dry period happens to be mostly a matter of management. However, it could be kept in mind that a optimum dry period is essential for every lactation to provide the opportunity for recouprating losses of body nutrients during lactation. Genetic part has to play little role in manifestation of this traits. Dry period is subjected for influence due to environment, management and feeding. Too short or no dry period at all or too long dry period also is undesirable in the economy for production of milk. In present study the mean dry period was 129.60 ± 3.90 days, which happens to be on higher as compared to the standard dry period of 60-90 days. Kushwaha and Misra (1969) recorded the dry period of 196.10 ± 90.40 days in pure Sahiwal. D'souza *et al.* (1970) observed the dry period of 176.30 ± 7.50 days in Sir x Friesian 1/2 breeds. Gurcharan Singh *et al.* (1980) reported the dry period of 194.40 ± 8.20 days in Friesian x Sahiwal. However, Sarode *et al.* (1982) and Bonde *et al.* (1983) in Friesian x Deoni reported the dry period on lower side to that of the dry period observed in present study.

Grade effect was non-significant. Similar trend was observed by Pandey *et al.* (1977) in various grades of Friesian x Red Sindhi crosses. However, Choudhary *et al.* (1977) and Dhat *et al.* (1978) reported significant effect of grade on dry period in Friesian x Sahiwal crosses.

The effect due to period on dry period was not significant in the present study. Choudhary et al. (1977) in Friesian x Sahiwal observed non-significant effect of period on dry period. Whereas, Bhat et al. (1978), Basu and Ghai (1980) reported the significant effect of period. Farm effect was highly significant in the present study, which was in agreement with the observation made by Bhat et al. (1978) in Friesian x Sahiwal. Farm to farm management differs inculcating its effect on the length of dry period. The age at 1st calving had non-significant effect on dry period in the present study. These observations are in agreement with those made by Kushwaha and Misra (1969) and Choudhary et al. (1977) in Friesian x Sahiwal.

The mean intercalving period was 439.73 ± 5.14 days in the present study. Singh and Choudhary (1961) observed intercalving period of 484.8 days in pure Sahiwal. Kushwaha and Misra (1969) reported the intercalving period of 498.1 ± 124.2 days in pure Sahiwal. Narain and Garg (1979) and Gurcharan Singh et al. (1980) reported the intercalving period of 442 and 462 days, respectively in Friesian x Sahiwal crossbreds. The observation made by these authors are on a higher side than those of observation made in present study. Intercalving period being the function of lactation period and dry period is expected to coincide with the standard for it.

Grade effect on intercalving period was non-significant. DMRT revealed non-significant differences among the intercalving period from various grades also. In the present study the intercalving period had a range of 440.50 ± 9.64 to 443.66 ± 6.70 days. Verma et al. (1973) in Friesian x Sahiwal, Taneja et al. (1974) in Friesian x Sahiwal, Friesian x Marlane and Friesian x Tharparkar, Bhat et al. (1978) in Sahiwal and Sahiwal x Friesian, Bhatnagar et al. (1979) in Brown Swiss x Sahiwal recorded the non-significant effect of grades on intercalving period. These observations are in agreement with those made in this study. The period effect was significant. In the present study DMRT revealed the significant differences in the intercalving period of different periodicities. Bhat et al. (1978) in Sahiwal and Sahiwal x Friesian and Jahota (1978) in Friesian x Sahiwal observed the significant effect of period on intercalving period. The farm effect was highly significant. Among the farms, differences were non-significant as revealed by DMRT. Bhat et al. (1978) observed significant effect of farm on intercalving period. The age at 1st calving had non-significant effect on intercalving period. Kushwaha and Misra (1969) observed similar trend of non-significant effect of age at 1st calving on intercalving period in pure Sahiwal.

Service period⁵ a component of lactation period and intercalving period. It is a differentiating phase of breeding activity during lactation period. Therefore, its genetic control and managemental deviations exhibits sensitivity. In the present study general mean for service period was 159.13 ± 5.05 days. It was quite longer period. Malik and Sandhu (1968) reported the average service period of 195.54 ± 67.20 days in pure Sahiwal. Chopra et al. (1973) reported the average service period of 180, 150 and 102 days in Sahiwal, Red Sindhi and its crosses with Brown Swiss F_1 . Gurcharan Singh et al. (1980) in Friesian x Sahiwal observed the service period of 184.70 days. Dashpande and Bonde (1963) reported the 1st service period as 154.39 ± 32 days in Friesian x Sahiwal crosses. In the present study grade effect did not influence the service period. Verma et al. (1973), Choudhary et al. (1977) and Bhat et al. (1978) observed the similar trend in Friesian x Sahiwal crossbred. The level of Friesian inheritance in Sahiwal did not helped to bring down the service period. This might be because of a sufficiently strong threshold of longer service period existing in Sahiwal parent. As a matter of fact there ought to have been improvement in reducing the service period. Selection from period 1 to 2 and 2 to 3 perhaps might be with major emphasis

on milk yield rather than on service period. The farm effect was significant. Bhat et al. (1978) in Friesian x Sahiwal and Deshpande and Sonde (1983) in Friesian x Sahiwal observed similar trend of significant farm effect. The age at 1st calving had non-significant effect. Choudhary et al. (1977) observed similar trend in Friesian x Sahiwal. This trend indicated that there is a scope for reducing the age at 1st calving. It will be worthwhile to apply the selection criterion based on relative economic value of service period along with other trait.

The general mean for monthly milk yield have been 406.11 ± 4.74 , 426.75 ± 4.76 , 403.54 ± 4.65 , 378.63 ± 4.46 , 353.93 ± 4.29 , 330.04 ± 4.18 , 304.35 ± 4.00 , 274.55 ± 4.12 , 247.05 ± 4.33 and 211.71 ± 4.75 kg respectively. The highest production was in the 2nd month and thereafter a steady downfall in yield from 3rd month onward was observed. In almost every month the grade effect on monthly milk yield was highly significant. Half breeds happen to be superior in monthly milk yield as compared with 3/4, 5/8 and 7/8 breeds. The 3/4 breeds maintained there superiority in monthly yield over 5/8 and 7/8 breeds from 1st to 5th month and thereafter 5/8 breeds established the superiority over other two and thus in 300 day milk yield, the sequence was 1/2 breeds (3440.24 ± 99.32 kg), 5/8 breeds (3200.15 ± 48.84 kg),

3/4 breeds (3195.86 ± 53.64 kg, and 7/8 breeds (2984.26 ± 77.19 kg). Taneja (1974) reported the 1st lactation yield of 300 day as 2213 kg in 1/2 breeds Friesian x Sahiwal. D'souza *et al.* (1970) reported 1st 300 day lactation yield as 2154.20 kg in 1/2 breeds Gir x Friesian. Gill *et al.* (1978) observed 305 day lactation yield as 2767 litre. Hayman (1972) recorded the significant effect of grade on lactation yield and stated that as the Friesian inheritance went on increasing there was a decreasing trend in 300 day milk production. The period effect on monthly milk yield and 300 day milk yield was highly significant. There has been improvement in monthly milk yield from period 1 to 2, 2 to 3 and for 300 day milk yield also. Khanna and Bhat (1972) reported the significant effect of period on 300 day milk yield. Farm effect was highly significant on monthly milk yield and 300 day milk yield. Bangalore farm maintained its superiority in monthly milk yield and 300 day milk yield over other farms. Khanna and Bhat (1972) observed similar trend of milk yield on other farms in Friesian x Sahiwal. Age at 1st calving did not show significant effect on monthly milk yield and also on 300 day milk yield. However, biological superiority of cows calved at the age of 1300 days and above have produced higher amount of milk in every month and also during 300 day milk yield. The vis-a-vis comparison of

higher milk yield in this group of cows to that of other age at 1st calving becomes essential as it should not mislead the breeder.

The total yield in the present study was recorded as 3405.24 ± 47.00 . The grade effect was highly significant. In the present study the total yield in 1/2 breeds was highest (3629.02 ± 67.49 kg) followed by 5/8 (3442.42 ± 55.21 kg), 3/4 (3352.15 ± 61.53 kg) and 7/8 breeds (3197.38 ± 90.44 kg), respectively. Matson (1937) reported the total yield as 1870, 3122, 3277, 2946 and 3210 kg in 1/8, 1/2, 5/8, 3/4 and 7/8 breeds Friesian x Sahiwal in a lactation period of 296, 312, 326, 323 and 239 days, respectively.

The total yield was highly significantly affected by the grade. These observations are similar to the trend reported by Jain *et al.* (1974) in Friesian x Sahiwal. Ahmed *et al.* (1975) recorded the significant effect of grade on milk yield in Friesian x Sahiwal. Similar trend was also observed by Arora and Desai (1977), Bhat *et al.* (1979), Choudhary and Barhat (1979), Narayan Swamy (1981), Deshpande and Londe (1982) and Tomar and Tomar (1982). Period effect was highly significant on total yield. Khanna and Bhat (1972), Jain and Shillon (1976), Raheja and Lalaine (1977), Choudhary and Barhat (1979) recorded

significant period effect on total yield. Deshpande and Sonde (1982) in Friesian x Sahiwal crossbred observed highly significant effect of period. Farm effect on total yield was highly significant. Khanna and Bhat (1971) reported similar trend of significant effect of farm on total yield in Friesian x Sahiwal. Bhat et al. (1974), Janaja and Bhat (1974) and Deshpande and Sonde (1982) observed the significant trend due to farm on total yield in Friesian x Sahiwal crosses which were in agreement with the present study. Age at 1st calving had significant effect on total yield. Kushwaha and Misra (1969), Nagpal and Acharya (1971) and Choudhary and Choudhary (1977) in Friesian x Sahiwal observed significant effect of age at 1st calving on total yield.

In case of 1/2 breeds, the genetic correlations of lactation period with dry period, intercalving period, service period, monthly milk yield, 300 day milk yield and total yield were positive and highly significant. This has revealed that there was correspondence between the factors affecting these traits. Under such a situation simultaneous approach of selection with due attention to the relative economic value of each trait would be useful. Sahota (1978) in Friesian x Sahiwal cross progeny observed a strong genetic correlations of lactation period with dry period, intercalving period and service period.

Significant genetic correlations of lactation period with 300 day milk yield and total yield was reported by Olivoir (1973) in Friesian. The phenotypic correlations of lactation period with dry period, intercalving period and service period were also highly significant. Janota (1978) and Deshpande (1981) observed significant correlations of lactation period with dry period, intercalving period and service period. Phenotypically the relationship between lactation period and monthly milk yield was not of conclusive nature. However, positive and highly significant correlations of lactation period with 300 day milk yield and total yield was recorded. Hargrove et al. (1969) in Friesians observed the phenotypic correlation of 0.34 between 1st lactation period and milk yield. Dalaine et al. (1971) in Mariana cow reported significant phenotypic correlation between lactation length and lactation yield. Sandhu et al. (1973), Deshpande (1981) reported the significant phenotypic correlation of lactation period with total yield.

Dry period had highly significant and negative genetic correlations with intercalving period and service period. Generally, it is conceived that dry period is the segment of intercalving period and mostly a matter of management, which can also be seen from the highly significant

phenotypic correlations of dry period with intercalving period and service period in the present study. Further dry period had positive and highly significant genetic correlations with monthly milk yield, 300 day milk yield but negative non-significant correlation with total yield. whereas, it had negative non-significant to highly significant correlation at phenotypic level. Therefore, suitable manipulation of dry period can be possible through management.

Highly significant genetic correlations of intercalving period with service period, monthly milk yield, 300 day milk yield and total yield was observed. Bhasin (1967) in Mewati cows, Sahota (1978) in Friesian x Sahiwal cows reported highly significant genetic correlation of intercalving period with service period. At phenotypic level correlation of intercalving period with service period was highly significant. The phenotypic correlations of intercalving period with most of the monthly milk yield was negative but non-significant; with 300 day milk yield was positive and non-significant and that with total yield positive highly significant.

The genetic correlations of service period with monthly milk yield, 300 day milk yield and total yield was positive and highly significant. Sandhu et al. (1973) in Friesian x Sahiwal reported very high genetic correlation

between service period and total yield. The phenotypic correlations among the monthly milk yield happens to be negative but non-significant and positive though non-significant with 300 day milk yield; highly significant and positive with total yield. Sanota (1974) reported positive phenotypic correlation between service period and total yield. This situation may be taken advantageous for selecting individual on the basis of part time lactation records.

In case of 3/4 brods, the lactation period had highly significant positive genetic correlation with dry period. Similar was the trend at phenotypic level. whereas, it was negative and highly significantly correlated with intercalving period, service period, monthly milk yield, 300 day milk yield and positive highly significant with total yield. On phenotypic level, lactation period had highly significant and positive correlations with intercalving period, service period and non-significant to highly significant with monthly milk yield, 300 day milk yield and total yield. The positive phenotypic correlation indicated the significance of environment. Dry period had highly significant negative genetic correlations with intercalving period, service period, monthly milk yield (except 3rd month), 300 day milk yield and total yield.

Whereas, on phenotypic background highly significant correlations of dry period with intercalving period and service period revealed the significance of management in influencing these traits. The phenotypic correlations of dry period with monthly milk yield and 300 day milk yield exhibited an undulating picture revealing the importance of management. Highly significant negative genetic correlations of intercalving period with service period, monthly milk yield, 300 day milk yield and total yield was observed. In phenotypic background the intercalving period and service period exhibited highly significant correlation indicating thereby the significance of environment. Non-significant positive or negative correlations did not allow to draw any conclusive inferences. Highly significant negative genetic correlations of service period with monthly milk yield, 300 day milk yield and total yield was observed. At phenotypic level the situation was undulating and non-conformitory.

The picture as regards to the genetic and phenotypic correlations among monthly milk yield, 300 day milk yield and total yield happened to be positive and highly significant. It has revealed that the 3/4 bred progeny with higher amount of Friesian blood required superior management for superior performance, more higher performance is not enough. Its only the conducive environment can help

for higher amount of inheritance. Breeding better animals with the intention to make them best necessitates provision of better management to augment best in performance.

In case of 5/8 breeds, the genetic correlations of lactation period with dry period, intercalving period and service period was significant to highly significant. Whereas, it was negative and highly significant to positive and highly significant with monthly milk yield and 300 day milk yield and total yield. This has revealed that at the genetic level the lactation period, dry period, intercalving period and service period had correspondence. Whereas, no definite trend could be observed in respect of correlation with milk yield. Phenotypically, lactation period exhibited positive and highly significant correlations with the traits studied. It has revealed that, irrespective of genetic correspondence among the traits, the management has contributed significantly. The genetic correlations amongst dry period, intercalving period and service period was positive and highly significant. Indicating a strong associationship between the alleles affecting these traits. However, at the phenotypic level the trend was not so. This has clearly signified the importance of managerial aspects. The correlation between monthly milk yield happened to be negative and highly significant and that with 300 day milk yield and total yield it was either

negative or positive indicating thereby in 5/8 breeds decision making on the genotypic relationship among these traits will be difficult as the situation being non-consistent. The phenotypic correlations among these traits exhibited a consistent significant positive relationship revealing the importance of environmental response.

In case of 7/8 breeds, the genetic correlations between lactation period, dry period, intercalving period and service period was positive and highly significant. Similarly positive and highly significant correlations amongst dry period, intercalving period, service period were observed indicating the correspondence amongst alleles governing these traits. The genetic correlations of dry period, intercalving period and service period with monthly milk yield, 300 day milk yield and total yield was not consistent and undulating. Similar situation was met with at the phenotypic level with a more or less varying degrees. This trend obviously has brought out the fact that 7/8 breeds Friesian x Sahiwal (with higher amount of Friesian inheritance) have responded inconsistently with environment which can also be seen from the lowest monthly as well as 300 day milk yield and total yield. Genetic correlations amongst monthly milk yield did not indicate any consistency. However, phenotypically consistent positive and highly significant correlations revealed the significance of management.

Heritability of lactation period in 1/2 breeds was 0.037 ± 0.011 . It is a low heritability. Narayankhedkar (1973) reported the heritability of 0.01 ± 0.01 in Sahiwal cows. Taneja et al. (1978) reported the heritability of 0.08 ± 0.06 for Friesian x Sahiwal grades with 4-30/64 genetic groups. Deshpande (1981) in Friesian x Sahiwal reported the heritability of 0.013 ± 0.01 . The heritability of dry period was negative. The importance of management perhaps might be the cause. Similar was the trend in case of intercalving period. The heritability of service period was 0.006 ± 0.009 . Chopra et al. (1973) in Sahiwal x Brown Swiss recorded the heritability of 0.036 ± 0.04 for this trait. Taneja et al. (1978) reported the heritability as 0.21 ± 0.09 . Deshpande and Bonde (1983) reported the heritability near to zero. The heritability for monthly milk yield ranged from 0.130 ± 0.018 to 0.227 ± 0.034 . The range is on a lower side. The heritability for 300 day milk yield and total yield was 0.219 ± 0.024 and 0.202 ± 0.022 , respectively. Mishra et al. (1979) in Friesian x Sahiwal reported the heritability of 0.65 ± 0.63 . Koley et al. (1981) observed the heritability of 0.34 ± 0.07 in Jersey x Moriana. Deshpande (1981) in Friesian x Sahiwal reported the heritability of 0.386 ± 0.020 . The heritability for total yield reported by Taneja et al. (1978) in

Friesian x Sahiwal was 0.17 ± 0.17 in 4-30/64 blood groups. Bonde et al. (1978) in Friesian x non-descript reported the heritability as 0.02 ± 0.01 . Doshpande (1961) reported 0.384 ± 0.022 heritability in Friesian x Sahiwal crossbreds.

The heritability of lactation period, dry period, intercalving period and service period in 3/4 breeds was -0.014 , -0.026 , 0.001 and -0.015 respectively. In 3/4 breeds heritable variance for this trait happened to be a very meagre amount. Taneja (1974) in pure Sahiwal observed -0.454 heritability. Tomar et al. (1972) in Mariana reported -0.07 heritability for service period. The heritability of monthly milk yield ranged from 0.080 to 0.199 . The observed heritability for monthly milk yield increased from 1st month to 6th months and thereafter declined. The heritability for 300 day milk yield and total yield was 0.102 and 0.106 . Mishra et al. (1979) in Friesian x Sahiwal observed the heritability of 0.65 ± 0.63 . Koley et al. (1971) in Jersey x Mariane recorded heritability of 0.34 ± 0.07 and Doshpande (1961) recorded heritability of 0.386 ± 0.020 in Friesian x Sahiwal for 300 day milk yield. The heritability for total yield was lower. Taneja et al. (1978) reported the heritability of 0.07 ± 0.08 in 36-63/64 breeds Friesian x Sahiwal. Doshpande (1961) in Friesian x Sahiwal reported the heritability of 0.384 ± 0.022 . Chopra et al. (1973) observed the heritability of 0.18 ± 0.01 in Friesian x Sahiwal.

The heritability of lactation period, intercalving period and service period in 5/8 breeds happened to be 0.015, 0.026 and 0.017. Whereas, in case of dry period it was negative indicating thereby additive variance in respect of these traits happen to be a very meagre amount. The heritability for monthly milk yield in respect of Friesian x Sahiwal was fluctuating and has a very small value. A similar situation was met with the heritability for 300 day milk yield and total yield.

The heritability of lactation period, intercalving period and service period in 7/8 breeds were of very small, indicating thereby that the heritable variance for these traits were very little. The heritability estimates for monthly milk yield for 1st to 6th month happen to be below 10 per cent and for 7, 8 and 9th month it was more than 10 per cent. Heritability of total yield recorded as 0.242 which was of medium order. Taneja *et al.* (1978) reported 0.07 ± 0.08 heritability of total yield in 36-63/64 blood group of Friesian x Sahiwal crossbreeds.

No character will be expressed unless proper environment is provided for the genes controlling the character. Similarly, no amount of environment will produce the character unless the required genes are present.

Genotype environment interaction ultimately becomes the matter for investigation and further manipulation to achieve the desired goals. The genotypes, none-the-less express their own entity in accordance of different situations. Its reaction with environment is something different which makes the genotype either to accept it or not to accept for a desired performance level. Breeding alone is incomplete till the breeding material is tested in those environments for which it is developed.

Atmospheric temperature and relative humidity influence the physiology of animals and therefore, affects its productivity differently under different environment. The mean monthly milk yield $\bar{Y} = 331.84$ kg with corresponding saturation deficit coefficient (a function of temperature and humidity) $\bar{X} = 5.724$ per cent for uncorrected overall data was observed. The regression coefficient was non-significant. Indicating thereby the Friesian x Sahiwal cross progeny phenotypically did not respond to the effect of saturation deficit coefficient (SDC). This might be because of the fact that environmental component might have played the major role in making the effect of SDC. In other words the crossbred had adapted to the temperature and humidity. However, no sooner the environmental component of variance was partitioned

from total phenotype and the genotypes were exposed for saturation deficit coefficient, the results were altogether different. Though the mean milk yield was $\bar{Y} = 339.720$ kg with corresponding saturation deficit coefficient $\bar{X} = 5.739$ per cent the functional relationship on genetic background happened to be highly significant indicating thereby the crossbred (overall corrected data) did responded to the different levels of SDC. The prediction equation (Table 26) developed indicated that the optimum production of 344.99 kg happened to be at 18.89 per cent SDC, which was the optimum tolerance limit. Above the tolerance limit (18.89 per cent SDC) the milk yield declined. The declination was steady (Graph 1a). This has indicated that the productivity of crossbreds in general was affected on either side due to the temperature and humidity. Regan and Richardson (1938) observed a sharp declining trend in milk yield of 13.05 to 7.65 kg per day due to increase of temperature from 4 to 35 °C. Worstell and Brody (1953) recorded a similar decreasing trend in milk yield when the temperature exceeds more than 29 °C. Moody *et al.* (1967), Hahn and Osburn (1969), Thompson (1973) and Ordonez (1980) reported the adverse effect of increased temperature on milk yield. Yeck and Stewart (1959) and Ludry *et al.* (1964) recorded the adverse effect of humidity on milk yield. Thus both

the temperature and humidity beyond a certain limit (specific to the geophysical situation) adversely affect the productivity. Heat stress and/or humidity load (both being the functions of each other) effect the physiology of milk secretion. It may be either through reduced intake of nutrients and/or through increased heat production in the body, leading to depress the yield. Visualising the effects of SDC on productivity in 1/2 breeds, it was observed that there was indifferent attitude. However, comparison of the value of coefficient of determination (R^2) biologically indicated the quadratic trend. The partial regression coefficient attached to c value being positive have succumbed the significance under quadratic type of model and tortioned down the effect leading to express a linear trend. As a result of linearity of production function the minima of 8.34 per cent SDC was set-out for the yield of 335.07 kg of milk. Such a trend might be because of a good amount of variability in the genotypes associated with 1/2 breeds in comparisons with rest of the grades in present study. Half breeds being better buffered in comparison to rest therefore, such a result may be expected. In case of other grades carrying higher level of Friesian inheritance than 1/2 breeds linearity was not observed. The higher amount of inheritance from Friesian in comparison with 1/2 breeds

had responded differently. The mean monthly milk yield in 3/4 breeds was 339.646 kg with corresponding saturation deficit coefficient of 5.756 per cent. The response of 3/4 breeds exhibited the quadratic trend with significant level. This has indicated the respondent (3/4 breeds) and the reactant (SDC per cent) have produced a non-linear function. Obviously 3/4 breeds exhibited the productivity of 357.20 kg of milk yield at the tolerance limit of 20.56 SDC per cent. Further the SDC exceeded tolerance limit, the curve shape downwards. Yeck and Stewart (1969) in Friesians observed a declination in milk yield at a temperature exceeding more than 24 °C. Johnson *et al.* (1962) reported that the response of milk yield to high temperature depends upon the tolerance of heat. Mahn and Osburn (1969) reported the reduction in milk yield due to reduction in thermo-humidity-index. Ordonez (1980) recorded the decreased milk yield by 0.86 kg in Friesian for each 1 °C increase in temperature over 19 °C. Igno and Aliu (1983) reported the environmental temperature of greater than 27 °C was tolerable to 1/2 bred crossbreeds which produced higher milk yield than 3/4 bred Friesians. The non-linear response of 3/4 breeds in production of milk indicated that the higher level of Friesian inheritance need something different type of housing management.

The non-linear response of milk production in 5/8 breds under the influence of saturation deficit coefficient was observed. The mean monthly milk yield of 340.01 kg with corresponding SDC of 5.762 per cent in 5/8 breds was recorded. The milk yield of 5/8 breds went on increasing till $Y = 344.61$ kg. After the tolerance limit of 19.55 per cent SDC the curve shape downward. The 5/8 breds carry lower level of Friesian inheritance as compared to 3/4 breds and it was expected their tolerance limit ought to have been higher than that of 3/4 breds but it did not happen. Both the reactant (19.55 per cent SDC) and respondent (344.61 kg) had lower values. Though 3/4 and 5/8 breds had comparable means (i.e. $\bar{Y} = 339.64$ kg for 3/4 and 340.01 kg for 5/8 breds) at the level of 5.756 and 5.762 per cent SDC but they exhibited different production trend.

In case of 7/8 breds the mean milk yield of 339.599kg with corresponding saturation deficit coefficient of 5.783 per cent was observed. Since the partial regression coefficient attached to quadratic term happens to be negative leading to exhibit a non-linear function. The milk yield went on increasing till $Y = 349.20$ kg at a saturation deficit coefficient of 13.34 per cent which was the tolerance limit. No sooner the tolerance limit

exceeded a downward shape of the curve was observed. It was interesting to observe that the performance record of 3/4, 5/8 and 7/8 breeds ($\bar{Y} = 339.646$, $\bar{Y} = 340.01$, $\bar{Y} = 339.59$) happen to be comparable at the saturation deficit coefficient of 5.756 to 5.783 per cent. Whereas, the trend of reactant and respondent revealed the variation through the prediction equation for these grades. The variation could be in the order of 3/4 followed by 7/8 and 5/8 breeds. Obviously this ranking is not superstitious. It is a ranking on the background of saturation deficit coefficient and yield estimates. The 3/4 breeds had a tolerance limit of 20.56 per cent followed by 5/8 (19.55 per cent) and 7/8 breeds (13.34 per cent).

The study of production reaction of various grades with the saturation deficit coefficient revealed that the 3/4, 5/8 and 7/8 breeds responded the environmental changes specifically with temperature and humidity. These observations guide in maintaining the Friesian inheritance.

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6. SUMMARY AND CONCLUSIONS

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The studies on "Performance of Friesian x Sahiwal grades with special reference to functions of temperature, humidity and milk yield under peninsular India" was carried out on 1/2, 3/4, 5/8 and 7/8 breeds cross progeny from 5 military dairy farms viz; Secunderabad, Bangalore, Belgaum, Pimpri and Devlali under the southern command. Data on lactation period, dry period, intercalving period, service period, monthly milk yield, 300 day milk yield and total yield in respect of 1/2, 3/4, 5/8 and 7/8 breeds were obtained from the breeding and performance records. In all 447 cross progeny from 6 sires comprising 1752 lactations were considered. The data on weekly temperature and humidity were obtained from the meteorological observatory situated in the vicinity of the farm. The data was subjected to least squares analysis to find out the effects of various factors and also effect due to sire component. Corrected data on monthly milk yield with corresponding temperature and humidity were used to find out the functional relationship between them. The results are summarised below.

- 1) The general mean for lactation period was 312.97 ± 2.80 days with highly significant effect of period and non-significant effect of grade, farm and age at 1st calving.

- 2) The general mean for dry period was 129.80 ± 3.90 days with highly significant effect of farm and non-significant effect of grade, period and age at 1st calving.
- 3) The general mean for intercalving period was 439.73 ± 5.14 days with significant effect of period, highly significant effect of farm and non-significant effect of grade and age at 1st calving.
- 4) The general mean for service period was 159.13 ± 5.05 days with highly significant effect of farm and non-significant effect of grade, period and age at 1st calving.
- 5) The general means for monthly milk yield for 1st to 10th months have been 406.11 ± 4.74 , 426.75 ± 4.76 , 403.54 ± 4.65 , 378.83 ± 4.46 , 353.93 ± 4.29 , 330.04 ± 4.18 , 304.35 ± 4.08 , 274.55 ± 4.12 , 247.05 ± 4.33 and 211.71 ± 4.73 kg with highly significant effect due to grade, period, farm and non-significant effect due to age at 1st calving.
- 6) The general mean for 300 day milk yield was 3210.13 ± 41.13 kg with highly significant effect of grade, period, farm and non-significant effect of age at 1st calving.

- 7) The general mean for total yield was 3405.24 $\pm$ 47.00 kg with highly significant effect of grade, period, farm and significant effect of age at 1st calving.

Genetic and phenotypic correlations

- 1) In case of 1/2 breeds the genetic correlation of lactation period with dry period, intercalving period, service period, monthly milk yield, 300 day milk yield and total yield were positive and highly significant. Similarly, highly significant and positive phenotypic correlation of lactation period with dry period, intercalving period, service period, monthly milk yield of 6 to 9th months, 300 day milk yield and total yield was observed. Highly significant negative genetic correlations between dry period, intercalving period and service period was observed. Whereas, positive highly significant genetic correlations with monthly milk yields and 300 day milk yield was observed. Highly significant phenotypic correlations of dry period with intercalving period and service period was observed. Whereas, negative highly significant correlations with monthly milk yield, 300 day milk yield and total yield existed. Highly significant positive genetic correlations of intercalving period with service period, monthly milk yield, 300 day

milk yield and total yield was observed. Highly significant and positive phenotypic correlations of intercalving period with service period and negative non-significant to negative highly significant with monthly milk yields and positive highly significant with total yield was observed. Highly significant genetic correlations among monthly milk yield, 300 day milk yield and total yield was recorded. Similar was the situation with phenotypic correlation.

The heritability estimates for lactation period, dry period, intercalving period, service period were 0.037 ± 0.011 , -0.026 ± 0.008 , -0.0002 ± 0.009 and 0.006 ± 0.009 . The heritability estimates for monthly milk yield ranged from 0.130 ± 0.017 to 0.227 ± 0.034 whereas, the heritability estimates for 300 day milk yield and total yield happened to be 0.219 ± 0.024 , 0.202 ± 0.022 , respectively.

ii) In case of 3/4 breeds the genetic correlations between lactation period and dry period was positive and highly significant and that between lactation period and intercalving period, service period, monthly milk yield and 300 day milk yield was negative and highly significant and that with total yield it was positive and highly significant. The genetic correlations between dry period and intercalving period and service period was negative and highly significant. Whereas, it was negative and highly significant with monthly

milk yield, 300 day milk yield and total yield except with milk yield of 3rd month. Intercalving period had negative highly significant genetic correlations with service period, monthly milk yield, 300 day milk yield and total yield. The genetic correlation of service period with monthly milk yield, 300 day milk yield and total yield was negative and highly significant. The phenotypic correlations among lactation period, dry period, intercalving period, service period, monthly milk yield, 300 day milk yield and total yield happened to be fluctuating, either positive or negative, either significant or non-significant. The genetic correlations among monthly milk yield, 300 day milk yield and total yield happen to be positively highly significant. The phenotypic correlation among monthly milk yield, 300 day milk yield and total yield were positive and highly significant.

The heritability estimates for lactation period, dry period, intercalving period and the service period were -0.014 ± 0.004 , -0.026 ± 0.003 , 0.001 ± 0.004 and -0.015 ± 0.004 respectively. The heritability estimates for monthly milk yield ranged from 0.080 ± 0.013 to 0.199 ± 0.015 . Whereas, it was 0.102 ± 0.010 and 0.106 ± 0.011 in case of 300 day milk yield and total yield respectively.

iii) In case of 5/8 breeds the genetic correlation of lactation period with dry period was positively significant

and that with the intercalving and service period it was positive and highly significant. The genetic correlations of lactation period with monthly milk yield was fluctuating from negative highly significant to positively highly significant. Three hundred day milk yield and total yield, however, had positive highly significant correlation. Dry period had highly significant positive genetic correlations with the intercalving period, service period, monthly milk yield, 300 day milk yield and total yield. Intercalving period had highly significant genetic correlations with the service period, monthly milk yield, 300 day milk yield and total yield. Highly significant genetic correlations of monthly milk yield, 300 day milk yield and total yield was observed. Lactation period had highly significant and positive phenotypic correlations amongst the traits. Whereas, the dry period, intercalving period, service period with monthly milk yield exhibited a fluctuating picture. The genetic correlations amongst monthly milk yield were fluctuating. Whereas, phenotypic correlation were positive highly significant.

The heritability estimates of the lactation period, dry period, intercalving period and the service period were 0.015 ± 0.003 , -0.017 ± 0.003 , 0.026 ± 0.003 and 0.017 ± 0.003 respectively. The heritability estimates for monthly milk yield were fluctuating with a very meagre magnitude.

Similar was the situation in case of 300 day milk yield and total yield.

iv) In case of 7/8 breeds the lactation period had positive and highly significant genetic correlations among dry period, intercalving period and service period and that with monthly milk yield it was either positive or negative. However, it was positive and highly significant with total yield. Dry period had positive and highly significant genetic correlation with the intercalving period, non-significant with the service period. But with monthly milk yield it happened to be fluctuating. With 300 day milk yield and total yield it was positive and highly significant. Intercalving period had positive highly significant genetic correlation with service period. Whereas it was fluctuating with monthly milk yield, 300 day milk yield and the total yield. The genetic correlation of the service period with monthly milk yield was fluctuating. The genetic correlations among monthly milk yields was mostly positive and highly significant with exception of negative correlations here and there. The phenotypic correlation among monthly milk yield was positive highly significant.

The heritability estimates for the lactation period, dry period, intercalving period and service period happened to be 0.081 ± 0.022 , -0.050 ± 0.013 , 0.160 ± 0.029 and

0.069 ± 0.210 respectively. The heritability estimates for monthly milk yield ranged from -0.109 ± 0.024 to 0.172 ± 0.035 .

Functional relationship

i) The functional relationship between monthly milk yield and saturation deficit coefficient of uncorrected data was non-significant. The functional relationship between monthly milk yield and corresponding saturation deficit coefficient of overall corrected data was highly significant with an optimum value of $X = \frac{b}{2c} = 18.89$ per cent SDC.

ii) The functional relationship between monthly milk yield and saturation deficit coefficient in case of 1/2 breds happened to be non-significant under quadratic type.

iii) The functional relationship between monthly milk yield and saturation deficit coefficient in 3/4 breds was significant. The optimum value for the curvature was $X = \frac{b}{2c} = 20.56$ per cent SDC.

iv) The functional relation between monthly milk yields and corresponding saturation deficit coefficient in 5/8 breds was significant with an optimum value of $X = \frac{b}{2c} = 19.55$ per cent SDC.

v) The functional relationship between monthly milk yields and saturation deficit coefficient in 7/8 breds was highly significant with optimum tolerance limit for curvature was $X = \frac{b}{2c} = 13.34$ per cent SDC.

The genetic manipulation of indigenous cattle through crossbreeding with exotic elite breeds has resulted in production of various grades of cross progeny in the country. The data on performance of the crossbreeds is available at various farms including military dairy farms. Evaluation of the crossbreeds for their productivity on total merit has become possible. Production, reproduction, adaptive characters involves the genetic interactions. In addition response of crossbreeds to environment is an important component of study. The study on performance of Friesian x Sahiwal grades with special reference to functions of temperature, humidity and milk yield in peninsular India was carried out with the objective to understand the extent of effect of various factors on monthly milk yield, 300 day milk yield and total yield of Friesian x Sahiwal grades. The study involved estimation of genetic correlation, phenotypic correlation and heritability of the various characters. In addition, the response of crossbreeds with temperature and humidity was studied through the relationship of saturation deficit coefficient and monthly milk yield. The data on lactation length, dry period, intercalving period, service period, monthly milk yield, 300 day milk yield and total yield in respect of 1/2, 3/4, 5/8 and 7/8 breeds Friesian x Sahiwal

from five military dairy farms under southern command in peninsular India were considered. In all 1752 lactations of 447 crossbred cows bred out of 6 sires during the period 1968-82 was included in the study. The data was analysed by the method of least squares analysis of variance. The corrected data were used for estimation of genetic parameters. The corrected data on monthly milk yield and corresponding monthly saturation deficit coefficient were used to assess the functional relationship. The results have been summarised and the conclusions are given below.

The lactation period, dry period, intercalving period and service period remain unaffected due to grade. Further a non-significant gradewise variation in each character was revealed by DMT. This has made it clear that these characters are tending to reach stable situation. Further strong positive genetic correlation among these traits in $1/2$, $5/8$ and $7/8$ bred and negative highly significant correlation in $3/4$ give clue about selection. The heritability estimate are almost on lower side and in most of the cases negative. Considering this situation the breeding programme for $1/2$ bred would be beneficial than going for higher grades.

Highly significant effect of period on lactation length, significant effect on calving interval has been

the response to the efforts made in improving these traits. The non-significant effect of period on dry period and respond to the genetic manipulation. whereas, their expression had been due to management. Significant management differences were observed among the farms. It has revealed that there is further scope for optimization of managemental practices at these farms. Non-significant effect of age at 1st calving on these character had revealed that there has been no interference of age at 1st calving in expression of these traits. Grade, period and farm effect have significantly affected the monthly milk yield, 300 day milk yield and total yield indicating differential response of genotype to these factors and therefore there is a scope for selective breeding. The heritability estimates for monthly milk yield, 300 day milk yield and total yield in $1/2$, $3/4$, $5/8$ and $7/8$ grades revealed that $1/2$ breeds had in general superior values followed by $3/4$ breeds. Thus the hereditary variance for milk yield in $1/2$ breeds may be better utilized to boost up further and develop the superior individuals so as to augment higher productivity in them.

The studies on functional relationship between monthly milk yield and saturation deficit coefficient in respect of overall corrected data indicated non-linearity with a optima

of 18.89 per cent SDC. Further the optima for 3/4, 5/8 and 7/8 grade were 20.56, 19.65 and 13.34 per cent SDC respectively, which has suggested that the yield response are subjected for variation in accordance of the variation in SDC. Controlling SDC by physical means brings limitation in the present circumstances. The functional relationship between monthly milk yield and saturation deficit coefficient in case of 1/2 breeds was linear type with a minima of 8.34 which has revealed that the 1/2 bred possess better capacity of tolerance and can do well in production as compared with other grades.

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ATTENDERS

APPENDIX I

Ration scales

Standing orders Military Farms, Livestock, Government of
India Press, New Delhi (1979).

1) Pregnancy ration

Category

<u>Period</u>	<u>Young stock</u>	<u>First calvers</u>	<u>Other cows</u>
A) From the date confirmed in calf	1 kg (conceiving before 17 months)	-	-
B) 90 to 60 days before calving	1.5 kg	1 kg	-
C) 61-30 days before calving	2.0 kg	12.5% (of expected peak yield)	12.5
D) 30 days before calving	3.0 kg	20%	20%

2) Production ration (TDM = 67.21%, BCP = 17.28%)

<u>Category</u>	<u>Concentration to milk ration</u>		
	1:3	1:2.5	1:2
a) Lower crossbred	Upto 9 kg daily yield	Over 9 to 18 kg daily yield	Over 18 kg daily yield
b) Higher crossbred	Upto 12 kg daily yield	Over 12 to 24 kg daily yield	Over 24 kg daily yield

Continued

3) Growth ration

One kg ration to all heifers from the date of calving till attainment of three years age in case of cows.

4) Basic ration and pregnancy ration

a) Young stock: Not in calf up to the age of 1½ years in case of crossbred cows will not be fed any maintenance ration except when fed on 'A' scale. They will be given 50 per cent of the maintenance ration till in calf. After being in calf, they will be treated to normal young stock.

b) Dry adults: Dry, not in calf, animals will not be given any maintenance ration when fed on 'B' scale and 'C' scale till they come in calf, after which for maintenance and pregnancy ration, they will be treated at par with other animals. When not in calf, dry animals fed on 'A' scale, they will be given 50 per cent of maintenance ration.

5) Production ration

For first two weeks after calving will be based on the estimated peak yield. After two weeks, animal will be fed for actual highest daily yield in the preceding week plus maximum of 4.5 kg of further increase expected.

Continued

(iii)

6) In case of exceptionally high yielders, the high energy concentrate ration will be specially computed.

Note:

Ration A = more concentrate less green

Ration B = green fodder available, with normal amount of concentrates

Ration C = excessive amounts of green fodder to compensate for less quantity of concentrate mixture.

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APPENDIX II

Least squares analysis of variance for factors affecting lactation length in Friesian x Sahiwal crossbreds.

Source	D.F.	Mean squares	'P'
Grade	3	1252.16	0.32
Period	2	81557.65	20.73**
Farm	4	8247.08	0.83
AFC	7	3403.02	0.87
Error	1725	3933.69	
Total:	1741	62.72	

* $P \leq 0.01$; ** $P \leq 0.05$

APPENDIX III

Least squares analysis of variance for factors affecting dry period in Friesian x Sahiwal crossbreds.

Source	D.F.	Mean squares	'P'
Grade	3	11299.92	1.48
Period	2	13399.13	1.76
Farm	4	75673.42	9.92**
AFC	7	4695.95	0.62
Error	1725	7630.03	
Total:	1741	87.35	

** $P \leq 0.01$; * $P \leq 0.05$

APPENDIX IV

Least squares analysis of variance for factors affecting
intercalving period in Friesian x Sahiwal crossbreds.

Source	D.F.	Mean squares	F
Grade	3	5730.83	0.43
Period	2	45929.05	3.47*
Farm	4	122631.81	9.27**
AFC	7	5563.97	0.42
Error	1725	13230.10	
Total:	1741	115.02	

** P $\angle$ 0.01; * P $\angle$ 0.05

APPENDIX V

Least squares analysis of variance for factors affecting
service period in Friesian x Sahiwal crossbreds.

Source	D.F.	Mean squares	F
Grade	3	8192.57	0.64
Period	2	25940.81	2.03
Farm	4	103738.35	8.11**
AFC	7	9930.18	0.78
Error	1725	12783.81	
Total:	1741	113.07	

** P $\angle$ 0.01; * P $\angle$ 0.05

APPENDIX VI

Least squares analysis of variance for factors affecting milk yield of 1st month in Friesian x Sahiwal crossbreds.

Source	D.F.	Mean squares	F
Grade	3	112935.76	10.02**
Period	2	1422174.30	125.16**
Farm	4	414561.15	36.78**
AFC	7	23444.94	2.08
Error	1725	11272.63	
Total:	1741	106.17	

** $P \leq 0.01$; * $P \leq 0.05$

APPENDIX VII

Least squares analysis of variance for factors affecting milk yield of 2nd month in Friesian x Sahiwal crossbreds.

Source	D.F.	Mean squares	F
Grade	3	158560.38	13.93**
Period	2	1801438.00	158.24**
Farm	4	436811.90	38.37**
AFC	7	26986.08	2.37
Error	1724	11384.36	
Total:	1740	106.70	

** $P \leq 0.01$; * $P \leq 0.05$

APPENDIX VIII

Least squares analysis of variance for factors affecting milk yield of 3rd month in Friesian x Sahiwal crossbreds.

Source	D.F.	Mean squares	F
Grade	3	122956.99	11.36**
Period	2	1573657.80	145.34**
Farm	4	406962.30	37.59**
AFC	7	22375.48	2.07
Error	1723	10827.48	
Total:	1739	104.06	

** $P \leq 0.01$; * $P \leq 0.05$

APPENDIX IX

Least squares analysis of variance for factors affecting milk yield of 4th month Friesian x Sahiwal crossbreds.

Source	D.F.	Mean squares	F
Grade	3	110029.62	11.00**
Period	2	1294351.70	129.44**
Farm	4	323600.05	32.36**
AFC	7	19250.07	1.93
Error	1723	9999.26	
Total:	1739	100.00	

** $P \leq 0.01$; * $P \leq 0.05$

APPENDIX X

Least squares analysis of variance for factors affecting milk yield of 5th month in Friesian x Sahiwal crossbreds.

Source	D.F.	Mean squares	F
Grade	3	87755.18	9.49**
Period	2	1071715.10	115.93**
Farm	4	321295.85	34.76**
AFC	7	22067.12	2.39
Error	1721	9244.60	
Total:	1737	96.15	

** $P \leq 0.01$; * $P \leq 0.05$

APPENDIX XI

Least squares analysis of variance for factors affecting milk yield of 6th month in Friesian x Sahiwal crossbreds.

Source	D.F.	Mean squares	F
Grade	3	60844.15	7.87**
Period	2	877868.00	100.40**
Farm	4	290330.95	33.20**
AFC	7	13328.51	1.52
Error	1717	8743.75	
Total:	1733	93.51	

** $P \leq 0.01$; * $P \leq 0.05$

APPENDIX XII

Least square analysis of variance for factors affecting milk yield of 7th month in Friesian x Sahiwal crossbreds.

Source	D.F.	Mean squares	F
Grade	3	50316.46	6.08**
Period	2	741228.85	89.51**
Farm	4	266876.62	32.23**
AFC	7	13700.18	1.65
Error	1706	8281.28	
Total:	1722	91.00	

** P / 0.01; * P / 0.05

APPENDIX XIII

Least squares analysis of variance factors affecting milk yield of 8th month in Friesian x Sahiwal crossbreds.

Source	D.F.	Mean squares	F
Grade	3	54248.68	6.56**
Period	2	599050.80	72.47**
Farm	4	207612.55	25.11**
AFC	7	10607.96	1.28
Error	1662	8266.65	
Total:	1678	90.92	

** P / 0.01; * P / 0.05

APPENDIX XIV

Least squares analysis of variance for factors affecting milk yield of 9th month in Friesian x Sahiwal crossbreds.

Source	D.F.	Mean squares	F
Grade	3	34446.66	4.22**
Period	2	360767.36	44.18**
Farm	4	152721.75	18.70**
AFC	7	5932.88	0.73
Error	1469	8166.10	
Total:	1485	90.37	

** $P \leq 0.01$; * $P \leq 0.05$

APPENDIX XV

Least squares analysis of variance for factors affecting milk yield of 10th month in Friesian x Sahiwal crossbreds.

Source	D.F.	Mean squares	F
Grade	3	3333.21	0.47**
Period	2	133251.29	18.66**
Farm	4	119973.80	16.80**
AFC	7	1657.07	0.26
Error	1132	7142.68	
Total:	1148	84.51	

** $P \leq 0.01$; * $P \leq 0.05$

APPENDIX XVI

Least squares analysis of variance for factors affecting 300 day milk yield in Friesian x Sahiwal crossbreds.

Source	D.F.	Mean squares	F
Grade	3	8054176.30	9.49**
Period	2	91511425.00	107.03**
Farm	4	24934720.00	29.38**
AFC	7	1408688.00	1.66
Error	1724	848673.15	
Total:	1740	921.23	

** P $\angle$ 0.01; * P $\angle$ 0.05

APPENDIX XVII

Least squares analysis of variance for factors affecting total milk yield in Friesian x Sahiwal crossbreds.

Source	D.F.	Mean squares	F
Grade	3	7449189.30	7.04**
Period	2	126471600.00	119.60**
Farm	4	27719350.00	26.21**
AFC	7	2429438.20	2.30*
Error	1625	1057464.10	
Total:	1641	1028.33	

** P $\angle$ 0.01; * P $\angle$ 0.05

APPENDIX XVII

Standard Meteorological weeks and dates

<u>Week</u>	<u>Month</u>	<u>Date</u>	<u>Week</u>	<u>Month</u>	<u>Date</u>
	<u>January</u>			<u>July</u>	
1		1-7	27		2-9
2		8-14	28		9-15
3		15-21	29		16-22
4		22-28	30		23-29
5		29 Feb.	31		30-5 Aug.
	<u>February</u>			<u>August</u>	
6		5-11	32		6-12
7		12-18	33		13-19
8		19-25	34		20-26
9		26-4 March	35		27-2 Sept.
	<u>March</u>			<u>September</u>	
10		5-11	36		3-9
11		12-18	37		10-16
12		19-25	38		17-23
13		26-1 April	39		24-30
	<u>April</u>			<u>October</u>	
14		2-8	40		1-7
15		9-15	41		8-14
16		16-22	42		15-21
17		23-29	43		22-28
18		30-6 May	44		29-4 Nov.
	<u>May</u>			<u>November</u>	
19		7-13	45		5-11
20		14-20	46		12-18
21		21-27	47		19-25
22		28-3 June	48		26-2 Dec.
	<u>June</u>			<u>December</u>	
23		4-10	49		3-9
24		11-17	50		10-16
25		18-24	51		17-23
26		25-1 July	52		24-31

- NOTE:
- 1) In leap years week 9 will be 26th February to 4th March i.e. of 8 days instead of 7 days.
 - 2) Last week of the year i.e. No.52 week will have 8 days, 24th to 31st December.

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(1971)

APPENDIX XIX Mean Temperature, Relative Humidity and Saturation Deficit Coe facient

Week	Secunderabad				Bengaluru				Balegaon(Bharwad)				Pimpri				Devlali (Niphad)			
	Mean Temp. (°C)	RH (%)	SDC (%)		Mean Temp. (°C)	RH (%)	SDC (%)		Mean Temp. (°C)	RH (%)	SDC (%)		Mean Temp. (°C)	RH (%)	SDC (%)		Mean Temp. (°C)	RH (%)	SDC (%)	
1	19.40	62.00	7.63		19.28	58.50	9.23		20.10	43	13.33		19.70	52.50	10.84		18.90	42.5	12.76	
2	19.05	68.50	6.93		20.50	64.50	8.52		20.68	49	12.69		20.00	53.50	10.89		17.90	48.0	10.87	
3	22.80	55.00	12.60		20.00	62.00	8.90		21.70	42	15.31		19.60	52.50	10.78		18.30	47.0	10.91	
4	23.20	65.00	9.80		22.60	66.00	9.23		21.30	56	10.95		19.70	61.00	8.35		16.60	51.0	9.50	
5	24.10	56.00	13.12		23.00	64.50	9.98		22.30	58	11.08		19.90	57.00	9.91		17.80	52.0	11.86	
6	27.30	53.50	16.65		21.80	59.50	12.57		24.90	44	17.43		22.20	64.00	14.39		19.70	40.0	14.04	
7	27.30	49.50	13.89		21.70	65.00	9.01		24.50	36	19.07		19.70	44.50	12.66		19.40	32.5	14.85	
8	25.05	56.00	13.95		23.40	64.50	10.15		24.20	48	15.43		22.40	47.50	14.12		21.90	39.5	16.10	
9	29.70	48.00	21.43		23.80	65.00	10.81		23.10	54	12.92		21.20	35.00	15.33		18.90	36.5	13.97	
10	29.70	53.50	19.07		23.80	60.50	11.49		24.40	43	16.98		21.90	38.00	16.10		21.00	26.0	18.42	
11	24.20	44.50	16.54		23.90	54.50	13.49		25.70	50	16.80		21.10	34.50	16.39		23.80	22.5	23.24	
12	26.00	36.50	21.34		24.60	54.50	13.90		27.70	44	21.61		23.30	40.00	21.66		26.70	35.5	23.20	
13	27.90	37.50	23.50		25.10	21.50	15.44		28.10	53	17.76		23.80	63.50	18.46		28.60	25.0	30.07	
14	25.25	50.00	14.35		26.30	53.00	15.98		28.10	56	16.63		28.50	41.00	22.17		28.00	26.0	27.97	
15	30.50	51.00	21.12		27.30	56.50	12.70		27.80	52	18.14		28.80	47.00	20.61		30.20	34.0	27.98	
16	29.45	51.00	20.34		26.30	64.00	12.24		27.30	60	14.28		28.60	41.00	22.78		29.20	41.0	23.65	
17	30.50	46.50	23.26		27.00	59.00	14.64		29.40	53	18.84		30.20	33.00	28.60		30.50	28.5	30.52	
18	31.60	34.50	37.30		26.40	57.50	14.50		27.40	54	16.42		24.90	39.50	18.71		30.40	35.0	27.56	
19	27.50	49.00	18.77		27.40	61.50	13.95		27.70	56	16.63		24.50	46.00	16.43		30.00	44.0	33.74	
20	29.80	57.50	18.07		26.40	50.50	13.48		27.80	57	16.25		29.50	21.00	19.99		30.20	46.0	22.47	
21	32.05	44.00	26.66		26.30	70.00	11.22		27.20	62	13.56		29.00	52.00	19.25		29.50	48.0	20.85	
22	27.15	69.50	14.87		23.90	78.00	6.43		24.70	81	6.02		27.60	70.50	10.77		33.40	65.0	17.60	
23	27.80	63.50	13.73		24.10	72.50	8.23		22.20	80	5.28		25.70	70.00	9.78		26.40	66.0	11.42	
24	28.40	65.00	13.30		23.50	71.00	5.46		24.10	75	7.45		26.70	64.50	12.25		27.20	57.0	15.70	
25	26.30	79.50	6.93		23.60	75.50	7.07		23.00	86	3.93		26.50	73.50	9.08		27.20	71.0	10.35	
26	23.00	63.50	10.22		23.80	72.00	8.14		23.30	81	5.33		25.10	79.00	6.69		25.10	77.0	7.29	
27	27.40	71.00	15.66		23.60	70.50	8.51		24.10	77	5.85		26.60	69.00	10.66		26.10	58.0	10.75	
28	33.50	61.00	20.19		24.30	70.00	9.06		23.70	80	5.96		25.60	74.00	8.44		25.50	72.0	8.87	
29	26.20	64.50	11.81		26.70	27.00	8.40		22.50	90	2.64		24.30	75.00	7.55		24.20	87.0	3.83	
30	27.70	66.50	12.37		23.50	76.50	6.75		23.00	83	4.77		24.70	80.50	5.98		25.60	78.0	7.39	
31	27.60	60.50	14.54		24.20	67.50	9.77		23.20	80	5.62		24.90	84.00	4.95		24.80	70	7.29	
32	27.60	63.00	13.62		24.00	70.00	8.94		22.70	84	4.49		22.80	80.00	8.24		24.80	78.0	6.97	
33	23.50	62.50	10.84		23.10	82.50	4.94		22.70	83	4.77		24.40	77.50	6.82		25.10	69.0	9.82	
34	26.50	81.00	6.59		22.10	94.50	4.10		23.00	83	4.77		27.10	76.50	7.48		25.60	73.0	9.07	
35	22.90	76.00	6.75		22.90	73.00	7.48		22.30	85	3.96		27.10	88.50	3.28		25.60	91.0	2.52	
36	21.60	67.50	7.40		23.80	69.00	9.02		22.60	81	5.33		23.90	78.00	6.43		24.10	82.0	5.36	
37	22.30	62.50	10.24		23.80	24.50	7.43		23.60	69	9.23		24.50	69.50	9.28		24.60	67.0	10.46	
38	23.45	62.50	10.84		24.40	26.50	7.12		25.10	78	6.97		23.10	63.50	10.31		28.40	55.0	7.01	
39	25.90	77.00	7.71		22.60	5.80	4.07		23.10	81	5.33		24.90	81.50	5.72		25.20	86.0	7.43	
40	25.90	78.50	6.11		23.00	74.50	7.17		23.10	82	5.05		24.50	76.00	7.31		24.70	75.0	7.92	
41	20.30	78.50	5.04		23.30	79.50	5.84		24.00	80	5.96		23.70	71.50	8.26		24.90	64.0	11.41	
42	25.70	76.00	7.97		22.80	26.50	6.43		24.00	53	11.02		33.30	71.50	8.12		23.30	62.0	13.65	
43	24.50	73.00	7.97		21.60	81.00	4.61		23.40	70	8.43		24.20	73.00	8.12		23.10	53.0	13.20	
44	22.90	64.50	9.98		22.20	69.00	8.26		23.80	61	11.62		22.00	59.00	10.83		21.10	41.0	14.69	
45	20.70	53.00	14.43		20.40	56.00	11.83		21.30	40	11.94		21.10	58.00	10.51		22.90	43.0	14.19	
46	19.95	65.00	6.02		20.00	79.00	4.92		21.20	55	11.29		29.20	58.50	15.14		19.00	41.0	12.98	
47	15.30	62.00	8.59		19.70	74.50	5.82		20.70	76	5.97		19.00	58.50	8.76		18.90	45.0	12.10	
48	13.60	61.00	5.70		14.20	56.00	5.56		19.20	56	9.68		18.00	57.50	8.76		17.50	45.0	10.67	
49	13.90	58.50	6.19		20.00	73.00	7.02		20.30	46	12.63		18.20	67.00	8.12		17.20	45.0	10.67	
50	18.90	84.50	3.41		20.00	77.50	5.27		19.60	58	9.82		18.00	55.00	9.27		15.70	53.0	8.55	
51	12.70	59.50	6.28		17.80	97.00	6.10		19.30	43	12.54		18.20	55.50	9.27		16.80	47.0	10.28	
52	19.20	60.50	3.85		18.40	53.00	7.79		20.20	44	13.10		18.70	58.00	8.99		17.30	48.0	10.08	

APPENDIX XX: Mean Temperature Relative Humidity and Saturation Deficit Coefficient.

1972

Week	Secunderabad				Bangalore				Belgaum (Dharwad)				Pimpri				Devalli (Niphad)			
	Mean Temp. (°C)	RH (%)	SDC (%)		Mean Temp. (°C)	RH (%)	SDC (%)		Mean Temp. (°C)	RH (%)	SDC (%)		Mean Temp. (°C)	RH (%)	SDC (%)		Mean Temp. (°C)	RH (%)	SDC (%)	
1	13.70	57.50	6.72		19.40	58.50	9.33		20.50	41.7	13.88		19.10	54.00	10.18		17.60	47	10.91	
2	14.60	67.00	5.55		18.40	60.50	8.32		20.60	45	13.59		18.80	47.50	11.30		17.40	42	11.25	
3	20.25	63.50	8.69		19.50	65.00	7.90		21.00	50	12.45		19.50	52.50	10.73		17.10	47	10.20	
4	19.20	59.50	9.04		18.80	60.00	8.61		20.90	48	12.94		20.50	55.00	10.80		18.70	45	11.88	
5	22.60	51.50	8.44		20.90	55.50	10.92		23.30	46	12.94		22.80	51.50	13.27		20.40	45	12.87	
6	23.20	53.50	8.47		23.20	63.00	10.49		22.10	48	13.72		19.30	54.50	10.43		16.80	51	9.50	
7	23.10	57.50	11.90		22.30	60.00	10.71		20.90	48	12.94		18.20	56.08	9.17		16.50	44	10.19	
8	23.80	56.00	12.76		22.28	46.00	14.39		23.50	48	14.61		24.60	54.50	13.90		21.30	44	13.94	
9	25.80	47.00	17.07		22.10	43.50	14.99		24.40	50	13.50		23.30	44.50	15.80		21.50	30	17.43	
10	26.20	43.50	18.76		22.10	44.50	14.72		24.90	35	20.60		24.60	38.50	18.76		23.20	25	21.07	
11	27.40	41.50	21.77		23.70	46.00	15.64		26.60	54	16.42		23.00	37.50	17.57		24.60	26	23.45	
12	28.80	41.00	25.85		22.20	44.50	14.79		26.80	57	15.35		28.20	37.00	14.08		27.20	25	26.77	
13	28.80	30.00	30.66		20.30	46.00	12.53		29.10	65	12.99		29.10	38.50	24.70		27.70	25	28.35	
14	30.50	39.50	26.08		27.00	56.00	15.71		27.30	45	19.63		39.00	39.00	15.55		25.90	28	21.19	
15	28.60	52.50	18.10		26.70	59.50	16.92		22.80	48	14.61		28.50	37.50	24.05		27.60	2	26.83	
16	29.00	39.00	26.23		26.20	50.00	18.46		27.80	58	15.87		28.40	34.50	25.09		27.70	28	27.21	
17	32.70	37.00	30.62		26.70	46.50	14.79		28.60	74	10.42		30.20	47.50	22.41		29.80	26	31.37	
18	30.70	43.00	24.63		26.30	56.50	14.79		27.70	69	11.71		29.40	44.50	22.57		29.30	36	25.66	
19	32.60	40.00	28.10		26.50	63.50	12.50		29.00	58	16.84		30.30	41.00	25.07		31.00	28	32.32	
20	30.60	48.50	22.20		29.50	63.50	8.77		30.40	82	5.70		30.40	54.50	19.12		32.60	40	30.18	
21	33.70	35.50	33.38		26.30	73.50	12.41		27.30	78	7.85		29.30	52.00	18.45		30.10	47	22.47	
22	33.70	33.00	34.68		26.70	58.50	14.32		27.40	66	12.12		29.80	94.50	18.75		29.98	46	24.24	
23	33.70	31.50	35.45		27.70	58.50	15.20		27.20	72	9.99		29.90	56.00	18.19		30.20	55	19.08	
24	32.20	48.00	24.34		26.20	70.50	10.05		26.20	72	9.48		29.90	66.50	9.66		29.50	61	18.53	
25	29.20	62.00	15.83		24.00	73.50	7.90		24.90	86	4.43		23.60	66.50	5.79		26.40	71	9.74	
26	26.25	79.00	6.99		23.20	79.50	5.81		22.80	90	2.81		25.30	82.00	4.76		25.10	83	5.38	
27	25.25	82.50	4.55		22.60	80.50	5.89		22.80	95	1.40		24.70	84.50	7.18		25.90	68	10.75	
28	27.45	72.00	6.02		24.00	70.50	8.80		23.30	87	3.55		20.60	76.50	5.31		26.80	65	12.49	
29	28.40	61.00	14.96		24.00	71.00	8.65		23.90	85	4.47		20.60	78.00	8.25		26.50	67	11.08	
30	28.60	62.50	14.48		23.90	74.50	7.45		25.30	83	5.06		25.30	75.00	8.02		26.50	67	11.08	
31	28.70	59.00	22.85		24.30	69.50	9.21		24.50	83	3.37		24.50	74.50	7.16		24.80	72	8.87	
32	28.40	58.00	19.59		24.10	72.00	8.38		23.90	88	3.09		24.50	76.00	7.31		24.20	78	6.58	
33	27.60	60.00	14.60		23.18	76.50	6.64		24.70	89	2.52		24.70	80.00	6.14		23.70	79	6.25	
34	26.40	77.00	7.85		22.70	74.50	6.95		22.90	91	5.05		25.30	69.50	9.79		25.20	68	10.14	
35	27.95	54.50	16.84		23.40	71.00	8.29		23.30	82	5.05		26.00	71.00	9.75		25.60	69	10.41	
36	28.45	67.00	12.68		23.80	69.00	9.02		24.60	83	3.38		26.00	79.00	6.82		26.10	71	9.74	
37	26.90	74.00	8.96		23.50	72.00	8.33		24.00	86	4.17		25.60	79.00	12.30		26.30	52	16.12	
38	27.90	68.00	11.81		24.00	77.50	6.71		25.00	80	6.34		26.80	64.50	14.21		26.30	52	16.12	
39	27.35	53.00	16.98		24.00	77.50	6.71		25.80	82	7.21		26.50	58.50	14.21		24.50	40	17.80	
40	25.65	68.00	10.41		22.50	83.50	4.46		25.30	80	6.34		26.80	54.50	15.76		25.60	39	20.49	
41	24.75	60.50	11.84		23.50	77.50	6.46		25.60	71	9.74		26.80	56.50	16.06		25.40	37	19.97	
42	24.72	56.00	13.51		23.40	70.50	8.44		27.60	65	11.76		27.60	56.00	16.06		27.20	35	23.20	
43	25.00	55.00	13.74		22.90	72.50	7.56		24.70	72	8.87		26.40	45.00	18.77		25.30	45	17.43	
44	24.15	79.00	6.15		22.30	81.00	5.09		23.60	83	5.06		24.30	73.50	8.00		22.90	53	13.20	
45	21.20	62.50	9.43		21.80	77.00	5.95		22.50	68	8.44		20.90	57.00	10.52		20.30	33	15.67	
46	22.25	5.85	11.09		21.70	7.00	7.47		22.70	57	12.08		21.20	52.00	11.96		20.80	35	16.10	
47	22.95	62.50	10.33		19.90	67.00	7.61		22.50	50	13.20		21.80	51.00	12.67		20.70	34	16.43	
48	23.25	66.50	9.52		22.70	70.00	8.18		22.80	58	11.80		20.20	57.00	10.91		17.40	37	12.22	
49	20.40	79.00	5.00		19.90	86.50	3.12		22.40	58	11.08		21.40	57.00	10.91		20.20	39	14.27	
50	22.50	67.00	8.91		20.40	78.00	5.25		22.40	64	9.50		23.41	57.50	12.15		21.60	45	14.52	
51	20.75	65.50	8.38		20.40	71.50	6.81		21.40	57	10.70		21.30	55.50	11.24		19.70	43	13.33	
52	21.65	65.00	8.99		20.50	67.00	7.92		22.40	55	11.48		21.50	56.50	11.09		20.00	47	12.46	

(1973)

APPE DIX XXI Mean Temperature Relative Humidity and Saturation Deficit Coefficient.

Week	Secunderabad				Bengaluru				Belgaum (Bharwad)				Pimpri				Devlali (Mumbai)			
	Mean Temp (°C)	RH (%)	SDC (%)	Mean Temp (°C)	RH (%)	SDC (%)	Mean Temp (°C)	RH (%)	Mean Temp (°C)	RH (%)	SDC (%)	Mean Temp (°C)	RH (%)	SDC (%)	Mean Temp (°C)	RH (%)	Mean Temp (°C)	RH (%)	SDC (%)	Mean Temp (°C)
1	17.00	56.00	8.56	19.50	64.00	8.13	22.40	65	22.40	65	9.24	22.70	50.50	13.67	22.50	41.00	22.50	41.00	13.67	15.57
2	19.80	60.50	9.06	20.40	59.50	9.67	23.00	65	23.00	65	9.83	21.10	58.50	10.38	19.80	48.00	19.80	48.00	10.38	11.44
3	20.50	55.00	10.80	21.00	56.00	10.96	22.90	40	22.90	40	16.89	20.20	50.00	11.82	20.20	40.00	20.20	40.00	11.82	12.36
4	19.60	59.00	9.31	20.60	57.00	10.37	21.40	43	21.40	43	14.19	19.50	47.50	11.85	19.50	39.00	19.50	39.00	11.85	10.37
5	22.20	48.00	13.86	22.30	59.00	10.98	23.20	46	23.20	46	15.17	14.20	39.50	9.88	17.90	36.00	17.90	36.00	9.88	13.18
6	22.80	57.00	11.77	22.80	61.00	9.10	24.00	42	24.00	42	17.28	22.20	47.50	12.99	22.20	39.00	22.20	39.00	12.99	15.18
7	23.00	58.00	11.81	22.60	60.50	10.72	24.10	42	24.10	42	17.28	23.30	40.50	16.91	23.30	30.00	23.30	30.00	16.91	17.43
8	23.70	52.50	13.76	22.60	50.50	13.43	26.00	42	26.00	42	19.48	24.80	48.00	16.02	22.80	53.00	22.80	53.00	16.02	13.20
9	25.40	52.00	15.46	20.10	47.50	12.35	24.50	48	24.50	48	15.49	28.20	49.00	19.42	22.20	43.00	22.20	43.00	19.42	15.04
10	26.00	42.00	19.49	24.10	49.00	15.26	26.10	50	26.10	50	16.48	25.20	46.50	19.02	24.20	29.00	24.20	29.00	19.02	21.15
11	26.40	43.50	19.64	23.80	41.00	17.16	26.80	34	26.80	34	23.56	24.70	38.50	18.86	23.20	23.00	23.20	23.00	18.86	21.63
12	29.10	40.50	23.94	25.00	46.00	17.12	27.20	40	27.20	40	21.42	26.80	36.50	22.00	25.40	26.00	25.40	26.00	22.00	23.45
13	29.70	30.00	28.75	24.60	45.50	16.65	26.50	57	26.50	57	18.44	30.40	44.00	24.86	29.40	32.00	29.40	32.00	24.86	27.26
14	30.10	35.00	27.66	26.80	50.50	17.15	27.90	53	27.90	53	17.76	30.10	38.00	26.38	29.10	26.00	29.10	26.00	26.38	29.67
15	29.30	40.00	21.18	28.20	54.00	17.52	30.20	55	30.20	55	19.08	30.10	37.00	27.16	30.10	33.00	30.10	33.00	27.16	28.40
16	29.50	42.00	23.66	27.30	49.00	19.42	29.70	51	29.70	51	20.77	30.70	30.00	30.37	29.20	20.00	29.20	20.00	30.37	32.08
17	31.50	38.50	28.06	28.30	53.50	17.77	30.40	50	30.40	50	21.20	30.30	33.00	28.59	31.20	27.00	31.20	27.00	28.59	32.77
18	30.15	40.00	25.57	23.70	48.50	14.91	29.50	52	29.50	52	19.24	31.50	35.50	29.43	31.60	31.00	31.60	31.00	29.43	32.84
19	31.80	40.50	27.40	26.60	57.00	14.78	28.20	60	28.20	60	15.10	29.40	58.50	16.87	30.50	48.00	29.40	48.00	16.87	22.04
20	30.40	50.00	21.48	27.50	55.00	16.37	29.10	57	29.10	57	17.24	29.50	51.50	19.79	30.00	49.00	29.50	49.00	19.79	21.62
21	33.60	30.00	32.27	25.90	65.50	11.33	27.70	67	27.70	67	12.47	30.40	52.50	20.71	31.90	44.00	31.90	44.00	20.71	26.65
22	33.50	30.00	31.66	26.40	64.50	11.93	27.70	63	27.70	63	13.98	30.50	53.00	20.26	31.00	49.00	31.00	49.00	20.26	24.27
23	33.30	30.00	30.71	25.20	70.00	9.95	25.50	85	25.50	85	4.75	27.80	75.00	9.19	28.60	67.00	27.80	67.00	9.19	13.23
24	32.30	40.50	25.23	24.60	64.50	10.85	24.50	86	24.50	86	4.17	26.30	72.50	9.35	27.20	72.00	26.30	72.00	9.35	16.63
25	29.20	50.00	18.98	24.30	62.50	11.32	24.90	75	24.90	75	7.92	27.60	62.50	13.69	28.40	56.00	27.60	56.00	13.69	13.98
26	26.30	70.00	8.50	24.30	62.50	10.87	24.90	86	24.90	86	3.93	27.50	66.50	12.19	28.40	63.00	27.50	63.00	12.19	16.63
27	25.60	77.00	7.47	22.80	77.00	6.30	23.00	86	23.00	86	3.09	23.50	85.50	3.88	26.00	82.00	26.00	82.00	3.88	6.04
28	27.30	69.00	11.19	23.50	67.50	9.34	22.80	89	22.80	89	3.09	23.50	86.50	3.88	24.20	81.00	24.20	81.00	3.88	5.66
29	28.50	65.00	13.47	24.00	70.00	8.94	23.40	88	23.40	88	3.37	24.00	83.00	5.09	24.70	83.00	24.70	83.00	5.09	5.38
30	28.60	58.00	16.22	24.90	66.50	10.36	23.40	85	23.40	85	4.47	25.20	76.50	7.51	25.10	78.00	25.10	78.00	7.51	6.97
31	28.50	50.00	16.93	27.80	81.00	6.99	20.10	87	20.10	87	3.04	25.50	77.50	7.28	25.30	77.00	25.50	77.00	7.28	7.29
32	28.25	56.00	16.78	22.20	82.00	4.78	23.10	90	23.10	90	2.81	24.30	84.50	4.68	25.50	77.00	24.30	77.00	4.68	6.04
33	27.80	63.00	13.60	22.30	79.00	5.62	22.50	88	22.50	88	3.16	23.90	87.00	4.00	24.90	80.00	23.90	80.00	4.00	6.25
34	26.70	69.00	10.53	22.50	76.50	6.35	22.70	90	22.70	90	2.81	23.70	80.50	5.65	24.50	79.00	23.70	79.00	5.65	3.09
35	27.90	55.00	13.61	22.80	75.00	6.84	23.00	89	23.00	89	3.01	23.20	86.50	3.83	25.20	89.00	23.20	89.00	3.83	4.77
36	28.30	65.00	13.37	23.30	71.00	8.26	22.50	85	22.50	85	3.96	22.40	85.50	3.97	23.30	83.00	22.40	83.00	3.97	7.74
37	26.90	73.00	9.61	23.60	69.50	8.80	18.00	81	18.00	81	3.91	23.70	82.00	5.22	23.70	74.00	23.70	74.00	5.22	7.74
38	28.50	66.00	13.24	22.10	84.50	4.12	22.20	84	22.20	84	4.22	23.80	84.50	4.51	25.20	79.00	23.80	79.00	4.51	6.65
39	27.00	56.00	15.71	22.90	74.00	7.15	22.70	82	22.70	82	3.35	24.30	81.50	5.59	25.10	85.00	24.30	85.00	5.59	4.47
40	25.60	70.00	9.74	22.10	74.50	6.77	17.90	82	17.90	82	3.70	25.30	75.00	8.02	25.80	77.00	25.30	77.00	8.02	7.72
41	24.90	69.00	9.60	22.60	74.50	6.92	23.10	77	23.10	77	6.46	24.30	66.00	10.26	24.00	55.00	24.30	55.00	10.26	13.41
42	25.00	65.00	11.10	23.00	74.00	7.31	24.20	71	24.20	71	8.64	24.60	68.00	9.78	24.10	56.00	24.60	56.00	9.78	13.11
43	25.00	68.50	9.99	22.40	78.00	5.92	22.90	80	22.90	80	5.62	24.80	80.50	6.01	24.90	56.00	24.80	56.00	6.01	10.14
44	23.50	82.00	5.17	22.20	82.00	4.80	23.00	76	23.00	76	6.74	19.10	73.50	5.86	22.60	56.00	19.10	56.00	5.86	9.16
45	23.50	65.00	10.05	19.30	60.00	8.94	18.80	53	18.80	53	10.34	20.10	65.00	8.22	19.50	43.00	20.10	43.00	8.22	12.54
46	21.80	62.00	9.82	19.70	71.50	7.34	18.80	61	18.80	61	9.71	23.20	65.00	9.92	22.40	34.00	23.20	34.00	9.92	17.42
47	21.70	64.00	9.27	19.50	55.50	10.05	18.50	43	18.50	43	11.74	19.00	69.00	6.82	18.50	43.00	19.00	43.00	6.82	11.74
48	22.80	68.00	8.76	20.40	65.50	8.08	17.80	51	17.80	51	10.09	19.40	62.50	8.43	18.30	45.00	19.40	45.00	8.43	11.33
49	22.60	70.00	8.14	20.40	60.50	9.43	20.90	65	20.90	65	8.71	21.40	59.50	10.28	20.80	54.00	21.40	54.00	10.28	11.45
50	23.00	70.00	8.43	19.10	72.50	6.09	20.40	64	20.40	64	8.42	21.40	59.50	10.28	18.70	52.00	21.40	52.00	10.28	10.56
51	21.00	71.00	7.23	18.30	72.50	5.76	19.70	72	19.70	72	6.55	16.40	62.50	6.99	20.50	55.00	16.40	55.00	6.99	10.53
52	21.30	72.00	9.60	18.40	65.50	7.27	20.10	68	20.10	68	7.48	14.80	63.00	6.30	18.80	60.00	14.80	60.00	6.30	8.88

(1974)

APPENDIX XXII: Mean Temperature, Relative Humidity and Saturation Deficit Coefficient.

Week	Secunderabad				Bangalore				Belgaum (Dharwad)				Pimpri				Devlali (Nipad)			
	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)		
1	17.90	57.50	8.68	18.30	63.50	7.65	20.30	66	7.95	19.20	59.50	9.01	25.90	80	6.72					
2	19.50	57.50	9.60	19.20	61.00	8.67	20.70	64	8.96	19.10	53.00	10.40	26.00	77	7.72					
3	15.35	54.50	7.91	19.80	60.00	9.17	21.50	67	8.21	19.70	56.00	10.04	25.30	67	10.16					
4	21.80	56.50	11.25	19.90	51.00	11.29	22.70	66	9.55	21.20	56.00	11.06	25.60	67	11.08					
5	23.20	56.50	12.33	20.10	54.50	10.70	23.60	52	14.30	21.00	51.00	12.21	25.60	51	6.39					
6	23.55	59.00	11.70	20.60	50.00	12.05	24.00	56	13.11	19.90	49.00	11.76	24.70	51	5.66					
7	23.50	59.00	11.78	21.30	59.50	10.23	23.70	61	11.62	21.60	51.00	12.55	24.70	77	7.29					
8	26.50	37.00	21.58	16.20	44.50	10.23	25.60	52	16.12	24.20	44.50	16.68	24.10	72	8.34					
9	26.70	40.00	20.70	23.30	52.00	13.67	25.70	68	10.75	24.70	41.00	18.09	23.50	75	7.82					
10	26.90	34.00	22.95	23.40	34.50	18.71	26.60	67	11.78	25.40	38.50	19.81	23.30	69	8.71					
11	27.50	31.50	24.91	22.40	32.50	18.14	26.90	61	13.92	26.50	37.00	12.66	25.20	75	7.92					
12	28.90	43.50	22.04	25.30	49.50	16.21	27.40	67	11.78	26.40	42.00	19.79	26.90	66	12.13					
13	30.10	49.00	21.70	26.90	62.50	13.04	26.70	69	11.06	24.60	36.00	20.00	25.90	76	8.06					
14	29.35	41.00	23.95	25.60	49.00	16.56	26.90	71	10.35	28.40	42.00	22.24	26.10	70	10.00					
15	30.00	48.50	22.69	26.50	55.50	15.24	28.10	67	12.47	29.70	42.00	23.82	26.00	72	7.40					
16	32.55	49.50	24.45	27.50	51.50	17.82	28.00	73	10.20	29.60	51.50	19.85	26.80	76	8.56					
17	31.70	48.50	23.65	27.30	53.50	16.79	33.80	62	20.21	28.90	43.50	22.05	24.60	60	12.68					
18	32.50	44.00	27.08	28.40	55.00	17.26	29.10	51	19.64	35.10	35.50	36.36	21.20	48	14.42					
19	32.10	56.00	21.01	26.80	62.50	12.99	29.10	61	15.63	31.20	37.50	28.24	18.70	42	12.76					
20	34.65	67.00	17.89	25.10	69.00	9.90	27.00	65	12.49	29.40	59.50	16.25	18.50	45	12.87					
21	29.30	60.00	16.21	24.30	73.00	8.15	26.00	68	12.85	27.20	63.50	13.66	18.70	49	11.22					
22	30.20	61.50	16.36	24.40	74.50	7.73	26.20	70	10.08	28.10	62.50	14.23	18.10	46	11.12					
23	28.90	55.00	17.56	25.30	63.50	11.71	25.80	66	11.42	28.10	57.50	16.13	19.00	56	9.67					
24	28.10	70.50	11.91	24.10	69.00	9.28	26.00	70	10.08	28.40	58.00	16.11	18.10	55	10.67					
25	28.65	59.00	8.82	24.40	71.00	8.79	20.50	78	5.14	27.90	65.00	12.92	18.10	59	8.44					
26	26.85	72.00	7.52	25.80	71.50	8.29	23.30	89	3.09	26.20	72.00	5.88	16.30	50	9.10					
27	27.20	66.00	12.23	25.10	79.00	5.93	23.30	89	3.09	25.20	70.50	6.87	18.80	60	8.88					
28	27.10	70.50	13.57	25.50	75.00	7.18	22.90	87	3.65	24.50	81.00	3.96	17.50	52	9.31					
29	27.20	68.00	11.51	24.20	70.00	9.02	23.60	83	4.96	25.60	74.00	8.44	17.20	55	8.73					
30	28.20	71.00	11.05	24.30	78.00	6.64	23.70	89	3.27	26.20	74.50	8.61	17.60	54	9.47					
31	26.25	83.50	4.58	21.20	86.00	3.52	22.60	90	3.81	25.00	84.50	8.48	17.80	39	12.56					
32	29.70	90.50	3.91	23.40	78.00	6.29	22.50	89	2.90	24.00	86.00	4.18	17.40	35	12.61					
33	26.50	80.00	6.95	23.30	73.00	7.69	22.80	86	3.93	24.10	84.00	4.79	20.40	36	14.97					
34	26.30	69.00	10.54	23.80	64.50	10.32	23.30	78	6.18	24.20	78.50	6.46	21.60	36	16.89					
35	21.45	66.00	8.65	23.50	70.50	8.47	23.30	78	6.18	23.80	82.00	5.24	21.70	29	18.74					
36	27.00	62.50	13.39	24.70	79.50	6.26	24.50	73	8.04	24.40	79.50	6.21	22.90	31	19.38					
37	25.65	80.50	6.34	22.90	78.50	5.91	23.00	81	5.33	25.31	74.50	8.19	24.30	26	22.05					
38	26.65	74.50	8.74	22.80	79.00	6.11	23.30	84	4.49	20.50	75.50	5.88	25.90	33	22.51					
39	26.65	79.50	7.02	22.10	83.00	4.51	23.40	84	4.49	25.40	75.00	4.83	27.80	30	26.46					
40	25.30	72.00	8.99	22.40	83.50	4.44	23.70	78	6.55	24.80	75.00	8.91	28.50	25	28.35					
41	26.10	77.00	7.76	22.00	79.50	5.96	24.20	78	6.55	25.50	75.00	8.09	28.50	28	27.21					
42	25.40	82.00	5.80	22.00	79.50	5.42	23.60	81	5.66	24.20	75.00	5.41	30.30	50	21.20					
43	24.40	74.00	7.88	19.10	77.50	4.99	22.90	81	5.33	23.80	75.50	7.13	29.70	36	27.13					
44	20.65	54.50	11.00	19.20	59.50	8.44	22.00	49	15.19	21.60	62.00	9.74	30.10	32	28.83					
45	19.95	56.50	10.05	20.50	65.50	8.28	22.20	36	16.89	26.40	58.50	14.16	29.80	37	26.71					
46	19.20	52.50	10.56	16.40	55.50	8.38	21.80	32	17.95	28.90	61.00	15.20	30.50	45	23.32					
47	19.05	71.50	6.29	20.80	67.50	11.26	22.70	61	10.95	20.50	65.50	8.28	29.10	61	24.46					
48	19.30	61.00	8.72	20.80	59.50	9.86	21.30	57	10.70	19.80	63.00	8.49	29.60	58	17.86					
49	19.60	64.00	8.17	19.80	67.00	7.57	20.10	50	11.70	14.90	61.00	6.69	28.20	52	20.44					
50	18.70	62.50	6.03	18.30	63.00	7.75	19.90	56	10.29	19.10	64.00	7.96	28.40	49	19.27					
51	19.10	64.50	7.85	18.70	72.50	5.89	19.60	56	10.29	19.10	64.00	7.96	23.10	57	16.25					
52	17.70	60.00	8.08	19.60	60.50	8.97	19.60	49	11.93	17.20	54.50	8.81	26.40	65	11.76					

APPENDIX XXIII: Mean Temperature, Relative Humidity and Saturation Deficit Coefficient.
(1975)

Week	Secunderabad				Bangalore				Belgaum (Bharwar)				Pimpri				Devlali (Niphad)			
	Mean Temp.	RH (%)	SDC (%)	Mean Temp.	RH (%)	SDC (%)	Mean Temp.	RH (%)	Mean Temp.	RH (%)	SDC (%)	Mean Temp.	RH (%)	SDC (%)	Mean Temp.	RH (%)	SDC (%)			
1	18.95	61.50	8.19	18.00	59.50	8.33	20.30	44.9	13.10	57.50	8.90	18.30	57.50	8.90	17.90	54.00	9.47			
2	19.50	52.50	10.73	18.20	62.00	8.55	19.30	48.00	11.44	53.00	8.69	17.70	53.00	8.69	17.10	50.00	9.70			
3	18.60	60.50	8.41	19.60	63.00	8.40	20.30	43.00	13.33	57.50	17.83	18.20	57.50	17.83	18.20	47.00	10.91			
4	22.90	74.50	7.45	22.30	64.00	9.64	23.30	59.00	11.52	59.50	9.67	20.40	59.50	9.67	19.10	52.00	18.56			
5	22.15	64.50	9.44	20.80	64.00	10.10	22.60	46.00	15.17	55.00	10.63	20.20	55.00	10.63	15.60	51.00	8.91			
6	24.70	60.00	12.27	23.70	67.50	8.74	24.60	41.00	18.70	51.50	12.17	21.16	51.50	12.17	19.90	51.00	11.46			
7	24.55	60.50	12.04	24.60	67.50	9.93	24.10	37.00	18.77	48.00	12.41	20.40	48.00	12.41	19.30	49.00	11.32			
8	23.60	64.50	10.24	22.40	60.50	10.62	24.20	47.00	15.79	51.50	12.93	21.30	51.50	12.93	21.30	47.00	13.19			
9	21.80	53.00	12.15	22.80	53.00	12.33	26.40	41.00	19.82	44.00	17.04	22.50	44.00	17.04	21.90	46.00	14.25			
10	26.50	64.50	12.16	24.90	63.50	11.29	26.60	47.00	18.92	48.50	13.72	22.20	48.50	13.72	22.20	46.00	16.89			
11	27.70	42.00	21.24	24.60	47.00	16.19	27.50	37.00	22.49	38.00	21.34	25.50	38.00	21.34	25.00	43.00	17.58			
12	28.00	50.00	18.90	20.80	46.00	13.14	27.50	31.00	24.63	33.50	21.50	25.50	33.50	21.50	25.00	43.00	18.06			
13	26.20	45.00	18.62	25.80	46.00	17.26	25.80	37.00	33.59	33.50	26.31	29.50	33.50	26.31	29.40	38.00	19.65			
14	30.25	37.00	26.94	24.70	55.00	13.80	28.70	50.00	18.04	35.50	26.76	29.20	35.50	26.76	29.20	31.00	27.66			
15	31.00	48.00	23.35	27.60	55.00	16.24	29.10	47.00	21.25	33.50	28.16	29.10	33.50	28.16	29.40	35.00	26.86			
16	31.70	48.50	23.65	28.30	52.50	18.15	29.50	52.00	19.24	30.50	23.34	30.30	31.50	23.34	30.60	34.00	29.63			
17	37.50	38.50	39.14	28.00	52.00	18.15	29.60	57.00	18.23	30.70	22.35	30.70	48.50	22.35	30.40	43.00	24.16			
18	27.25	43.50	20.38	26.20	62.50	12.70	27.10	67.00	11.78	48.50	16.58	28.90	48.50	16.58	30.00	52.00	20.35			
19	30.10	39.00	25.95	26.50	58.00	14.39	27.50	65.00	12.49	57.50	19.49	29.10	57.50	19.49	29.60	46.00	22.89			
20	32.64	37.50	30.35	25.80	68.00	10.47	27.70	62.00	14.36	47.00	20.60	28.80	47.00	20.60	29.20	45.00	22.05			
21	33.90	36.00	33.07	25.60	66.50	10.86	28.90	56.00	17.64	47.00	12.68	27.40	65.00	12.68	30.50	56.00	18.65			
22	30.30	59.50	19.08	25.40	66.50	10.79	27.20	72.00	9.99	65.00	14.62	27.30	59.50	14.62	29.40	57.00	17.24			
23	30.10	58.00	17.87	24.40	68.00	9.70	26.60	66.00	12.13	59.50	7.00	25.60	79.00	7.00	26.00	80.00	6.72			
24	28.65	69.00	11.99	24.60	65.50	10.54	25.80	85.00	4.47	79.00	5.96	24.60	80.50	5.96	25.40	77.00	7.29			
25	28.50	62.00	12.72	23.20	72.00	7.94	23.60	86.00	3.93	80.50	7.83	25.20	75.50	7.83	26.70	73.00	9.63			
26	26.25	74.50	8.65	22.80	76.00	3.57	23.50	86.00	4.17	75.50	6.75	24.70	78.00	6.75	26.30	78.00	7.39			
27	25.95	81.00	6.26	22.80	80.00	5.48	23.70	86.00	3.93	78.00	6.85	25.10	78.00	6.85	24.80	83.00	6.93			
28	25.35	75.00	8.04	22.90	76.50	7.46	22.90	85.00	4.47	78.50	7.17	25.70	78.00	7.17	26.10	76.00	8.06			
29	26.75	73.00	9.34	23.50	78.50	6.18	24.10	85.00	5.96	80.00	4.25	24.40	86.00	4.25	25.20	86.00	4.43			
30	27.35	70.50	10.67	28.10	75.00	9.49	24.50	80.00	3.37	86.00	4.25	24.40	86.00	4.25	24.50	90.00	2.68			
31	25.35	83.50	5.31	22.00	81.50	4.86	22.80	88.00	3.37	86.00	4.53	23.90	84.50	4.53	24.50	90.00	2.98			
32	25.80	77.50	7.36	23.10	76.50	6.64	23.50	88.00	5.36	86.00	4.19	24.10	86.00	4.19	23.70	83.00	5.06			
33	25.65	78.50	7.00	28.50	76.00	9.24	23.90	84.00	4.76	84.50	5.22	23.90	84.50	5.22	24.50	90.00	2.98			
34	26.40	72.00	9.02	23.40	74.00	7.44	24.00	82.00	5.36	86.00	4.19	24.10	86.00	4.19	23.70	83.00	5.06			
35	25.65	83.50	5.37	21.70	83.50	4.25	24.00	81.00	5.66	85.50	5.22	27.20	85.50	5.22	24.60	85.00	4.75			
36	30.05	58.00	17.84	21.90	80.50	5.07	22.50	88.00	3.16	77.00	8.85	28.50	77.00	8.85	23.50	85.00	4.21			
37	25.70	75.00	8.15	22.80	78.50	5.89	23.90	76.00	7.15	76.50	6.69	23.30	76.50	6.69	24.40	78.00	6.56			
38	26.80	76.50	8.14	23.50	72.50	7.02	24.70	79.00	4.75	81.50	6.25	26.50	81.50	6.25	26.30	76.00	8.06			
39	26.30	81.00	6.42	23.00	76.50	6.61	23.90	77.00	3.87	75.50	3.41	20.10	75.50	3.41	26.50	78.00	7.39			
40	25.20	77.50	7.19	22.50	75.00	7.00	23.80	78.00	6.55	75.00	7.49	24.60	75.50	7.49	25.20	72.00	9.99			
41	25.30	77.00	7.38	22.50	75.00	6.75	24.40	75.00	7.45	75.00	8.18	25.80	75.00	8.18	26.60	72.00	9.99			
42	25.40	83.00	5.48	22.70	74.00	6.93	23.60	82.00	5.36	76.50	9.28	24.90	76.50	9.28	25.00	65.00	11.09			
43	24.40	78.00	6.67	21.70	80.50	5.02	23.50	82.00	5.05	76.50	7.04	24.00	76.50	7.04	24.00	64.00	10.72			
44	27.90	62.50	13.84	20.80	82.00	4.38	23.50	82.00	5.05	72.00	8.14	23.80	72.00	8.14	23.40	64.00	10.11			
45	19.90	57.00	9.91	20.70	70.00	7.27	23.80	65.00	10.43	64.00	9.68	22.40	64.00	9.68	21.20	52.00	11.95			
46	19.90	52.00	11.06	20.70	62.00	9.20	20.30	47.00	11.93	59.00	8.73	18.60	59.00	8.73	18.60	44.00	12.32			
47	20.15	57.00	10.14	19.80	65.50	7.91	20.00	54.00	10.76	62.00	9.65	21.40	62.00	9.65	19.00	49.00	11.22			
48	19.40	64.00	8.09	18.50	69.00	6.57	20.30	56.00	10.29	60.00	8.05	17.50	60.00	8.05	17.00	46.00	10.47			
49	19.40	65.50	7.75	20.00	66.00	7.91	21.10	55.00	11.20	58.50	6.10	18.20	58.50	6.10	18.20	50.00	10.30			
50	18.20	64.00	7.50	18.30	61.50	8.02	19.90	48.00	12.16	58.50	6.79	13.80	58.50	6.79	18.30	45.00	11.33			
51	18.20	65.00	7.29	18.10	68.00	6.63	18.90	51.00	10.78	54.00	6.71	17.30	54.00	6.71	17.30	51.00	9.50			
52	17.65	59.00	8.21	17.30	60.00	7.90	18.30	45.00	11.33	59.00	7.56	16.20	59.00	7.56	16.30	53.00	8.55			

(1976)

APPENDIX XXIV. Mean Temperature, Relative Humidity and Saturation Deficit Coefficient.

Week	Secunderabad				Bengaluru				Belgaon (Dhamar)				Pimpri				Devlali (Naphad)			
	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)		
1	19.50	66.00	7.68	18.90	66.00	6.93	19.80	50.50	11.70	18.90	63.50	7.79	24.55	58.50	13.31	24.55	58.50	13.31		
2	18.25	65.50	7.21	18.00	68.00	6.60	19.50	56.00	9.68	18.30	62.00	7.96	18.05	58.50	8.65	18.05	58.50	8.65		
3	19.60	65.50	7.83	13.80	67.50	5.66	20.40	52.00	11.23	18.98	62.50	8.12	17.05	59.00	7.95	17.05	59.00	7.95		
4	19.10	68.00	7.09	18.40	67.50	7.31	20.50	44.50	13.10	18.80	56.00	9.47	18.15	49.00	10.50	18.15	49.00	10.50		
5	21.20	72.00	6.84	20.40	70.00	7.12	22.25	48.50	13.72	20.30	59.00	9.74	17.45	60.00	7.76	17.45	60.00	7.76		
6	20.30	67.00	7.84	20.00	58.50	9.72	21.40	44.50	13.94	18.80	50.00	10.76	17.70	49.50	10.50	17.70	49.50	10.50		
7	21.90	60.00	10.39	19.70	56.50	9.93	22.90	45.50	15.45	18.85	50.50	13.37	18.05	46.50	11.88	18.05	46.50	11.88		
8	23.70	45.50	15.78	21.30	57.00	13.39	24.60	43.00	18.06	23.00	48.00	14.62	19.60	42.00	13.57	19.60	42.00	13.57		
9	24.10	43.50	16.91	22.50	50.50	13.37	25.65	32.00	22.84	20.90	40.50	14.55	18.95	39.50	13.45	18.95	39.50	13.45		
10	26.50	49.00	17.47	24.30	49.50	15.24	26.80	47.50	18.92	24.70	35.00	18.71	19.85	37.00	14.70	19.85	37.00	14.70		
11	27.50	40.50	21.26	24.00	43.00	17.00	27.30	40.50	21.42	24.70	35.00	19.93	21.60	38.00	16.36	21.60	38.00	16.36		
12	29.30	36.50	25.73	24.70	50.00	15.33	27.85	52.50	18.14	27.30	44.00	20.22	21.55	34.00	16.43	21.55	34.00	16.43		
13	29.00	40.00	24.06	25.90	53.50	15.28	27.40	52.50	17.13	26.90	38.00	21.56	24.95	40.00	19.02	24.95	40.00	19.02		
14	28.50	47.50	20.25	24.20	63.50	10.97	27.40	52.50	18.14	29.60	41.00	24.15	26.90	45.00	19.63	26.90	45.00	19.63		
15	31.10	44.50	25.20	26.20	61.00	13.21	28.40	55.00	17.01	24.30	37.50	18.86	26.90	43.00	23.91	26.90	43.00	23.91		
16	31.40	40.50	27.06	23.80	59.00	11.92	28.55	56.00	15.70	28.10	39.50	22.95	26.20	40.00	20.16	26.20	40.00	20.16		
17	29.50	43.50	23.05	24.90	56.50	13.61	27.10	52.00	17.13	28.10	40.10	21.78	25.15	46.50	17.11	25.15	46.50	17.11		
18	30.95	23.50	33.47	26.10	48.00	17.54	27.15	52.00	18.14	28.60	48.50	19.89	25.85	45.00	18.48	25.85	45.00	18.48		
19	31.50	37.00	28.75	26.90	55.50	15.47	28.40	60.50	15.12	29.50	44.00	22.85	27.00	45.50	19.63	27.00	45.50	19.63		
20	32.30	34.50	31.47	26.50	61.00	20.88	28.15	60.50	15.12	24.50	48.00	15.82	25.75	52.00	17.13	25.75	52.00	17.13		
21	32.60	37.00	30.55	27.10	58.00	15.05	28.55	60.00	9.07	28.70	60.00	15.50	26.90	48.00	17.13	26.90	48.00	17.13		
22	30.75	48.00	22.60	26.30	61.00	13.26	25.85	73.00	9.07	28.70	79.00	6.11	25.45	88.50	3.80	25.45	88.50	3.80		
23	28.10	60.50	14.99	25.30	62.00	12.20	23.90	84.00	7.60	26.30	63.00	12.58	26.05	65.50	11.76	26.05	65.50	11.76		
24	29.20	55.00	18.17	25.90	60.50	12.98	25.25	76.50	10.41	22.60	63.00	10.04	25.10	62.00	12.04	25.10	62.00	12.04		
25	29.10	58.00	16.90	25.70	62.00	12.39	26.70	79.00	6.65	26.10	78.50	7.25	26.05	3.50	9.07	26.05	3.50	9.07		
26	27.70	67.00	12.64	25.10	66.50	10.66	24.70	81.50	6.02	26.50	76.65	8.00	25.40	70.50	9.51	25.40	70.50	9.51		
27	26.80	75.00	8.66	24.80	78.00	6.78	25.10	84.50	4.76	26.50	87.50	3.84	25.10	84.50	9.07	25.10	84.50	9.07		
28	26.45	74.50	9.72	24.40	69.00	9.39	23.95	93.50	4.76	24.70	85.50	4.24	24.40	85.00	4.47	24.40	85.00	4.47		
29	24.70	82.00	5.52	24.20	71.00	8.72	22.65	93.50	1.96	23.90	85.50	7.12	25.00	78.500	6.97	25.00	78.500	6.97		
30	26.35	76.50	8.01	24.80	68.00	9.86	23.50	84.00	4.49	25.50	78.00	2.96	25.25	92.00	2.53	25.25	92.00	2.53		
31	25.25	79.50	6.57	24.10	78.00	6.59	23.05	91.50	2.52	23.00	89.50	2.96	25.30	81.50	6.02	25.30	81.50	6.02		
32	26.45	71.00	9.92	24.30	73.50	8.00	23.80	84.50	4.76	24.30	79.50	6.30	26.55	83.00	5.71	26.55	83.00	5.71		
33	26.75	70.00	10.37	24.30	77.50	6.79	24.15	84.50	4.76	24.30	80.50	5.99	26.85	78.00	7.85	26.85	78.00	7.85		
34	25.30	82.50	5.62	23.60	84.00	4.62	24.65	78.50	6.97	24.80	77.00	7.09	27.05	80.00	7.14	27.05	80.00	7.14		
35	25.10	82.50	5.57	23.30	76.00	6.84	23.60	84.50	4.76	24.70	80.50	5.82	27.05	80.50	7.56	27.05	80.50	7.56		
36	25.10	73.00	8.60	24.20	76.00	7.21	23.70	78.00	6.55	24.00	80.50	5.06	27.35	80.50	8.21	27.35	80.50	8.21		
37	27.45	68.50	11.44	24.10	72.50	8.23	24.50	77.00	6.85	24.50	80.50	7.61	27.35	77.50	8.21	27.35	77.50	8.21		
38	26.60	67.50	11.18	24.10	67.50	9.73	24.35	68.00	9.53	24.40	75.00	8.33	28.05	77.50	8.69	28.05	77.50	8.69		
39	26.40	59.50	13.82	24.30	86.00	4.23	25.30	71.50	9.19	26.60	69.00	10.66	27.95	77.50	11.13	27.95	77.50	11.13		
40	27.00	61.00	13.93	25.00	66.00	10.78	26.10	63.00	12.43	21.50	65.00	8.93	26.60	53.00	16.77	26.60	53.00	16.77		
41	28.00	54.50	17.83	24.30	61.00	11.77	26.25	48.00	17.47	21.00	54.00	16.43	27.65	47.50	20.03	27.65	47.50	20.03		
42	25.20	59.00	13.05	22.10	81.00	5.04	25.70	49.50	17.13	24.80	53.00	14.48	27.10	40.00	21.42	27.10	40.00	21.42		
43	26.35	57.00	14.65	24.60	63.50	11.15	25.05	65.50	11.09	25.50	56.50	14.07	26.90	55.00	16.06	26.90	55.00	16.06		
44	23.20	59.00	11.62	22.20	68.50	8.30	24.20	47.00	15.79	23.20	55.00	12.76	24.30	45.50	16.39	24.30	45.50	16.39		
45	25.50	74.50	8.22	23.00	79.00	5.91	25.35	64.50	11.41	25.90	68.00	10.84	26.90	68.00	11.42	26.90	68.00	11.42		
46	23.95	76.00	7.63	22.20	76.50	6.27	24.25	60.50	11.92	24.90	58.50	12.10	27.05	58.50	14.99	27.05	58.50	14.99		
47	23.00	79.50	5.77	22.20	84.50	4.13	23.75	77.00	6.85	24.40	74.50	7.73	28.35	75.50	9.45	28.35	75.50	9.45		
48	23.25	69.50	8.66	21.30	78.00	5.56	24.00	61.50	11.62	23.60	66.00	9.81	25.95	63.00	13.77	25.95	63.00	13.77		
49	22.60	69.00	8.41	21.50	76.00	6.12	23.20	62.00	10.67	23.30	65.00	9.97	20.95	63.00	9.21	20.95	63.00	9.21		
50	20.90	68.50	7.71	20.00	72.00	6.56	20.95	54.50	11.45	20.70	64.50	8.60	22.20	60.50	10.56	22.20	60.50	10.56		
51	18.95	63.00	8.03	21.30	75.50	6.19	21.10	56.00	10.95	20.30	60.50	8.16	22.15	58.50	11.08	22.15	58.50	11.08		
52	20.90	56.00	10.76	21.50	7.84	23.40	21.90	50.00	13.20	20.30	58.00	8.68	20.15	58.00	9.82	20.15	58.00	9.82		

APPENDIX XXV. Mean Temperature Relative Humidity and Saturation Deficit Coefficient.

Week	Secunderabad				Bangalore				Belgaum (Dharwad)				Pimpri				Devalli (Niphad)			
	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)		
1	19.30	58.50	9.28	19.30	55.50	9.95	20.65	42.00	14.44	19.30	55.50	9.95	19.00	59.50	9.02	19.00	59.50	9.02		
2	20.30	57.00	10.22	20.00	57.50	9.95	21.70	45.00	14.52	20.00	57.50	9.95	19.30	57.50	9.46	19.30	57.50	9.46		
3	21.75	58.50	10.70	20.30	65.50	8.20	22.00	56.50	11.61	20.30	65.50	8.20	19.40	61.50	8.58	19.40	61.50	8.58		
4	21.60	59.00	10.51	21.10	67.00	8.26	23.05	53.50	13.20	21.10	67.00	8.26	18.70	61.00	8.58	18.70	61.00	8.58		
5	20.30	59.50	9.62	21.40	63.00	9.39	22.60	42.50	16.29	21.40	63.00	9.39	17.20	45.00	10.67	17.20	45.00	10.67		
6	22.65	57.50	11.56	23.40	65.50	9.87	24.00	39.50	18.17	23.40	65.50	9.87	16.80	53.00	9.11	16.80	53.00	9.11		
7	23.70	51.00	10.29	20.50	58.00	13.82	24.00	49.00	15.19	20.50	58.00	13.82	20.50	45.00	12.87	20.50	45.00	12.87		
8	25.90	58.00	13.80	23.10	63.50	10.30	26.15	51.00	16.46	23.10	63.50	10.30	21.30	48.50	12.94	21.30	48.50	12.94		
9	25.70	50.00	16.29	22.50	54.00	12.62	26.45	46.00	18.14	22.50	54.00	12.62	19.30	47.00	11.66	19.30	47.00	11.66		
10	26.48	47.50	17.95	23.10	53.00	13.26	27.45	41.50	21.06	23.10	53.00	13.26	20.40	45.00	12.87	20.40	45.00	12.87		
11	27.25	42.00	20.90	24.70	51.50	14.88	28.00	55.00	17.01	24.70	51.50	14.88	21.50	36.00	14.43	21.50	36.00	14.43		
12	29.50	46.50	21.82	24.30	52.00	14.74	28.50	55.50	17.01	24.30	52.00	14.74	22.60	32.50	17.40	22.60	32.50	17.40		
13	28.75	47.00	20.57	25.20	65.00	11.19	38.65	49.00	20.45	25.20	65.00	11.19	23.90	37.00	18.77	23.90	37.00	18.77		
14	29.25	50.00	20.22	26.20	63.50	12.36	28.65	54.50	18.44	26.20	63.50	12.36	27.20	41.50	20.88	27.20	41.50	20.88		
15	30.70	46.00	23.43	25.90	71.00	9.53	28.30	39.00	23.05	25.90	71.00	9.53	26.40	46.50	18.14	26.40	46.50	18.14		
16	29.95	47.00	21.95	21.70	56.50	11.20	28.60	47.50	23.05	21.70	56.50	11.20	27.40	38.00	22.13	27.40	38.00	22.13		
17	29.50	48.50	21.01	25.50	65.50	11.16	26.45	66.00	11.42	25.50	65.50	11.16	27.90	39.00	23.05	27.90	39.00	23.05		
18	25.45	55.50	15.66	25.90	70.50	9.69	28.55	52.00	18.14	25.90	70.50	9.69	27.70	48.00	19.65	27.70	48.00	19.65		
19	25.20	51.00	15.66	26.10	72.50	10.28	28.60	62.50	15.23	26.10	72.50	10.28	26.10	51.50	17.49	26.10	51.50	17.49		
20	32.70	41.00	28.70	26.20	70.50	9.95	27.55	62.00	13.56	26.20	70.50	9.95	25.90	49.00	17.13	25.90	49.00	17.13		
21	31.10	49.50	22.75	26.20	71.00	9.82	27.35	62.50	10.08	25.20	71.00	9.82	25.20	52.50	15.21	25.20	52.50	15.21		
22	31.70	46.00	24.80	25.20	71.00	8.91	26.45	70.00	10.35	24.70	74.50	8.91	25.50	55.00	15.12	25.50	55.00	15.12		
23	30.80	52.00	20.90	24.70	74.50	5.59	26.65	71.50	10.35	24.70	74.50	5.59	26.40	82.50	5.70	26.40	82.50	5.70		
24	28.85	62.50	14.61	24.50	79.00	6.39	25.95	74.50	8.73	24.50	79.00	6.39	25.50	79.00	6.65	25.50	79.00	6.65		
25	28.10	68.50	13.53	23.60	88.00	5.77	24.05	87.00	3.87	23.60	88.00	5.77	25.20	80.00	10.04	25.20	80.00	10.04		
26	28.00	65.00	13.23	24.90	75.00	7.73	24.40	85.50	4.47	24.90	75.00	7.73	24.70	80.00	6.04	24.70	80.00	6.04		
27	26.40	78.00	7.51	24.10	74.00	7.78	23.70	86.00	4.17	24.10	74.00	7.78	25.60	82.00	6.02	24.60	81.00	6.02		
28	28.10	65.00	13.28	24.50	78.00	6.70	24.20	83.50	5.06	24.50	78.00	6.70	25.00	83.50	5.38	25.00	83.50	5.38		
29	27.45	76.50	8.70	23.50	85.00	4.32	23.80	87.50	3.87	23.50	85.00	4.32	25.00	85.50	2.85	24.80	85.50	2.85		
30	25.65	87.00	4.23	23.30	82.50	4.99	23.15	90.50	2.81	23.30	82.50	4.99	25.20	80.50	6.34	25.20	80.50	6.34		
31	26.50	71.00	9.93	24.00	76.00	7.16	23.70	80.00	5.96	24.00	76.00	7.16	25.20	80.50	6.34	25.20	80.50	6.34		
32	26.25	77.00	7.87	24.20	76.00	7.21	23.65	85.00	4.47	24.20	76.00	7.21	25.60	81.00	6.38	25.60	81.00	6.38		
33	26.45	76.50	8.01	24.50	76.50	7.15	24.60	78.50	6.97	24.50	76.50	7.15	26.30	78.50	7.39	26.30	78.50	7.39		
34	24.40	85.00	4.55	24.00	75.00	7.45	24.40	76.50	7.15	24.00	75.00	7.45	27.50	83.00	6.06	27.50	83.00	6.06		
35	24.80	80.00	6.16	23.60	77.50	6.44	23.45	88.00	3.37	23.60	77.50	6.44	27.70	86.50	5.29	27.70	86.50	5.29		
36	25.90	72.00	9.20	23.60	77.50	6.44	23.45	88.00	5.05	23.60	77.50	6.44	28.50	84.00	6.04	28.50	84.00	6.04		
37	26.30	64.50	12.78	24.50	69.50	9.28	23.84	74.00	7.74	24.50	69.50	9.28	28.20	76.00	9.07	28.20	76.00	9.07		
38	27.40	60.00	14.49	24.40	79.50	6.29	24.95	61.50	12.36	24.40	79.50	6.29	28.00	71.50	10.96	28.00	71.50	10.96		
39	27.70	69.00	11.36	24.70	77.00	7.06	25.55	74.50	8.73	24.70	77.00	7.06	29.70	55.50	15.12	29.70	55.50	15.12		
40	26.00	81.50	6.22	24.30	78.50	6.61	38.50	84.00	10.60	24.30	78.50	6.61	29.20	62.50	15.23	29.20	62.50	15.23		
41	25.45	67.00	11.45	23.60	78.00	6.65	38.50	84.00	10.14	23.60	78.00	6.65	26.60	45.50	18.48	26.60	45.50	18.48		
42	25.95	71.00	9.55	23.60	88.50	3.30	24.65	68.50	12.36	23.60	88.50	3.30	25.60	37.00	22.49	25.60	37.00	22.49		
43	28.25	65.00	15.45	21.90	89.00	2.86	23.50	56.50	15.19	21.90	89.00	2.86	25.90	42.00	19.48	25.90	42.00	19.48		
44	25.20	68.00	10.23	23.00	75.00	7.03	24.80	60.00	12.68	23.00	75.00	7.03	27.80	48.00	19.65	27.80	48.00	19.65		
45	23.95	75.00	8.01	22.40	78.00	5.92	24.10	49.00	15.19	22.40	78.00	5.92	27.50	57.00	15.35	27.50	57.00	15.35		
46	25.25	75.00	6.53	21.50	84.50	3.96	23.85	70.00	8.94	21.50	84.50	3.96	27.40	63.50	13.20	27.40	63.50	13.20		
47	24.45	78.50	6.53	22.50	80.50	5.87	23.60	72.50	8.34	22.50	80.50	5.87	27.60	83.00	6.42	27.60	83.00	6.42		
48	28.20	68.50	8.82	22.30	82.50	7.45	23.55	75.00	7.45	22.30	82.50	7.45	26.30	65.50	11.09	26.30	65.50	11.09		
49	21.25	64.50	8.95	21.30	70.00	7.58	21.65	55.00	11.68	21.30	70.00	7.58	25.40	54.50	15.45	25.40	54.50	15.45		
50	18.35	60.00	8.40	19.40	67.00	6.52	19.50	49.50	12.45	19.40	67.00	6.52	20.00	59.00	9.59	20.00	59.00	9.59		
51	19.30	65.00	9.11	19.90	67.00	7.33	21.53	50.00	12.45	19.90	67.00	7.33	17.80	58.00	8.65	17.80	58.00	8.65		
52	19.30	65.00	9.11	20.46	63.50	8.51	21.32	51.50	12.20	20.46	63.50	8.51	17.80	58.00	8.65	17.80	58.00	8.65		

APPENDIX: XXVI: Mean Temperature, Relative Humidity and Saturation Deficit Coefficient.

(1978)

Week	Secunderabad				Bangalore				Belgaum (Dharwad)				Pimpri				Devleli (Niphed)			
	Mean Temp. (°C)	RH (%)	SDC (%)		Mean Temp. (°C)	RH (%)	SDC (%)		Mean Temp. (°C)	RH (%)	SDC (%)		Mean Temp. (°C)	RH (%)	SDC (%)		Mean Temp. (°C)	RH (%)	SDC (%)	
1	22.45	66.50	9.03		21.60	68.50	8.07		21.80	54.50	12.14		19.30	65.50	7.71		17.50	59.50	7.95	
2	20.40	72.50	6.57		21.00	66.00	8.47		21.60	59.00	10.82		19.48	66.50	7.53		18.30	65.00	7.21	
3	20.90	59.50	9.91		19.90	63.50	8.41		21.60	46.00	14.25		20.30	60.50	9.39		19.20	56.00	9.68	
4	22.30	61.00	10.44		22.10	64.00	9.55		22.80	52.50	13.48		20.80	64.00	8.74		18.50	59.00	9.84	
5	23.30	58.50	11.82		21.90	66.50	8.70		23.55	52.50	14.30		21.30	62.00	9.40		19.20	55.50	9.90	
6	23.00	69.00	8.72		23.40	69.00	9.72		23.15	51.50	13.76		20.70	62.00	9.20		14.20	58.00	6.76	
7	24.30	57.00	12.98		23.60	67.00	9.52		31.85	45.00	26.18		21.40	56.50	9.70		19.30	57.00	9.46	
8	25.30	72.50	8.30		23.80	68.50	9.17		24.05	46.00	16.09		22.00	56.00	11.62		19.90	53.00	10.99	
9	26.60	54.00	14.76		22.20	56.50	11.59		25.55	40.50	20.16		25.30	56.00	14.12		20.90	50.00	12.45	
10	26.60	46.00	18.56		24.60	59.50	12.37		35.05	48.50	29.22		24.78	52.50	14.57		20.50	43.50	13.33	
11	26.50	53.50	15.93		26.10	62.80	14.34		34.60	44.00	31.47		23.50	56.00	12.64		21.40	39.50	15.18	
12	28.50	48.50	19.82		26.70	65.00	12.80		35.35	38.00	34.84		23.40	39.00	17.44		20.70	34.00	16.43	
13	27.60	49.50	18.43		27.30	58.50	14.98		27.35	35.50	23.20		20.70	30.80	16.76		22.70	41.50	16.57	
14	30.50	48.50	22.20		27.50	50.50	18.00		28.70	56.00	17.64		28.60	35.50	24.91		23.10	28.50	20.23	
15	31.50	46.50	24.41		27.90	61.00	14.30		28.45	59.50	15.49		25.50	35.50	20.86		26.80	29.50	25.34	
16	31.80	36.50	29.25		28.30	64.50	13.57		28.70	49.50	20.45		27.70	36.50	23.26		25.40	40.50	19.02	
17	29.90	50.50	20.47		26.20	66.50	11.34		28.60	49.00	20.45		28.70	54.00	17.63		27.10	48.50	18.56	
18	31.60	44.00	25.63		27.20	57.20	15.29		29.10	53.00	18.84		29.80	45.00	22.66		27.30	34.50	23.56	
19	32.00	54.50	21.70		27.70	64.50	13.01		29.75	55.50	19.08		30.10	43.50	24.00		25.85	35.50	21.84	
20	33.15	44.00	28.30		26.30	69.00	10.54		26.90	65.50	12.49		29.10	59.50	16.30		27.60	51.50	18.52	
21	31.25	54.50	20.07		26.60	72.00	9.63		27.95	70.00	11.34		30.40	56.00	18.91		27.70	50.00	18.50	
22	30.60	55.50	19.25		25.20	73.00	8.63		24.85	82.50	5.70		28.40	64.50	13.62		25.50	55.50	14.26	
23	30.30	56.50	18.63		25.20	70.50	9.43		24.60	80.00	6.34		27.80	70.50	10.87		24.70	64.50	9.02	
24	27.90	73.50	9.78		24.00	75.50	7.31		23.95	84.50	4.76		25.88	80.00	6.55		24.80	78.00	6.97	
25	25.35	82.50	5.63		24.00	78.00	6.56		23.35	91.00	2.52		24.50	85.50	4.42		24.90	85.00	3.48	
26	27.83	65.00	12.87		23.80	82.00	5.24		24.10	79.50	6.25		25.50	70.50	5.40		25.30	71.50	9.19	
27	25.20	78.00	7.03		23.70	80.50	5.65		23.65	80.00	5.62		25.50	75.50	8.09		24.20	82.00	5.36	
28	25.80	81.50	6.06		23.30	83.00	4.84		23.65	84.00	4.76		24.90	80.00	6.19		24.00	77.50	7.29	
29	26.30	77.50	7.65		23.30	85.00	4.27		24.40	80.50	5.96		25.50	78.00	7.12		25.40	77.00	7.29	
30	26.60	76.50	8.08		23.90	79.00	5.49		23.80	88.50	3.57		25.10	83.50	5.29		25.30	80.50	6.34	
31	26.40	76.50	8.03		23.70	78.00	6.37		23.50	84.50	4.49		24.40	87.50	3.79		25.20	78.50	6.97	
32	25.70	76.00	7.82		23.70	79.50	5.93		23.65	84.00	4.76		24.20	84.00	4.81		25.70	75.50	8.40	
33	23.90	86.50	3.95		22.80	82.00	4.95		22.60	82.50	5.05		23.80	83.50	4.80		25.60	81.50	6.38	
34	25.20	81.50	5.92		22.80	85.00	4.11		23.00	89.00	3.09		25.10	79.50	6.53		25.50	76.50	7.60	
35	25.25	75.50	7.85		23.20	79.50	5.81		23.00	85.50	4.21		23.80	83.50	4.80		26.90	86.00	4.99	
36	25.65	72.50	8.95		24.20	82.00	7.97		22.95	78.00	6.18		23.80	79.50	5.96		26.40	75.50	8.23	
37	26.00	83.50	5.55		23.30	80.50	5.55		23.85	76.00	7.15		25.20	72.50	8.23		25.50	71.50	9.19	
38	26.45	81.00	6.50		23.60	80.00	5.77		24.15	82.50	5.36		25.90	77.50	7.39		26.55	79.00	7.05	
39	26.30	80.00	6.80		23.60	84.50	4.40		23.55	84.00	4.49		25.00	75.00	7.99		27.80	76.00	9.07	
40	26.45	75.00	8.55		22.60	78.50	5.84		23.45	74.50	7.30		25.00	70.50	9.07		28.70	77.50	9.22	
41	26.65	68.00	11.72		21.70	75.00	7.67		25.60	72.50	9.40		26.70	69.00	10.70		28.90	58.00	16.84	
42	25.40	70.50	9.50		23.70	76.00	6.95		24.50	73.00	8.04		26.70	62.00	11.69		26.00	53.00	15.79	
43	23.75	69.00	9.00		23.80	79.50	5.96		24.15	74.00	7.74		28.70	62.50	14.53		25.90	51.50	16.46	
44	25.15	79.50	6.54		23.40	83.50	4.72		24.00	79.50	6.25		24.75	59.50	12.45		27.43	47.00	18.92	
45	25.10	75.00	7.96		22.70	80.50	5.32		23.70	82.50	5.36		25.20	71.00	9.31		29.70	67.50	13.99	
46	24.90	68.00	9.90		22.50	72.50	7.60		24.20	69.50	9.23		25.20	73.00	8.63		27.30	61.50	13.92	
47	21.80	61.00	10.08		21.90	69.50	7.46		22.05	54.00	12.14		27.70	60.00	14.65		24.20	50.00	14.90	
48	23.55	72.00	8.06		21.50	74.50	6.50		22.85	65.50	9.83		22.60	79.00	5.70		26.30	78.00	7.39	
49	23.50	69.50	8.76		21.00	81.50	4.01		21.50	61.50	9.71		21.10	70.00	7.51		24.90	73.50	8.55	
50	20.30	67.50	7.72		20.60	78.00	5.31		21.25	65.00	8.71		29.40	64.00	14.64		19.90	56.50	10.29	
51	20.20	61.50	9.10		20.50	73.50	6.36		20.60	57.50	10.70		20.70	60.00	8.49		20.30	54.50	10.76	
52	21.90	60.00	10.39		21.00	85.50	3.62		21.65	71.00	6.15		20.90	61.50	9.42		19.50	57.50	9.46	

APPENDIX XXVII: Mean Temperature, Relative Humidity and Saturation Deficit Coefficient.

(1979)

Week	Secunderabad				Bangalore				Belgaum(Dharyar)				Pimpri				Devlali (Niphad)			
	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	SDC (%)
1	22.60	65.50	9.36	20.70	65.50	9.52	22.05	64.00	16.89	21.40	64.50	9.01	21.40	66.00	9.01	21.40	66.00	9.01	21.40	8.46
2	20.31	69.50	7.25	20.60	69.00	7.48	21.50	55.50	11.20	21.50	62.00	9.69	19.60	61.50	9.69	19.60	61.50	9.69	19.60	9.00
3	20.61	72.50	6.64	22.10	70.50	7.96	23.05	58.50	11.80	21.60	65.50	8.84	20.40	65.50	8.84	20.40	65.50	8.84	20.40	8.19
4	23.50	66.50	9.62	21.80	78.50	5.56	23.65	59.50	12.21	23.50	62.00	10.91	22.80	65.50	10.91	22.80	65.50	10.91	22.80	9.83
5	24.50	62.50	11.41	23.60	68.00	9.23	22.90	57.50	12.08	19.20	57.00	9.56	17.30	61.00	9.56	17.30	61.00	9.56	17.30	7.56
6	24.80	63.50	9.70	23.90	71.50	8.32	24.00	55.00	13.41	21.50	55.00	11.48	16.10	60.50	11.48	16.10	60.50	11.48	16.10	7.28
7	24.60	64.00	11.00	23.40	74.50	7.29	23.30	53.50	13.20	21.00	56.50	10.84	18.50	62.00	10.84	18.50	62.00	10.84	18.50	7.82
8	25.70	67.50	10.59	23.40	81.50	5.43	23.75	53.50	14.00	21.70	59.00	10.55	18.90	53.00	10.55	18.90	53.00	10.55	18.90	10.34
9	24.15	61.00	11.71	23.00	71.00	8.15	24.45	50.00	14.90	23.60	54.00	13.27	21.60	57.00	13.27	21.60	57.00	13.27	21.60	11.35
10	25.30	33.50	19.41	24.90	61.50	11.90	26.30	44.00	18.81	23.50	44.00	16.08	21.20	44.50	16.08	21.20	44.50	16.08	21.20	13.94
11	25.75	49.00	16.66	24.80	47.50	16.17	27.30	40.00	21.42	25.10	40.50	18.94	21.40	35.50	18.94	21.40	35.50	18.94	21.40	16.18
12	28.80	57.50	19.25	21.30	58.50	10.48	28.20	46.00	20.41	25.30	38.08	19.89	21.60	29.50	19.89	21.60	29.50	19.89	21.60	18.74
13	29.81	41.50	24.12	27.30	53.00	16.97	28.35	48.50	19.65	25.80	37.00	20.61	21.40	36.50	20.61	21.40	36.50	20.61	21.40	15.93
14	30.50	33.00	28.88	27.00	57.50	15.18	29.25	43.50	22.85	27.10	40.50	21.32	22.10	34.50	21.32	22.10	34.50	21.32	22.10	17.29
15	30.50	45.50	23.49	27.80	61.50	14.15	29.65	55.00	10.53	28.90	37.00	24.58	24.70	34.50	24.58	24.70	34.50	24.58	24.70	20.92
16	30.75	45.50	23.77	27.20	64.50	12.77	28.35	58.00	15.87	28.20	36.50	26.37	25.80	32.50	26.37	25.80	32.50	26.37	25.80	21.55
17	31.65	41.50	26.82	23.60	55.00	12.78	28.95	61.50	15.63	31.10	38.00	26.37	25.80	32.50	26.37	25.80	32.50	26.37	25.80	22.84
18	33.20	50.50	35.17	28.00	69.50	11.53	29.80	51.50	20.77	29.20	39.50	28.98	24.40	31.50	28.98	24.40	31.50	28.98	24.40	21.87
19	31.15	49.50	22.79	27.30	63.00	13.36	29.75	60.50	16.96	32.20	39.50	28.98	27.30	50.50	28.98	27.30	50.50	28.98	27.30	17.85
20	27.50	56.50	15.82	26.80	53.50	16.11	26.05	55.00	15.12	28.10	48.50	19.54	23.80	51.00	19.54	23.80	51.00	19.54	23.80	14.60
21	31.70	37.50	28.70	27.20	59.50	14.57	27.05	53.00	16.77	28.40	52.50	18.22	25.40	45.50	18.22	25.40	45.50	18.22	25.40	17.43
22	31.60	44.00	25.63	26.90	65.00	13.21	28.30	61.50	14.74	33.40	53.00	23.93	25.00	43.50	23.93	25.00	43.50	23.93	25.00	18.06
23	33.90	40.00	31.01	26.60	70.00	10.32	27.90	64.50	13.60	30.30	54.00	19.70	25.90	50.00	19.70	25.90	50.00	19.70	25.90	16.80
24	32.80	45.50	26.60	25.40	78.50	6.93	26.30	75.50	8.40	29.20	57.50	17.16	25.70	66.00	17.16	25.70	66.00	17.16	25.70	11.42
25	33.12	70.00	15.15	24.20	81.50	5.56	23.60	87.50	3.87	27.50	70.00	10.91	26.10	77.50	10.91	26.10	77.50	10.91	26.10	7.72
26	26.60	69.50	10.49	24.20	74.00	7.37	23.20	89.00	3.09	25.50	80.50	6.31	25.60	67.00	6.31	25.60	67.00	6.31	25.60	11.08
27	28.30	66.00	6.99	24.50	73.00	8.22	24.25	82.00	5.36	26.30	71.00	9.80	25.30	73.50	9.80	25.30	73.50	9.80	25.30	8.40
28	27.80	67.00	12.13	25.00	72.00	8.95	23.20	86.50	3.93	25.10	77.50	7.16	25.00	72.56	7.16	25.00	72.56	7.16	25.00	8.87
29	28.80	61.00	15.17	25.20	72.00	8.95	23.50	82.50	5.05	25.50	75.50	7.93	25.00	74.56	7.93	25.00	74.56	7.93	25.00	8.24
30	27.75	72.00	10.28	23.10	81.50	5.85	24.45	82.00	5.36	25.10	81.00	6.05	25.70	76.50	6.05	25.70	76.50	6.05	25.70	8.06
31	25.10	81.00	6.05	22.90	86.00	3.85	22.50	91.00	2.37	24.30	85.00	4.53	23.80	87.00	4.53	23.80	87.00	4.53	23.80	3.87
32	26.20	70.00	10.16	23.20	74.00	7.37	22.10	91.50	2.37	23.40	87.50	3.58	25.20	91.50	3.58	25.20	91.50	3.58	25.20	2.85
33	26.90	70.00	11.07	24.00	73.00	8.05	22.70	86.00	3.93	23.40	80.50	5.58	24.60	78.50	5.58	24.60	78.50	5.58	24.60	6.97
34	27.40	62.00	13.77	24.30	71.50	8.60	23.60	75.00	7.45	24.30	71.50	8.60	24.70	71.00	8.60	24.70	71.00	8.60	24.70	9.19
35	27.50	78.50	7.82	23.70	80.50	5.65	24.15	79.50	6.25	25.30	75.00	6.02	25.50	74.50	6.02	25.50	74.50	6.02	25.50	8.24
36	27.45	71.00	10.53	24.40	79.50	5.08	23.75	78.00	6.55	24.60	73.50	8.10	25.10	77.50	8.10	25.10	77.50	8.10	25.10	8.24
37	27.15	77.50	8.08	24.40	79.50	6.21	24.70	81.50	6.02	25.50	87.50	4.05	28.10	77.50	4.05	28.10	77.50	4.05	28.10	8.69
38	27.95	79.50	7.58	23.30	85.50	4.13	24.35	84.50	4.76	25.70	86.50	4.40	28.20	79.00	4.40	28.20	79.00	4.40	28.20	7.93
39	24.90	83.50	5.11	23.20	83.50	4.66	23.20	87.50	3.65	25.00	81.50	4.87	28.40	80.00	4.87	28.40	80.00	4.87	28.40	7.56
40	26.30	73.00	9.18	23.90	81.50	5.41	24.10	79.50	6.25	26.67	69.00	10.66	28.20	75.50	10.66	28.20	75.50	10.66	28.20	9.45
41	26.45	53.00	12.65	24.20	72.00	8.42	25.60	71.00	9.74	21.70	73.00	6.95	30.00	71.50	6.95	30.00	71.50	6.95	30.00	12.29
42	26.50	60.50	13.53	23.40	67.00	9.64	25.55	62.00	12.76	26.20	66.00	11.51	29.00	62.50	11.51	29.00	62.50	11.51	29.00	15.23
43	24.60	66.00	10.39	23.40	82.50	5.11	24.55	67.50	10.46	25.40	63.50	11.76	28.90	63.50	11.76	28.90	63.50	11.76	28.90	14.83
44	25.40	67.00	10.63	23.30	75.50	6.95	23.95	68.50	9.53	24.90	59.00	14.30	27.50	57.00	14.30	27.50	57.00	14.30	27.50	15.35
45	25.35	69.50	9.81	23.30	78.50	6.12	24.20	70.00	8.94	24.60	67.50	10.05	28.70	60.50	10.05	28.70	60.50	10.05	28.70	16.04
46	23.95	77.00	6.73	22.50	87.50	3.38	24.35	79.50	6.25	24.30	73.50	7.40	27.05	73.50	7.40	27.05	73.50	7.40	27.05	9.63
47	24.45	69.50	9.26	22.20	86.50	5.75	23.80	77.50	6.65	24.70	75.50	8.13	27.50	74.50	8.13	27.50	74.50	8.13	27.50	9.82
48	23.50	78.50	6.18	21.80	77.50	5.82	23.60	78.00	6.55	23.30	75.50	6.98	27.20	77.50	6.98	27.20	77.50	6.98	27.20	10.31
49	21.90	65.50	8.96	22.40	77.50	6.05	22.45	64.50	9.50	29.90	69.00	12.82	26.60	65.00	12.82	26.60	65.00	12.82	26.60	12.49
50	21.15	64.50	8.90	21.80	78.00	5.69	24.05	66.00	6.73	20.70	65.50	8.36	24.40	65.50	8.36	24.40	65.50	8.36	24.40	11.32
51	22.80	70.00	8.21	21.80	74.00	6.72	22.75	63.00	10.39	21.90	66.00	8.83	23.50	65.50	8.83	23.50	65.50	8.83	23.50	9.83
52	20.00	63.00	8.66	20.00	68.00	7.49	20.75	60.50	9.96	20.60	61.50	9.28	19.50	60.50	9.28	19.50	60.50	9.28	19.50	8.88

Appendix XXVIII: Mean Temperature, Relative Humidity and Saturation Deficit Coefficient. (1980)

Week	Secunderabad			Bangalore			Belgaum (Dharwad)			Pimpri			Devalli (Niphad)		
	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)
1	23.00	69.00	8.72	18.40	60.00	8.31	22.50	59.50	10.82	20.80	68.00	7.79	19.80	70.50	7.02
2	21.40	65.00	8.88	19.20	60.50	8.62	22.00	57.00	11.35	21.50	66.00	8.67	20.50	66.00	7.95
3	20.80	57.50	10.35	20.40	59.50	9.67	21.40	56.50	10.95	21.50	66.50	8.54	19.90	62.00	8.89
4	23.35	49.00	14.55	23.00	64.50	9.98	22.85	54.50	12.92	20.20	72.50	6.50	18.50	57.50	8.85
5	19.50	48.00	11.74	19.90	50.00	11.21	22.30	63.00	9.76	19.80	58.50	9.52	17.10	59.00	7.95
6	24.85	57.50	13.12	22.50	65.00	9.19	24.35	50.50	14.90	21.20	56.50	10.94	17.40	56.00	8.53
7	20.30	55.00	10.69	22.40	62.00	18.52	25.40	49.50	16.16	23.20	52.50	13.92	20.30	50.00	11.70
8	26.50	47.00	18.15	22.20	46.50	14.35	26.00	45.50	18.48	24.00	49.50	15.05	19.30	49.50	11.22
9	27.70	15.50	18.81	22.50	50.50	19.23	26.85	36.00	22.84	24.30	45.50	16.45	19.40	45.50	12.10
10	26.80	44.50	20.40	23.75	52.00	13.50	26.00	44.50	18.81	23.60	45.50	15.72	19.60	49.00	11.93
11	26.80	47.50	18.19	23.70	46.00	15.64	26.45	41.00	19.82	25.50	49.50	16.33	22.50	40.00	15.84
12	28.90	33.00	26.05	22.56	45.00	14.80	28.05	35.50	20.45	27.40	49.50	21.40	22.50	37.50	16.63
13	29.91	42.50	23.78	24.00	46.00	15.78	28.45	49.00	20.45	27.40	49.50	18.30	22.50	37.00	18.77
14	28.90	50.00	19.51	24.60	45.50	16.65	28.00	53.00	17.76	28.50	44.00	21.55	24.50	35.50	19.37
15	32.20	49.50	24.19	25.00	48.00	16.14	29.50	59.50	16.44	30.10	34.00	28.08	17.00	34.00	13.80
16	31.70	40.00	27.55	25.50	49.00	16.01	27.95	62.50	14.36	30.90	38.50	26.86	20.20	41.00	12.60
17	33.35	40.50	30.25	26.80	50.50	17.15	28.60	65.50	14.03	30.50	39.50	26.08	27.40	36.00	22.40
18	32.48	42.50	27.31	27.35	53.00	17.92	28.75	67.50	13.23	30.60	50.00	21.62	26.60	37.00	22.49
19	38.50	35.50	43.33	28.00	49.00	19.42	30.10	65.00	14.84	29.20	34.00	26.65	24.70	37.50	19.97
20	33.10	19.00	40.87	28.40	53.50	17.51	29.15	62.00	15.23	31.20	42.50	25.98	25.80	43.50	19.15
21	34.20	30.00	37.46	25.85	50.50	16.98	28.85	54.00	18.44	29.10	48.50	20.72	26.00	46.50	18.14
22	32.20	50.50	23.71	26.50	63.50	12.50	27.85	68.50	12.09	29.70	58.00	17.25	26.00	56.50	14.78
23	28.90	65.00	13.66	26.00	58.50	14.65	24.30	85.50	4.47	26.50	77.00	7.88	25.40	75.50	7.60
24	27.70	77.00	8.43	26.70	60.00	14.14	24.80	80.50	4.44	27.30	74.00	9.39	26.10	73.00	8.40
25	28.00	65.00	13.23	26.20	70.00	10.01	24.25	88.50	3.57	26.00	79.50	6.90	25.90	76.00	8.06
26	27.45	68.00	11.72	24.50	72.00	8.17	23.20	90.50	2.81	25.70	81.50	6.03	24.40	76.58	7.15
27	26.80	71.58	9.87	24.00	70.50	8.80	22.70	92.50	2.24	24.20	86.50	4.06	24.40	86.00	4.17
28	27.45	69.00	11.25	24.50	71.00	8.76	23.40	87.50	3.65	25.30	77.50	7.22	25.60	80.00	6.72
29	27.80	65.00	12.87	24.00	70.00	8.94	23.90	84.00	4.76	25.40	76.50	7.57	25.80	75.50	8.40
30	25.25	82.00	5.77	24.90	66.50	10.36	23.90	84.50	4.76	24.70	84.50	4.76	25.60	83.00	5.71
31	25.15	83.50	5.27	24.30	69.50	9.21	22.65	94.00	1.68	23.80	87.50	4.64	24.60	89.50	3.48
32	25.50	77.50	7.28	22.20	72.00	7.28	22.75	90.50	2.81	24.40	89.50	3.19	25.40	84.50	5.07
33	26.90	78.50	7.48	23.50	75.50	6.84	23.70	88.50	3.57	25.30	78.50	6.90	26.30	81.50	6.38
34	24.90	80.00	6.19	22.10	74.50	6.76	22.95	91.00	2.52	24.30	84.00	4.83	27.40	86.00	4.99
35	26.40	73.50	9.04	23.40	72.00	8.23	23.10	90.00	2.81	24.20	83.00	5.11	27.00	82.50	6.42
36	25.00	78.00	6.98	23.30	71.00	8.26	23.50	83.50	4.77	24.00	77.50	6.71	25.70	80.50	6.72
37	26.40	72.00	7.56	22.90	78.00	5.91	23.75	79.50	6.25	24.50	74.50	7.76	26.20	73.00	9.07
38	26.70	76.50	8.11	24.00	77.00	6.56	24.45	85.50	4.47	25.90	71.50	9.34	28.30	71.50	10.96
39	27.60	66.50	12.23	24.10	77.00	6.60	24.70	83.50	5.38	25.80	77.50	7.36	27.90	72.50	10.58
40	26.10	59.00	13.83	22.60	74.50	6.92	25.10	75.50	7.92	26.30	68.00	10.88	28.90	67.50	13.23
41	21.60	59.00	10.51	23.00	74.00	7.31	25.90	68.50	10.75	26.80	66.00	11.78	27.40	50.00	17.85
42	20.10	65.00	8.23	23.40	70.00	8.45	25.45	61.00	12.36	25.30	55.00	14.44	27.30	43.00	20.34
43	20.00	56.00	10.23	22.40	78.50	5.86	24.75	60.00	12.68	23.40	56.00	12.58	26.30	48.00	17.47
44	22.90	55.00	12.37	20.70	60.00	9.82	23.80	45.00	16.39	26.60	53.00	16.16	28.30	47.50	20.03
45	23.80	55.00	13.09	21.75	70.00	7.40	23.80	49.50	15.19	23.40	60.00	11.44	26.30	48.50	17.47
46	25.70	75.00	8.15	19.90	67.00	7.61	23.35	81.00	5.33	24.60	75.00	7.64	26.70	64.50	14.43
47	22.81	63.50	10.20	19.10	72.00	6.02	24.05	67.50	9.83	24.00	70.50	8.80	25.80	62.00	12.76
48	26.10	56.00	14.84	19.90	67.50	7.81	21.60	55.00	11.88	20.10	61.50	9.10	24.00	64.50	10.72
49	21.30	52.00	12.12	19.70	74.50	5.82	21.90	52.50	12.67	20.20	64.50	8.39	20.40	57.00	10.06
50	19.20	50.00	11.12	20.45	75.00	5.93	22.10	48.00	13.74	19.90	59.50	9.87	20.20	55.00	10.53
51	21.20	66.50	8.42	20.40	71.00	6.80	21.70	60.00	10.56	19.90	65.00	8.07	19.90	58.50	9.82
52	23.50	73.00	7.76	20.40	60.50	9.43	21.00	64.00	8.96	18.60	67.50	7.07	21.10	61.00	9.12

Appendix: XXIX Mean Temperature, Relative Humidity and Saturation deficit coefficient.

Week	Secunderabad			Bangalore			Belgaum (Dharwar)			Pimpri			Devlali (Niphad)		
	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)	Mean Temp. (°C)	RH (%)	SDC (%)
1	20.60	57.50	10.25	18.30	62.50	7.92	21.30	54.00	11.45	20.30	64.50	8.44	19.10	63.50	8.83
2	20.00	67.50	8.10	19.05	61.00	8.32	21.10	54.50	11.45	17.60	68.00	6.43	19.20	60.50	8.80
3	19.30	66.50	7.49	20.05	62.00	8.90	21.60	53.50	12.40	19.60	68.50	7.15	19.30	55.50	9.90
4	22.60	64.50	9.53	20.00	59.00	9.60	22.60	52.50	13.48	20.30	66.50	7.96	17.60	57.00	8.85
5	23.00	53.00	13.21	20.10	54.50	10.70	22.70	52.50	13.48	20.30	57.50	10.10	17.70	55.50	9.27
6	23.00	55.00	12.65	19.00	64.00	8.01	23.40	48.00	13.61	20.70	49.50	12.23	19.48	55.40	9.90
7	24.50	41.50	17.80	19.90	50.50	11.26	23.90	48.00	15.49	22.40	49.00	13.71	19.70	52.50	9.68
8	26.70	42.50	22.09	20.08	61.50	8.96	24.90	47.50	16.80	24.90	54.00	14.22	19.70	49.00	11.93
9	26.30	35.00	22.09	16.00	45.00	10.11	25.79	48.00	17.47	24.20	44.00	15.83	20.00	47.50	12.40
10	26.70	48.00	17.94	20.10	47.50	12.35	26.70	46.00	19.27	24.50	42.50	17.58	20.30	44.00	13.10
11	26.18	56.00	14.60	23.30	52.00	13.67	26.80	44.00	19.99	22.50	45.00	14.85	21.60	38.00	16.36
12	27.40	55.50	16.12	24.50	47.00	15.96	28.05	45.00	20.79	23.90	50.00	14.60	22.00	33.50	17.68
13	28.80	51.00	19.76	24.50	46.00	16.80	28.08	47.50	20.03	21.50	42.50	14.66	23.40	38.00	17.42
14	31.25	41.50	26.48	25.00	49.00	16.12	28.40	51.50	18.52	26.60	38.50	21.14	24.30	36.00	19.07
15	30.40	38.50	26.43	25.00	46.00	17.12	28.85	52.50	19.24	30.20	37.00	26.89	26.20	37.00	21.16
16	32.20	41.00	28.26	25.20	46.00	17.26	28.43	54.00	17.38	28.00	45.50	20.61	26.60	36.50	22.84
17	29.50	49.00	20.81	24.00	55.50	13.51	27.93	59.00	15.49	26.50	48.50	17.64	26.90	38.50	22.13
18	31.20	47.50	21.62	27.60	55.50	16.14	28.67	55.00	18.04	29.50	46.50	21.78	26.30	39.50	20.49
19	30.38	45.50	23.24	28.10	52.00	18.12	29.29	59.00	16.44	29.50	49.00	20.81	26.23	40.00	20.16
20	33.70	34.00	33.90	28.00	52.00	18.01	27.54	61.00	13.92	30.20	42.50	21.56	25.70	47.50	17.80
21	33.60	38.50	31.50	25.80	68.50	10.49	27.93	59.50	15.49	30.20	49.50	19.46	26.00	49.50	17.12
22	32.70	44.50	27.00	26.20	62.00	12.58	26.63	70.50	10.71	30.60	55.00	19.46	25.70	52.50	16.12
23	31.90	58.00	19.41	26.50	58.00	14.39	25.48	77.00	6.97	29.20	64.50	14.34	25.50	66.50	10.77
24	30.40	60.50	16.97	25.60	64.00	12.01	25.25	78.00	4.76	29.20	74.50	10.30	23.60	78.00	8.94
25	27.90	64.50	13.10	24.80	68.00	9.52	24.25	84.50	4.76	25.70	69.00	10.10	25.40	73.10	8.55
26	26.10	74.00	8.77	24.65	65.50	10.55	23.95	84.50	4.76	26.00	86.50	10.64	25.15	75.50	7.92
27	26.30	74.50	10.67	23.10	78.00	22.50	23.84	84.50	4.76	24.80	86.00	4.32	24.90	76.50	7.60
28	27.20	69.50	10.97	23.00	75.00	7.14	23.68	85.00	4.47	25.20	83.00	5.44	24.80	82.00	5.70
29	28.60	65.00	13.52	22.80	77.00	6.30	23.65	85.00	4.47	25.00	84.00	5.08	25.10	78.50	6.97
30	26.70	78.50	7.42	22.90	76.50	7.46	23.76	84.50	4.96	24.70	84.50	4.45	25.20	72.00	8.87
31	29.80	91.00	6.71	22.60	85.00	4.07	23.03	88.00	3.37	24.90	85.00	4.64	24.80	83.50	5.38
32	25.50	78.00	7.12	23.00	74.50	7.17	23.19	86.00	3.93	23.60	86.50	3.90	25.40	83.00	5.38
33	26.60	82.50	6.02	24.80	66.50	10.32	23.55	85.50	4.47	24.50	84.00	4.87	25.80	81.00	7.61
34	26.90	78.50	7.48	23.10	76.50	6.64	23.62	82.00	5.36	24.20	83.50	4.96	26.30	79.00	7.05
35	26.40	80.50	6.66	23.40	74.00	7.44	23.46	85.50	4.21	25.10	73.50	3.44	26.80	82.00	6.42
36	25.90	80.00	4.57	22.10	84.00	4.15	23.49	79.50	5.90	25.30	75.50	7.86	26.70	79.00	7.49
37	26.10	81.50	6.24	22.90	74.00	7.15	24.13	77.50	6.85	26.00	80.50	6.56	27.00	75.00	8.92
38	25.50	87.00	4.21	22.10	74.50	6.77	24.45	76.50	7.15	26.10	80.50	6.58	27.90	75.50	9.15
39	25.70	82.00	5.87	22.50	77.00	7.07	24.61	80.00	5.96	24.70	80.50	5.98	27.50	69.50	11.06
40	26.45	78.50	7.35	21.50	76.00	6.78	24.66	75.00	7.92	25.20	71.50	9.11	28.35	67.50	12.17
41	29.40	72.00	11.39	23.00	74.00	7.31	25.45	66.00	10.77	26.40	68.00	10.92	28.00	54.00	17.55
42	23.90	69.50	8.88	17.70	74.50	5.82	25.17	62.50	12.04	24.50	57.50	12.93	26.90	47.00	18.92
43	23.40	78.00	6.29	21.70	80.00	5.01	24.40	64.50	10.72	25.50	66.50	10.84	26.80	48.00	18.56
44	24.20	77.00	6.91	21.70	71.50	7.34	24.15	60.00	11.92	24.90	69.50	9.43	27.00	49.00	18.20
45	22.70	67.00	8.99	19.50	65.50	8.08	24.23	63.00	11.02	24.20	72.00	8.42	27.80	63.00	13.90
46	19.35	67.00	7.50	20.50	62.00	9.20	24.00	71.50	8.64	18.20	59.00	58.54	27.50	64.00	12.85
47	19.50	59.50	9.47	19.80	65.50	7.91	23.42	69.50	8.71	18.50	57.50	9.00	26.60	64.10	12.85
48	20.50	49.00	12.41	19.55	56.00	10.01	23.12	66.50	9.55	19.00	59.50	8.91	26.20	70.00	10.08
49	20.10	57.00	9.97	18.10	68.00	6.63	22.14	59.00	10.82	21.80	60.00	10.34	23.60	63.50	11.02
50	20.30	57.00	10.22	18.30	72.50	5.76	21.27	56.50	10.95	22.10	56.50	11.54	22.60	57.00	12.00
51	20.50	57.00	10.32	19.70	74.50	5.82	21.51	57.00	10.70	22.90	83.50	4.54	21.10	58.50	10.43
52	20.30	63.00	8.79	18.40	62.00	7.58	21.32	59.50	10.20	20.40	61.00	9.31	19.40	60.50	8.80