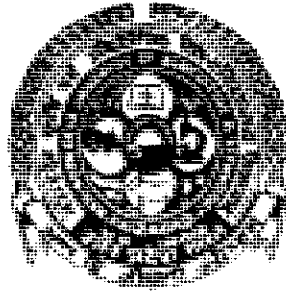
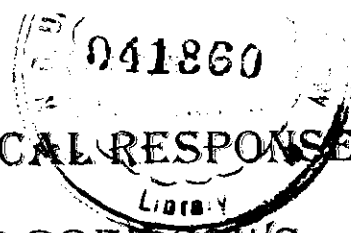


**EFFECT OF SEASONS ON BIOLOGICAL RESPONSES
AND PRODUCTIVITY OF CROSS-BRED COWS**



THESIS

SUBMITTED TO THE

NARENDRA DEVA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY

IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN

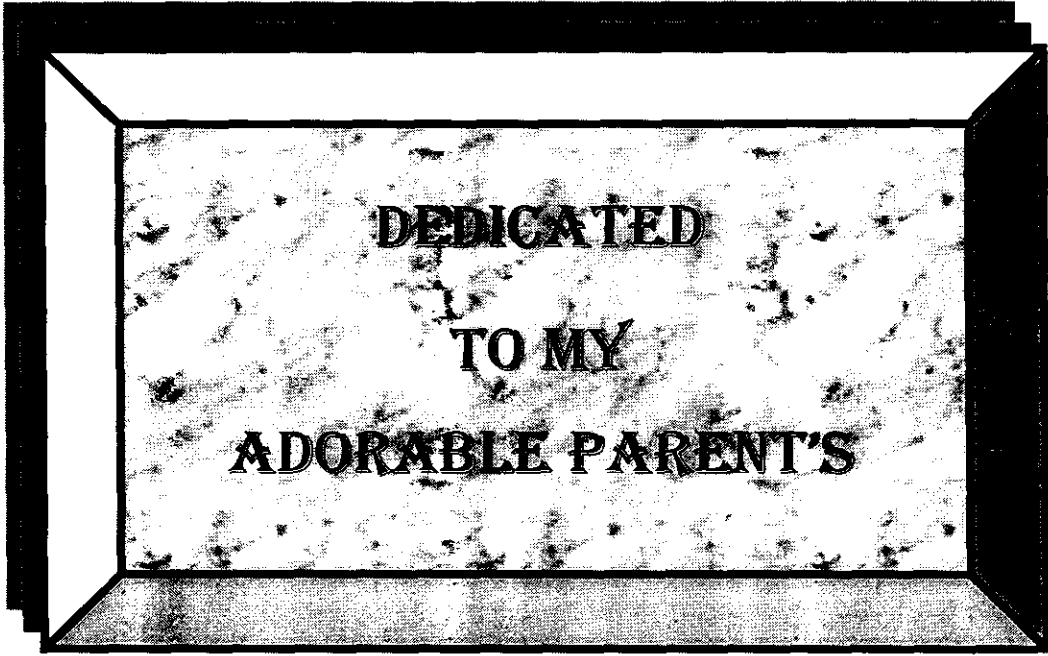
ANIMAL SCIENCE (LIVESTOCK PRODUCTION & MANAGEMENT)

BY

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FAIZABAD (U.P.)
INDIA
2001**



DEDICATED

TO MY

ADORABLE PARENT'S



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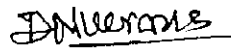
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CERTIFICATE - I

This is to certify that the thesis entitled '**Effect of seasons on biological responses and productivity of cross-bred cows**' submitted for the degree of **Doctor of Philosophy** in the subject of **Animal Science (Livestock Production and Management)** of Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Faizabad, is a bonafide research work carried out by **Sri Dharendra Kumar Srivastava**, under my supervision and that no part of this thesis has been submitted for any other degree.

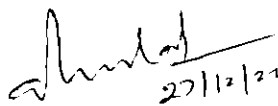
The assistance and help received during the course of investigation have been fully acknowledged.

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September, 15 2001

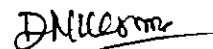

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CERTIFICATE - II

This is to certify that the thesis entitled 'Effect of seasons on biological responses and productivity of cross-bred cows' submitted by Sri Dharendra Kumar Srivastava to the Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Faizabad, in partial fulfilment of the requirements for the degree of Doctor of Philosophy in the subject of Animal Science (Livestock Production and Management) has been approved by the Student's Advisory Committee after an oral examination on the same in collaboration with an external examiner.


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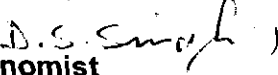
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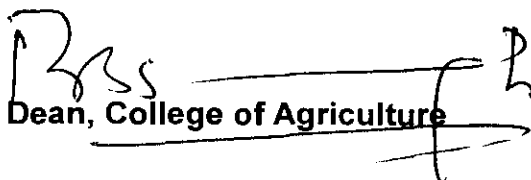

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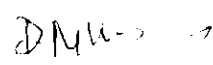
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INTRODUCTION

INTRODUCTION

The cow (*Bos indicus*) belongs to Bovidae family of the animal kingdom and has significant place in India as a dairy animal. Out of total milk production cow has contributed about 45 per cent milk and rank first in the world. Cows are the producers of milk liked by millions of peoples due to its nutritive value as well as easy in digestion. Besides, it is also very use full; and health nutritionists recommended its use for a newly born baby after goat milk. Cow is multifunctional animal, which provide milk, meat, skin, manure and draught bullock also. In India and other developing countries a regular efforts are being made to improve the production of indigenous cattle through breeding, feeding and management. These systems will continue to play a major role in the progress of India during 21st century. The nutrient requirements of cross-breds are higher than indigenous breed of cattle.

Hence, cross-breeding has been expected as the quickest method of increasing milk production and is being adopted on a large scale in the country. These cross-breds do not do equally well in all places and in all conditions. They show stress symptoms under high environmental temperature and produces lower amount of milk. These animals even with recommended nutritional level do not perform so well as in temperate zone secondly Mullick (1961) has observed that when even Indian breeds like Haryana, Red sindhi, Sahiwal and Gir are transported away from home tract for increasing milk production of that area, their performance detoriates and is never the same as in their own region. These points out to the need of studying

adaptability of animals to new environments through systematic studies of behaviour and production under different environmental conditions.

The environmental factor can be classified into internal and external. The farmers are regulated by physiological set up of the animal and the latter includes the nutritional level climatic conditions, disease level and general management. There is a great deal of inter relationship among these contributing factors.

The manner in which an animal reacts to meteorological conditions is of immense informatic value for selecting the right type of cattle possessing those attributes which promotes adaptability. Interpretation of the reactions of climate variables upon the animals gives a good indication of physiological differences existing between breed and even individual animals. The animal will adapted to a certain environment after possesses distinctive characteristics indicating adaptability. If these characteristics are known, such animals can be carefully picked up for selective breeding and also for transport to other points of the country, having more or less similar climatic conditions.

Hence, there is need for obtaining accurate informations on various nutrient requirement, physiological reactions, milk production, haematological attributes and certain bio-chemical constituents of blood under different seasons and climates on different physiological states of animals. Such informations are of great importance in understanding the various physiological and on nutritional processes and adaptability status of animals with reference to local environmental conditions.

Inspite of the important role played by the cross-bred cows, very little attention has been played by the scientists in the dairy industry to study their nutrient utilization, physiological responses, milk production, haematological picture and bio-chemical constituents of blood and the effect of different

seasons on different physiological states of animals viz., Calves under one year of age, Non-pregnant-Non-lactating, Non-pregnant-lactating and Pregnant-Non-lactating cross-bred cows.

In the present investigation an effort has been made to study the effect of seasons on biological responses and productivity of cross-bred cows. The present study is therefore being undertaken with following objectives :-

1. To study the seasonal change in body temperature and cardio-respiratory responses in cross-bred cows.
2. To find out the interaction of meteorological elements and physiological status of cross-bred cows and their feed intake.
3. To study the effect of season on haematological attributes and certain bio-chemical constituents of blood in cross-bred cows.
4. To find out optimum environmental temperature and humidity for maximum comfort to the animal body and for maximum growth and production.

REVIEW
OF
LITERATURE

REVIEW OF LITERATURE

The milch animals like cross-breds have been the subject of studying since a long by veterinarians for their milk yield etc. Comparative studies of feed utilization of indigenous and cross-breds have been evaluated and it was concluded that the cross-breds are more efficient in feed utilization capacity than indigenous animals. Hot humid climate of tropical and sub tropical areas of the world generally cause low production in animals. For improvement of cross-bred cows performance under different climatic conditions at different geographic regions. It is necessary first to assess the impact of the climatic micro environment on various system directly or indirectly related to growth, production and reproduction with other related ancillary physiological activities.

Seasonal changes also play a key role in these characteristics keeping in view of the above fact, a research problem entitled "Effect of seasons on biological responses and productivity of cross-bred cows" was proposed. The research work which was already done by various workers on seasonal effect on feed consumption and digestibility of nutrients, milk production, physiological reactions and blood parameters have been reviewed as under :-

Effect of seasons on feed consumption and digestibility of nutrients

The young calves under one year of age suffer much more than adults and in summer they tend to go off their feed and loose condition (Badreldin *et al.*, 1951).

Mullick and Kehar (1952) observed that ingestion of dry matter in Kumaini steer was much less in summer and autumn as compared with winter and spring period.

Ragsdale *et al.* (1953) observed the effect of humidity at higher environmental temperature on the feed intake of dairy cattle. At 75° F the effect of humidity on feed consumption was not significant, at 86° F, however, the depression in feed consumption was greater at high than low humidity and this difference increased with increasing temperature. Normal level of feed consumption was reported when the environmental condition returned to control temperature of 65° F.

Raghavan *et al.* (1963) carried out experiments in summer, autumn, winter and spring with male Haryana cattle and Murrah buffaloes. They found that animals changed the proportional investigation of various nutrients at different seasons of the year. During the summer months with a temperature range of 30-41°C, intake of protein and fat decreased and carbohydrate intake increased.

Ichhponani and Sidhu (1966 a, b) observed that dry matter intake of green berseem, by Zebu cattle and buffaloes at the rate of 3.8 and 3.4 ^{kg} ~~kg~~/100 kg body weight, respectively.

Ponnappa *et al.* (1971) reported an inverse relationship between water consumption and dry matter intake of both cattle and buffaloes. Improved coefficient of digestibility of dry matter was observed in buffaloes than those of cattle.

Grant *et al.* (1974) studied that factor affecting digestibility such as dry matter intake, metabolism loss and ability of Haryana cattle and buffalo to select the Napier grass. Buffalo digested 2.1 to 4 per cent more of the nutrients than cattle during wet season, but species effect was no different.

during the dry season. Dry matter intake was significantly lower for buffaloes in all trials. Lower dry matter intake contributes to higher digestibility by buffaloes in wet season.

Bhatia *et al.* (1979) observed higher digestibility of dry matter and crude fibre in buffaloes than in cattle (Haryana x Jersey). No significant difference was observed in digestibility of other nutrients between the two species. Less dry matter intake by the buffaloes was responsible for higher dry matter digestibility.

Sengar *et al.* (1983) ~~experiment was conducted~~ on Holstein Friesian and cross-bred cattle (Holstein Friesian x Haryana) in winter and summer season, observed that there was significant difference in dry matter intake per 100 ~~Kg~~ ^{kg} body weight ($P < 0.01$) between seasons, whereas the values expressed on metabolic body size ($\text{Kg}^{0.75}$) differed significantly both for season ($P < 0.01$) and breed ($P < 0.05$). Dry matter, crude fibre and ether extract digestibilities were also significantly different ($P < 0.05$) between seasons and breeds. All the animals were on positive nitrogen balance.

Lal *et al.* (1986) studied the effect of air, temperature and humidity on feed consumption and observed that dry matter intake decreased significantly in rainy season as compared to winter season.

Verma and Husain (1986 b) studied the seasonal changes in feed consumption of Haryana cattle and observed for assessment of the adaptability of this species for tropical climate. Dry matter intake by experimental animals decreased significantly ($P < 0.01$) in summer than in winter.

Verma and Husain (1988 c) observed that dry matter intake decreased significantly ($P < 0.01$) in summer season as compared to other seasons of the year. Dry matter and crude protein digestibility were significantly higher in

winter season, whereas, crude fibre digestibility was significantly higher in summer season. Nitrogen balance was significantly lower ($P < 0.01$) in summer season.

Verma *et al.* (1988) studied the dry matter intake in Harijana cattle and Murrah buffaloes was 3.32 ± 0.23 and 2.67 ± 0.11 ~~Kg~~/~~100~~ ~~Kg~~ body weight, respectively. There was significant ($P < 0.05$) difference in the dry matter consumption between the two species of animals.

Cappa *et al.* (1991) reported that at higher temperature feed consumption in cows was low.

Mishra (1995) observed the DM intake and digestibility of feed nutrient in buffaloes was significantly higher in winter than other seasons of the year. Similar observations were also reported by Bharat (1987) and Verma and Ram (1992).

Verma *et al.* (1999) observed the effect of different seasons on feed consumption and nutrient utilization in Murrah buffaloes. It was observed that maximum feed consumption and nutrient utilization was in winter season as compared to other seasons of the year.

Om Prakash (1999) studied the effect of different seasons of the year on Non-Pregnant-Non-lactating and Non-Pregnant-lactating buffaloes on feed consumption and digestibility of nutrients.

In non-pregnant-non-lactating animals D.M. intake decreased significantly ($P < 0.01$) in summer season than other seasons of the year. DM and C.P. digestibility were significantly higher ($P < 0.01$) in winter season. Nitrogen balance was significantly lower ($P < 0.01$) in summer and rainy season than other seasons of the year.

In non-pregnant-lactating animal DM, CP, EE and NFE digestibilities were significantly higher ($P < 0.01$) in winter season, whereas, crude fibre

digestibility was significantly higher only in summer season. There was significant difference ($P < 0.01$) in nitrogen balance in the different seasons of the year.

Experiment was conducted by Verma *et al.* (2000) on seasonal changes in feed consumption and digestibility of nutrients in buffaloes. Dry matter intake decreased significantly ($P < 0.01$) in summer season than other seasons of the year. Dry matter and crude protein digestibility were significantly higher ($P < 0.01$) in winter season, whereas, crude fibre digestibility was significantly higher in summer season. Nitrogen balance was significantly lower ($P < 0.01$) in summer and rainy season than other seasons of the year.

Effect of seasons on physiological reactions

1. Body temperature

Kibler and Brody (1950) studied the influence of humidity on heat exchange of body temperature regulation in Jersey, Holstein, Brahman and Brown Swiss cattle. The observation revealed that the level of humidity has no measurable effect at low temperature. Increased atmospheric humidity at temperature level from 75° to 100° F increased the rectal temperature of Jersey, Holstein and Brown Swiss cattle.

Mullick and Kehar (1952) reported that changes in air temperature appeared to be a major cause affecting variation in the body temperature of Indian cattle. The value of body temperature parameter was positively correlated with air temperature. The body temperature, for instance, can have its own place in evaluating the adaptability of the animals, especially those of non-zebu origin.

McDonalt and Bell (1958) reported that in the range between 10 to 30°C daily minimum air temperature of cows showed an over compensating increase in rectal temperature.

Raghavan and Mullick (1961) reported that the range of the mean value of the rectal temperature of animal varied from 99.9 to 100.7° F whereas, between the months the maximum and minimum figures were 101.5° F to 99.1° F with the overall average of 100.4 ± 0.97 . Highly significant differences ($P < 0.01$) were observed in rectal temperature at monthly intervals in various seasons. Among the breeds of Indian cattle (Hariana, Kankrej, Tharparker, Sahiwal and Gir breed) differences in the elevation of rectal temperature under hot humid (temperature 40.6°C, relative humidity 70%) and hot arid (temperature 43.9°C, relative humidity 15%). Conditions were not significant. Although the ambient temperature was higher under hot arid condition, the rectal temperature was more elevated in hot humid conditions. The skin temperature, however, was found to be higher under hot arid conditions (U.S.P.L. 480, Project on animal climatology, 1962-67).

Bhosrekar *et al.* (1966) conducted an experiment on thirteen female calves each of Red sindhi, Sahiwal and Tharparker breeds, to study the rectal temperature in shed from 14.00 to 16.00 hour. Simultaneously record of air temperature and absolute humidity were maintained. Results showed that rectal temperature had negative correlation in period (0-6 months).

Bhosrekar *et al.* (1967) reported that physiological reaction of Tharparker cows and their adaptability of different climatic factors from December, 1964 to November, 1965 and found that significant seasonal variations in rectal temperature.

Singh and Sadhu (1970) reported that a greater proportion of variation in the skin temperature was accounted by the changes in the climatic

conditions in buffaloes than in Haryana cattle. Whereas, the air temperature had a significant effect on the chest and scrotal temperature in both buffaloes and Haryana cattle, relative humidity had significant influence on the temperature of the scrotal skin of the zebu, indicating its better sweating capacity than buffaloes.

O,Kelly (1973) observed that an elevation of rectal temperature by 1.3°C could occur at an ambient temperature of 33°C in *Bos taurus* and 38°C in *Bos indicus* at an age of 3 months. In 18 months old animals, it was 30°C ambient temperature in *Bos taurus* but 43°C in *Bos indicus*.

Collier *et al.* (1982) studied that physiological reaction and health of dairy animals were affected by change in environmental temperature and humidity.

Chikamune and Shimizu (1983) reported that climate adaptability of swamp buffaloes to environment was compared with that the Holstein cattle. The coefficient of correlation indicated the body temperature of buffaloes had highly significant correlation with seasonal change of air temperature, unlike in Holstein. In both the species there was positive and highly significant correlation between seasonal temperature.

Mullick (1984) made observation of groups of cattle and buffaloes for body temperature and cardio-respiratory response during the summer months. In buffaloes, the average figures for these physiological responses were lower in comparison to cattle.

Verma and Husain (1985) observed the rectal temperature in different physiological states of Haryana cattle. A significantly higher rectal temperature was observed in calves under one year of age in Haryana cattle.

Verma and Husain (1986 a) observed the rectal temperature in different physiological states of Murrah buffaloes. A significantly higher rectal

temperature was observed in calves under one year of age. The morning values of rectal temperature were lower than the evening values of all the categories of animals. Rectal temperature in pregnant and lactating animals were significantly higher ($P < 0.01$) than in non-pregnant and non-lactating animals.

Verma and Husain (1988 b, c) reported that rectal temperature was significantly higher ($P < 0.01$) in summer season than other seasons of the year. The morning values of rectal temperature were lower than the evening values in all the seasons.

Verma and Ram (1992) reported that significant difference in rectal temperature during different seasons in buffaloes. It was directly correlated with the ambient temperature and relative humidity.

Om Prakash *et al.* (1995) conducted an experiment on under 1 year of age, 1-2 years, 2-3 years, Non-pregnant-non-lactating, Non-pregnant-lactating and pregnant-non-lactating Gangatiri breed. Statistical analysis of the data revealed that the calves under 1 year of age had significantly ($P < 0.01$) higher rectal temperature as compared to the remaining group of animals, except pregnant-non-lactating group. The rectal temperature of 1-2 and 2-3 year old animals indicated non-significant difference but it was recorded significantly ($P < 0.01$) higher in pregnant-non-lactating group when compared with pregnant-non-lactating group of animals. Non-pregnant-lactating and pregnant-non-lactating group of Gangatiri cows showed a significant difference of rectal temperature. The difference between evening and morning rectal temperature was found to be significant.

Om Prakash (1999) studied the effect of different seasons of the year on non-pregnant-non-lactating and non-pregnant-lactating buffaloes on body temperature. In non-pregnant-non-lactating animals body temperature was significantly ($P < 0.01$) higher in summer season than other seasons of the year.

In non-pregnant-lactating animals significant difference in body temperature was observed in different seasons of the year. The morning values of rectal temperature were always lower than evening values.

Verma *et al.* (2000) studied the seasonal changes on rectal temperature in cattle and buffaloes. Rectal temperature was significantly higher ($P < 0.01$) in summer season than other seasons of the year. The morning values of rectal temperature were lower than evening values in all the seasons.

2. Pulse rate

While the heart or pulse rate of healthy cattle varies only with in narrow limits, it is easily affected by various factors like nutritional states of the animal, gestation, lactation and age etc.

Kibler and Brody (1950) reported a slight decrease in pulse rate in Brahaman cattle at 99° F and a sharp decrease in Brown Swiss, Jersey and Holstein cows between 80° F and 99° F and an increase in pulse rate of all breeds again at 105° F chamber temperature.

Casady *et al.* (1956) reported that there was a marked rise in pulse rate at chamber temperature of 70° F and again at 95° F in Holstein bulls in a study of continuous exposure for 29-50 days. In chamber of studies reported on continuous exposure to hot condition resulted in the lesser rise in pulse rate at the end of exposure (Bianca, 1959).

Mullick (1960) studied that under high humidity condition cows showed a significant increase in the pulse rate. In both the species (buffaloes and cows) the pulse rate showed less change.

Raghavan and Mullick (1961) reported that range of the mean values of the individual animal varied from 50 to 54 beats/minute, whereas, between the months maximum and minimum figures were 57 to 45 with in overall

average of 32 ± 3.92 beats/minute. The figures were treated statistically according to the analysis of variance of F value showed that the differences due to the months as well as between the animals were highly significant at one per cent level.

Mullick (1964) reported that pulse rate was positively correlated with the increase in air temperature in male and female buffaloes.

Whittow (1965) observed that there was an increase in the heart rate and cardiac output under both controlled hot dry and hot humidity conditions, though the magnitude of rise was greater in later condition.

Bhosrekar *et al.* (1966) conducted an experiment with thirteen female calves each of Red Sindhi, Sahiwal and Tharparkar breeds. The weekly pulse rate in a shed from 14.00 to 16.00 hours, simultaneously records of air temperature and absolute humidity were maintained. Result showed that pulse rate was mainly affected by age throughout the period of study. As the calves grew older, pulse rate showed downward trend.

Hafez (1968) studied that the pulse rate response to heat exposure either by a rise or fall depending on the type and level of heat exposure.

Chikamune and Shimizu (1983) compared the climatic adaptability of swamp buffaloes to environment with that of Holstein cattle. Negative correlation was observed between air temperature and pulse rate and delayed effect of air temperature on the two physiological responses in buffaloes upon exposure to direct sunlight, buffaloes become more hypothermic than cattle but removed rapidly by shading, showering and wallowing.

Verma and Husain (1985) observed that the pulse rate in different physiological state of Haryana cattle. Significantly higher pulse rate was found in animals under one year of age.

Verma and Husain (1986 a) observed the effect of seasonal variation on pulse rate in buffaloes. The pulse rate was not affected markedly in different seasons, although it was higher in rainy season. A tendency lower pulse rate in summer was observed which may be due to lower metabolic rate.

Verma and Husain (1988 b) reported that the pulse rate was significantly higher ($P < 0.01$) in summer season than other seasons of the year. The morning values of pulse rate were lower than evening values in all the seasons.

Verma and Ram (1992) reported that moderate increase in pulse rate during exposure to hot atmosphere from reference cool environment in a group of buffaloes.

Panneerselvum *et al.* (1993) reported that the physiological responses in non-descript Surti and Murrah buffaloes up to 72 hours water deprivation and mild form of exercise were compared. Significant ($P < 0.01$) decrease in pulse rate were recorded in all the breeds.

Om Prakash *et al.* (1995) experiment was conducted on calves under 1 year of age, 1-2 years, 2-3 years, non-pregnant-non-lactating, non-pregnant-lactating and pregnant-non-lactating Gangatiri breed to observed pulse rate. Analysis showed highly significant ($P < 0.01$) difference between calves under 1 year of age and remaining age groups.

Om Prakash (1999) studied the effect of seasons on non-pregnant-non-lactating and non-pregnant-lactating buffaloes on pulse rate in cattle. In non-pregnant-non-lactating animals pulse rate was significantly higher ($P < 0.01$) in summer season than other seasons of the year. In non-pregnant-lactating animals significant difference in pulse rate was observed in different seasons of the year. The morning values of pulse rate is lower than evening values in all the seasons.

Verma *et al.* (2000) observed the seasonal changes in pulse rate : buffaloes. Pulse rate was significantly higher ($P < 0.01$) in summer season than other seasons of the year. The morning values of pulse rate were lower than evening values in all the seasons.

3. Respiration rate

The respiration rate was most conspicuous and could be considered to be one of the Indices for assessing heat tolerance. The rates of respiration, pulmonary ventilation and respiratory vaporisation increases from moist oral surface and lungs with increasing environmental temperature in case of cattle. The increase in respiratory vaporisation supplements in adequate outer surface vaporisation in cattle. A large number of workers studied the respiration behaviour of cattle both in field as well as psychrometric chamber where temperature and humidity are controlled.

Mullick and Kehar (1952) observed that change in air temperature appeared to be the major cause affecting variation in the respiration rate of Indian cattle. The values of respiration rate were positively correlated with air temperature. They further observed the relative humidity (about 80%) at some influence in causing variation in the level of reactions. No doubt, the respiration is a sensitive parameter but no more than due weightage can be given to any single body function.

Casady *et al.* (1956) observed that there was a marked increase in respiration rate of Holstein bulls at 70° F and above up to 95° F chamber temperature.

Mullick (1960) reported that under high humidity condition cows showed respiration rate remain unchanged. In the buffalo cows their physiological reactions showed less change.

Raghavan and Mullick (1961) observed that the range of the mean value of the respiration rate in the individual animal varied from 18 to 22, whereas, between the months maximum and minimum figures were 38 and 10 with an over all average of 20 ± 8.76 respiration rate per minute. The figure of standard deviation showed highest value of 6.02 during the highest temperature, indicating variations of the rate between the individual animals. According to the analysis of variance the differences between the monthly averages as well as between the animals were significant at 1% level.

Kibler (1962) observed that the short horn calves had consistently higher respiration rate than Brahamans, when kept at 80° F for one year. Exposure to 80° F for one year had limited effect on the respiration rate in the Holstein, Brown Swiss and Jersey yearling heifers. The respiration rate in lactating Holstein cows has been to remain higher without showing trend of receiving throughout the nine weeks exposure to 84° F ambient temperature.

Mullick (1964) observed that respiration rate was significantly positively correlated with the increase in the air temperature in male and female buffaloes.

Kibler (1964) reported that the respiration rate of lactating Holstein cows increased significantly under two weeks exposure at 75° F ambient temperature or above as compared to the values under two weeks exposure at 65° F (50% R.H.). Respiration rate was reported to increase slightly at three temperature and humidity conditions of 75° F, 90% R.H., 80° F, 30% R.H., 80° F, 50% R.H. moderate increase in both the response was reported to be at four ambient temperature humidity conditions of 85° F, 50% R.H., 90° F, 23% R.H., 90° F, 25% R.H. and 80° F, 80% R.H. The four ambient temperature humidity conditions which caused the greatest increase in respiration rate was reported to be 95° F, 25% R.H., 85° F, 70% R.H., 90° F, 42% R.H. and 90° F, 50% R.H.

Bhosrekar *et al.* (1966) conducted experiment in thirteen female calves of each Red Sindhi, Sahiwal and Tharparker breeds observed weekly respiration in a shed from 14.00 to 16.00 hours. Simultaneously, records of air temperature and absolute humidity were maintained. Result showed that respiration rate mainly influenced by the atmospheric temperature of the experimental animals. Bhosrekar *et al.* (1967) observed that significant seasonal variation in respiration rate was recorded in cattle.

The seasonal changes in respiration rate of buffaloes, while, observing adaptability of buffaloes for tropical climate. To observe the increase in respiration rate is with in the rage of physiological variations (Pandey and Roy, 1969, a).

Rhynes (1973) studied that the rapid increase in the respiration rate in Hereford bulls in first two days at 35.5°C ambient temperature (R.H. 50%) which remained elevated for the rest period of study.

Verma and Husain (1985) observed the respiration rate in different physiological states of Haryana cattle. A significantly higher respiration rate was observed in calves under one year of age. Carido-respiratory response in pregnant and lactating animals were significantly higher ($P < 0.01$) than non-pregnant and non-lactating animals.

Verma and Husain (1986 a) observed the seasonal changes in respiration rate in buffaloes for the assessment of the adaptability of this species for tropical climate. A significant increase in the respiration rate was observed during the hotter part of the year when the environmental temperature exceeded the critical limit. The morning values of physiological reactions were lower than the evening values in all the seasons.

Verma and Husain (1988 b) reported that the respiration rate was significantly higher ($P < 0.01$) in summer season than other seasons of the

year. The morning values of respiration rate were lower than the evening values in all the seasons. Similar results were also reported by Verma and Ram (1992).

Panneerselvum *et al.* (1993) observed the physiological responses in non-descript Surti and Murrah buffaloes to 72 hours. Water deprivation and mild form of exercise were compared. Significant ($P < 0.01$) decrease in respiratory rates were recorded in all the breeds.

Om Prakash *et al.* (1995) experiment was conducted on calves under one year of age, 1-2 years, 2-3 years, non-pregnant-non-lactating, non-pregnant-lactating and pregnant-non-lactating Gangatiri breed for assessment of respiration rate. To observe the difference between morning and evening value of respiration rate was found to be significant ($P < 0.01$) in all the groups of animals.

Om Prakash (1999) studied the effect of different seasons of the year on non-pregnant-non-lactating and non-pregnant-lactating buffaloes on cardio-respiratory responses. In non-pregnant-non-lactating animals respiration rate was significantly higher ($P < 0.01$) in summer season than other seasons of the year. In non-pregnant-lactating animals significant difference in respiration rate was observed in different seasons of the year. The morning value of respiration rate was lower than evening value.

Verma *et al.* (2000) observed the seasonal changes in cardio-respiratory response in buffaloes. Respiration rate was significantly higher ($P < 0.01$) in summer season than other seasons of the year. The morning value of respiration rate was lower than the evening value in all the seasons.

Effect of Seasons on Milk Production and its Composition

Air temperature plays a greater role in quantitative as well as qualitative milk production. A number of research workers have given due considerations on different aspects, related to the seasonal variations in milk production and its composition.

Ragsdale *et al.* (1948-1949) studied the effect of environmental temperature on milk yield and composition of milk from Holstein, Jersey, Brown Swiss and Brahman cow in psychrometric laboratory where temperature was increased from 60 to 105° F and lowered from 60 to 90° F. Total milk yield was decreased from 80-75% at environmental temperature above 80° F in Holstein, 85° F in case of Jersey and Brown Swiss, Brahmans showed no apparent decline in milk yield till 90-95° F. Fat percentage decreases from 10 to 40% as compared to control animals probably due to decline in total milk yield.

Cobble and Herman (1951) reported that the influence of environmental temperature from 60 to 105°F in animals of Jersey, Holstein, Brown Swiss and Brahman breeds. Studies indicates an increase in butter fat, fat percentage, total solids, chloride content and a decrease in SNF percentage, lactose, total nitrogen content and specific gravity with rising temperature above 80 to 90°F with an increase in fat content which accompanied the decrease in milk yield. No effect on milk composition of Brahman cows due to high environmental temperature.

Singh *et al.* (1962) observed that the season of calving had a significant effect on lactation yield. The cows, calving in winter and spring season produced more milk than those during other seasons of the year. Among the

months of seasons cows calving during the months of November to March were best yielders. Lactation length was not affected by season of calving.

Raizada *et al.* (1971) studied that the differences in the peak yield in either types of buffaloes between seasons were not significant. The days to reach peak yield were significantly less in off season calves than in normal season calves. The milk yield differed significantly between lactation in Murrah buffaloes.

Basu and Ghai (1978) studied the influence of year, season, purity, lactation length, service period and calving interval on milk production in Murrah buffaloes estimates were made of heritability and repeatability of milk yield and of the breeding value of sires. The least square analysis of the data showed significant effect of year, purity and lactation length on milk yield.

Kaushik and Tondon (1979) made a genetic study on butter fat, protein, total solids and solid not fat (S.N.F.) in milk from Haryana cattle. The percentage of all 4 constituents was low during April to June (summer months) and high during December to January (winter season). The overall average percentage of the four constituents in Haryana cattle milk was 4.35 ± 0.03 for butter fat, 3.33 ± 0.02 for protein, 13.4 ± 0.02 and 9.05 ± 0.01 for total solid and solid not fat, respectively.

Garcha and Tiwana (1980) reported the effect of various environmental and physiological factors affecting persistency of milk yield and some other economic traits in buffaloes, observed that the period of calving affected all these (Peak yield, days to reach yield, lactation length and lactation yield) traits significantly whereas season of calving affected days to reach peak yield and length, peak yield and time taken to reach the peak. They found that the month of calving had significant effect of all these parameters, the yield being higher among buffaloes which calved in July. This could be the effect of

climatic environment, directly as well as indirectly through availability of nutrients during different months. Usually the milk production rise during the first couple of months, then maintains a plateau, and starts declining after 4 months of lactation.

Lal *et al.* (1986) reported the effect of temperature and humidity on milk yield in various seasons of the year. The milk yield was reduced significantly in summer season. Milk composition did not differ due to change in ambient temperature.

Verma and Husain (1988 a) recorded a decline in milk yield under high environmental temperature. Similar observations were reported by Balakrishnan and Nagarcenkar (1988) and Grewal and Sastry (1988).

Verma and Ram (1992) reported that there was a significant difference ($P < 0.01$) in the milk yield in various seasons. Milk composition did not vary from season to season.

Mishra (1995) observed that daily milk yield was higher in winter season than other seasons of the year. Statistically significant difference was observed in the milk yield in different seasons of the year. There was significant difference in 4% milk yield, water % and total solid % in different seasons of the year. Fat, solid not fat, lactose and protein per cent was observed non-significant in different seasons of the year.

Verma *et al.* (1999) reported that higher milk yield in winter season than other seasons of the year in Murrah buffaloes. There was significant difference in milk yield in different seasons of the year.

Om Prakash (1999) studied the effect of different seasons of the year on non-pregnant-lactating buffaloes on milk production and its composition. Significant ($P < 0.01$) difference was observed in the milk yield and 4% FCM yield in different seasons of the year. Significant difference ($P < 0.01$) was

observed in percentage of water, total solid, fat, S.N.F. and lactose in different seasons of the year. Non-significant difference was observed in protein percentage in different seasons of the year.

Verma *et al.* (2000) conducted an experiment on seasonal changes in milk production and its composition in buffaloes. Statistically there was a significant difference ($P < 0.01$) in milk yield and 4% FCM yield in different seasons. Milk composition viz., water, total solid, S.N.F. and fat showed non-significant in different seasons of the year.

Effect of Seasons on Haematological Picture

Blood plays an important role in animal health and production. Hence, there is need for obtaining accurate informations on haematological characteristics and certain bio-chemical constituents of blood in different seasons. Such informations are of great importance in understanding the various physiological and nutritional process and adaptability status of an animal with reference to local environmental conditions. Several scientists are worked on blood parameters in cows and buffaloes in different seasons of the year.

Mullick and Kehar (1959) observed the haemoglobin value of exotic and Indian crosses and pure Haryana cattle over 12 months of age. They reported lowest haemoglobin value in exotic crosses when air temperature ranged between 11°C and 39°C and the relative humidity between 15 and 89 per cent.

Mullick (1960) observed an inverse relationship between body temperature and haemoglobin content. He recorded six Haryana and six buffalo female in shed during April to October (1949) and then compared the values during humid periods with those during the dry periods and reported

that haemoglobin value was higher in buffaloes than in cattle, while, body temperature was lower.

Raghavan and Gaffar (1960) reported that the variation, which occurs in blood sedimentation rate, according to age and packed cell volume, the rate is slow in very young animals. It is also influenced by packed cell volume of RBC. The greater the PCV, the slower was ESR and vice-versa.

Raghavan and Mullick (1962) working with Murrah buffaloes reported that seasonal variation had significant effect on red and white blood cells and haemoglobin.

Sagar (1962) observed the seasonal variation in haemoglobin content of blood in dairy cattle. The average haemoglobin value of cattle herd was 9.48 gm/100 ml of blood. The graphical representation of data shows that haemoglobin content of blood of all groups of cattle is higher during summer than in winter showing there by that climate has some influence on haemoglobin content. No statistically significant difference was observed in the haemoglobin value of cattle based on season, breed and groups.

Patel *et al.* (1965) studied the haematology of four categories of Gir cattle from Saurashtra in different seasons. Significant difference was found for various blood constituents of different categories of animals studied during different seasons. TEC, TLC and lymphocytes are significantly higher and Hb, polymorphs and eosinophils are lower in young calves. In summer TEC, TLC and polymorphs are higher and Hb is lower.

Khajuria and Razdan (1966 a) investigated the influence of physiological states and the effect of humid and winter season on blood picture of calves, heifers (in pregnancy) and cows (in first lactation) of Sahiwal and Tharparkar breed. They reported that whereas, no breed difference existed, the age of animal had a marked effect on erythrocytes count, erythrocyte sized,

packed cell volume and haemoglobin concentration. Season had a significant effect on haemoglobin level. Further they (1966 b) investigated the influence of different physiological states and the effect of humid and winter season on total and differential leucocyte counts. Statistically significant differences were not observed either incase of total count or in differential count. Breed difference also did not exist. Total count and eosinophills percentage were not influenced by different physiological state, age of animal was found to have marked effect on neutrophills, lymphocyte and monocyte counts. The counts were lowest in calves and highest in lactating animals.

Mithuji *et al.* (1966) studied the haematology of Kankrej cattle and reported that young animals showed total erythrocyte count was about 50 per cent higher than in adult animals. Haemoglobin value averaged 11.80 ± 0.175 gms per cent. The differential leucocyte gave an average value of 23 per cent neutrophills, 6 per cent eosinophills, 67 per cent lymphocyte and 4 per cent monocyte.

Bhosrekar *et al.* (1967) observed ~~that~~ seasonal variation in haemoglobin content in sahiwal and Tharparker cows. Reported ~~that~~ significant seasonal variation in haemoglobin content and observed lower haemoglobin level as compared to Tharparker cows.

Rattan *et al.* (1968) conduted the experiment in twenty four cows respectively eight Sindhi, eight 1/2 Ayrshire x Sindhi, four 1/4 Ayrshire x Sindhi and four 1/8 Ayrshire x Sindhi to study the haematological constituents. The RBC, WBC, Hb and packed cell volume of the blood were estimated from each cow at the interval of 21 days for one year duration. It was found that the blood of Sindhi breed of cows had the higher cellular constituents than cross-breds.

Patel *et al.* (1969) observed the blood picture in four different categories of Surti buffaloes were examined for haematological and biochemical constituents during different seasons. The result indicated that the various constituents showed variation among the categories. The TEC was higher in buffalo bull and calves and the concentration of haemoglobin was maximum in bulls. Eosinophils percentage was very high in buffaloes and the lymphocytes were maximum in calves.

Patel *et al.* (1971) studied on blood of Surti buffaloes in different categories and different seasons. Total erythrocytes counts are high in bulls and calves. The total erythrocyte, total leucocytes count and polymorphs are high during winter.

Pandey *et al.* (1978) observed the blood status of Mehsana buffaloes of Surat district during monsoon, winter and summer seasons. The study indicated that the haemoglobin, TEC and TLC varied from 7.5 and 10.8 g per cent, 3.41 to 6.39×10^6 per cumm and 8.8 to 16.37×10^3 cumm, respectively.

Rowlands *et al.* (1979) observed the blood composition of cows in commercial dairy herd and its relationship with season and lactation and reported that the concentration of Hb and PCV were consistently higher in non-lactating than lactating cows and concluded that lactation need not be considered when deciding standard value, except, for Hb and PCV.

Talvelkar and Kulkarni (1980) studied the haematology of 18 Gir and 18 cross-bred (Gir x Jersey, Gir x Holstein) lactating cows ranging in age from 4 to 6 years from Kokan region. Slight differences in mean value of total erythrocyte count, haemoglobin, PCV, MCV, MCH, MCHC, total leucocyte, neutrophils and leucocyte in Gir and cross-bred cows. Which are not statistically significant.

Shukla *et al.* (1981) estimated the haematology of cattle & buffalo and reported Hb, TEC and TLC value varied from 8.3-9.5, 4.5-6.8 and 6.9-13.2 in cattle and 8.0-10.5, 4.2-6.4 and 7.9-2.2 in buffalo, respectively. Average differential leucocyte count value per cent were 23.54 and 30.1, neutrophils 5.33 and 3.77 eosinophils, 0.3 to 0.4 hasophills, 3.26 and 3.58 monocyte, 67.53 and 62.16 lymphocyte in cattle and buffalo, respectively.

Singh (1987) conducted an experiment on cattle (Haryana, Jersey, Jersey x Haryana, Holstein x Haryana) and Murrah buffalo to observe the blood constituents in winter and summer season. Reported that haemoglobin content, erythrocytes count and packed cell volume have reduced during summer season when ambient temperature was high. The reduction was maximum in Jersey and least in Haryana, the exotic crosses falling in between two. Buffaloes had higher haemoglobin than cattle in both seasons but lowest erythrocytes and packed cell volume value. Erythrocyte sedimentation rate and total leucocyte count are higher in buffalo than cattle in both the seasons. Erythrocyte sedimentation rate was highest in Jersey and least in Haryana. Exotic crosses are intermediate between the two.

Verma and Ram (1992) observed the seasonal changes in certain haematological characters of Murrah buffaloes in different seasons. Haematological parameters viz., haemoglobin, erythrocytes count and packed cell volume were found reduced during summer when ambient temperature was high.

Bahga *et al.* (1995) observed seasonal variation in haemoglobin and PCV in buffalo bulls. The values of haemoglobin and packed cell volume during summer, rainy, autumn and winter seasons were statistically non-significant. It can be concluded that Hb and PCV values were lower during winter season.

Verma *et al.* (2000) observed the seasonal changes in haematological characters in buffaloes. Observed that haemoglobin, erythrocytes count and packed cell volume had reduced during summer when ambient temperature was high. ESR and TLC increased during summer indicating summer stress condition.

Effect of seasons on bio-chemical constituents of blood

Satchidanadan *et al.* (1962) observed the blood sugar level in buffalo. Blood sugar value was determined in buffalo belonging to Murrah and local breeds and a third category cross between Murrah and local animals. The mean blood sugar level in Murrah, local and graded buffalo were 58.02, 50.93, and 47.22 mg per 100 ml, respectively.

Raghavan and Mullick (1962) working^{ed} with Murrah buffalo and reported that seasonal variation had significant effect on blood sugar value.

Setty and Razdan (1966) observed the chemical composition of blood in dairy cattle during winter and humid season reported that a significantly high serum cholesterol and blood urea nitrogen levels during humid season.

Bhosrekar *et al.* (1967) observed that seasonal variation in blood sugar and serum cholesterol level in Sahiwal and Tharparkar cows for the study of their adaptability to different climatic factors from December (1964) to November (1965) and found significant seasonal variation in blood sugar and serum cholesterol level.

Pandey and Roy (1969 b) reported that the total proteins, total globulins and alpha, beta and gama globulins were more in blood serum of buffalo exposed to high environmental temperature than in protected groups. This is understandable as a natural corollary to stress conditions created in buffaloes by high temperature. However, this does not seem to fall in line with

the observation (Pandy and Roy, 1969 C) unless changes in serum proteins and their fractions are also considered a process of adoption.

Verma and Pandey (1975) conducted the experiment on blood cholesterol level in the different physiological states on adult female buffaloes. Thirty healthy adult Murrah buffaloes were taken and divided into 3 groups of ten in each viz., non-lactating-pregnant, lactating-non-pregnant and non-lactating-non-pregnant. Differences for cholesterol between those physiological groups were highly significant.

Murtuza (1977) studied the serum protein in Haryana cattle under various physiological states. Analysis of variance of data of serum protein concentration did not show significant differences between various physiological states.

Kulkarni *et al.* (1984) observed the blood urea nitrogen from Jersey and Gir lactating cows. The mean value of blood urea nitrogen concentration in Jersey (13.31 ± 0.62 mg) and Gir (14.02 ± 0.04 mg per cent) cows. The differences in mean value of urea nitrogen concentration in Gir and Jersey cow is not statistically significant.

Mehta and Gangwar (1985) studied the effect of season on concentration of blood plasma, cholesterol and free fatty acid in lactating buffaloes. The study revealed that the mean value of cholesterol were highest in winter and lowest in hot humid summer.

Adnan *et al.* (1986) observed the blood composition of zebu *tauras* cross-bred cattle and reported from lactating cows and pregnant dry heifers of 75 per cent exotic inheritance in winter (Dec.-Jan.) and hot humid (June-July) season for obtaining normal value of haematocrit as 33.46 ± 0.377 per cent, total plasma protein (7.48 ± 0.184) gm per dl. Blood urea nitrogen 17.14 ± 0.64 gm per dl. The main sources of variation in these parameters were lactating

status, season and interaction between two. Significant difference was observed in haematocrit, total serum protein and blood urea nitrogen during winter and hot humid seasons.

Singh (1987) experiment was conducted on cattle (Haryana, Jersey, Jersey x Haryana, Holstein x Haryana) and Murrah buffalo to observed the bio-chemical constituents of blood in winter and summer seasons. Reported that serum cholesterol show significant difference between seasons and between groups of animals. Total protein decreased with increasing temperature but the differences are non-significant. Serum protein was high in Haryana than exotic breeds and crosses. Blood urea is differed in different breeds and seasons. It was highest in Jersey and least in Haryana. Blood glucose significantly varied between season and breeds. It is decline at high ambient temperature in all the animals. Buffalo showed lower glucose level than cattle in both the season and this difference was highly significant. Exotic animals and their crosses with zebu showed lower glucose level than pure Haryana but this difference was non-significant.

Verma and Ram (1992) observed the seasonal changes in bio-chemical constituents of blood of Murrah buffaloes. Reported that buffaloes showed lower blood cholesterol, glucose, urea and protein in summer than in winter season.

Experiment was conducted by Verma *et al.* (2000) on seasonal changes in bio-chemical constituents of blood in buffaloes. Observed that buffalo showed lower blood cholesterol, glucose, urea and protein in summer than in winter season.

MATERIALS

AND

METHODS

MATERIALS AND METHODS

The present investigation entitled "Effect of seasons on biological responses and productivity of cross-bred cows" was conducted at the Instructional Livestock farm of Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad, U.P., which is situated at an altitude of 24.47° and 26.56° North and longitude of 82.12° and 83.98° East on an elevation of about 113 meters above sea level in the Gangetic Alluvium of eastern Uttar Pradesh. The area falls in sub-tropical zone, which is characterized by hot and dry summer and sufficiently cold winter. The observations were recorded during December 1998 to November 1999. The methodology adopted during the experimentation is as follows :

Selection of Animals

Forty cross-bred cows (Haryana x Holstein Friesian) were selected for the present study. The cows were divided into four groups, consisting of ten in each according to their physiological states viz.,

1. Calves under one year of age
2. Non-pregnant-non-lactating
3. Non-pregnant-lactating
4. Pregnant-non-lactating

While, selecting the animals every care was taken to have animals nearly identical as far as possible in respect of body weight, number and stage of lactation and milk yield etc.

Weighing of Animals

The animals were weighed around 8.00 A.M. in the morning hours before feeding and watering prior to the metabolism trial. The average of weights for three consecutive days was taken as body weight record.

Management and Housing

The selected animals were regularly vaccinated against Foot and mouth, Black quarter and haemorrhagic septicaemia diseases. The animals were housed in well ventilated cemented sheds were washed and cleaned daily. The animals were maintained in the experimental sheds with arrangement for individual feeding and watering. Proper attention was paid to cleanliness and other related hygienic conditions.

Feeding and watering

Five sets of experiments were conducted in different seasons viz., Winter, Spring, Summer, Rainy and Autumn. The low temperature period from December to February was classified as winter season. March-April was classified as spring season and high temperature and low humidity period from May to June was classified as summer season. The high temperature and high humidity period from July to September was classified as rainy season and October to November was classified as autumn season. The seasonal variations in climatic picture of sheds are presented in Table-1.

At the start of experiment, the animals were fed according to ICAR (1985) standard with wheat straw and concentrate mixture comprising of equal parts of mustard cake, crushed maize and wheat bran. Each experimental animal was given 30 g mineral mixture and 40 g common salt daily. Rovimix was also added to the ration to supply 25,000 I.U. of vitamin A

and 2,500 I.U. of vitamin D₃. The experimental rations were offered for six weeks. Thereafter a seven days duration, metabolism trial was conducted.

Water was offered *ad-libitum* twice daily. Once in the morning at 10.00 A.M. and again in the afternoon at 4.00 P.M. before feeding.

Feeding and Residue records

A weighed quantity of feed was offered individually to experimental animals twice in a day, once in the morning at 10.00 A.M and again in the evening at 4.00 P.M.. Residue left was recorded next day in the morning hours. Before experiment started all the animals were offered weighed amount of the experimental ration for 25 days. Daily record of feed offered and residue left was maintained during the experimental period. Thus actual amount of feed consumed by each animal was determined.

Metabolism Trial

A metabolism trial of seven days duration was conducted to determine the digestibility coefficients of dry matter, crude protein, ether extract, crude fibre, nitrogen free extract and organic matter.

The animals were transferred to the metabolism cages for 10 days before the commencement of actual trial to acclimatise them in the situation. The faeces, urine and residues were discarded two days before the actual collection period. During this period faeces and urine was collected separately and carefully weighed after twenty four hours. Each sample was then mixed thoroughly and small amount was taken atrandom from the different portions of the bulk in a wide mouthed glass stoppered bottle and taken to the laboratory, where suitable aliquot was weighed for analysis.

Sampling of Feed and Residue

A 100 g from each representative sample of feed offered and residue left during the metabolism trial were collected daily for dry matter estimation. Finally these samples were grinded in a grinder and kept in a glass stoppered wide mouthed bottle separately for further analysis.

Collection and Sampling of Faeces and Urine

The faeces and urine during twenty four hours collected were weighed every day at 9.00 A.M. and thoroughly mixed. A representative sample of 250 g (faeces) and 200 ml (urine) from each animal was brought to the laboratory for further analysis.

Aliquoting and Preservation of Faeces and Urine for chemical analysis

(A) Faeces

Aliquot of 1/100 parts was taken daily in weighed petridishes and dried in a hot air oven at 80-100°C for 24 hours. Another aliquot of 1/1000 parts was mixed with 5 ml of 25 per cent sulphuric acid and preserved in previously weighed air tight glass stoppered bottle for nitrogen estimation and daily such aliquots were pooled for seven days.

(B) Urine

For nitrogen estimation aliquot of 1/200 parts was directly transferred to Kjeldahl flask containing 30 ml of concentrated sulphuric acid. The aliquots for seven days were pooled in the same Kjeldahl's flask assigned to each animal. A duplicate sample was also made in each case.

Chemical analysis of Feed, Faeces, Residues and Urine

During present investigation analytical techniques followed for the estimation of dry matter and proximate principles were those recommended by A.O.A.C. (1960) are as follows :

1. Estimation of Dry Matter (D.M.)

100 g of each sample was taken in previously weighed peteridish and placed in the hot air oven at 100°C for at least 6 hours. Then dishes were cooled at room temperature and weighed. This operation was repeated till a constant weight was attained. Now the dry matter content per 100 g of sample was calculated by the formula :

Weight of tray = a g.

Weight of tray + sample = b g.

Weight of sample before drying = b - a g.

Weight of tray + dried sample = c g.

Weight of dried sample = c - a g.

$$\text{Percentage of Dry Matter (D. M.)} = \frac{\text{Weight of dried sample (c - a)}}{\text{Weight of fresh sample (b - a)}} \times 100$$

2. Estimation of Crude Protein (CP)

A known weight of sample was taken in Kjeldahl flask and concentrated sulphuric acid (H₂SO₄) and digestion mixture {20% copper sulphate (CuSO₄) and 80% sodium sulphate (Na₂SO₄)} was added to it. Then the Kjeldahl flask were kept on heaters for digestion. After complete digestion, the digested material was transferred into 250 ml volumetric flask up to the mark and kept over night for cooling. An aliquot (10 ml) was distilled with 40% Sodium Hydroxide (NaOH) and ammonia (NH₃) liberated was collected in about 10 ml 2% boric acid solution containing Tashiro's indicator. Ammonia

trapped with boric acid was titrated against N/7 H₂SO₄. The amount of nitrogen was multiplied by a factor 6.25 to get the crude protein value in the material.

The nitrogen content was obtained by the formula :

$$\text{Per cent Nitrogen} = \frac{\text{Volume of N / 7 sulphuric acid} \times 0.0014 \times \text{Aliquot factor}}{\text{Weight of samples on dry matter basis}} \times 100$$

Per cent of crude Protein = % N x 6.25.

3. Estimation of Ether Extract (E.E.)

The known amount of finely ground sample was taken in a thimble, made up of filter paper and dried at a uniform temperature of 100°C over night. The dried sample in the thimble was extracted in a soxhlet's ether extractor for twelve hours. The oil flask being used was dried in oven before and after and weighed to constant weight.

The difference in the weight of oil flask before and after extraction gave the amount of ether extract and was expressed as per cent on dry matter using formula :

$$\text{Per cent Ether Extract} = \frac{\text{Weight of Ether Extract (Fat)}}{\text{Weight of the sample on dry matter basis}} \times 100$$

4. Estimation of Crude Fibre (C.F.)

Dry fat free samples were digested first with 1.25% sulphuric acid and then after filtering through the muslin cloth under suction, with 1.25% sodium hydroxide for 30 minutes in both the cases. Retitration was carried out till process is over. The residue was transferred quantitatively into the crucible, dried at 100°C and weighed. Then it was ashed in the muffle-furnace at about

500°C for 3 hours and weighed. The loss in weight was taken to be crude fibre content, mainly representing cellulose and lignin.

The crude fibre is calculated by difference of acid alkali treated dry residue and ash content and then calculated as percentage in the feed stuff using the following formula :

$$\text{Per cent crude fibre} = \frac{(\text{Weight of crucible + dry residue}) - (\text{Weight of crucible + Ash})}{\text{Weight of sample}} \times 100$$

5. Estimation of Total Ash

5 g of sample was placed into a silica crucible and weighed. The sample was placed into a muffle-furnace and ignited at 550°C for 4-5 hours. The muffle-furnace was allowed to cool down at 100°C and the crucible was removed from the furnace and transferred it into a desiccator, cool and weighed.

The per cent of Ash was calculated by the following formula :

$$\text{Per cent of total Ash} = \frac{(\text{Weight of silica dish + ash}) - (\text{Weight of silica dish})}{\text{Weight of sample}} \times 100$$

6. Estimation of Nitrogen free extract (N.F.E.)

This fraction mainly comprised of soluble carbohydrates viz.; starch, sugars, hemicellulose etc. Its percentage was calculated by subtracting the sum of the percentage of crude Protein, crude fibre, ether extract and total ash content on dry matter basis from hundred.

$$\text{N.F.E. \%} = 100 - (\text{C.P. \%} + \text{C.F. \%} + \text{E.E. \%} + \text{total ash \%})$$

Where,

C.P. = Crude Protein

C.F. = Crude fibre

E.E. = Ether extract

7. Estimation of Organic matter

It was calculated by subtracting the per cent total ash content on dry matter basis from hundred.

8. Estimation of Nitrogen Balance

It was calculated by subtracting the sum of N of faeces, N of urine and N of milk from the N intake.

$$\text{N balance} = \text{N intake} - (\text{N of faeces} + \text{N of urine} + \text{N of milk})$$

Rectal temperature and Cardio-Respiratory Record

Sufficient time was allowed to lapse between feeding and watering of the animals and measurement of their physiological responses. Rectal temperature, Pulse rate and respiration rate of experimental animals were recorded at 04 hours and 16 hours for consecutive seven days.

Rectal temperature was measured by clinical thermometer by putting it inside rectum, two inches deep touching mucous membrane for one minute. Respiration rate was counted from the flank movement and pulse rate by palpating coccygeal artery. All the observations were recorded when the animals were in resting state under shed. Shed did not offer any material for the comfort to the animals. The dry and wet bulb thermometer reading was also recorded simultaneously at the time of recording the observations in the morning and evening every day. The maximum and minimum temperatures, pulse rate and respiration rate were recorded twice in a day.

Milking and Milk Sampling

Milking was done twice daily, once at 4.00 A.M. in the morning and another at 4.00 P.M. in the evening in different seasons. In every season milk sample was collected from each individual animal. Milk samples were taken after milk was thoroughly mixed. Separate sample was collected for each

milking then these samples were pooled and fat content of milk was determined immediately. The milk samples were brought to laboratory and kept for subsequent analysis after addition 0.5 ml. formaldehyde for preservation.

Milk Analysis

Milk samples were collected from individual animals in the morning and evening for chemical analysis. The samples were analysed for fat, protein, ash, lactose, total solids and solid not fat (S.N.F.) contents according to method discussed by Agrawala and Sharma (1964).

The conversion of normal milk into 4% fat corrected milk was done on the equation worked by Gaines (1928) as given below:-

$$4\% \text{ F C M} = 0.4 \text{ M} + 15 \text{ F}$$

where,

F C M = Fat corrected milk

M = Weight of the milk (kg/day)

F = Weight of the fat content in it.

1. Milk fat

The milk fat in the milk samples was estimated by Gerber's method.

Placed the tubes in a stand with opened stopper and in upwards position. Added 10ml of H₂SO₄ (10:1), 11ml of milk and 1ml of amylalcohol into each tube. The tubes were tightly corked and shaken until all traces of crude disappeared. Centrifuged the tubes immediately for four minutes at 1100 r.p.m.. Removed the tubes from centrifuge, transferred them to water bath at 68^oc, immersed them to the top of fat column and left for 2-3 minutes until column was in equilibrium. The tubes were taken out and adjusted the stopper

to bring the lower end of the fat column against a unit graduation and read from their to the lowest part of the upper miniscus.

2. Milk Protein

Poured 10ml of milk into a 500ml Kjeldahl digestion flask, directly on to the bottom. To this 0.7g. of mercuric oxide, 15g. of powdered potassium sulphate and 25ml of Concentrated H_2SO_4 was added and heated over a low flame till a major portion of water is evaporated. Finally using a blue full flame and the digestion was completed. Nitrogen content was determined according to Kjeldahl method. For calculation of total nitrogen content the values were multiplied by the factor 6.38 to obtain protein content of the milk.

3. Milk Ash

Poured 25 ml. of the milk into a previously dried and weighed silica crucible and weighed as quickly as possible. Heated on low flame to evaporate milk to dryness (skin of the milk was broken periodically with glass rod). When dried, increased the heat until the contents were ignited with a lighted taper. Transferred the crucible to a muffle-furnace and ignited at $600^{\circ}C$ for two hours. Cooled and recorded its ash contents.

4. Milk Lactose

Lactose percentage was estimated with the help of following formula:-

$$\text{Lactose \%} = \text{Total solids \%} - (\% \text{ Fat} + \% \text{ Protein} + \% \text{ Ash})$$

5. Milk Total Solids (TS)

Total solids mean the residue left after complete evaporation of water from milk. It includes fat, proteins, lactose and mineral matter of milk.

The moisture cup was placed in the oven for 30 minutes. Add 5 ml of milk with a pipette and weighed as quickly as possible. So that constant evaporation could be avoided. After that the moisture cup was placed in the

oven at 100°C until the weight is constant. It is cooled in desiccator to record its weight. Calculate total solids as a percentage of volume of milk.

6. Milk Solids Not Fat (S.N.F.)

Solids not fat (S.N.F.) percentage was estimated with the help of following formula:-

$$\text{Solids not fat \%} = \text{Total Solids \%} - \text{Fat \%}$$

Analysis of Blood

The blood samples from the calves under 1 year age, Non-pregnant-non-lactating, Non-pregnant-lactating and Pregnant-Non-lactating cross-bred cows were collected every week in different seasons of the year for estimating various blood parameters. Shaved the hair from the skin on the site of jugular vein, washed with 70% alcohol and allowed it to dried. Blood collection was done in the morning hours between 7.30 to 8.00 A.M. after an overnight fasting. The bleeding was done under aseptic condition by means of a sterilised 16 gauge hypodermic stainless steel needle from the jugular vein. Discarded first few drops of blood and then collected in a suitable well dried container which contained an anticoagulant (Sodium fluoride 10.0 mg/ml of blood for blood glucose estimation and for other blood parameters Ethylene diamine tetra acetic acid (EDTA) 1.0 mg/ml of blood was used). Mixed blood with anticoagulant by rotatory movement.

A. Haematological Parameters

1. Haemoglobin

Haemoglobin was estimated in samples of blood with the help of Photoelectric haemoglobinometer (Systronics India- Model 185). This instrument works on Gyannethaemoglobin principles directed by Drobkin (1944).

Reagents

0.20 gm Potassium ferric cyanide

0.05 gm Potassium cyanide

1.0 gm Sodium bi-carbonate

These reagents are dissolved in 1 litre of distilled water.

Procedure

5 ml Drobkin's solution was taken in a test tube and 0.02 ml blood was added and mixed thoroughly. The test tube left for 20 minutes at room temperature. The zero point of instrument was adjusted with the help of blank solution. Then placed the sample inside the instrument and the value of haemoglobin were directly read on the scale, expressed in gm.

2. Total Erythrocytes Count (TEC) (Red Blood Corpuscles)

The method described by Gupta *et. al.* (1992) was followed for counting erythrocytes.

Principle

A measured quantity of blood is diluted with a fluid which is isotonic with blood and prevents its coagulation. The diluted blood is spread on a counting chamber and the number of cells in a circumscribed volume is counted under the microscope.

Diluting Fluid

A solution of 1% formalin (40% formaldehyde) in 31.3 gm/l trisodium citrate was freshly made and filtered.

Procedure

(i) Took a few drops of blood on a watch glass. Sucked up 0.5 mark of the R.B.C. pipette. Wiped out tip of the R.B.C. pipette.

(ii) Took sufficient quantity of diluting fluid on a separate watch glass.

(iii) Drew the diluting fluid into the same pipette (containing blood up to 0.5 mark) up to 101 mark.

(iv) Shook the pipette atleast for 3 minutes by folding it loosely in one hand (after removing attached rubber tube) between the thumb and the fore fingers.

(v) Placed a cover slip on the counting chamber. Discarded few drops from pipette and then placed a small quantity of the diluted blood between the cover slip and counting chamber.

(vi) Allowed the solution to settle down for a few minutes and then started counting under high power lense of the microscope.

(vii) In the Neubauer ruling small squares in the central large 1 mm square were used for counting erythrocytes. The number of cells in the four corner squares and one central square of 16 squares were counted including those cells which lie within the area or on the dividing lines to the left or above the section.

Calculation

Red blood cells/mm³ of blood = Number of cells in 5 squares x 10000.

3. Total Leucocytes Count (TLC) (White blood Corpuscles)

The method described by Olsen (1937) was followed for counting of leucocytes.

Principle

The blood is diluted (20 times) with a diluent which destroys the red blood cells. The diluted blood is placed in a Neubauer counting chamber for counting.

Diluting Fluid

Mixed 2.0 ml glacial acetic acid and one drop of gentian violet in 100 ml of distilled water.

Procedure

Procedure was similar to that for R.B.C. except :-

- (i) Fluid was drawn up to 11 mark (20 times dilution)
- (ii) Counting was made in four large (1 mm) corner squares of Neubauer counting chamber and expressed in thousand per mm^3 .

Calculation

$$\text{WBC}/\text{mm}^3 \text{ of blood} = \text{Total number of cells in four large corner squares} \times 50$$

4. Packed Cell Volume (PCV)

Principles

On centrifugation of blood in heparinised capillary tubes in micro haematocrit centrifuge, the cells settle down and Packed cell volume is read on the reader.

Procedure

- (i) Took blood collected in EDTA up to 1 / 2 or 3 / 4th length of the haematocrit tube.
- (ii) Sealed the tube on the opposite end using sealing wax.
- (iii) Transferred the tubes to the high speeds haematocrit centrifuge and placed in grooves of the centrifuge head.
- (iv) Centrifuged for 5 minutes at 11000 r.p.m. and then read on the reader to get direct haematocrit value in per cent.

B. Bio-chemical Parameters

1. Serum Cholesterol

The method described by Zack (1957) was adopted for estimation of serum cholesterol.

Principle

Proteins are precipitated by adding the serum to a stable ferric chloride acetic acid reagent and the colour is developed by adding Sulphuric acid to a portion of protein free extract. The colour measurement is made in spectrophotometer at 560 nm and the amount of total cholesterol is calculated.

Reagents

1. Acetic acid

Purified by treating the analytical the reagent under reflux with about 1% (w/v) chromium trioxide for two hours and distilled. Discarded first 10% of the distillate.

2. Ferric Chloride - Acetic acid reagent

Prepared 0.05% solution of Ferric chloride (A.R.) in pure acetic acid (reagent no. 1).

3. Concentrated H₂SO₄

4. Stock Cholesterol Solution

1 mg/ml in pure acetic acid.

5. Cholesterol Standard Solution

Diluted 1 ml stock solution to 25 ml with Ferric chloride - acetic acid reagent. Five millilitres of this solution contain 0.2 mg of cholesterol.

Procedure

- (i) Added 0.1 ml of serum to 10 ml ferric chloride - acetic acid reagent in glass stoppered centrifuge tube, mixed well and set a side for 10-15 minutes (or over night) for the proteins to flocculate.
- (ii) Centrifuged the contents and transferred 5 ml of clear supernant fluid to a glass stoppered test tube.
- (iii) Put 5 ml of Ferric chloride - acetic acid reagents (blank) and 5ml of cholesterol standard into other two tubes, respectively.
- (iv) Added 3 ml of sulphuric acid from burette to each tube.
- (v) Stoppered the tubes tightly and mixed the contents thoroughly by repeated inversion.
- (vi) Loosen the stoppers carefully and set the tube a side for 20-30 minutes for full colour development.
- (vii) Measured the colour against the blank in a Spectrophotometer at 560 nm.

Calculation

$$\text{Cholesterol(mg / 100ml)} = \frac{\text{O. D. of unknown}}{\text{O. D. of known}} \times 0.2 \times 2000$$

2. Serum Protein

Protein content was analysed by conventional Kjeldahl method (A.O.A.C.,1960). 1 ml of serum was digested in the presence of digestion mixture (CuSO₄ 20%, Na₂SO₄ 80%) and H₂SO₄. After complete digestion the digested material was transferred into distillation flask. An aliquot was distilled with 40 per cent NaOH and ammonia liberated was collected in about 10 ml. 2 per cent boric acid solution containing Tashiro's indicator, ammonia trapped with boric acid was treated against N/7 H₂SO₄. The amount of nitrogen was multiplied by a factor 6.25 to get the protein value in the serum.

3. Blood Urea

Diacetyl mono-oxine method described by Oser (1965) was adopted for determination of blood urea.

Principle

In this method when urea is heated with Diacetyl mono-oxine in acid solution a yellow colour develops. This colour, depends on oxidation with per sulphate, is compared in the colorimeter with a standard urea solution similarly treated.

Reagents

- (i) Sulphuric acid 50% by volume.
- (ii) Diacetyl mono- oxine: - A 3 per cent aqueous solution kept atleast 4 week at room temperature becomes stable and keeps indefinitely if stoppered lightly and kept in refrigerator when not being used.
- (iii) Potassium per Sulphate Solution: - A 1 per cent aqueous solution should be kept in refrigerator and made up every week.
- (iv) Standard urea nitrogen stock Solution:- Prepared a standard urea solution containing 0.643 g. of pure dry urea in one litre of distilled water (5 ml contains 1.5 mg. Urea nitrogen).
- (v) Standard urea nitrogen working Solution:- 5 ml of stock urea solution in a 100 ml volumetric flask and diluted to mark (3 ml contain 0.45 mg urea nitrogen).
- (vi) Tungstic acid blood Filtrate :- One ml blood was taken in a graduated test tube (15 ml capacity) and in this test tube added 7 ml of distilled water, 1 ml of 10 per cent Sodium Tungstate solution and finally added 1 ml of $\frac{2}{3}$ N H_2SO_4 and mixed properly. This mixture was kept for 10

minutes and filtered through filter paper No. 42. Funnel was covered with a watch glass during filtration to minimise evaporation.

Procedure

Placed 3 ml of Tungstic acid blood filtrate solution in a test tube, 3 ml urea standard solution in second test tube and 3 ml distilled water in third test tube. To each tube added exactly 4 ml of concentrated sulphuric acid and 0.5 ml Diacetyl amino - oxine solution. Mixed the contents by rotation, cover each tube by glass marble and placed the tube in vigorously boiling water bath for 10 minutes, removed from bath and within 5 minutes without cooling slowly added 0.20 ml of per sulphate solution. So that a separate layer is formed. Put stopper and mixed quickly within 10 minutes read all the tubes in photoelectric colorimeter using were length of 420 millimicron.

Calculation

$$\text{mg of urea nitrogen / 100 ml of blood} = \frac{\text{Densities of unknown}}{\text{Densities of standard}} \times 0.045 \times \frac{100}{0.3}$$

4. Blood Glucose

Principle

The protein-free blood filtrate is heated with alkaline copper solution, using a tube to prevent re-oxidation. The cuprous oxide, thus, formed is treated with phosphomolybdic acid solution to obtain a blue colour the density of which is compared with that of standard (Folin and Wu, 1920).

Reagents

(i) 10% Sodium tungstate solution:- Dissolved 10 g. of reagent grade carbonate free sodium tungstate in distilled water and diluted into 100 ml.

(ii) 0.66 N H_2SO_4 - Added 3.5 g (1.86 ml) of concentrated H_2SO_4 in a 100 ml volumetric flask - filled with water. Made the volume up to the mark. Titrated against standard alkali to adjust normality, if necessary.

(iii) Alkaline copper Solution :- Dissolved 4.0 g of pure anhydrous Sodium carbonate in about 40 ml of water in a 100 ml volumetric flask. Added 0.75 g of tartaric acid and dissolved. Then added 0.45 g of copper sulphate, mixed and made the volume up to the mark. The solution may be filtered, if necessary, through good quality filter paper, the solution can be kept indefinitely.

(iv) Phosphomolybdic acid solution:- Took 35 g of molybdic acid and 5 g of sodium tungstate in a beaker. Added 200 ml of 10% sodium hydroxide and 200 ml of distilled water. Boiled vigorously for 20-40 minutes to removed ammonia present in the molybdic acid. Cooled it and diluted to 350 ml. Added 125 ml of concentrated phosphoric acid and diluted to 500 ml.

(v) Standard Glucose solution:- Prepared saturated of benzoic acid. Made 1% solution of highly purified glucose in saturated benzoic acid (stock solution). Diluted 20 ml of stock solution to 100 ml with water to get concentration of 2 mg of glucose per millilitre. Took 5 ml and 10 ml of diluted sugar solution separately and made the volume to 100 ml with water (working solutions containing 0.2 and 0.4 mg, respectively, in 2 ml).

Procedure

(i) Preparation of tungstic acid blood filtrate : - Took 1 ml of blood in a graduated tube (15 ml capacity). Added exactly 7 ml of water and mixed. Finally, added 1 ml of 0.66N H_2SO_4 slowly with shaking. Put stopper and shaken well. Allowed it to stand for 10 minutes. The change in colour from red to brown indicates complete coagulation. If coagulation is not complete added

10% H₂SO₄ drop by drop with shaking until there is no foaming and the dark brown coagulation has set in; and made the volume to 10ml mark. Filtered this solution through filter paper in a dry container until as much filtrate as possible was obtained. Funnel covered with a watch glass during filtration to minimize evaporation.

(ii) Transferred 2ml of filtrate to a Folin - Wu sugar tube graduated at 25ml. Took 2ml of standard sugar solution containing 0.2 and 0.4mg of glucose, respectively, in other similar tubes.

(iii) For blank, took 2ml water in another Folin - Wu tube.

(iv) Added 2ml of alkaline copper solution to each tube. Heated for eight minutes after transferring the tubes rapidly on to a water bath. Cooled in running water without shaking.

(v) Added 2ml of Phosphomolybdic acid reagent to each tube and waited for one minute. Then made the volume up to mark (25ml) with water, and mixed well.

(vi) Recorded the optical density at 420nm, setting the photoelectric colorimeter to zero density with the blank solution.

Calculation

$$\text{Blood glucose (mg / 100 ml)} = \frac{\text{Density of unknown}}{\text{Density of standard}} \times \text{mg glucose in standard} \times \frac{100}{0.2}$$

Statistical Analysis

Calculation of mean, standard error and analysis of variance have been carried out according to the methods described by Snedecor and Cochran (1968).

EXPERIMENTAL

RESULTS

EXPERIMENTAL RESULTS

Seasonal average of climatic data from December, 1998 to November, 1999

The seasonal average of climatic data of out side the shed environment from December, 1998 to November, 1999 have been presented in Table-1.

Chemical composition of the feeds

Samples of the wheat straw and concentrate mixture were collected daily from the feed given to the experimental animals. A part of the sample was dried in hot air oven for analysis and rest of the sample was processed for analysis of crude protein, ether extract, crude fibre, nitrogen free extract and total ash. The data of chemical composition of different feeds have been shown in Table-2.

Effect of seasons on dry matter consumption

Body weight of the experimental animals viz., calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and Pregnant-Non-lactating cross-bred cows and their intake of dry matter in different seasons are presented in Table-3.

The body weight of calves under one year of age was 86.95 ± 3.29 , 87.55 ± 3.26 , 89.00 ± 3.53 , 91.20 ± 3.38 and 90.10 ± 3.84 (Kg.) in winter, spring, summer, rainy and autumn seasons, respectively.

The body weight of Non-Pregnant-Non-lactating cross-bred cows was 63.45 ± 13.15 , 270.40 ± 12.89 , 270.10 ± 11.95 , 270.80 ± 12.53 and 269.00 ± 3.55 Kg. in winter, spring, summer, rainy and autumn seasons, respectively.

The body weight of Non-Pregnant-lactating cross-bred cows was 345.00 ± 10.93 , 350.80 ± 10.48 , 348.70 ± 10.56 , 349.80 ± 11.02 and 353.50 ± 11.59 Kg. in winter, spring, summer, rainy and autumn seasons, respectively.

The body weight of Pregnant-Non-lactating cross-bred cows was 365.90 ± 7.79 , 369.40 ± 7.81 , 367.50 ± 7.89 , 373.40 ± 7.83 and 374.60 ± 7.13 Kg. in winter, spring, summer, rainy and autumn seasons, respectively.

Dry matter consumption per day by calves under one year of age was 2.50 ± 0.11 , 2.25 ± 0.09 , 2.15 ± 0.09 , 2.40 ± 0.10 and 2.32 ± 0.10 Kg. in winter, spring, summer, rainy and autumn seasons, respectively. The higher dry matter consumption was found in winter season followed by rainy, autumn, spring and summer season, respectively. The analysis of variance of data showed that non-significant difference was found between different seasons of the year (Table-3-a).

Dry matter consumption per day by Non-Pregnant-Non-lactating cross-bred cows was 7.64 ± 0.35 , 6.96 ± 0.36 , 6.70 ± 0.34 , 7.40 ± 0.35 and 7.15 ± 0.35 Kg. in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data revealed that there was non-significant difference among different seasons of the year (Table-3-d). The maximum dry matter intake was found in winter season followed by rainy, autumn, spring and summer seasons, respectively.

Dry matter consumption per day by Non-Pregnant-lactating cross-bred cows was 10.05 ± 0.26 , 9.07 ± 0.30 , 8.74 ± 0.28 , 9.55 ± 0.29 and 9.21 ± 0.30 Kg. in winter, spring, summer, rainy and autumn seasons, respectively. The analysis of variance of data revealed that significant difference ($P < 0.05$) in dry matter consumption among the different seasons of the year (Table-3-g). Analysis of data showed that dry matter consumption was significantly higher

($P < 0.05$) in winter season than other seasons of the year, while, spring and summer, rainy and winter, autumn and rainy seasons did not touch the level of significance.

Dry matter consumption per day by Pregnant-Non-lactating cross-bred cows was 10.83 ± 0.20 , 9.79 ± 0.17 , 9.32 ± 0.18 , 10.41 ± 0.20 and 10.00 ± 0.18 Kg. in winter, spring, summer, rainy and autumn seasons, respectively. The analysis of variance of data showed that highly significant differences ($P < 0.01$) were found among different seasons of the year (Table-3-J). Critical difference analysis of data showed that dry matter consumption was significantly higher ($P < 0.01$) in winter season than other seasons of the year. Whereas, winter and rainy, spring, rainy and autumn, rainy and autumn seasons remained unaffected and found to be non-significant.

Dry matter consumption/100 Kg body weight/day by calves under one year of age was 2.86 ± 0.03 , 2.57 ± 0.02 , 2.42 ± 0.03 , 2.63 ± 0.06 and 2.58 ± 0.07 Kg in winter, spring, summer, rainy and autumn seasons, respectively (Table-3). Statistical analysis of data (Table-3-b) brought highly significant difference ($P < 0.01$) in the consumption of dry matter/100 Kg body weight in different seasons. Analysis of data showed that the consumption of dry matter/100 Kg body weight was significantly higher ($P < 0.01$) in winter season than other seasons of the year, while, spring and summer, rainy and autumn seasons found to be non-significant.

Dry matter consumption/100 Kg body weight/day by Non-Pregnant-Non-lactating cross-bred cows was 2.91 ± 0.03 , 2.57 ± 0.03 , 2.47 ± 0.02 , 2.73 ± 0.02 and 2.66 ± 0.03 Kg in winter, spring, summer, rainy and autumn seasons, respectively (Table-3). The analysis of variance of data showed that highly significant difference ($P < 0.01$) was found among different seasons of the year (Table-3-e). The dry matter consumption/100 Kg body weight was statistically

($P < 0.01$) higher in winter season followed by rainy, autumn, spring and summer seasons. Whereas, spring and rainy, rainy and autumn seasons are found non-significant.

Dry matter consumption/100 Kg body weight/day by Non-Pregnant-lactating cross-bred cows was 2.92 ± 0.02 , 2.58 ± 0.02 , 2.51 ± 0.02 , 2.71 ± 0.02 and 2.61 ± 0.02 Kg in winter, spring, summer, rainy and autumn seasons, respectively (Table-3). Analysis of variance of data revealed that highly significant difference ($P < 0.01$) in dry matter consumption/100 Kg body weight in different seasons of the year (Table-3-h). Critical difference analysis of data revealed that dry matter consumption/100 Kg body weight was significantly higher ($P < 0.01$) in winter season than other seasons of the year, while, spring and autumn seasons did not touch the level of significance.

Dry matter consumption/100 Kg body weight/day by Pregnant-Non-lactating cross-bred cows was 2.96 ± 0.01 , 2.65 ± 0.03 , 2.54 ± 0.01 , 2.79 ± 0.02 and 2.67 ± 0.03 Kg in winter, spring, summer, rainy and autumn seasons, respectively (Table-3). Statistical analysis of data showed that highly significant difference ($P < 0.01$) in dry matter consumption/100 Kg body weight in different seasons of the year (Table-3-k). Statistically higher dry matter consumption/100 Kg body weight was found in winter season followed by rainy, autumn, spring and summer seasons. Whereas, spring, summer, rainy and autumn, autumn and summer, rainy and autumn seasons were showed non-significant difference from each other.

Dry matter intake per Kg metabolic body weight/day in calves under one year of age was 87.41 ± 1.59 , 78.57 ± 1.13 , 74.11 ± 1.26 , 81.18 ± 1.88 and 79.39 ± 2.08 gram in winter, spring, summer, rainy and autumn seasons, respectively (Table-3). Analysis of variance of data revealed that highly

significant difference ($P < 0.01$) were observed among the different seasons of the year (Table-3-c). Dry matter intake per Kg. metabolic body weight in gram was significantly higher ($P < 0.01$) in winter season than other seasons of the year, while, spring, rainy and autumn seasons did not differ significantly to each other.

Dry matter intake per Kg. metabolic body weight/day in Non-Pregnant-Non-lactating cross-bred cows was 116.77 ± 1.52 , 104.16 ± 1.86 , 100.17 ± 1.76 , 110.63 ± 1.65 and 107.50 ± 1.66 gram in winter, spring, summer, rainy and autumn seasons, respectively (Table-3). Statistical analysis of data showed that highly significant difference ($P < 0.01$) were found among the different seasons of the year (Table-3-f). Critical difference analysis of data showed that significantly ($P < 0.01$) higher dry matter intake per Kg metabolic body weight in gram, was found in winter season followed by rainy, autumn, spring and summer seasons. Whereas, spring, summer and autumn, rainy and autumn seasons showed non-significant difference.

Dry matter intake per Kg metabolic body weight/day in Non-Pregnant-lactating cross-bred cows was 125.53 ± 0.73 , 111.73 ± 1.35 , 108.23 ± 1.28 , 117.99 ± 0.97 and 112.84 ± 1.08 gram in winter, spring, summer, rainy and autumn seasons, respectively (Table-3). The analysis of variance of data revealed that highly significant difference ($P < 0.01$) were found in various seasons of the year (Table-3-i). Dry matter intake per Kg metabolic body weight was significantly higher ($P < 0.01$) in winter season than other seasons of the year, while, spring and autumn seasons did not touch the level of significance.

Dry matter intake per Kg metabolic body weight/day in Pregnant-Non-lactating cross-bred cows was 129.40 ± 0.36 , 116.17 ± 1.00 , 110.97 ± 0.46 ,

122.51 \pm 0.84 and 117.47 \pm 1.18 gram in winter, spring, summer, rainy and autumn seasons, respectively (Table-3). Statistical analysis of data (Table-3-1) showed highly significant difference ($P < 0.01$) were observed in various seasons of the year. Significantly higher ($P < 0.01$) dry matter intake per Kg metabolic body weight was found in winter season than other seasons of the year. Whereas, spring and autumn seasons did not differ significantly.

Effect of seasons on digestibility coefficient of Nutrients

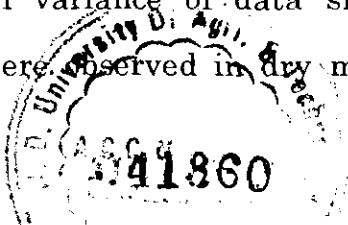
The digestibility coefficient of various nutrients in different seasons by calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and Pregnant-Non-lactating cross-bred cows are described below :-

Dry matter digestibility

The digestibility coefficient of dry matter in calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and Pregnant-Non-lactating cross-bred cows in different seasons have been presented in Table-4.

The digestibility coefficient of dry matter in calves under one year of age was 69.10 \pm 0.23, 66.01 \pm 0.19, 61.54 \pm 0.18, 64.72 \pm 0.28 and 67.46 \pm 0.29 in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of the data revealed that highly significant ($P < 0.01$) difference in the dry matter digestibility among various seasons of the year (Table-4-a). Significantly higher dry matter digestibility was found in winter season than other seasons of the year.

The digestibility coefficient of dry matter in Non-Pregnant-Non-lactating cross-bred cows was 66.96 \pm 0.11, 63.88 \pm 0.22, 58.18 \pm 0.19, 58.46 \pm 0.25 and 64.91 \pm 0.19 in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data showed that highly significant differences ($P < 0.01$) were observed in dry matter digestibility in different



seasons of the year (Table-4-b). Critical difference analysis showed that significantly higher ($P < 0.01$) dry matter digestibility was found in winter season followed by autumn, spring, rainy and summer seasons. Whereas, digestibility of dry matter did not differ in summer and rainy season.

The digestibility coefficient of dry matter in Non-Pregnant-lactating cross-bred cows was 67.42 ± 0.12 , 64.17 ± 0.16 , 59.57 ± 0.16 , 62.67 ± 0.26 and 65.32 ± 0.29 in winter, spring, summer, rainy and autumn seasons, respectively. The analysis of variance of data showed that highly significant difference ($P < 0.01$) in dry matter digestibility among various seasons of the year (Table-4-c). Statistically higher digestibility of dry matter was found in winter season than other seasons of the year.

The digestibility coefficient of dry matter in Pregnant-Non-lactating cross-bred cows was 67.09 ± 0.07 , 64.07 ± 0.17 , 59.53 ± 0.15 , 62.70 ± 0.27 and 65.29 ± 0.29 in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data marked out that highly significant difference ($P < 0.01$) in dry matter digestibility in different seasons of the year (Table-4-d). Significantly higher digestibility of dry matter was observed in winter season than in autumn, spring, rainy and summer seasons.

Crude protein digestibility

The digestibility coefficient of crude protein in calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and Pregnant- Non-lactating cross-bred cows in different seasons have been presented in Table-5.

The digestibility coefficient of crude protein in calves under one year of age was 67.64 ± 0.17 , 63.25 ± 0.15 , 52.26 ± 0.20 , 59.36 ± 0.19 and 62.91 ± 0.12 in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data showed that highly significant differences ($P < 0.01$) were

found in crude protein digestibility in various seasons of the year (Table-5-a). Statistically higher crude protein digestibility was observed in winter season than in spring, autumn, rainy and summer seasons. Where as spring and autumn seasons did not differ significantly.

The digestibility coefficient of crude protein in Non-Pregnant-Non-lactating cross-bred cows was 66.85 ± 0.16 , 61.80 ± 0.18 , 50.45 ± 0.17 , 55.94 ± 0.13 and 61.63 ± 0.14 in winter, spring, summer, rainy and autumn seasons, respectively. The analysis of variance of data revealed that highly significant differences ($P < 0.01$) were observed in crude protein digestibility among various seasons of the year (Table-5-b). Critical difference analysis showed that significantly higher crude protein digestibility was observed in winter season than other seasons of the year, while, spring and autumn seasons did not touch the level of significance.

The digestibility coefficient of crude protein in Non-Pregnant-lactating cross-bred cows was 67.54 ± 0.17 , 63.15 ± 0.14 , 52.18 ± 0.21 , 59.31 ± 0.19 and 62.84 ± 0.12 in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data marked out that highly significant differences ($P < 0.01$) were observed in various seasons of the year (Table-5-c). Digestibility of crude protein was significantly higher in winter season than spring, autumn, rainy and summer seasons. Whereas, spring and autumn seasons did not differ significantly.

The digestibility coefficient of crude protein in Pregnant-Non-lactating cross-bred cows was 67.45 ± 0.17 , 62.99 ± 0.12 , 52.02 ± 0.20 , 59.14 ± 0.18 and 62.71 ± 0.11 in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data revealed that highly significant differences ($P < 0.01$) were observed among various seasons of the year

(Table-5-d). Significantly higher digestibility of crude protein was observed in winter season than other seasons of the year, while, spring and autumn seasons showed non- significant difference.

Ether Extract digestibility

The digestibility coefficient of ether extract in calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and Pregnant-Non-lactating cross-bred cows in different seasons have been presented in Table-6.

The digestibility coefficient of ether extract in calves under one year of age was 71.28 ± 0.16 , 69.92 ± 0.14 , 68.58 ± 0.28 , 67.60 ± 0.22 and 70.43 ± 0.14 in winter, spring, summer, rainy and autumn seasons, respectively. The analysis of variance of data showed that highly significant differences ($P < 0.01$) were observed in digestibility of ether extract in different seasons of the year (Table-6-a). Analysis of data showed that significantly higher ether extract digestibility was found in winter season followed by autumn spring, summer and rainy seasons.

The digestibility coefficient of ether extract in Non-Pregnant-Non-lactating cross-bred cows was 70.55 ± 0.12 , 68.87 ± 0.20 , 67.97 ± 0.21 , 67.22 ± 0.18 and 69.94 ± 0.13 in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data revealed that highly significant difference ($P < 0.01$) in the ether extract digestibility among different seasons (Table-6-b). Critical difference marked out that the digestibility of ether extract was found significantly higher in winter season than autumn, spring, summer and rainy seasons.

The digestibility coefficient of ether extract in Non-Pregnant-lactating cross-bred cows was 71.10 ± 0.15 , 69.75 ± 0.13 , 68.34 ± 0.30 , 67.54 ± 0.18 and 70.24 ± 0.15 in winter, spring, summer, rainy and autumn seasons,

respectively. Analysis of variance of data marked out that highly significant differences ($P < 0.01$) exists in the digestibility of ether extract in different seasons of the year (Table-6-c). Digestibility coefficient of ether extract was observed significantly higher in winter season than the other seasons of the year, while, spring and autumn seasons did not differ significantly.

The digestibility coefficient of ether extract in Pregnant-Non-lactating cross-bred cows was 70.69 ± 0.12 , 69.08 ± 0.18 , 68.14 ± 0.19 , 67.43 ± 0.16 and 70.15 ± 0.14 in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data revealed that highly significant difference ($P < 0.01$) was observed in ether extract digestibility among various seasons of the year (Table-6-d). Significantly higher digestibility of ether extract was in winter season followed by autumn, spring, summer and rainy seasons.

Crude Fibre digestibility

The digestibility coefficient of crude fibre in calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and Pregnant-Non-lactating cross-bred cows in different seasons have been shown in Table-7.

The digestibility coefficient of crude fibre in calves under one year of age was 55.96 ± 0.10 , 60.63 ± 0.07 , 61.74 ± 0.05 , 59.04 ± 0.07 and 59.62 ± 0.10 in winter, spring, summer, rainy and autumn seasons, respectively. The analysis of variance of data revealed that highly significant difference ($P < 0.01$) was observed in crude fibre digestibility among various seasons of the year (Table-7-a). Critical difference analysis showed that significantly higher crude fibre digestibility was found in summer season than spring, autumn, rainy and winter seasons.

The digestibility coefficient of crude fibre in Non-Pregnant-Non-lactating cross-bred cows was 54.88 ± 0.18 , 59.87 ± 0.11 , 60.59 ± 0.11 , 58.43 ± 0.11 and 59.06 ± 0.14 in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data marked out that highly significant difference ($P < 0.01$) was observed in crude fibre digestibility in different seasons of the year (Table-7-b). Digestibility coefficient of crude fibre was significantly higher in summer season followed by spring, autumn, rainy and winter seasons.

The digestibility of crude fibre in Non-Pregnant-lactating cross-bred cows was 55.65 ± 0.13 , 60.35 ± 0.12 , 61.48 ± 0.08 , 58.73 ± 0.10 and 59.45 ± 0.13 per cent in winter, spring, summer, rainy and autumn seasons, respectively. The analysis of variance of data showed that highly significant difference ($P < 0.01$) in crude fibre digestibility was observed in different seasons of the year (Table-7-c). Critical difference analysis observed that digestibility coefficient of crude fibre was significantly higher in summer season than spring, autumn, rainy and winter seasons.

The digestibility coefficient of crude fibre in Pregnant-Non-lactating cross-bred cows was 55.08 ± 0.18 , 60.10 ± 0.12 , 60.89 ± 0.14 , 58.65 ± 0.13 and 59.25 ± 0.15 in winter, spring, summer, rainy and autumn seasons, respectively. An examination of data revealed that highly significant difference ($P < 0.01$) in crude fibre digestibility was observed among different seasons (Table-7-d). Critical difference analysis of data showed that significantly higher ($P < 0.01$) in summer season than other seasons of the year.

Nitrogen Free Extract digestibility

The digestibility coefficient of Nitrogen free extract in calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and

Pregnant-Non-lactating cross-bred cows in different seasons have been presented in Table-8.

The digestibility coefficient of Nitrogen free extract in calves under one year of age was 70.87 ± 0.16 , 69.94 ± 0.12 , 72.33 ± 0.24 , 72.62 ± 0.23 and 69.77 ± 0.14 in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data revealed that highly significant difference ($P < 0.01$) was found in digestibility coefficient of Nitrogen free extract in different seasons of the year (Table-8-a). Critical difference analysis showed that significantly higher Nitrogen free extract digestibility was observed in rainy season than summer, winter, spring and autumn seasons, while, spring and autumn, summer and rainy seasons did not touch the level of significance.

The digestibility coefficient of Nitrogen free extract in Non-Pregnant-Non-lactating cross-bred cows was 69.96 ± 0.19 , 69.15 ± 0.09 , 71.42 ± 0.30 , 71.56 ± 0.39 and 69.05 ± 0.12 in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data showed that highly significant difference ($P < 0.01$) was observed in different seasons of the year (Table-8-b). Digestibility coefficient of nitrogen free extract was observed significantly higher in rainy season followed by summer, winter, spring and autumn seasons, whereas, spring and autumn, summer and rainy seasons did not differ significantly to each other.

The digestibility coefficient of nitrogen free extract in Non-Pregnant-lactating cross-bred cows was 70.40 ± 0.14 , 69.55 ± 0.10 , 71.95 ± 0.27 , 72.25 ± 0.31 and 69.46 ± 0.14 in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data marked out that highly significant difference ($P < 0.01$) was found among various seasons (Table-8-c).

Digestibility coefficient of nitrogen free extract was observed significantly higher in rainy season than summer, winter, spring and autumn seasons, while, spring and autumn, summer and rainy seasons did not touch the level of significance.

The digestibility coefficient of nitrogen free extract in Pregnant-Non-lactating cross-bred cows was 70.28 ± 0.18 , 69.31 ± 0.10 , 71.74 ± 0.26 , 71.93 ± 0.36 and 69.20 ± 0.13 in winter, spring, summer, rainy and autumn seasons, respectively. An examination of data revealed that highly significant difference ($P < 0.01$) was observed in digestibility coefficient of nitrogen free extract among various seasons of the year (Table-8-d). Critical difference analysis of data showed significantly higher ($P < 0.01$) in rainy season than other seasons of the year, while, differences between spring and autumn, summer and rainy seasons were found to be non-significant.

Organic matter digestibility

The digestibility coefficient of organic matter in calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and Pregnant-Non-lactating cross-bred cows in different seasons have been shown in Table-9.

The digestibility coefficient of organic matter in calves under one year of age was 60.91 ± 0.42 , 60.60 ± 0.41 , 58.24 ± 0.37 , 60.27 ± 0.40 and 60.35 ± 0.42 in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data revealed that highly significant difference ($P < 0.01$) was observed in organic matter digestibility among various seasons of the year (Table-9-a). Digestibility coefficient of organic matter was found significantly higher in winter season than spring, autumn, rainy and summer

seasons. Whereas, digestibility coefficient of organic matter in winter, spring, rainy and autumn seasons did not differ to each other.

The digestibility coefficient of organic matter in Non-Pregnant-Non-lactating cross-bred cows was 60.02 ± 0.43 , 59.66 ± 0.39 , 57.20 ± 0.46 , 59.33 ± 0.32 and 59.57 ± 0.41 in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data marked out that highly significant difference ($P < 0.01$) was observed in digestibility coefficient of organic matter in different seasons of the year (Table-9-b). Critical difference analysis of data showed that significantly higher organic matter digestibility was found in winter season than other seasons of the year, while, winter, spring, rainy and autumn seasons did not differ significantly to each other.

The digestibility coefficient of organic matter in Non-Pregnant-lactating cross-bred cows was 60.56 ± 0.42 , 60.24 ± 0.41 , 57.70 ± 0.46 , 59.97 ± 0.41 and 60.14 ± 0.41 in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data showed that highly significant difference ($P < 0.01$) was observed in digestibility coefficient of organic matter in different seasons of the year (Table-9-c). Digestibility coefficient of organic matter was found significantly higher in winter season followed by spring, autumn, rainy and summer seasons, while winter, spring, rainy and autumn seasons did not differ significantly to each other.

The digestibility coefficient of organic matter in Pregnant-Non-lactating cross-bred cows was 60.29 ± 0.42 , 59.98 ± 0.41 , 57.51 ± 0.42 , 59.67 ± 0.40 and 59.95 ± 0.41 in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data revealed that highly significant difference ($P < 0.01$) was observed among various seasons of the year (Table-9-d). Digestibility coefficient of organic matter was found significantly

higher in winter season than spring, autumn, rainy and summer seasons, while, differences among winter, spring, rainy and autumn seasons were found to be non-significant.

Effect of seasons on Nitrogen balance

The nitrogen balance in calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and Pregnant-Non-lactating cross-bred cows in different seasons have been presented in Table-10.

The nitrogen balance in calves under one year of age was 25.34 ± 0.18 , 23.62 ± 0.22 , 17.23 ± 0.48 , 22.45 ± 0.18 and 24.38 ± 0.33 gram/day in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data showed that highly significant difference ($P < 0.01$) in the nitrogen balance in different seasons of the year (Table-10-a). The nitrogen balance was significantly higher in winter season followed by autumn, spring, rainy and summer seasons. Difference between winter and autumn, autumn and spring seasons were found to be non-significant.

The nitrogen balance in Non-Pregnant-Non-lactating cross-bred cows was 12.20 ± 0.07 , 10.48 ± 0.21 , 7.92 ± 0.09 , 9.23 ± 0.24 and 11.24 ± 0.41 gram/day in winter, spring, summer, rainy and autumn seasons, respectively. The analysis of variance of data revealed that highly significant difference ($P < 0.01$) was observed in various seasons of the year (Table-10-b). Nitrogen balance was observed significantly higher in winter season than autumn, spring, rainy and summer seasons.

The nitrogen balance in Non-Pregnant-lactating cross-bred cows was 23.48 ± 0.19 , 21.76 ± 0.26 , 15.68 ± 0.43 , 20.57 ± 0.21 and 22.52 ± 0.22 gram/day in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data marked out that highly significant difference ($P < 0.01$) in

nitrogen balance was observed among various seasons of the year (Table-10-c). Critical difference analysis showed that significantly higher nitrogen balance was found in winter season than autumn, spring, rainy and summer seasons.

The nitrogen balance in Pregnant-Non-lactating cross-bred cows was 21.86 ± 0.21 , 20.14 ± 0.38 , 14.12 ± 0.22 , 18.89 ± 0.57 and 20.90 ± 0.52 gram/day in winter, spring, summer, rainy and autumn seasons, respectively. The analysis of variance of data showed highly significant difference ($P < 0.01$) in different seasons of the year (Table-10-d). Nitrogen balance was observed significantly higher in winter season than other seasons of the year. Whereas, differences between winter and autumn, spring and autumn seasons were found to be non-significant.

Effect of seasons on Rectal temperature and Cardio-respiratory responses

Rectal temperature

Rectal temperature at 04 hours and 16 hours in calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and Pregnant-Non-lactating cross-bred cows in different seasons have been presented in Table-11.

Rectal temperature at 04 hours in calves under one year of age was 38.4 ± 0.01 , 38.6 ± 0.01 , 38.6 ± 0.01 , 38.6 ± 0.01 and 38.6 ± 0.01 °C in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data showed that highly significant difference ($P < 0.01$) in rectal temperature at 04 hours in different seasons of the year (Table-11-a). Significantly higher rectal temperature was observed in summer season than rainy, spring, autumn and winter seasons, while, spring, rainy and autumn, summer and rainy seasons did not differ significantly to each other.

Rectal temperature at 16 hours in calves under one year of age was 38.5 ± 0.005 , 38.6 ± 0.006 , 38.9 ± 0.003 , 38.6 ± 0.01 and 38.6 ± 0.005 °C in winter, spring, summer, rainy and autumn seasons, respectively. The analysis of variance of data revealed that highly significant difference ($P < 0.01$) was observed among various seasons of the year (Table-11-b). Rectal temperature at 16 hours was significantly higher in summer season followed by rainy, spring, autumn and winter seasons. Whereas, spring, rainy and autumn, spring and autumn seasons were found to be non-significant.

Rectal temperature at 04 hours in Non-Pregnant-Non-lactating cross-bred cows was 38.1 ± 0.02 , 38.3 ± 0.003 , 38.3 ± 0.004 , 38.3 ± 0.006 and 38.3 ± 0.007 °C in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data revealed that highly significant difference ($P < 0.01$) in rectal temperature at 04 hours in different seasons of the year (Table-11-c). Significantly higher rectal temperature at 04 hours was found in summer season than other seasons of the year. Whereas, spring, summer, rainy and autumn seasons did not differ significantly to each other.

Rectal temperature at 16 hours in Non-Pregnant-Non-lactating cross-bred cows was 38.3 ± 0.01 , 38.4 ± 0.006 , 38.5 ± 0.006 , 38.4 ± 0.01 and 38.3 ± 0.006 °C in winter, spring, summer, rainy and autumn seasons, respectively. An examination of data revealed that highly significant difference ($P < 0.01$) was observed in different seasons of the year (Table-11-d). Rectal temperature at 16 hours was significantly higher in summer season than rainy, spring, autumn and winter seasons. Spring season did not significantly differ to rainy and autumn seasons.

Rectal temperature at 04 hours in non-Pregnant-lactating cross-bred cows was 38.3 ± 0.02 , 38.4 ± 0.01 , 38.5 ± 0.006 , 38.5 ± 0.01 and 38.4 ± 0.09 °C in winter, spring, summer, rainy and autumn seasons, respectively. The

analysis of variance of data showed that highly significant difference ($P < 0.01$) was observed in different seasons (Table-11-e). Significantly higher rectal temperature at 04 hours was found in summer season than other seasons of the year. Whereas, spring, summer, rainy and autumn, summer and rainy, rainy and autumn seasons were found to be non-significant.

Rectal temperature at 16 hours in Non-Pregnant-lactating cross-bred cows was 38.4 ± 0.007 , 38.5 ± 0.01 , 38.8 ± 0.006 , 38.5 ± 0.01 and 38.5 ± 0.007 °C in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data revealed that highly significant differences ($P < 0.01$) were observed among various seasons of the year (Table-11-f). Rectal temperature at 16 hours was significantly higher in summer season followed by rainy, spring, autumn and winter seasons, while, spring and rainy, spring and autumn seasons did not differ significantly.

Rectal temperature at 04 hours in Pregnant-Non-lactating cross-bred cows was 38.1 ± 0.02 , 38.3 ± 0.007 , 38.4 ± 0.008 , 38.4 ± 0.01 and 38.3 ± 0.005 °C in winter, spring, summer, rainy and autumn seasons, respectively. An examination of data revealed that highly significant difference ($P < 0.01$) in rectal temperature at 04 hours in different seasons of the year (Table-11-g). Critical difference analysis showed that significantly higher rectal temperature was found in summer season than other seasons of the year. Whereas, spring, summer, rainy and autumn seasons did not differ significantly to each other.

Rectal temperature at 16 hours in Pregnant-Non-lactating cross-bred cows was 38.3 ± 0.01 , 38.4 ± 0.01 , 38.7 ± 0.01 , 38.4 ± 0.009 and 38.4 ± 0.009 °C in winter, spring, summer, rainy and autumn seasons, respectively. The analysis of variance of data showed that highly significant differences ($P < 0.01$) were observed in rectal temperature among various seasons of the

year (Table-11-h). Rectal temperature at 16 hours was significantly higher in summer season than rainy, spring, autumn and winter seasons, while, spring and rainy, spring and autumn seasons were found to be non-significant.

Pulse rate

Pulse rate per minute at 04 hours and 16 hours in calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and Pregnant-Non-lactating cross-bred cows in different seasons have been shown in Table-11.

Pulse rate at 04 hours in calves under one year of age was 60.4 ± 0.54 , 63.2 ± 0.42 , 64.8 ± 0.33 , 64.3 ± 0.31 and 63.0 ± 0.45 per minute in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data showed that highly significant difference ($P < 0.01$) was observed in pulse rate among various seasons of the year (Table-11-i). Significantly higher pulse rate was found in summer season than rainy, spring, autumn and winter seasons, while, spring and autumn, summer and rainy seasons were found statistically non-significant.

Pulse rate at 16 hours in calves under one year of age was 62.5 ± 0.58 , 64.3 ± 0.42 , 66.4 ± 0.43 , 65.8 ± 0.34 and 65.6 ± 0.40 per minute in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data revealed that highly significant differences ($P < 0.01$) were observed in pulse rate at 16 hours in different seasons of the year (Table-11-j). Pulse rate was found significantly higher in summer season than other seasons of the year. Whereas, summer, rainy and autumn, rainy and autumn seasons did not differ significantly to each other.

Pulse rate at 04 hours in Non-Pregnant-Non-lactating cross-bred cows was 60.0 ± 0.47 , 62.9 ± 0.53 , 64.4 ± 0.32 , 64.0 ± 0.20 and 62.7 ± 0.30 per minute

in winter, spring, summer, rainy and autumn seasons, respectively. The analysis of variance of data marked out highly significant difference ($P < 0.01$) in pulse rate in different seasons of the year (Table-11-k). Critical difference analysis showed that significantly higher pulse rate was observed in summer season followed by rainy, spring, autumn and winter seasons, while, spring and autumn, summer and rainy seasons did not touch the level of significance.

Pulse rate at 16 hours in Non-Pregnant-Non-lactating cross-bred cows was 62.1 ± 0.50 , 63.7 ± 0.30 , 66.0 ± 0.41 , 65.1 ± 0.22 and 64.5 ± 0.32 per minute in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data showed that highly significant difference ($P < 0.01$) in pulse rate at 16 hours among different seasons (Table-11-l). Significantly higher pulse rate at 16 hours was found in summer season than the other seasons. Whereas, spring and autumn, rainy and autumn seasons did not differ significantly.

Pulse rate at 04 hours in Non-Pregnant-lactating cross-bred cows was 60.2 ± 0.44 , 63.1 ± 0.43 , 64.7 ± 0.30 , 64.2 ± 0.21 and 62.9 ± 0.23 per minute in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data showed highly significant difference ($P < 0.01$) in pulse rate at 04 hours among different seasons of the year (Table-11-m). Critical difference analysis marked out that pulse rate was significantly higher in summer season than rainy, spring, autumn and winter seasons, whereas, spring and autumn, summer and rainy seasons did not differ significantly.

Pulse rate at 16 hours in Non-Pregnant-lactating cross-bred cows was 62.3 ± 0.50 , 64.2 ± 0.42 , 66.3 ± 0.50 , 65.3 ± 0.29 and 65.0 ± 0.28 per minute in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data showed that highly significant difference ($P < 0.01$) in pulse rate among different seasons of the year (Table-11-n). Critical difference

analysis exhibited that pulse rate was significantly higher in summer season than rainy, autumn, spring and winter seasons, while, spring and autumn, rainy and autumn seasons did not differ from each others.

Pulse rate at 04 hours in Pregnant-Non-lactating cross-bred cows was 60.1 ± 0.46 , 63.0 ± 0.45 , 64.6 ± 0.38 , 64.1 ± 0.24 and 62.8 ± 0.27 per minute in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data marked out that highly significant difference ($P < 0.01$) exists in the pulse rate among different seasons of year (Table-11-O). Pulse rate at 04 hours was observed significantly higher in summer season than other seasons of the year, while, spring and autumn, summer and rainy seasons did not touch the level of significance.

Pulse rate at 16 hours in Pregnant-Non-lactating cross-bred cows was 62.2 ± 0.47 , 64.1 ± 0.46 , 66.1 ± 0.37 , 65.2 ± 0.28 and 64.9 ± 0.30 per minute in winter, spring, summer, rainy and autumn seasons, respectively. An examination of data revealed that highly significant difference ($P < 0.01$) in pulse rate in different seasons of the year (Table-11-p). Critical difference analysis of data showed that significantly higher in summer season than rainy, autumn, spring and winter seasons, while, spring and autumn, summer and rainy, rainy and autumn seasons differences were found to be non-significant.

Respiration Rate

Respiration rate per minute at 04 hours and 16 hours in calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and Pregnant-Non-lactating cross-bred cows in different seasons have been presented in Table-11.

Respiration rate at 04 hours in calves under one year of age was 15.2 ± 0.32 , 20.8 ± 0.50 , 27.8 ± 0.47 , 23.7 ± 0.51 and 20.3 ± 0.40 per minute in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data marked out that highly significant differences ($P < 0.01$) were observed in different seasons of the year (Table-11-q). Respiration rate at 04 hours was observed significantly higher in summer season than rainy, spring, autumn and winter seasons, while, spring and autumn seasons did not touch the level of significance.

Respiration rate at 16 hours in calves under one year of age was 16.7 ± 0.30 , 21.6 ± 0.50 , 33.1 ± 0.48 , 28.2 ± 0.49 and 22.6 ± 0.53 per minute in winter, spring, summer, rainy and autumn seasons, respectively. An examination of data revealed that highly significant differences ($P < 0.01$) were observed among various seasons of the year (Table-11-r). Critical difference analysis of data showed that significantly higher respiration rate was found in summer season followed by rainy, autumn, spring and winter seasons, while, differences between spring and autumn seasons were found to be non-significant.

Respiration rate at 04 hours in Non-Pregnant-Non-lactating cross-bred cows was 14.0 ± 0.15 , 18.6 ± 0.49 , 26.0 ± 0.52 , 22.4 ± 0.40 and 18.2 ± 0.38 per minute in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data showed that highly significant difference ($P < 0.01$) in the respiration rate among different seasons (Table-11-s). Significantly higher respiration rate at 04 hours was found in summer season than other seasons of the year, where as, spring and autumn seasons did not differ significantly.

Respiration rate at 16 hours in Non-Pregnant-Non-lactating cross-bred cows was 15.2 ± 0.31 , 20.1 ± 0.38 , 31.8 ± 0.31 , 27.0 ± 0.43 and 20.7 ± 0.38 per minute in winter, spring, summer, rainy and autumn seasons, respectively. The analysis of variance of data revealed that highly significant difference ($P < 0.01$) in respiration rate at 16 hours were observed among various seasons of the year (Table-11-t). Critical difference analysis marked out that respiration rate was found significantly higher in summer season than rainy, autumn, spring and winter seasons, whereas, respiration rate at 16 hours did not differ in spring and autumn seasons of the year.

Respiration rate at 04 hours in Non-Pregnant-lactating cross-bred cows was 14.5 ± 0.16 , 19.0 ± 0.38 , 26.6 ± 0.40 , 22.8 ± 0.46 and 18.8 ± 0.45 per minute in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data showed that highly significant difference ($P < 0.01$) in respiration rate at 04 hours among the different seasons (Table-11-u). Critical difference analysis exhibited that the respiration rate was significantly higher in summer season than rainy, spring, autumn and winter seasons, while, differences between spring and autumn season were found to be non-significant.

Respiration rate at 16 hours in Non-Pregnant-lactating cross-bred cows was 15.6 ± 0.41 , 20.7 ± 0.54 , 32.2 ± 0.55 , 27.8 ± 0.47 and 21.4 ± 0.49 per minute in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data marked out that highly significant differences ($P < 0.01$) were observed in respiration rate at 16 hours among different seasons of the year (Table-11-v). Respiration rate was observed significantly higher in summer season than other seasons of the year, while, autumn and spring seasons did not touch the level of significance.

Respiration rate at 04 hours in Pregnant-Non-lactating cross-bred cows was 14.3 ± 0.14 , 18.7 ± 0.44 , 26.4 ± 0.53 , 22.6 ± 0.33 and 18.4 ± 0.33 per minute in winter, spring, summer, rainy and autumn seasons, respectively. An examination of data showed highly significant difference ($P < 0.01$) in respiration rate at 04 hours among different seasons (Table-11-w). Critical difference analysis of data showed that respiration rate was significantly higher in summer season than other seasons of the year, while, differences between spring and autumn seasons were found to be non-significant.

Respiration rate at 16 hours in Pregnant-Non-lactating cross-bred cows was 15.4 ± 0.28 , 20.3 ± 0.34 , 32.0 ± 0.48 , 27.5 ± 0.32 and 21.0 ± 0.39 per minute in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data showed that highly significant difference ($P < 0.01$) in respiration rate at 16 hours in different seasons of the year (Table-11-x). Respiration rate at 16 hours was significantly higher in summer season followed by rainy, autumn, spring and winter seasons, while, differences between autumn and spring seasons were found to be non-significant.

Effect of seasons on Milk Production and its Composition

Milk production and its composition in Non-Pregnant-lactating cross-bred cows in different seasons have been presented in Table-12.

The average milk production was 10.33 ± 0.25 , 9.57 ± 0.23 , 7.56 ± 0.18 , 9.33 ± 0.23 and 9.60 ± 0.18 kg. in winter, spring, summer, rainy and autumn seasons, respectively. Statistically highly significant difference ($P < 0.01$) was observed in the milk production in different seasons of the year (Table-12-a). Critical difference analysis of data showed that the milk production was found to be significantly higher in winter season than autumn, spring, rainy and

summer seasons, while, spring, rainy and autumn, autumn and rainy seasons did not differ significantly to each others.

The average 4% Fat corrected milk yield was 9.62 ± 0.23 , 9.57 ± 0.26 , 8.20 ± 0.20 , 8.49 ± 0.24 and 9.10 ± 0.24 kg. in winter, spring, summer, rainy and autumn seasons, respectively. The analysis of variance of data on 4% FCM yield showed highly significant difference ($P < 0.01$) among different seasons of the year (Table-12-b). 4% FCM yield was found significantly higher in winter season followed by spring, autumn, rainy and summer seasons, while, winter, spring and autumn, spring and autumn, rainy and summer seasons did not differ significantly to each others.

The percentage of water in milk was 88.19 ± 0.14 , 87.12 ± 0.11 , 86.40 ± 0.09 , 87.80 ± 0.10 and 87.59 ± 0.09 in winter, spring, summer, rainy and autumn seasons. Analysis of variance of data marked out that highly significant difference ($P < 0.01$) in water percentage among different seasons of the year (Table-12-c). Water percentage was found significantly higher in winter season than other seasons of the year. However, differences between rainy and autumn seasons were found to be non-significant.

The average percentage of fat in milk was 3.58 ± 0.06 , 4.00 ± 0.08 , 4.55 ± 0.03 , 3.40 ± 0.02 and 3.80 ± 0.08 in winter, spring, summer rainy and autumn seasons, respectively. Analysis of variance of data showed highly significant difference ($P < 0.01$) in fat percentage between different seasons of the year (Table-12-d). Critical difference analysis marked out that fat percentage was significantly higher in summer season than other seasons of the year.

Average percentage of protein in milk in winter, spring, summer, rainy and autumn seasons was 3.53 ± 0.04 , 3.58 ± 0.03 , 3.60 ± 0.04 , 3.68 ± 0.03 and

3.66 ± 0.05, respectively. The analysis of variance of data showed non-significant difference in percentage of protein in different seasons of the year (Table-12-e).

The average percentage of lactose in milk was 4.10 ± 0.05, 4.65 ± 0.04, 4.70 ± 0.04, 4.42 ± 0.07 and 4.27 ± 0.08 in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data showed that highly significant differences ($P < 0.01$) were observed in lactose percentage among different seasons of the year (Table-12-f). Critical difference analysis marked out that lactose percentage was significantly higher in summer season followed by spring, rainy, autumn and winter seasons, while, differences between spring and summer seasons was found to be non-significant.

The average percentage of ash in milk was 0.60 ± 0.02, 0.65 ± 0.02, 0.75 ± 0.03, 0.70 ± 0.03 and 0.68 ± 0.02 in winter, spring, summer, rainy and autumn seasons, respectively. An examination of data revealed that highly significant differences ($P < 0.01$) were found in percentage of ash in different seasons of the year (Table-12-g). Ash percentage was significantly higher in summer season than other seasons of the year, while, summer and rainy, rainy, spring and autumn, autumn and spring seasons did not differ significantly to each other.

The average percentage of total solid in milk was 11.81 ± 0.14, 12.88 ± 0.11, 13.60 ± 0.09, 12.20 ± 0.10 and 12.41 ± 0.09 in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data revealed that highly significant differences ($P < 0.01$) were observed in percentage of total solid in milk among various seasons of the year (Table-12-h). Critical difference analysis showed that total solid percentage was significantly higher in summer season followed by spring, autumn, rainy and winter seasons.

However, differences between rainy and autumn seasons were found to be non-significant.

The average percentage of solid not fat (S.N.F.) in milk was 8.23 ± 0.09 , 8.88 ± 0.06 , 9.05 ± 0.07 , 8.80 ± 0.10 and 8.61 ± 0.10 in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data showed that highly significant differences ($P < 0.01$) were observed in percentage of solid not fat in different seasons of the year (Table-12-i). Percentage of solid not fat in milk was significantly higher in summer season than spring, rainy, autumn and winter seasons, while, spring and rainy, summer and spring, rainy and autumn seasons did not differ significantly to each other.

Effect of seasons on Haematological and bio-chemical parameters of Blood

Haematological and bio-chemical parameters of blood in calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant- lactating and Pregnant-Non-lactating cross-bred cows in different seasons have been presented in Table-13.

1. Haemoglobin

Haemoglobin content in blood in calves under one year of age was 13.00 ± 0.34 , 12.85 ± 0.40 , 12.10 ± 0.30 , 12.36 ± 0.30 and 12.67 ± 0.32 gm/100 ml blood in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data showed that haemoglobin content in blood were found to be non-significant in different seasons of the year (Table-13-a). Haemoglobin content in blood was observed higher in winter season than other seasons of the year.

Haemoglobin content in blood in Non-Pregnant-Non-lactating cross-bred cows was 12.00 ± 0.35 , 11.87 ± 0.35 , 11.12 ± 0.34 , 11.34 ± 0.38 and 11.71 ± 0.35 gm/100 ml blood in winter, spring, summer, rainy and autumn seasons, respectively. An examination of data showed that haemoglobin content in blood was found to be non-significant among different seasons of the year (Table 13-i). Haemoglobin content in blood was found higher in winter season followed by spring, autumn, rainy and summer seasons.

Haemoglobin content in blood in Non-Pregnant-lactating cross-bred cows was 11.50 ± 0.35 , 11.20 ± 0.40 , 10.35 ± 0.31 , 10.68 ± 0.36 and 11.10 ± 0.33 gm/100 ml blood in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data revealed that non-significant differences were found in haemoglobin content in blood in different seasons of the year (Table-13-q). Haemoglobin content in blood was found higher in winter season than other seasons of the year.

Haemoglobin content in blood in Pregnant-Non-lactating cross-bred cows was 11.00 ± 0.34 , 10.90 ± 0.31 , 10.03 ± 0.32 , 10.23 ± 0.32 and 10.56 ± 0.31 gm/100 ml blood in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data showed that haemoglobin content in blood were found to be non-significant in different seasons of the year (Table-13-y). Haemoglobin content was found higher in winter season than spring, autumn, rainy and summer seasons.

2. Total Erythrocytes Count (R.B.Cs)

Total erythrocytes count in calves under one year of age was 9.50 ± 0.17 , 9.25 ± 0.19 , 8.15 ± 0.23 , 8.44 ± 0.21 and 8.71 ± 0.20 million/mm³ in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data revealed that highly significant differences ($P < 0.01$) were

found in total erythrocytes count among different seasons of the year (Table-13-b). Critical difference analysis showed that significantly higher erythrocytes count were found in winter season followed by spring, autumn, rainy and summer seasons, while, winter and autumn, rainy and summer, autumn and rainy seasons did not differ significantly to each other.

Total erythrocytes count in Non-Pregnant-Non-lactating cross-bred cows was 8.00 ± 0.22 , 7.84 ± 0.25 , 6.90 ± 0.18 , 7.30 ± 0.20 and 7.63 ± 0.21 million/mm³ in winter, spring, summer, rainy and autumn seasons, respectively. The analysis of variance of data marked out that highly significant differences ($P < 0.01$) were observed in total erythrocyte count in different seasons of the year (Table-13-j). Total erythrocytes count was significantly higher in winter season than other seasons of the year, whereas, winter, spring and autumn, spring and autumn, rainy and summer, autumn and rainy seasons did not differ significantly to each other.

Total erythrocytes count in Non-Pregnant-lactating cross-bred cows was 7.50 ± 0.22 , 7.22 ± 0.20 , 6.81 ± 0.21 , 7.10 ± 0.20 and 7.19 ± 0.22 million/mm³ in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data revealed that total erythrocytes counts were found non-significant in different seasons of the year (Table-13-r). Total erythrocytes count was found higher in winter season than spring, autumn, rainy and summer seasons.

Total erythrocytes count in Pregnant-Non-lactating cross-bred cows was 7.40 ± 0.20 , 7.15 ± 0.21 , 6.24 ± 0.21 , 6.55 ± 0.17 and 6.86 ± 0.14 million/mm³ in winter, spring, summer, rainy and autumn seasons, respectively. An examination of data marked out that highly significant differences ($P < 0.01$) were observed in total erythrocyte count among different seasons of the year (Table-13-z). Critical difference analysis showed that total

erythrocytes count was significantly higher in winter season followed by spring, autumn, rainy and summer seasons, while, winter and spring, spring and autumn, autumn and rainy, rainy and summer seasons did not differ significantly to each others.

3. Total Leucocytes Count (W.B.Cs)

Total leucocytes count in calves under one year of age was 5.64 ± 0.12 , 6.33 ± 0.15 , 6.75 ± 0.14 , 6.56 ± 0.14 and 5.92 ± 0.13 thousand/mm³ in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data revealed that highly significant differences ($P < 0.01$) were observed in total leucocytes count in different seasons of the year (Table-13-c). Significantly higher total leucocytes count was found in summer season than other seasons of the year, whereas, summer and rainy, rainy and spring, autumn and winter seasons did not differ significantly to each other.

Total leucocytes count in Non-Pregnant-Non-lactating cross-bred cows was 6.82 ± 0.14 , 7.45 ± 0.15 , 7.95 ± 0.15 , 7.78 ± 0.12 and 7.16 ± 0.18 thousand/mm³ in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data showed that highly significant differences ($P < 0.01$) were observed in total leucocytes count among different seasons (Table-13-k). Total leucocytes count was significantly higher in summer season followed by rainy, spring, autumn and winter seasons, whereas, summer and rainy, rainy and spring, autumn and winter, differences between seasons found to be non-significant.

Total leucocytes count in Non-Pregnant-lactating cross-bred cows was 7.10 ± 0.16 , 7.93 ± 0.12 , 8.25 ± 0.10 , 8.12 ± 0.14 and 7.35 ± 0.20 thousand/mm³ in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data revealed that highly significant differences ($P < 0.01$) were

found in total leucocyte count in different seasons of the year (Table-13-s). Critical difference analysis showed that significantly higher total leucocytes count was found summer season than other seasons of the year, while, summer, spring and rainy, rainy and spring, autumn and winter seasons did not differ significantly to each others.

Total leucocytes count in Pregnant-Non-lactating cross-bred cows was 7.49 ± 0.18 , 8.00 ± 0.20 , 8.50 ± 0.16 , 8.21 ± 0.21 and 7.60 ± 0.17 thousand/mm³ in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data showed that highly significant difference ($P < 0.01$) in total leucocytes count among different seasons (Table-13-Aa). Total leucocytes count was found significantly higher in summer season than rainy, spring, autumn and winter seasons, while, summer and rainy, rainy and spring, spring and autumn, autumn and winter seasons did not differ significantly to each other.

4. Packed Cell Volume (PCV)

The average percentage of Packed cell volume in calves under one year of age was 45.00 ± 0.37 , 44.82 ± 0.43 , 43.94 ± 0.35 , 44.25 ± 0.41 and 44.58 ± 0.46 in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data revealed that non-significant differences were observed in different seasons of the year (Table-13-d). Packed cell volume was found higher in winter season than other seasons of the year.

Average percentage of Packed cell volume in Non-Pregnant-Non-lactating cross-bred cows was 49.00 ± 0.49 , 48.75 ± 0.41 , 47.90 ± 0.38 , 48.12 ± 0.44 and 48.50 ± 0.52 in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data showed that non-significant differences were observed in packed cell volume in different seasons of the year

(Table-13-l). Higher packed cell volume was found in winter season than other seasons of the year.

The average percentage of Packed cell volume in Non-Pregnant-lactating cross-bred cows was 51.00 ± 0.36 , 50.84 ± 0.42 , 49.85 ± 0.42 , 50.20 ± 0.45 and 50.72 ± 0.38 in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data showed that non-significant differences were found in packed cell volume among different seasons (Table-13-t). Packed cell volume was found higher in winter season than spring, autumn, rainy and summer seasons.

Average percentage of Packed cell volume in Pregnant-Non-lactating cross-bred cows was 56.00 ± 0.41 , 55.77 ± 0.58 , 54.88 ± 0.44 , 55.30 ± 0.43 and 55.63 ± 0.48 in winter, spring, summer, rainy and autumn seasons, respectively. An examination of data revealed that non-significant difference were observed in packed cell volume in different seasons of the year (Table-13-Ab). Higher packed cell volume was observed in winter season followed by spring, autumn, rainy and summer seasons.

5. Blood Urea

Blood urea in calves under one year of age was 6.50 ± 0.12 , 7.45 ± 0.18 , 9.42 ± 0.23 , 8.78 ± 0.19 and 7.10 ± 0.20 mg/100 ml blood in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data showed highly significant difference ($P < 0.01$) in blood urea among different seasons of the year (Table-13-e). Blood urea was found significantly higher in summer season than other seasons of the year. Differences between spring and autumn seasons were found to be non-significant.

Blood urea in Non-Pregnant-Non-lactating cross-bred cows was 21.65 ± 0.47 , 23.27 ± 0.66 , 26.13 ± 0.78 , 25.58 ± 0.54 and 22.44 ± 0.55 mg/100 ml blood

in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data showed that highly significant differences ($P < 0.01$) were observed in blood urea between different seasons (Table-13-m). Significantly higher blood urea was observed in summer season followed by rainy, spring, autumn and winter seasons, while, spring and autumn, summer and rainy, autumn and winter seasons did not differ significantly to each other.

Blood urea in Non-Pregnant-lactating cross-bred cows was 24.00 ± 0.63 , 25.96 ± 0.60 , 29.21 ± 0.71 , 28.30 ± 0.75 and 25.51 ± 0.78 mg/100 ml blood in winter, spring, summer rainy and autumn seasons, respectively. An examination of data revealed that highly significant differences ($P < 0.01$) were observed in blood urea in different seasons of the year (Table-13-u). Blood urea was significantly higher in summer season than other seasons of the year, while, spring and autumn, summer and rainy seasons did not found significant.

Blood urea in Pregnant-Non-lactating cross-bred cows was 22.50 ± 0.52 , 24.22 ± 0.83 , 26.16 ± 0.68 , 25.64 ± 0.84 and 23.75 ± 0.59 mg/100 ml blood in winter, spring, summer, rainy and autumn seasons, respectively. The analysis of variance of data showed highly significant difference ($P < 0.01$) in blood urea among different seasons of the year (Table-13-Ac). Critical difference analysis showed that blood urea was found significantly higher in summer season than other seasons of the year, while, spring and autumn, summer and rainy, rainy and spring, autumn and winter seasons did not differ significantly to each other.

6. Blood Glucose

Blood glucose in calves under one year of age was 60.50 ± 0.88 , 59.10 ± 0.99 , 55.40 ± 0.85 , 57.21 ± 0.88 and 58.30 ± 1.04 mg/100 ml blood in winter,

spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data revealed that highly significant difference ($P < 0.01$) in blood glucose among different seasons of the year (Table-13-f). Critical difference analysis showed that blood glucose was found significantly higher in winter season than other seasons of the year, while, winter and spring, spring, rainy and autumn, autumn and rainy, rainy and summer seasons did not differ significantly to each other.

Blood glucose in Non-Pregnant-Non-lactating cross-bred cows was 54.00 ± 1.08 , 53.18 ± 1.12 , 49.82 ± 0.91 , 51.36 ± 0.78 and 52.80 ± 0.85 mg/100 ml blood in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data showed that significant differences ($P < 0.05$) were observed in blood glucose in different seasons of the year (Table-13-n). Blood glucose was found significantly higher in winter season followed by spring, autumn, rainy and summer seasons, whereas, winter, spring and autumn, spring, rainy and autumn, autumn and rainy, rainy and summer seasons did not differ significantly to each other.

Blood glucose in Non-Pregnant-lactating cross-bred cows was 51.75 ± 0.80 , 50.62 ± 1.00 , 47.30 ± 0.83 , 48.94 ± 0.67 and 49.33 ± 1.03 mg/100 ml blood in winter, spring, summer, rainy and autumn seasons, respectively. An examination of data revealed that significant differences ($P < 0.05$) were observed in blood glucose among different seasons (Table-13-v). Blood glucose was significantly higher in winter season than other seasons of the year, while, winter and spring, autumn, summer and rainy, rainy and summer seasons did not touch the level of significance.

Blood glucose in Pregnant-Non-lactating cross-bred cows was 48.60 ± 0.95 , 47.70 ± 0.96 , 44.20 ± 0.85 , 46.59 ± 1.19 and 46.95 ± 1.15 mg/100 ml blood

in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data showed that non-significant differences were observed in different seasons of the year (Table-13-Ad). Blood glucose was found higher in winter season than spring, autumn, rainy and summer seasons.

7. Serum Cholesterol

Serum cholesterol in calves under one year of age was 55.00 ± 0.93 , 52.37 ± 0.84 , 34.50 ± 0.83 , 40.55 ± 0.82 and 48.72 ± 0.84 mg/100 ml blood in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data revealed that highly significant differences ($P < 0.01$) were observed in serum cholesterol in different seasons of the year (Table-13-g). Critical difference analysis showed that serum cholesterol was significantly higher in winter season than other seasons of the year.

Serum cholesterol in Non-Pregnant-Non-lactating cross-bred cows was 76.28 ± 0.93 , 74.13 ± 0.90 , 69.47 ± 0.85 , 72.81 ± 0.82 and 73.67 ± 0.80 mg/100 ml blood in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data showed highly significant difference ($P < 0.01$) in serum cholesterol among different seasons (Table-13-O). Serum cholesterol was found significantly higher in winter season followed by spring, autumn, rainy and summer seasons, while, spring, rainy and autumn, autumn and rainy seasons did not differ significantly to each other.

Serum cholesterol in Non-Pregnant-lactating cross-bred cows was 83.15 ± 0.91 , 80.00 ± 0.85 , 60.35 ± 0.99 , 72.84 ± 0.93 and 77.49 ± 0.75 mg/100 ml blood in winter, spring, summer, rainy and autumn seasons, respectively. An examination of data showed that highly significant difference ($P < 0.01$) in serum cholesterol among different seasons (Table-13-w). Serum cholesterol was found significantly higher in winter season than other seasons of the year.

Serum cholesterol in Pregnant-Non-lactating cross-bred cows was 126.26 ± 0.82 , 110.40 ± 0.96 , 95.83 ± 0.86 , 104.60 ± 0.91 and 107.22 ± 0.96 mg/100 ml blood in winter, spring, summer, rainy and autumn seasons, respectively. The analysis of variance of data revealed that highly significant difference ($P < 0.01$) in serum cholesterol in different seasons of the year (Table-13-Ae). Critical difference analysis showed that serum cholesterol was significantly higher in winter season than spring, autumn, rainy and summer seasons.

8. Serum Protein

Serum Protein in calves under one year of age was 7.65 ± 0.81 , 7.62 ± 0.20 , 7.53 ± 0.20 , 7.58 ± 0.19 and 7.60 ± 0.17 gm/100 ml blood in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data revealed that non-significant differences were observed in different seasons of the year (Table-13-h). Serum protein was found higher in winter season than other seasons of the year.

Serum protein in Non-Pregnant-Non-lactating cross-bred cows was 7.42 ± 0.23 , 7.40 ± 0.22 , 7.32 ± 0.20 , 7.37 ± 0.21 and 7.38 ± 0.25 gm/100 ml blood in winter, spring, summer, rainy and autumn seasons, respectively. An examination of data showed that non-significant differences were observed in serum protein among different seasons (Table-13-p). Serum protein was observed higher in winter season followed by spring, autumn, rainy and summer seasons.

Serum protein in Non-Pregnant-lactating cross-bred cows was 7.55 ± 0.21 , 7.52 ± 0.17 , 7.48 ± 0.21 , 7.50 ± 0.18 and 7.51 ± 0.18 gm/100 ml blood in winter, spring, summer, rainy and autumn seasons, respectively. Statistical analysis of data showed non-significant differences in serum protein in

different seasons of the year (Table-13-x). Serum protein was higher in winter season than other seasons of the year.

Serum protein in Pregnant-Non-lactating cross-bred cows was 7.60 ± 0.19 , 7.57 ± 0.19 , 7.50 ± 0.19 , 7.55 ± 0.19 and 7.56 ± 0.19 gm/100 ml blood in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data showed that non-significant differences were observed in serum protein among different seasons of the year (Table-13-Af). Serum protein was found higher in winter season followed by spring, autumn, rainy and summer seasons.

TABLE -1: Seasonal average of climatic data of shed environment from December, 1998 to November, 1999.

| S. No. | Seasons | Temperature (°c) | | Relative humidity (%) |
|--------|---------------------------------|------------------|---------|-----------------------|
| | | Minimum | Maximum | |
| 1. | Winter (December - February) | 9.50 | 21.77 | 69.43 |
| 2. | Spring (March - April) | 17.10 | 35.65 | 41.90 |
| 3. | Summer (may - June) | 25.80 | 36.40 | 58.10 |
| 4. | Rainy (July - September) | 25.77 | 31.57 | 82.17 |
| 5. | Autumn (October - November) | 18.75 | 30.80 | 68.50 |

TABLE -2: Chemical composition of different ingredients fed to cross-bred cows (% on dry matter basis).

| S. No. | Feed offered | D. M. | C. P. | E. E. | C. F. | N. F. E. | Total Ash |
|--------|---------------------|-------|-------|-------|-------|----------|-----------|
| 1. | Wheat Straw | 90.00 | 2.00 | 1.00 | 38.00 | 47.00 | 12.00 |
| 2. | Concentrate Mixture | 90.00 | 20.00 | 12.00 | 2.50 | 61.50 | 4.00 |
| 3. | Mustard Cake | 90.00 | 36.00 | 11.00 | 10.00 | 33.00 | 10.00 |
| 4. | Wheat Bran | 90.00 | 13.00 | 2.50 | 13.00 | 64.50 | 7.00 |
| 5. | Crushed Maize | 90.00 | 11.10 | 4.40 | 1.90 | 80.70 | 1.90 |

TABLE -3: Dry matter consumption by cross-bred cows in different seasons.

| S. No. | Different Physiological states of cross-bred cows | Body weight (Kg) | Total Dry matter intake (Kg) | Dry matter intake/100 kg body weight (Kg) | Metabolic body weight (W0.75 Kg) | Dry matter intake per Kg. metabolic body weight (gram) |
|----------------------|---|------------------|------------------------------|---|----------------------------------|--|
| WINTER SEASON | | | | | | |
| 1. | Calves under one year of age | 86.95 ± 3.29 | 2.50 ± 0.11 | 2.86 ± 0.03 | 28.44 ± 0.81 | 87.41 ± 1.59 |
| 2. | Non-pregnant-non-lactating | 263.45 ± 13.15 | 7.64 ± 0.35 | 2.91 ± 0.03 | 65.25 ± 2.44 | 116.77 ± 1.52 |
| 3. | Non-pregnant-lactating | 345.00 ± 10.93 | 10.05 ± 0.26 | 2.92 ± 0.02 | 79.99 ± 1.89 | 125.53 ± 0.73 |
| 4. | Pregnant-non-lactating | 365.90 ± 7.79 | 10.83 ± 0.20 | 2.96 ± 0.01 | 83.63 ± 1.34 | 129.40 ± 0.36 |
| SPRING SEASON | | | | | | |
| 1. | Calves under one year of age | 87.55 ± 3.26 | 2.25 ± 0.09 | 2.57 ± 0.02 | 28.59 ± 0.80 | 78.57 ± 1.13 |
| 2. | Non-pregnant-non-lactating | 270.40 ± 12.89 | 6.96 ± 0.36 | 2.57 ± 0.03 | 66.55 ± 2.39 | 104.16 ± 1.86 |
| 3. | Non-pregnant-lactating | 350.80 ± 10.48 | 9.07 ± 0.30 | 2.58 ± 0.02 | 81.00 ± 1.80 | 111.73 ± 1.35 |
| 4. | Pregnant-non-lactating | 369.40 ± 7.81 | 9.79 ± 0.17 | 2.65 ± 0.03 | 84.23 ± 1.34 | 116.17 ± 1.00 |

TABLE contd

| S. No. | Different Physiological states of cross-bred cows | Body weight (Kg) | Total Dry matter intake (Kg) | Dry matter intake/100 kg body weight (Kg) | Metabolic body weight (W ^{0.75} Kg) | Dry matter intake per Kg. metabolic body weight (gram) |
|----------------------|---|------------------|------------------------------|---|--|--|
| SUMMER SEASON | | | | | | |
| 1. | Calves under one year of age | 89.00 ± 3.53 | 2.15 ± 0.09 | 2.42 ± 0.03 | 28.94 ± 0.86 | 74.11 ± 1.26 |
| 2. | Non-pregnant-non-lactating | 270.10 ± 11.95 | 6.70 ± 0.34 | 2.47 ± 0.02 | 66.52 ± 2.21 | 100.17 ± 1.76 |
| 3. | Non-pregnant-lactating | 348.70 ± 10.56 | 8.74 ± 0.28 | 2.51 ± 0.02 | 80.61 ± 1.83 | 108.23 ± 1.28 |
| 4. | Pregnant-non-lactating | 367.50 ± 7.89 | 9.32 ± 0.18 | 2.54 ± 0.01 | 83.90 ± 1.36 | 110.97 ± 0.46 |
| RAINY SEASON | | | | | | |
| 1. | Calves under one year of age | 91.20 ± 3.38 | 2.40 ± 0.10 | 2.63 ± 0.06 | 29.48 ± 0.82 | 81.18 ± 1.88 |
| 2. | Non-pregnant-non-lactating | 270.80 ± 12.53 | 7.40 ± 0.35 | 2.73 ± 0.02 | 66.64 ± 2.31 | 110.63 ± 1.65 |
| 3. | Non-pregnant-lactating | 349.80 ± 11.02 | 9.55 ± 0.29 | 2.71 ± 0.02 | 80.82 ± 1.90 | 117.99 ± 0.97 |
| 4. | Pregnant-non-lactating | 373.40 ± 7.83 | 10.41 ± 0.20 | 2.79 ± 0.02 | 84.91 ± 1.34 | 122.51 ± 0.84 |
| AUTUMN SEASON | | | | | | |
| 1. | Calves under one year of age | 90.10 ± 3.84 | 2.32 ± 0.10 | 2.58 ± 0.07 | 29.20 ± 0.94 | 79.39 ± 2.08 |
| 2. | Non-pregnant-non-lactating | 269.00 ± 13.55 | 7.15 ± 0.35 | 2.66 ± 0.03 | 66.30 ± 2.49 | 107.50 ± 1.66 |
| 3. | Non-pregnant-lactating | 353.50 ± 11.59 | 9.21 ± 0.30 | 2.61 ± 0.02 | 81.45 ± 1.99 | 112.84 ± 1.08 |
| 4. | Pregnant-non-lactating | 374.60 ± 7.13 | 10.00 ± 0.18 | 2.67 ± 0.03 | 85.12 ± 1.22 | 117.47 ± 1.18 |

TABLE -3 (a) : Analysis of variance of data on the Total Dry matter intake in different seasons in calves under one year of age (Kg).

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|------------|--------------|----|
| | | | | | 5% | 1% |
| Between Season | 4 | 0.69062 | 0.1727 | NS 1.79 | - | - |
| Error | 45 | 4.34 | 0.0964 | | | |
| Total | 49 | 5.03062 | | | | |

NS = Non - Significant

TABLE -3 (b) : Analysis of variance of data on the DM intake/100 Kg. body weight in different seasons in calves under one year of age (Kg).

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|-------|-------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 1.02381 | 0.256 | ** 11.64 | 0.11 | 0.16 |
| Error | 45 | 0.98 | 0.022 | | | |
| Total | 49 | 2.00381 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -3 (c) : Analysis of variance of data on the DM intake g. per Kg. metabolic body weight in different seasons i calves under one year of age (g).

| Source of variation | d. f. | SS | M S S | FC | C D value at | |
|---------------------|-------|---------|--------|---------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 932.95 | 233.24 | | | |
| Error | 45 | 1192.77 | 26.51 | 8.80 ** | 3.87 | 5.55 |
| Total | 49 | 2125.72 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -3 (d) : Analysis of variance of data on the Total Dry matter intake in different seasons in non-pregnant-non-lactating cross-bred cows (Kg).

| Source of variation | d. f. | SS | M S S | FC | C D value at | |
|---------------------|-------|---------|--------|----------|--------------|-----|
| | | | | | 5% | 1% |
| Between Season | 4 | 5.3916 | 1.3479 | | | |
| Error | 45 | 54.96 | 1.2213 | 1.10 N S | --- | --- |
| Total | 49 | 60.3516 | | | | |

N S = Non - Significant

Analysis of variance of data on the DM intake/100 Kg. body weight in different seasons in non-pregnant non-lactating cross-bred cows (Kg).

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|-----|--------------|-------|
| | | | | | 5% | 1% |
| Between Season | 4 | 1.05857 | 0.2646 | ** | 0.066 | 0.094 |
| Error | 45 | 0.35 | 0.0078 | | | |
| Total | 49 | 1.40857 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -3 (f) : Analysis of variance of data on the DM intake g. per Kg metabolic body weight in different seasons in non-pregnant-non-lactating cross-bred cows (g).

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|-----|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 1600.17 | 400.04 | ** | 4.03 | 5.80 |
| Error | 45 | 1290.89 | 28.69 | | | |
| Total | 49 | 2891.06 | | | | |

** = Significant at 1% level (P < 0.01)

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|-------|-------|--------------|----|
| | | | | | 5% | 1% |
| Between Season | 4 | 9.8951 | 2.474 | | | |
| Error | 45 | 36.97 | 0.822 | 3.01* | 0.69 | — |
| Total | 49 | 46.8651 | | | | |

* = Significant at 5% level ($P < 0.05$)

TABLE -3 (h) : Analysis of variance of data on the DM intake/100 Kg. body weight in different seasons in non-pregnant-lactating cross-bred cows (Kg).

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|---------|--------------|-------|
| | | | | | 5% | 1% |
| Between Season | 4 | 0.98863 | 0.2472 | | | |
| Error | 45 | 0.19 | 0.0042 | 58.86** | 0.049 | 0.070 |
| Total | 49 | 1.17863 | | | | |

** = Significant at 1% level ($P < 0.01$)

TABLE -3 (i) : Analysis of variance of data on the DM intake g. per Kg metabolic body weight in different seasons in non-pregnant-lactating cross-bred cows (g).

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|----------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 1806.09 | 451.52 | 37.04 ** | 2.62 | 3.77 |
| Error | 45 | 548.57 | 12.19 | | | |
| Total | 49 | 2354.66 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -3 (j) : Analysis of variance of data on the Total Dry matter intake in different seasons in pregnant-non-lactating cross-bred cows (Kg).

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|---------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 13.3782 | 3.3446 | 9.58 ** | 0.44 | 0.63 |
| Error | 45 | 15.71 | 0.3491 | | | |
| Total | 49 | 29.0882 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -3 (k) : Analysis of variance of data on the DM intake/100 Kg. body weight in different seasons in pregnant-non-lactating cross-bred cows (Kg).

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|--------|--------|----------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 1.0158 | 0.2540 | 60.48 ** | 0.15 | 0.22 |
| Error | 45 | 0.19 | 0.0042 | | | |
| Total | 49 | 1.2058 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -3 (l) : Analysis of variance of data on the DM intake g. per Kg metabolic body weight in different seasons in pregnant-non-lactating cross-bred cows (g).

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|----------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 1947.30 | 486.83 | 70.66 ** | 1.97 | 2.83 |
| Error | 45 | 309.94 | 6.89 | | | |
| Total | 49 | 2257.24 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -4 : Digestibility coefficient of Dry matter by cross-bred cows in different seasons.

| S. No. | Different Physiological states of cross-bred cows | Total dry matter intake (g) | WINTER SEASON | | | Digestibility coefficient |
|----------------------|---|-----------------------------|-----------------------|-------------------------|---------------------------|---------------------------|
| | | | Dry matter voided (g) | Dry matter digested (g) | Digestibility coefficient | |
| 1. | Calves under one year of age | 2496.00 ± 110.94 | 771.65 ± 35.81 | 1724.35 ± 75.77 | 69.10 ± 0.23 | |
| 2. | Non-pregnant-non-lactating | 7640.00 ± 354.40 | 2523.08 ± 114.50 | 5116.93 ± 240.32 | 66.96 ± 0.11 | |
| 3. | Non-pregnant-lactating | 10045.00 ± 261.03 | 3272.43 ± 84.13 | 6772.57 ± 177.96 | 67.42 ± 0.12 | |
| 4. | Pregnant-non-lactating | 10825.00 ± 196.53 | 3561.44 ± 61.16 | 7263.56 ± 135.76 | 67.09 ± 0.07 | |
| SPRING SEASON | | | | | | |
| 1. | Calves under one year of age | 2253.00 ± 91.88 | 766.50 ± 31.34 | 1487.40 ± 61.14 | 66.01 ± 0.19 | |
| 2. | Non-pregnant-non-lactating | 6964.00 ± 357.12 | 2483.96 ± 133.31 | 4450.44 ± 231.30 | 63.88 ± 0.22 | |
| 3. | Non-pregnant-lactating | 9067.00 ± 296.94 | 3249.99 ± 110.10 | 5817.01 ± 188.46 | 64.17 ± 0.16 | |
| 4. | Pregnant-non-lactating | 9785.00 ± 172.29 | 3516.27 ± 64.89 | 6268.73 ± 110.73 | 64.07 ± 0.17 | |

TABLE contd

| S. No. | Different Physiological states of cross-bred cows | Total dry matter intake (g) | Dry matter voided (g) | Dry matter digested (g) | Digestibility coefficient |
|----------------------|---|-----------------------------|-----------------------|-------------------------|---------------------------|
| | | | | | |
| SUMMER SEASON | | | | | |
| 1. | Calves under one year of age | 2150.00 ± 89.63 | 826.70 ± 34.31 | 1323.30 ± 55.69 | 61.54 ± 0.18 |
| 2. | Non-pregnant-non-lactating | 6696.00 ± 336.32 | 2800.24 ± 142.27 | 3895.77 ± 194.86 | 58.18 ± 0.19 |
| 3. | Non-pregnant-lactating | 8740.00 ± 283.48 | 3532.12 ± 109.37 | 5207.88 ± 175.27 | 59.57 ± 0.16 |
| 4. | Pregnant-non-lactating | 9315.00 ± 179.10 | 3769.24 ± 71.15 | 5545.76 ± 110.13 | 59.53 ± 0.15 |
| RAINY SEASON | | | | | |
| 1. | Calves under one year of age | 2398.00 ± 99.47 | 845.24 ± 33.88 | 1552.76 ± 66.42 | 64.72 ± 0.28 |
| 2. | Non-pregnant-non-lactating | 7401.00 ± 353.03 | 3078.41 ± 157.87 | 4322.59 ± 196.66 | 58.46 ± 0.25 |
| 3. | Non-pregnant-lactating | 9549.00 ± 291.72 | 3564.37 ± 109.47 | 5984.63 ± 187.21 | 62.67 ± 0.26 |
| 4. | Pregnant-non-lactating | 10407.00 ± 203.02 | 3880.84 ± 75.24 | 6526.17 ± 135.42 | 62.70 ± 0.27 |
| AUTUMN SEASON | | | | | |
| 1. | Calves under one year of age | 2320.00 ± 98.71 | 755.15 ± 33.46 | 1564.85 ± 66.37 | 67.46 ± 0.29 |
| 2. | Non-pregnant-non-lactating | 7150.00 ± 345.99 | 2510.43 ± 125.25 | 4639.57 ± 221.83 | 64.91 ± 0.19 |
| 3. | Non-pregnant-lactating | 9206.00 ± 298.39 | 3192.36 ± 103.49 | 6013.65 ± 199.85 | 65.32 ± 0.29 |
| 4. | Pregnant-non-lactating | 10001.00 ± 181.93 | 3471.32 ± 70.15 | 6529.68 ± 121.57 | 65.29 ± 0.29 |

TABLE -4 (a) : Analysis of variance of data on the digestibility coefficient of dry matter in different seasons in calve under one year of age.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|-------|----------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 329.721 | 82.43 | 144.61 ^{**} | 0.57 | 0.82 |
| Error | 45 | 25.608 | 0.57 | | | |
| Total | 49 | 355.329 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -4 (b) : Analysis of variance of data on the digestibility coefficient of dry matter in different seasons in Non-Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|----------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 625.613 | 156.40 | 401.03 ^{**} | 0.47 | 0.68 |
| Error | 45 | 17.506 | 0.39 | | | |
| Total | 49 | 643.119 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -4 (c) : Analysis of variance of data on the digestibility coefficient of dry matter in different seasons in Non Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|-------|----------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 347.211 | 86.80 | | | |
| Error | 45 | 19.501 | 0.43 | 201.86** | 0.49 | 0.70 |
| Total | 49 | 366.712 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -4 (d) : Analysis of variance of data on the digestibility coefficient of dry matter in different seasons in Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|-------|----------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 325.666 | 81.42 | | | |
| Error | 45 | 19.036 | 0.42 | 193.86** | 0.49 | 0.70 |
| Total | 49 | 344.702 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -5 : Digestibility coefficient of crude protein (C.P.) by cross-bred cows in different seasons.

| S. No. | Different Physiological states of cross-bred cows | Total C. P. consumed (g) | C. P. voided (g) | C. P. digested (g) | Digestibility coefficient |
|----------------------|---|--------------------------|------------------|--------------------|---------------------------|
| | | | | | |
| 1. | Calves under one year of age | 331.44 ± 12.81 | 107.27 ± 4.22 | 224.17 ± 8.65 | 67.64 ± 0.17 |
| 2. | Non-pregnant-non-lactating | 395.80 ± 7.09 | 131.28 ± 2.86 | 264.52 ± 4.29 | 66.85 ± 0.16 |
| 3. | Non-pregnant-lactating | 1001.90 ± 10.85 | 325.12 ± 2.92 | 676.78 ± 8.39 | 67.54 ± 0.17 |
| 4. | Pregnant-non-lactating | 783.50 ± 3.93 | 255.07 ± 2.13 | 528.43 ± 2.60 | 67.45 ± 0.17 |
| SPRING SEASON | | | | | |
| 1. | Calves under one year of age | 328.74 ± 12.26 | 120.84 ± 4.62 | 207.90 ± 7.69 | 63.25 ± 0.15 |
| 2. | Non-pregnant-non-lactating | 382.28 ± 7.14 | 146.05 ± 2.91 | 236.23 ± 4.37 | 61.80 ± 0.18 |
| 3. | Non-pregnant-lactating | 943.10 ± 10.05 | 347.50 ± 3.84 | 595.61 ± 6.61 | 63.15 ± 0.14 |
| 4. | Pregnant-non-lactating | 762.70 ± 3.45 | 282.28 ± 1.38 | 480.42 ± 2.56 | 62.99 ± 0.12 |

TABLE contd

| S. No. | Different Physiological states of cross-bred cows | Total C. P. consumed (g) | C. P. voided (g) | C. P. digested (g) | Digestibility coefficient |
|----------------------|---|--------------------------|------------------|--------------------|---------------------------|
| SUMMER SEASON | | | | | |
| 1. | Calves under one year of age | 331.36 ± 13.14 | 158.23 ± 6.47 | 173.13 ± 6.74 | 52.26 ± 0.20 |
| 2. | Non-pregnant-non-lactating | 376.92 ± 6.73 | 186.82 ± 3.71 | 190.10 ± 3.11 | 50.45 ± 0.17 |
| 3. | Non-pregnant-lactating | 826.04 ± 8.41 | 393.14 ± 3.96 | 431.10 ± 5.33 | 52.18 ± 0.21 |
| 4. | Pregnant-non-lactating | 753.30 ± 8.58 | 361.44 ± 2.09 | 391.86 ± 2.61 | 52.02 ± 0.20 |
| RAINY SEASON | | | | | |
| 1. | Calves under one year of age | 343.52 ± 12.66 | 139.61 ± 5.25 | 203.91 ± 7.49 | 59.36 ± 0.19 |
| 2. | Non-pregnant-non-lactating | 391.02 ± 7.06 | 172.28 ± 3.16 | 218.74 ± 3.99 | 55.94 ± 0.13 |
| 3. | Non-pregnant-lactating | 937.80 ± 14.22 | 381.64 ± 6.03 | 556.16 ± 8.67 | 59.31 ± 0.19 |
| 4. | Pregnant-non-lactating | 775.14 ± 4.06 | 316.71 ± 2.26 | 458.44 ± 2.64 | 59.14 ± 0.18 |
| AUTUMN SEASON | | | | | |
| 1. | Calves under one year of age | 341.84 ± 14.85 | 127.40 ± 5.40 | 214.44 ± 9.53 | 62.91 ± 0.12 |
| 2. | Non-pregnant-non-lactating | 386.00 ± 6.92 | 148.09 ± 2.61 | 237.91 ± 4.39 | 61.63 ± 0.14 |
| 3. | Non-pregnant-lactating | 943.90 ± 16.81 | 350.63 ± 5.44 | 593.27 ± 11.45 | 62.84 ± 0.12 |
| 4. | Pregnant-non-lactating | 767.02 ± 3.64 | 286.02 ± 1.67 | 481.00 ± 2.39 | 62.71 ± 0.11 |

TABLE -5 (a) : Analysis of variance of data on the digestibility coefficient of crude protein in different seasons in calves under one year of age.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|-----------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 1317.90 | 329.48 | 1336.14 ^{**} | 0.40 | 0.58 |
| Error | 45 | 13.18 | 0.29 | | | |
| Total | 49 | 1331.08 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -5 (b) : Analysis of variance of data on the digestibility coefficient of crude protein in different seasons in Non-Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|-----------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 1582.85 | 395.13 | 1580.52 ^{**} | 0.37 | 0.53 |
| Error | 45 | 11.30 | 0.25 | | | |
| Total | 49 | 1594.15 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -5 (c) : Analysis of variance of data on the digestibility coefficient of crude protein in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 1314.30 | 328.58 | 1133.03 ** | 0.40 | 0.58 |
| Error | 45 | 12.96 | 0.29 | | | |
| Total | 49 | 1327.26 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -5 (d) : Analysis of variance of data on the digestibility coefficient of crude protein in different seasons in Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 1324.84 | 331.21 | 1273.88 ** | 0.39 | 0.56 |
| Error | 45 | 11.75 | 0.26 | | | |
| Total | 49 | 1336.59 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -6 : Digestibility coefficient of Ether Extract (E.E.) by cross-bred cows in different seasons.

| S. No. | Different Physiological states of cross-bred cows | Total E. E. consumed (g) | WINTER SEASON | | Digestibility coefficient |
|----------------------|---|--------------------------|------------------|--------------------|---------------------------|
| | | | E. E. voided (g) | E. E. digested (g) | |
| 1. | Calves under one year of age | 197.00 ± 7.58 | 56.52 ± 2.01 | 140.49 ± 5.59 | 71.28 ± 0.16 |
| 2. | Non-pregnant-non-lactating | 224.90 ± 3.54 | 66.25 ± 1.14 | 158.65 ± 2.45 | 70.55 ± 0.12 |
| 3. | Non-pregnant-lactating | 589.95 ± 6.82 | 170.46 ± 1.88 | 419.49 ± 5.20 | 71.10 ± 0.15 |
| 4. | Pregnant-non-lactating | 454.75 ± 1.97 | 133.28 ± 0.88 | 321.47 ± 1.40 | 70.69 ± 0.12 |
| SPRING SEASON | | | | | |
| 1. | Calves under one year of age | 195.89 ± 7.29 | 58.93 ± 2.23 | 136.96 ± 5.09 | 69.92 ± 0.14 |
| 2. | Non-pregnant-non-lactating | 218.14 ± 3.57 | 67.93 ± 1.26 | 150.19 ± 2.42 | 68.87 ± 0.20 |
| 3. | Non-pregnant-lactating | 556.19 ± 5.96 | 168.24 ± 1.92 | 387.96 ± 4.24 | 69.75 ± 0.13 |
| 4. | Pregnant-non-lactating | 444.35 ± 1.72 | 137.40 ± 1.01 | 306.95 ± 1.35 | 69.08 ± 0.18 |

TABLE contd

| S. No. | Different Physiological states of cross-bred cows | Total E. E. consumed (g) | | E. E. voided (g) | | E. E. digested (g) | | Digestibility coefficient |
|----------------------|---|--------------------------|--|------------------|--|--------------------|--|---------------------------|
| | | SUMMER SEASON | | SUMMER SEASON | | SUMMER SEASON | | |
| 1. | Calves under one year of age | 197.72 ± 7.84 | | 62.09 ± 2.41 | | 135.63 ± 5.53 | | 68.58 ± 0.28 |
| 2. | Non-pregnant-non-lactating | 215.46 ± 3.36 | | 69.02 ± 1.19 | | 146.45 ± 2.30 | | 67.97 ± 0.21 |
| 3. | Non-pregnant-lactating | 483.58 ± 4.98 | | 153.67 ± 2.41 | | 331.71 ± 3.83 | | 68.34 ± 0.30 |
| 4. | Pregnant-non-lactating | 439.65 ± 1.79 | | 140.09 ± 1.14 | | 299.56 ± 1.26 | | 68.14 ± 0.19 |
| RAINY SEASON | | | | | | | | |
| 1. | Calves under one year of age | 204.60 ± 7.54 | | 65.29 ± 2.51 | | 138.31 ± 5.41 | | 67.60 ± 0.22 |
| 2. | Non-pregnant-non-lactating | 222.51 ± 3.53 | | 72.91 ± 1.09 | | 149.60 ± 2.53 | | 67.22 ± 0.18 |
| 3. | Non-pregnant-lactating | 551.88 ± 8.40 | | 179.17 ± 3.07 | | 372.72 ± 5.57 | | 67.54 ± 0.18 |
| 4. | Pregnant-non-lactating | 450.57 ± 2.03 | | 146.72 ± 0.76 | | 303.85 ± 1.80 | | 67.43 ± 0.16 |
| AUTUMN SEASON | | | | | | | | |
| 1. | Calves under one year of age | 201.62 ± 8.44 | | 59.63 ± 2.53 | | 141.99 ± 5.93 | | 70.43 ± 0.14 |
| 2. | Non-pregnant-non-lactating | 220.00 ± 3.46 | | 66.14 ± 1.09 | | 153.86 ± 2.43 | | 69.94 ± 0.13 |
| 3. | Non-pregnant-lactating | 556.37 ± 9.75 | | 165.56 ± 2.89 | | 390.81 ± 7.05 | | 70.24 ± 0.15 |
| 4. | Pregnant-non-lactating | 446.51 ± 1.82 | | 133.28 ± 0.76 | | 313.23 ± 1.49 | | 70.15 ± 0.14 |

TABLE -6 (a) : Analysis of variance of data on the digestibility coefficient of ether extract in different seasons in calves under one year of age.

| Source of variation | d. f. | SS | MSS | FC | C D value at | |
|---------------------|-------|--------|-------|---------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 86.46 | 21.62 | 56.30** | 0.47 | 0.68 |
| Error | 45 | 17.28 | 0.384 | | | |
| Total | 49 | 103.74 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -6 (b) : Analysis of variance of data on the digestibility coefficient of ether extract in different seasons in Non-Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | SS | MSS | FC | C D value at | |
|---------------------|-------|-------|-------|---------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 74.66 | 18.67 | 64.38** | 0.40 | 0.58 |
| Error | 45 | 13.07 | 0.29 | | | |
| Total | 49 | 87.73 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -6 (c) : Analysis of variance of data on the digestibility coefficient of ether extract in different seasons in Non-pregnant-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|-------|-------|---------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 82.65 | 20.66 | 54.37 ^{**} | 0.47 | 0.68 |
| Error | 45 | 17.08 | 0.38 | | | |
| Total | 49 | 99.73 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -6 (d) : Analysis of variance of data on the digestibility coefficient of ether extract in different seasons in Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|-------|-------|---------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 73.36 | 18.34 | 70.54 ^{**} | 0.39 | 0.56 |
| Error | 45 | 11.65 | 0.26 | | | |
| Total | 49 | 85.01 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -7 : Digestibility coefficient of crude fibre (C.F.) by cross-bred cows in different seasons.

| S. No. | Different Physiological states of cross-bred cows | Total C. F. consumed (g) | C. F. voided (g) | C. F. digested (g) | Digestibility coefficient |
|----------------------|---|--------------------------|------------------|--------------------|---------------------------|
| | | | | | |
| 1. | Calves under one year of age | 393.26 ± 22.00 | 173.28 ± 9.87 | 219.98 ± 12.14 | 55.96 ± 0.10 |
| 2. | Non-pregnant-non-lactating | 2423.95 ± 134.67 | 1095.01 ± 63.43 | 1328.94 ± 71.38 | 54.88 ± 0.18 |
| 3. | Non-pregnant-lactating | 2237.37 ± 117.47 | 991.79 ± 50.93 | 1245.58 ± 66.68 | 55.65 ± 0.13 |
| 4. | Pregnant-non-lactating | 2995.25 ± 74.68 | 1345.39 ± 33.78 | 1649.86 ± 41.78 | 55.08 ± 0.18 |
| SPRING SEASON | | | | | |
| 1. | Calves under one year of age | 296.66 ± 15.29 | 116.84 ± 6.14 | 179.82 ± 9.15 | 60.63 ± 0.07 |
| 2. | Non-pregnant-non-lactating | 2167.07 ± 135.71 | 869.44 ± 53.95 | 1297.63 ± 8.18 | 59.87 ± 0.11 |
| 3. | Non-pregnant-lactating | 1943.10 ± 119.59 | 770.82 ± 48.14 | 1172.28 ± 71.54 | 60.35 ± 0.12 |
| 4. | Pregnant-non-lactating | 2600.05 ± 65.47 | 1037.27 ± 25.79 | 1562.78 ± 39.97 | 60.10 ± 0.12 |

TABLE contd

| S. No. | Different Physiological states of cross-bred cows | Total C. F. consumed (g) | C. F. voided (g) | C. F. digested (g) | Digestibility coefficient |
|----------------------|---|--------------------------|------------------|--------------------|---------------------------|
| SUMMER SEASON | | | | | |
| 1. | Calves under one year of age | 248.29 ± 15.32 | 93.91 ± 6.25 | 154.38 ± 9.21 | 61.74 ± 0.05 |
| 2. | Non-pregnant-non-lactating | 2065.23 ± 127.80 | 815.00 ± 52.43 | 1250.23 ± 75.42 | 60.59 ± 0.11 |
| 3. | Non-pregnant-lactating | 2036.81 ± 118.46 | 744.53 ± 65.12 | 1292.28 ± 78.08 | 61.48 ± 0.08 |
| 4. | Pregnant-non-lactating | 2421.45 ± 68.06 | 947.40 ± 28.21 | 1474.06 ± 40.20 | 60.89 ± 0.14 |
| RAINY SEASON | | | | | |
| 1. | Calves under one year of age | 328.33 ± 22.05 | 134.52 ± 9.06 | 193.81 ± 12.99 | 59.04 ± 0.07 |
| 2. | Non-pregnant-non-lactating | 2333.13 ± 134.15 | 969.78 ± 55.96 | 1363.35 ± 78.30 | 58.43 ± 0.11 |
| 3. | Non-pregnant-lactating | 2155.73 ± 111.57 | 889.74 ± 46.48 | 1265.98 ± 65.20 | 58.73 ± 0.10 |
| 4. | Pregnant-non-lactating | 2836.41 ± 77.15 | 1172.94 ± 32.40 | 1663.48 ± 45.10 | 58.65 ± 0.13 |
| AUTUMN SEASON | | | | | |
| 1. | Calves under one year of age | 305.79 ± 22.99 | 123.55 ± 9.46 | 182.25 ± 13.54 | 59.62 ± 0.10 |
| 2. | Non-pregnant-non-lactating | 2237.75 ± 131.48 | 915.94 ± 53.17 | 1321.82 ± 78.48 | 59.06 ± 0.14 |
| 3. | Non-pregnant-lactating | 1999.83 ± 100.65 | 811.25 ± 41.59 | 1188.58 ± 59.18 | 59.45 ± 0.13 |
| 4. | Pregnant-non-lactating | 2682.13 ± 69.13 | 1093.03 ± 28.79 | 1589.10 ± 40.81 | 59.25 ± 0.15 |

TABLE -7 (a) : Analysis of variance of data on the digestibility coefficient of crude fibre in different seasons in calves under one year of age.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|----------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 189.586 | 47.397 | 752.33 ^{**} | 0.18 | 0.27 |
| Error | 45 | 2.835 | 0.063 | | | |
| Total | 49 | 192.421 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -7 (b) : Analysis of variance of data on the digestibility coefficient of crude fibre in different seasons in Non-Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|----------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 196.001 | 49.000 | 275.28 ^{**} | 0.32 | 0.46 |
| Error | 45 | 8.011 | 0.178 | | | |
| Total | 49 | 204.012 | | | | |

**** = Significant at 1% level (P < 0.01)**

ABLE -7 (c) : Analysis of variance of data on the digestibility coefficient of crude fibre in different seasons in Non-pregnant-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|-----------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 193.815 | 48.454 | 384.56 ** | 0.27 | 0.39 |
| Error | 45 | 5.65 | 0.126 | | | |
| Total | 49 | 199.465 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -7 (d) : Analysis of variance of data on the digestibility coefficient of crude fibre in different seasons in Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|-----------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 201.155 | 50.289 | 236.10 ** | 0.35 | 0.51 |
| Error | 45 | 9.598 | 0.213 | | | |
| Total | 49 | 210.753 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -8 : Digestibility coefficient of Nitrogen free extract (N.F.E.) by cross-bred cows in different seasons.

| S. No. | Different Physiological states of cross-bred cows | Total N. F. E. consumed (g) | N. F. E. voided (g) | N. F. E. digested (g) | Digestibility coefficient |
|----------------------|---|-----------------------------|---------------------|-----------------------|---------------------------|
| WINTER SEASON | | | | | |
| 1. | Calves under one year of age | 1399.90 ± 60.56 | 407.95 ± 18.30 | 991.95 ± 42.45 | 70.87 ± 0.16 |
| 2. | Non-pregnant-non-lactating | 3786.55 ± 166.57 | 1137.00 ± 49.46 | 2649.55 ± 117.90 | 69.96 ± 0.19 |
| 3. | Non-pregnant-lactating | 5366.40 ± 116.25 | 1518.19 ± 89.23 | 3778.21 ± 83.32 | 70.40 ± 0.14 |
| 4. | Pregnant-non-lactating | 5544.50 ± 92.37 | 1648.10 ± 31.32 | 3896.40 ± 63.30 | 70.28 ± 0.18 |
| SPRING SEASON | | | | | |
| 1. | Calves under one year of age | 1287.43 ± 51.46 | 387.01 ± 15.51 | 900.42 ± 36.05 | 69.94 ± 0.12 |
| 2. | Non-pregnant-non-lactating | 3468.83 ± 167.85 | 1074.49 ± 55.35 | 2394.34 ± 112.88 | 69.15 ± 0.09 |
| 3. | Non-pregnant-lactating | 4875.13 ± 137.62 | 1484.32 ± 41.89 | 3390.71 ± 96.24 | 69.55 ± 0.10 |
| 4. | Pregnant-non-lactating | 5055.70 ± 80.97 | 1551.83 ± 26.33 | 3503.87 ± 55.31 | 69.31 ± 0.10 |

TABLE contd

| S. No. | Different Physiological states of cross-bred cows | Total N. F. E. consumed (g) | N. F. E. voided (g) | N. F. E. digested (g) | Digestibility coefficient |
|----------------------|---|-----------------------------|---------------------|-----------------------|---------------------------|
| SUMMER SEASON | | | | | |
| 1. | Calves under one year of age | 1242.79 ± 50.84 | 343.63 ± 13.64 | 899.16 ± 37.58 | 72.33 ± 0.24 |
| 2. | Non-pregnant-non-lactating | 3342.87 ± 158.07 | 958.41 ± 53.33 | 2384.46 ± 105.47 | 71.42 ± 0.30 |
| 3. | Non-pregnant-lactating | 4632.41 ± 129.50 | 1298.60 ± 35.45 | 3333.81 ± 97.07 | 71.95 ± 0.27 |
| 4. | Pregnant-non-lactating | 4834.80 ± 84.18 | 1366.66 ± 29.23 | 3468.14 ± 59.00 | 71.74 ± 0.26 |
| RAINY SEASON | | | | | |
| 1. | Calves under one year of age | 1365.15 ± 54.52 | 373.42 ± 14.48 | 991.73 ± 40.50 | 72.62 ± 0.23 |
| 2. | Non-pregnant-non-lactating | 3674.22 ± 165.92 | 1047.24 ± 54.36 | 2626.98 ± 113.98 | 71.56 ± 0.39 |
| 3. | Non-pregnant-lactating | 5089.64 ± 138.30 | 1411.47 ± 37.55 | 3678.16 ± 105.20 | 72.25 ± 0.31 |
| 4. | Pregnant-non-lactating | 5348.04 ± 95.42 | 1501.51 ± 33.91 | 3846.53 ± 70.06 | 71.93 ± 0.36 |
| AUTUMN SEASON | | | | | |
| 1. | Calves under one year of age | 1325.59 ± 54.81 | 400.35 ± 16.93 | 925.24 ± 38.00 | 69.77 ± 0.14 |
| 2. | Non-pregnant-non-lactating | 3556.25 ± 162.62 | 1099.75 ± 48.03 | 2456.50 ± 114.80 | 69.05 ± 0.12 |
| 3. | Non-pregnant-lactating | 4938.87 ± 146.49 | 1478.68 ± 37.20 | 3430.25 ± 101.90 | 69.46 ± 0.14 |
| 4. | Pregnant-non-lactating | 5157.22 ± 85.51 | 1601.40 ± 20.36 | 3555.82 ± 71.37 | 69.20 ± 0.13 |

TABLE -8 (a) : Analysis of variance of data on the digestibility coefficient of Nitrogen free extract in different seasons in calves under one year of age.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|-------|-------|----------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 69.88 | 17.47 | 51.38 ** | 0.44 | 0.63 |
| Error | 45 | 15.29 | 0.34 | | | |
| Total | 49 | 85.17 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -8 (b) : Analysis of variance of data on the digestibility coefficient of Nitrogen free extract in different seasons in Non-Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|--------|-------|----------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 63.919 | 15.98 | 27.08 ** | 0.57 | 0.82 |
| Error | 45 | 26.46 | 0.59 | | | |
| Total | 49 | 90.379 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -8 (c) : Analysis of variance of data on the digestibility coefficient of Nitrogen free extract in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|-------|-------|---------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 69.26 | 17.32 | 38.49** | 0.50 | 0.72 |
| Error | 45 | 20.05 | 0.45 | | | |
| Total | 49 | 89.31 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -8 (d) : Analysis of variance of data on the digestibility coefficient of Nitrogen free extract in different seasons in Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|--------|--------|---------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 67.273 | 16.818 | 33.37** | 0.54 | 0.77 |
| Error | 45 | 22.724 | 0.504 | | | |
| Total | 49 | 89.997 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -9 : Digestibility coefficient of organic matter (O.M.) by cross-bred cows in different seasons.

| S. No. | Different Physiological states of cross-bred cows | Total O. M. consumed (g) | O. M. | | Digestibility coefficient |
|----------------------|---|--------------------------|------------------|------------------|---------------------------|
| | | | voided (g) | digested (g) | |
| WINTER SEASON | | | | | |
| 1. | Calves under one year of age | 2321.60 ± 102.26 | 906.15 ± 38.38 | 1415.45 ± 65.65 | 60.91 ± 0.42 |
| 2. | Non-pregnant-non-lactating | 6831.20 ± 311.87 | 2738.71 ± 146.17 | 4092.49 ± 169.17 | 60.02 ± 0.43 |
| 3. | Non-pregnant-lactating | 9195.60 ± 226.04 | 3624.87 ± 87.96 | 5570.74 ± 152.00 | 60.56 ± 0.42 |
| 4. | Pregnant-non-lactating | 9778.00 ± 172.95 | 3884.40 ± 95.88 | 5893.60 ± 90.36 | 60.29 ± 0.42 |
| SPRING SEASON | | | | | |
| 1. | Calves under one year of age | 2108.72 ± 85.41 | 829.61 ± 31.38 | 1279.11 ± 55.57 | 60.60 ± 0.41 |
| 2. | Non-pregnant-non-lactating | 6236.32 ± 314.27 | 2522.13 ± 142.17 | 3714.19 ± 174.78 | 59.66 ± 0.39 |
| 3. | Non-pregnant-lactating | 8317.52 ± 260.16 | 3304.66 ± 101.44 | 5012.86 ± 168.02 | 60.24 ± 0.41 |
| 4. | Pregnant-non-lactating | 8862.80 ± 151.61 | 3549.88 ± 84.97 | 5312.92 ± 79.11 | 59.98 ± 0.41 |

TABLE contd

| S. No. | Different Physiological states of cross-bred cows | Total O. M. consumed (g) | O. M. voided (g) | O. M. digested (g) | Digestibility coefficient |
|----------------------|---|--------------------------|------------------|--------------------|---------------------------|
| SUMMER SEASON | | | | | |
| 1. | Calves under one year of age | 2020.16 ± 83.64 | 845.42 ± 39.87 | 1174.74 ± 44.51 | 58.24 ± 0.37 |
| 2. | Non-pregnant-non-lactating | 6000.48 ± 295.97 | 2571.39 ± 138.25 | 3429.09 ± 162.03 | 57.20 ± 0.46 |
| 3. | Non-pregnant-lactating | 7980.64 ± 247.33 | 3371.00 ± 128.31 | 4599.64 ± 127.69 | 57.70 ± 0.46 |
| 4. | Pregnant-non-lactating | 8449.20 ± 157.61 | 3603.94 ± 76.93 | 4845.26 ± 105.22 | 57.51 ± 0.42 |
| RAINY SEASON | | | | | |
| 1. | Calves under one year of age | 2241.60 ± 91.76 | 889.75 ± 35.37 | 1351.85 ± 58.06 | 60.27 ± 0.40 |
| 2. | Non-pregnant-non-lactating | 6620.88 ± 310.67 | 2698.44 ± 141.42 | 3922.44 ± 170.79 | 59.33 ± 0.32 |
| 3. | Non-pregnant-lactating | 8735.04 ± 257.23 | 3494.38 ± 98.17 | 5240.66 ± 169.22 | 59.97 ± 0.41 |
| 4. | Pregnant-non-lactating | 9404.16 ± 176.57 | 3796.95 ± 97.88 | 5607.21 ± 88.33 | 59.67 ± 0.40 |
| AUTUMN SEASON | | | | | |
| 1. | Calves under one year of age | 2171.36 ± 91.39 | 859.88 ± 34.62 | 1311.48 ± 58.52 | 60.35 ± 0.42 |
| 2. | Non-pregnant-non-lactating | 6400.00 ± 304.47 | 2593.82 ± 140.67 | 3806.18 ± 166.92 | 59.57 ± 0.41 |
| 3. | Non-pregnant-lactating | 8438.96 ± 265.94 | 3361.35 ± 101.80 | 5077.62 ± 173.47 | 60.14 ± 0.41 |
| 4. | Pregnant-non-lactating | 9052.88 ± 160.10 | 3628.96 ± 89.23 | 5423.92 ± 82.47 | 59.95 ± 0.41 |

TABLE -9 (a) : Analysis of variance of data on the digestibility coefficient of organic matter in different seasons in calves under one year of age.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|--------|-------|---------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 44.57 | 11.14 | 6.83 ** | 0.96 | 1.38 |
| Error | 45 | 73.35 | 1.63 | | | |
| Total | 49 | 117.92 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -9 (b) : Analysis of variance of data on the digestibility coefficient of organic matter in different seasons in Non-Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|---------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 50.214 | 12.554 | 7.69 ** | 0.96 | 1.38 |
| Error | 45 | 73.444 | 1.632 | | | |
| Total | 49 | 123.658 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -9 (c) : Analysis of variance of data on the digestibility coefficient of organic matter in different seasons i

Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|--------|--------|---------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 52.91 | 13.228 | 6.05 ** | 1.11 | 1.59 |
| Error | 45 | 98.43 | 2.187 | | | |
| Total | 49 | 151.34 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -9 (d) : Analysis of variance of data on the digestibility coefficient of organic matter in different seasons in

Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|---------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 50.351 | 12.588 | 7.40 ** | 0.97 | 1.40 |
| Error | 45 | 76.611 | 1.702 | | | |
| Total | 49 | 126.962 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -10 : Effect of seasons on Nitrogen balance in cross-bred cows.

| S. No. | Different Physiological states of cross-bred cows | Nitrogen intake (g) | Nitrogen out go (g) | | | Total Nitrogen out go (g) | Nitrogen Balance (g) |
|----------------------|---|---------------------|---------------------|--------------|--------------|---------------------------|----------------------|
| | | | Faeces | Urine | Milk | | |
| WINTER SEASON | | | | | | | |
| 1. | Calves under one year of age | 53.03 ± 2.05 | 17.16 ± 0.68 | 10.53 ± 1.34 | — | 27.69 ± 2.01 | 25.34 ± 0.18 |
| 2. | Non-Pregnant-non-lactating | 63.33 ± 1.13 | 21.01 ± 0.46 | 30.12 ± 0.70 | — | 51.13 ± 1.15 | 12.20 ± 0.07 |
| 3. | Non-Pregnant-lactating | 160.33 ± 1.74 | 52.02 ± 0.47 | 27.73 ± 0.97 | 57.10 ± 1.39 | 136.85 ± 1.88 | 23.48 ± 0.19 |
| 4. | Pregnant-non-lactating | 125.36 ± 0.63 | 40.81 ± 0.34 | 62.69 ± 0.42 | — | 103.50 ± 0.61 | 21.86 ± 0.21 |
| SPRING SEASON | | | | | | | |
| 1. | Calves under one year of age | 52.60 ± 1.96 | 19.34 ± 0.74 | 9.64 ± 1.27 | — | 28.98 ± 1.99 | 23.62 ± 0.22 |
| 2. | Non-Pregnant-non-lactating | 61.16 ± 1.14 | 23.37 ± 0.47 | 27.31 ± 0.66 | — | 50.68 ± 1.08 | 10.48 ± 0.21 |
| 3. | Non-Pregnant-lactating | 150.90 ± 1.61 | 55.60 ± 0.61 | 19.79 ± 1.88 | 53.75 ± 1.69 | 129.14 ± 1.61 | 21.76 ± 0.26 |
| 4. | Pregnant-non-lactating | 122.03 ± 0.55 | 45.16 ± 0.22 | 56.73 ± 0.42 | — | 101.89 ± 0.51 | 20.14 ± 0.38 |

TABLE contd

| S. No. | Different Physiological states of cross-bred cows | Nitrogen intake (g) | Nitrogen out go (g) | | | Total Nitrogen out go (g) | Nitrogen Balance (g) |
|----------------------|---|---------------------|---------------------|--------------|--------------|---------------------------|----------------------|
| | | | Faeces | Urine | Milk | | |
| SUMMER SEASON | | | | | | | |
| 1. | Calves under one year of age | 53.02 ± 2.10 | 25.32 ± 1.03 | 10.47 ± 1.09 | — | 35.79 ± 2.07 | 17.23 ± 0.48 |
| 2. | Non-Pregnant-non-lactating | 60.30 ± 1.08 | 29.89 ± 0.59 | 22.49 ± 0.46 | — | 52.38 ± 1.04 | 7.92 ± 0.09 |
| 3. | Non-Pregnant-lactating | 132.17 ± 1.35 | 63.19 ± 0.59 | 10.74 ± 0.77 | 42.56 ± 0.94 | 116.49 ± 1.59 | 15.68 ± 0.43 |
| 4. | Pregnant-non-lactating | 120.53 ± 0.57 | 57.83 ± 0.33 | 48.58 ± 0.51 | — | 106.41 ± 0.66 | 14.12 ± 0.22 |
| RAINY SEASON | | | | | | | |
| 1. | Calves under one year of age | 54.96 ± 2.03 | 22.34 ± 0.84 | 10.17 ± 1.21 | — | 32.51 ± 2.02 | 22.45 ± 0.18 |
| 2. | Non-Pregnant-non-lactating | 62.56 ± 1.13 | 27.57 ± 0.51 | 25.76 ± 0.62 | — | 53.33 ± 1.09 | 9.23 ± 0.24 |
| 3. | Non-Pregnant-lactating | 150.05 ± 2.27 | 61.06 ± 0.96 | 14.63 ± 0.77 | 53.79 ± 1.29 | 129.48 ± 2.34 | 20.57 ± 0.21 |
| 4. | Pregnant-non-lactating | 124.02 ± 0.65 | 50.67 ± 0.36 | 54.46 ± 0.52 | — | 105.13 ± 0.58 | 18.89 ± 0.57 |
| AUTUMN SEASON | | | | | | | |
| 1. | Calves under one year of age | 54.70 ± 2.38 | 20.39 ± 0.86 | 9.93 ± 1.58 | — | 30.32 ± 2.42 | 24.38 ± 0.33 |
| 2. | Non-Pregnant-non-lactating | 61.76 ± 1.11 | 23.70 ± 0.42 | 26.82 ± 0.90 | — | 50.52 ± 1.29 | 11.24 ± 0.41 |
| 3. | Non-Pregnant-lactating | 151.02 ± 2.69 | 56.10 ± 0.87 | 17.33 ± 2.64 | 55.07 ± 1.33 | 128.50 ± 2.76 | 22.52 ± 0.22 |
| 4. | Pregnant-non-lactating | 122.72 ± 0.58 | 45.76 ± 0.27 | 56.06 ± 0.62 | — | 101.82 ± 0.66 | 20.90 ± 0.52 |

TABLE -10 (a) : Analysis of variance of data on the Nitrogen balance in different seasons in calves under one year of age.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|-------|----------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 376.141 | 94.04 | 41.98 ** | 1.13 | 1.62 |
| Error | 45 | 100.91 | 2.24 | | | |
| Total | 49 | 477.051 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -10 (b) : Analysis of variance of data on the Nitrogen balance in different seasons in Non-Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|----------|-------|----------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 112.7759 | 28.19 | 49.46 ** | 0.57 | 0.82 |
| Error | 45 | 25.44 | 0.57 | | | |
| Total | 49 | 138.2159 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -10 (c) : Analysis of variance of data on the Nitrogen balance in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|--------|-------|----------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 373.17 | 93.29 | | | |
| Error | 45 | 34.06 | 0.76 | 122.75 ^{**} | 0.66 | 0.94 |
| Total | 49 | 407.23 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -10 (d) : Analysis of variance of data on the Nitrogen balance in different seasons in Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|-------|---------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 367.939 | 91.98 | | | |
| Error | 45 | 74.74 | 1.66 | 55.41 ^{**} | 0.97 | 1.40 |
| Total | 49 | 442.679 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -11 : Seasonal variation in Rectal temperature, Pulse rate and Respiration rate in cross-bred cows.

| Sl. No. | Different Physiological states of cross-bred cows | MORNING (04 hours) | | | | EVENING (16 hours) | | | | |
|----------------------|---|-------------------------|-------------------|-------------------------|-------------------------|----------------------|-------------------------|-------------------------|-------------------|-------------------------|
| | | Rectal temperature (°c) | Pulse Rate/minute | Respiration Rate/minute | Rectal temperature (°c) | Pulse Rate/minute | Respiration Rate/minute | Rectal temperature (°c) | Pulse Rate/minute | Respiration Rate/minute |
| WINTER SEASON | | | | | | | | | | |
| 1. | Calves under one year of age | 38.4 ± 0.01 | 60.4 ± 0.54 | 15.2 ± 0.32 | 38.5 ± 0.005 | 62.5 ± 0.58 | 16.7 ± 0.30 | | | |
| 2. | Non-Pregnant-Non-lactating | 38.1 ± 0.02 | 60.0 ± 0.47 | 14.0 ± 0.15 | 38.3 ± 0.01 | 62.1 ± 0.50 | 15.2 ± 0.31 | | | |
| 3. | Non-Pregnant-lactating | 38.3 ± 0.02 | 60.2 ± 0.44 | 14.5 ± 0.16 | 38.4 ± 0.007 | 62.3 ± 0.50 | 15.6 ± 0.41 | | | |
| 4. | Pregnant-Non-lactating | 38.1 ± 0.02 | 60.1 ± 0.46 | 14.3 ± 0.14 | 38.3 ± 0.01 | 62.2 ± 0.47 | 15.4 ± 0.28 | | | |
| SPRING SEASON | | | | | | | | | | |
| 1. | Calves under one year of age | 38.6 ± 0.01 | 63.2 ± 0.42 | 20.8 ± 0.50 | 38.6 ± 0.006 | 64.3 ± 0.42 | 21.6 ± 0.50 | | | |
| 2. | Non-Pregnant-Non-lactating | 38.3 ± 0.003 | 62.9 ± 0.53 | 18.6 ± 0.49 | 38.4 ± 0.006 | 63.7 ± 0.30 | 20.1 ± 0.38 | | | |
| 3. | Non-Pregnant-lactating | 38.4 ± 0.01 | 63.1 ± 0.43 | 19.0 ± 0.38 | 38.5 ± 0.01 | 64.2 ± 0.42 | 20.7 ± 0.54 | | | |
| 4. | Pregnant-Non-lactating | 38.3 ± 0.007 | 63.0 ± 0.45 | 18.7 ± 0.44 | 38.4 ± 0.01 | 64.1 ± 0.46 | 20.3 ± 0.34 | | | |

TABLE contd

| Sl. No. | Different Physiological states of cross-bred cows | MORNING (04 hours) | | | | EVENING (16 hours) | | | | |
|----------------------|---|-------------------------|-------------------|-------------------------|-------------------------|----------------------|-------------------------|-------------------------|-------------------|-------------------------|
| | | Rectal temperature (°c) | Pulse Rate/minute | Respiration Rate/minute | Rectal temperature (°c) | Pulse Rate/minute | Respiration Rate/minute | Rectal temperature (°c) | Pulse Rate/minute | Respiration Rate/minute |
| SUMMER SEASON | | | | | | | | | | |
| 1. | Calves under one year of age | 38.6 ± 0.01 | 64.8 ± 0.33 | 27.8 ± 0.47 | 38.9 ± 0.003 | 66.4 ± 0.43 | 33.1 ± 0.48 | | | |
| 2. | Non-Pregnant-Non-lactating | 38.3 ± 0.004 | 64.4 ± 0.32 | 26.0 ± 0.52 | 38.5 ± 0.006 | 66.0 ± 0.41 | 31.8 ± 0.31 | | | |
| 3. | Non-Pregnant-lactating | 38.5 ± 0.006 | 64.7 ± 0.30 | 26.6 ± 0.40 | 38.8 ± 0.006 | 66.3 ± 0.50 | 32.2 ± 0.55 | | | |
| 4. | Pregnant-Non-lactating | 38.4 ± 0.008 | 64.6 ± 0.38 | 26.4 ± 0.53 | 38.7 ± 0.01 | 66.1 ± 0.37 | 32.0 ± 0.48 | | | |
| RAINY SEASON | | | | | | | | | | |
| 1. | Calves under one year of age | 38.6 ± 0.01 | 64.3 ± 0.31 | 23.7 ± 0.51 | 38.6 ± 0.01 | 65.8 ± 0.34 | 28.2 ± 0.49 | | | |
| 2. | Non-Pregnant-Non-lactating | 38.3 ± 0.006 | 64.0 ± 0.20 | 22.4 ± 0.40 | 38.4 ± 0.01 | 65.1 ± 0.22 | 27.0 ± 0.43 | | | |
| 3. | Non-Pregnant-lactating | 38.5 ± 0.01 | 64.2 ± 0.21 | 22.8 ± 0.46 | 38.5 ± 0.01 | 65.3 ± 0.29 | 27.8 ± 0.47 | | | |
| 4. | Pregnant-Non-lactating | 38.4 ± 0.01 | 64.1 ± 0.24 | 22.6 ± 0.33 | 38.4 ± 0.009 | 65.2 ± 0.28 | 27.5 ± 0.32 | | | |
| AUTUMN SEASON | | | | | | | | | | |
| 1. | Calves under one year of age | 38.6 ± 0.01 | 63.0 ± 0.45 | 20.3 ± 0.40 | 38.6 ± 0.005 | 65.6 ± 0.40 | 22.6 ± 0.53 | | | |
| 2. | Non-Pregnant-Non-lactating | 38.3 ± 0.007 | 62.7 ± 0.30 | 18.2 ± 0.38 | 38.3 ± 0.006 | 64.5 ± 0.32 | 20.7 ± 0.38 | | | |
| 3. | Non-Pregnant-lactating | 38.4 ± 0.009 | 62.9 ± 0.23 | 18.8 ± 0.45 | 38.5 ± 0.007 | 65.0 ± 0.28 | 21.4 ± 0.49 | | | |
| 4. | Pregnant-Non-lactating | 38.3 ± 0.005 | 62.8 ± 0.27 | 18.4 ± 0.33 | 38.4 ± 0.009 | 64.9 ± 0.30 | 21.0 ± 0.39 | | | |

Note : Figures shows average of ten observations.

TABLE -11 (a) : Analysis of variance of data on the Rectal temperature at 04 hours in different seasons in calves under one year of age.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|-------|--------|----------|--------------|-------|
| | | | | | 5% | 1% |
| Between Season | 4 | 0.302 | 0.0755 | 58.08 ** | 0.027 | 0.039 |
| Error | 45 | 0.060 | 0.0013 | | | |
| Total | 49 | 0.362 | | | | |

** = Significant at 1% level ($P < 0.01$)

TABLE -11 (b) : Analysis of variance of data on the Rectal temperature at 16 hours in different seasons in calves under one year of age.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|-------|--------|-----------|--------------|-------|
| | | | | | 5% | 1% |
| Between Season | 4 | 0.652 | 0.1630 | 148.18 ** | 0.025 | 0.036 |
| Error | 45 | 0.050 | 0.0011 | | | |
| Total | 49 | 0.702 | | | | |

** = Significant at 1% level ($P < 0.01$)

TABLE -11 (c) : Analysis of variance of data on the Rectal temperature at 04 hours in different seasons in Non-Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|-------|--------|----------|--------------|-------|
| | | | | | 5% | 1% |
| Between Season | 4 | 0.371 | 0.0928 | 58.00 ** | 0.030 | 0.043 |
| Error | 45 | 0.070 | 0.0016 | | | |
| Total | 49 | 0.441 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -11 (d) : Analysis of variance of data on the Rectal temperature at 16 hours in different seasons in Non-Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|-------|--------|----------|--------------|-------|
| | | | | | 5% | 1% |
| Between Season | 4 | 0.383 | 0.0958 | 87.09 ** | 0.025 | 0.036 |
| Error | 45 | 0.050 | 0.0011 | | | |
| Total | 49 | 0.433 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -11 (e) : Analysis of variance of data on the Rectal temperature at 04 hours in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|-------|--------|----------------------|--------------|-------|
| | | | | | 5% | 1% |
| Between Season | 4 | 1.068 | 0.267 | 242.73 ^{**} | 0.025 | 0.036 |
| Error | 45 | 0.050 | 0.0011 | | | |
| Total | 49 | 1.118 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -11 (f) : Analysis of variance of data on the Rectal temperature at 16 hours in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|-------|--------|----------------------|--------------|-------|
| | | | | | 5% | 1% |
| Between Season | 4 | 0.643 | 0.1608 | 146.18 ^{**} | 0.025 | 0.036 |
| Error | 45 | 0.050 | 0.0011 | | | |
| Total | 49 | 0.693 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -11 (g) : Analysis of variance of data on the Rectal temperature at 04 hours in different seasons in Pregnant-

Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F _C | C D value at | |
|---------------------|-------|------|--------|---------------------|--------------|-------|
| | | | | | 5% | 1% |
| Between Season | 4 | 0.31 | 0.0775 | 48.44 ^{**} | 0.030 | 0.043 |
| Error | 45 | 0.07 | 0.0016 | | | |
| Total | 49 | 0.38 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -11 (h) : Analysis of variance of data on the Rectal temperature at 16 hours in different seasons in Pregnant-

Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F _C | C D value at | |
|---------------------|-------|-------|--------|----------------------|--------------|-------|
| | | | | | 5% | 1% |
| Between Season | 4 | 0.751 | 0.1878 | 117.38 ^{**} | 0.030 | 0.043 |
| Error | 45 | 0.071 | 0.0016 | | | |
| Total | 49 | 0.821 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -11 (i) : Analysis of variance of data on the Pulse rate at 04 hours in different seasons in calves under one year of age.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|--------|-------|----------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 116.32 | 29.08 | 16.71 ** | 0.99 | 1.42 |
| Error | 45 | 78.41 | 1.74 | | | |
| Total | 49 | 194.73 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -11 (j) : Analysis of variance of data on the Pulse rate at 16 hours in different seasons in calves under one year of age.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|--------|-------|----------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 96.68 | 24.17 | 14.83 ** | 0.96 | 1.38 |
| Error | 45 | 73.22 | 1.63 | | | |
| Total | 49 | 169.90 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -11 (k) : Analysis of variance of data on the Pulse rate at 04 hours in different seasons in Non-Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|--------|-------|---------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 118.59 | 29.65 | 20.17 ^{**} | 0.91 | 1.30 |
| Error | 45 | 66.01 | 1.47 | | | |
| Total | 49 | 184.60 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -11 (l) : Analysis of variance of data on the Pulse rate at 16 hours in different seasons in Non-Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|--------|-------|---------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 87.68 | 21.92 | 16.61 ^{**} | 0.86 | 1.23 |
| Error | 45 | 59.22 | 1.32 | | | |
| Total | 49 | 146.90 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -11 (m) : Analysis of variance of data on the Pulse rate at 04 hours in different seasons in Non-Pregna lactating cross-bred cows.

| Source of variation | d. f. | SS | MSS | FC | C D value at | |
|---------------------|-------|--------|-------|---------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 120.71 | 30.18 | 26.47 ^{**} | 0.81 | 1.16 |
| Error | 45 | 51.13 | 1.14 | | | |
| Total | 49 | 171.84 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -11 (n) : Analysis of variance of data on the Pulse rate at 16 hours in different seasons in Non-Pregnant- lactating cross-bred cows.

| Source of variation | d. f. | SS | MSS | FC | C D value at | |
|---------------------|-------|--------|-------|---------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 89.88 | 22.47 | 13.62 ^{**} | 0.96 | 1.38 |
| Error | 45 | 74.42 | 1.65 | | | |
| Total | 49 | 164.30 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -11 (o) : Analysis of variance of data on the Pulse rate at 04 hours in different seasons in Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | SS | MSS | FC | C D value at | |
|---------------------|-------|--------|-------|---------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 120.54 | 30.14 | | | |
| Error | 45 | 62.05 | 1.38 | 21.84** | 0.89 | 1.28 |
| Total | 49 | 182.59 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -11 (p) : Analysis of variance of data on the Pulse rate at 16 hours in different seasons in Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | SS | MSS | FC | C D value at | |
|---------------------|-------|--------|-------|---------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 86.61 | 21.65 | | | |
| Error | 45 | 66.31 | 1.47 | 14.73** | 0.91 | 1.30 |
| Total | 49 | 152.92 | | | | |

** = Significant at 1% level (P < 0.01)

**TABLE .11 (q) : Analysis of variance of data on the Respiration rate at 04 hours in different seasons in calves un
one year of age.**

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|----------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 864.001 | 216.00 | 109.64** | 1.06 | 1.52 |
| Error | 45 | 88.58 | 1.97 | | | |
| Total | 49 | 952.581 | | | | |

** = Significant at 1% level (P < 0.01)

**TABLE .11 (r) : Analysis of variance of data on the Respiration rate at 16 hours in different seasons in calves under
one year of age.**

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|----------|--------|----------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 1604.861 | 401.22 | 183.21** | 1.13 | 1.59 |
| Error | 45 | 98.36 | 2.19 | | | |
| Total | 49 | 1703.221 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -11 (s) : Analysis of variance of data on the Respiration rate at 04 hours in different seasons in Non-Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|----------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 827.916 | 206.98 | 123.94 ^{**} | 0.97 | 1.40 |
| Error | 45 | 75.22 | 1.67 | | | |
| Total | 49 | 903.136 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -11 (t) : Analysis of variance of data on the Respiration rate at 16 hours in different seasons in Non-Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|----------|--------|----------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 1671.991 | 418.00 | 311.94 ^{**} | 0.87 | 1.26 |
| Error | 45 | 60.27 | 1.34 | | | |
| Total | 49 | 1732.261 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -10 (v) : Analysis of variance of data on the Respiration rate at 04 hours in different seasons in Non-Pregnant lactating cross-bred cows.

| Source of variation | d. f. | SS | M S S | FC | C D value at | |
|---------------------|-------|--------|--------|----------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 835.12 | 208.78 | 141.07** | 0.91 | 1.30 |
| Error | 45 | 66.53 | 1.48 | | | |
| Total | 49 | 901.65 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -11 (v) : Analysis of variance of data on the Respiration rate at 16 hours in different seasons in Non-Pregnant lactating cross-bred cows.

| Source of variation | d. f. | SS | M S S | FC | C D value at | |
|---------------------|-------|---------|--------|----------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 1688.32 | 422.08 | 172.28** | 1.18 | 1.69 |
| Error | 45 | 110.42 | 2.45 | | | |
| Total | 49 | 1798.74 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -11 (w) : Analysis of variance of data on the Respiration rate at 04 hours in different seasons in Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|--------|--------|----------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 844.28 | 211.07 | | | |
| Error | 45 | 63.90 | 1.42 | 148.64 ^{**} | 0.89 | 1.28 |
| Total | 49 | 908.18 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -11 (x) : Analysis of variance of data on the Respiration rate at 16 hours in different seasons in Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|----------|--------|----------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 1700.904 | 425.23 | | | |
| Error | 45 | 61.01 | 1.36 | 312.67 ^{**} | 0.87 | 1.26 |
| Total | 49 | 1761.914 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -12 : Seasonal Variation in Milk yield and its composition in Non-Pregnant-lactating cross-bred cows.

| S. No. | ATTRIBUTES | SEASONS | | | |
|--------|----------------------------|--------------|--------------|--------------|--------------|
| | | WINTER | SPRING | SUMMER | AUTUMN |
| 1. | Milk yield (Kg) | 10.33 ± 0.25 | 9.57 ± 0.23 | 7.56 ± 0.18 | 9.33 ± 0.23 |
| 2. | 4% FCM yield (Kg) | 9.62 ± 0.23 | 9.57 ± 0.26 | 8.20 ± 0.20 | 8.49 ± 0.24 |
| 3. | Water (%) | 88.19 ± 0.14 | 87.12 ± 0.11 | 86.40 ± 0.09 | 87.80 ± 0.10 |
| 4. | Fat (%) | 3.58 ± 0.06 | 4.00 ± 0.08 | 4.55 ± 0.03 | 3.40 ± 0.02 |
| 5. | Protein (%) | 3.53 ± 0.04 | 3.58 ± 0.03 | 3.60 ± 0.04 | 3.68 ± 0.03 |
| 6. | Lactose (%) | 4.10 ± 0.05 | 4.65 ± 0.04 | 4.70 ± 0.04 | 4.42 ± 0.07 |
| 7. | Ash (%) | 0.60 ± 0.02 | 0.65 ± 0.02 | 0.75 ± 0.03 | 0.70 ± 0.03 |
| 8. | Total Solid (%) | 11.81 ± 0.14 | 12.88 ± 0.11 | 13.60 ± 0.09 | 12.20 ± 0.10 |
| 9. | Solid not fat (S.N.F.) (%) | 8.23 ± 0.09 | 8.88 ± 0.06 | 9.05 ± 0.07 | 8.80 ± 0.10 |

TABLE -12 (a) : Analysis of variance of data on the Milk yield in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|-------|---------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 42.6187 | 10.65 | 22.66 ^{**} | 0.52 | 0.75 |
| Error | 45 | 21.15 | 0.47 | | | |
| Total | 49 | 63.7687 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -12 (b) : Analysis of variance of data on the 4% FCM yield in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|-------|--------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 16.0181 | 4.005 | 7.27 ^{**} | 0.55 | 0.80 |
| Error | 45 | 24.79 | 0.551 | | | |
| Total | 49 | 4080.81 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -12 (c) : Analysis of variance of data on the Water per cent in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|-------|-------|---------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 18.95 | 4.74 | 39.50 ^{**} | 0.25 | 0.36 |
| Error | 45 | 5.25 | 0.12 | | | |
| Total | 49 | 24.20 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -12 (d) : Analysis of variance of data on the Fat per cent in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|-------|-------|---------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 7.897 | 1.974 | 54.83 ^{**} | 0.14 | 0.21 |
| Error | 45 | 1.61 | 0.036 | | | |
| Total | 49 | 9.507 | | | | |

**** = Significant at 1% level (P < 0.01)**

Analysis of variance of data on the Protein per cent in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | SS | M S S | FC | C D value at | |
|---------------------|-------|--------|-------|---------|--------------|----|
| | | | | | 5% | 1% |
| Between Season | 4 | 0.1394 | 0.035 | 2.06 NS | - | - |
| Error | 45 | 0.75 | 0.017 | | | |
| Total | 49 | 0.8894 | | | | |

NS = Non-Significant

TABLE -12 (f) : Analysis of variance of data on the Lactose per cent in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | SS | M S S | FC | C D value at | |
|---------------------|-------|--------|--------|----------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 2.5265 | 0.6316 | 19.49 ** | 0.13 | 0.19 |
| Error | 45 | 1.4600 | 0.0324 | | | |
| Total | 49 | 3.9865 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -12 (g) : Analysis of variance of data on the Ash per cent in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|--------|--------|---------|--------------|-------|
| | | | | | 5% | 1% |
| Between Season | 4 | 0.1162 | 0.0291 | 4.04 ** | 0.064 | 0.092 |
| Error | 45 | 0.3250 | 0.0072 | | | |
| Total | 49 | 0.4412 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -12 (h) : Analysis of variance of data on the Total Solid per cent in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|----------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 18.6984 | 4.6746 | 40.06 ** | 0.25 | 0.36 |
| Error | 45 | 5.2500 | 0.1167 | | | |
| Total | 49 | 23.9484 | | | | |

** = Significant at 1% level (P < 0.01)

ABLE -12 (i) : Analysis of variance of data on the Solid not fat (S.N.F.) in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|--------|--------|---------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 3.9016 | 0.9754 | 13.31 ^{**} | 0.20 | 0.29 |
| Error | 45 | 3.3000 | 0.0733 | | | |
| Total | 49 | 7.2016 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -13 : Effect of seasons on Haematological and bio-chemical parameters of blood in cross-bred cows.

| S No. | Different Physiological states of cross-bred cows | Haemoglobin (gm/100 ml blood) | Erythrocytes (RBCs) (Million/mm ³) | Leucocytes (WBCs) (Thousand/mm ³) | P C V (%) | Blood Urea (mg/100 ml blood) | Blood glucose (mg/100 ml blood) | Serum cholesterol (mg/100 ml blood) | Serum protein (gm/100 ml blood) |
|-------|---|-------------------------------|--|---|--------------|------------------------------|---------------------------------|-------------------------------------|---------------------------------|
| | | | | | | | | | |
| 1. | Calves under one year of age | 13.00 ± 0.34 | 9.50 ± 0.17 | 5.64 ± 0.12 | 45.00 ± 0.37 | 6.50 ± 0.12 | 60.50 ± 0.88 | 55.00 ± 0.93 | 7.65 ± 0.18 |
| 2. | Non-Pregnant-Non-lactating | 12.00 ± 0.35 | 8.00 ± 0.22 | 6.82 ± 0.14 | 49.00 ± 0.49 | 21.65 ± 0.47 | 54.00 ± 1.08 | 76.28 ± 0.93 | 7.42 ± 0.23 |
| 3. | Non-Pregnant-lactating | 11.50 ± 0.35 | 7.50 ± 0.22 | 7.10 ± 0.16 | 51.00 ± 0.36 | 24.00 ± 0.63 | 51.75 ± 0.80 | 83.15 ± 0.91 | 7.55 ± 0.21 |
| 4. | Pregnant-Non-lactating | 11.00 ± 0.34 | 7.40 ± 0.20 | 7.49 ± 0.18 | 56.00 ± 0.41 | 22.50 ± 0.52 | 48.60 ± 0.95 | 126.26 ± 0.82 | 7.60 ± 0.19 |
| 1. | Calves under one year of age | 12.85 ± 0.40 | 9.25 ± 0.19 | 6.33 ± 0.15 | 44.82 ± 0.43 | 7.45 ± 0.18 | 59.10 ± 0.99 | 52.37 ± 0.84 | 7.62 ± 0.20 |
| 2. | Non-Pregnant-Non-lactating | 11.87 ± 0.35 | 7.84 ± 0.25 | 7.45 ± 0.15 | 48.75 ± 0.41 | 23.27 ± 0.66 | 53.18 ± 1.12 | 74.13 ± 0.90 | 7.40 ± 0.22 |
| 3. | Non-Pregnant-lactating | 11.20 ± 0.40 | 7.22 ± 0.20 | 7.93 ± 0.12 | 50.84 ± 0.42 | 25.96 ± 0.60 | 50.62 ± 1.00 | 80.00 ± 0.85 | 7.52 ± 0.17 |
| 4. | Pregnant-Non-lactating | 10.90 ± 0.31 | 7.15 ± 0.21 | 8.00 ± 0.20 | 55.77 ± 0.58 | 24.22 ± 0.83 | 47.70 ± 0.96 | 110.40 ± 0.96 | 7.57 ± 0.19 |

| S No | Different Physiological states of cross-bred cows | Haemoglobin (gm/100 ml blood) | Erythrocytes (RBCs) (Million/mm ³) | Leucocytes (WBCs) (Thousand/mm ³) | P C V (%) | Blood Urea (mg/100 ml blood) | Blood glucose (mg/100 ml blood) | Serum cholesterol (mg/100 ml blood) | Serum protein (gm/100 ml blood) |
|----------------------|---|-------------------------------|--|---|--------------|------------------------------|---------------------------------|-------------------------------------|---------------------------------|
| SUMMER SEASON | | | | | | | | | |
| 1. | Calves under one year of age | 12.10 ± 0.30 | 8.15 ± 0.23 | 6.75 ± 0.14 | 43.94 ± 0.35 | 9.42 ± 0.23 | 55.40 ± 0.85 | 34.50 ± 0.83 | 7.53 ± 0.20 |
| 2. | Non-Pregnant-Non-lactating | 11.12 ± 0.34 | 6.90 ± 0.18 | 7.95 ± 0.15 | 47.90 ± 0.38 | 26.13 ± 0.78 | 49.82 ± 0.91 | 69.47 ± 0.85 | 7.32 ± 0.20 |
| 3. | Non-Pregnant-lactating | 10.35 ± 0.31 | 6.81 ± 0.21 | 8.25 ± 0.10 | 49.85 ± 0.42 | 29.21 ± 0.71 | 47.30 ± 0.83 | 60.35 ± 0.99 | 7.48 ± 0.21 |
| 4. | Pregnant-Non-lactating | 10.03 ± 0.32 | 6.24 ± 0.21 | 8.50 ± 0.16 | 54.88 ± 0.44 | 26.16 ± 0.68 | 44.20 ± 0.85 | 95.83 ± 0.86 | 7.50 ± 0.19 |
| RAINY SEASON | | | | | | | | | |
| 1. | Calves under one year of age | 12.36 ± 0.30 | 8.44 ± 0.21 | 6.56 ± 0.14 | 44.25 ± 0.41 | 8.78 ± 0.19 | 57.21 ± 0.88 | 40.55 ± 0.82 | 7.58 ± 0.19 |
| 2. | Non-Pregnant-Non-lactating | 11.34 ± 0.38 | 7.30 ± 0.20 | 7.78 ± 0.12 | 48.12 ± 0.44 | 25.58 ± 0.54 | 51.36 ± 0.78 | 72.81 ± 0.82 | 7.37 ± 0.21 |
| 3. | Non-Pregnant-lactating | 10.68 ± 0.36 | 7.10 ± 0.20 | 8.12 ± 0.14 | 50.20 ± 0.45 | 28.30 ± 0.75 | 48.94 ± 0.67 | 72.84 ± 0.93 | 7.50 ± 0.18 |
| 4. | Pregnant-Non-lactating | 10.23 ± 0.32 | 6.55 ± 0.17 | 8.21 ± 0.21 | 55.30 ± 0.43 | 25.64 ± 0.84 | 46.59 ± 1.19 | 104.60 ± 0.91 | 7.55 ± 0.19 |
| AUTUMN SEASON | | | | | | | | | |
| 1. | Calves under one year of age | 12.67 ± 0.32 | 8.71 ± 0.20 | 5.92 ± 0.13 | 44.58 ± 0.46 | 7.10 ± 0.20 | 58.30 ± 1.04 | 48.72 ± 0.84 | 7.60 ± 0.17 |
| 2. | Non-Pregnant-Non-lactating | 11.71 ± 0.35 | 7.63 ± 0.21 | 7.16 ± 0.18 | 48.50 ± 0.52 | 22.44 ± 0.55 | 52.80 ± 0.85 | 73.67 ± 0.80 | 7.38 ± 0.25 |
| 3. | Non-Pregnant-lactating | 11.10 ± 0.33 | 7.19 ± 0.22 | 7.35 ± 0.20 | 50.72 ± 0.38 | 25.51 ± 0.78 | 49.33 ± 1.03 | 77.49 ± 0.75 | 7.51 ± 0.18 |
| 4. | Pregnant-Non-lactating | 10.56 ± 0.31 | 6.86 ± 0.14 | 7.60 ± 0.17 | 55.63 ± 0.48 | 23.75 ± 0.59 | 46.95 ± 1.15 | 107.22 ± 0.96 | 7.56 ± 0.19 |

TABLE -13 (a) : Analysis of variance of data on the Haemoglobin in different seasons in calves under one year of age.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|----------|--------------|----|
| | | | | | 5% | 1% |
| Between Season | 4 | 5.3492 | 1.3373 | 1.18 N S | - | - |
| Error | 45 | 50.8042 | 1.1290 | | | |
| Total | 49 | 56.1534 | | | | |

N S = Non-Significant

TABLE -13 (b) : Analysis of variance of data on the Erythrocytes (RBCs) in different seasons in calves under one year of age.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|---------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 12.5048 | 3.1262 | 7.92 ** | 0.47 | 0.68 |
| Error | 45 | 17.7690 | 0.3949 | | | |
| Total | 49 | 30.2738 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -13 (c) : Analysis of variance of data on the Leucocytes (WBCs) in different seasons in calves under one year of age.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|---------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 8.3744 | 2.0936 | 10.97** | 0.34 | 0.48 |
| Error | 45 | 8.5911 | 0.1909 | | | |
| Total | 49 | 16.9655 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -13 (d) : Analysis of variance of data on the Packed Cell Volume (PCV) in different seasons in calves under one year of age.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|--------|-------|---------|--------------|----|
| | | | | | 5% | 1% |
| Between Season | 4 | 7.344 | 1.836 | 1.12 NS | - | - |
| Error | 45 | 73.992 | 1.644 | | | |
| Total | 49 | 81.336 | | | | |

NS = Non-Significant

TABLE -13 (e) : Analysis of variance of data on the Blood Urea in different seasons in calves under one year of age.

| source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|---------|---------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 58.6882 | 14.6721 | 46.56** | 0.42 | 0.60 |
| Error | 45 | 15.7550 | 0.3151 | | | |
| Total | 49 | 74.4432 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -13 (f) : Analysis of variance of data on the Blood glucose in different seasons in calves under one year of age.

| source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|--------|-------|--------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 148.82 | 37.21 | 4.32** | 2.20 | 3.16 |
| Error | 45 | 387.89 | 8.62 | | | |
| Total | 49 | 536.71 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -13 (g) : Analysis of variance of data on the Serum cholesterol in different seasons in calves under one year of age.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|--------|---------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 2906.68 | 726.67 | 99.68 ^{**} | 2.03 | 2.92 |
| Error | 45 | 328.06 | 7.29 | | | |
| Total | 49 | 3234.74 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -13 (h) : Analysis of variance of data on the Serum Protein in different seasons in calves under one year of age.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|-------|--------------------|--------------|----|
| | | | | | 5% | 1% |
| Between Season | 4 | 0.0861 | 0.022 | 0.06 ^{NS} | - | - |
| Error | 45 | 16.1465 | 0.359 | | | |
| Total | 49 | 16.2326 | | | | |

NS = Non-Significant

TABLE -13 (i) : Analysis of variance of data on the Haemoglobin in different seasons in Non-Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|-------|--------------------|--------------|----|
| | | | | | 5% | 1% |
| Between Season | 4 | 5.4399 | 1.36 | | | |
| Error | 45 | 55.7366 | 1.24 | 1.10 ^{NS} | - | - |
| Total | 49 | 61.1765 | | | | |

NS = Non-Significant

TABLE -13 (j) : Analysis of variance of data on the Erythrocytes (RBCs) in different seasons in Non-Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|-------|--------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 7.7952 | 1.95 | | | |
| Error | 45 | 21.036 | 0.47 | 4.15 ^{**} | 0.52 | 0.75 |
| Total | 49 | 28.8312 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -13 (k) : Analysis of variance of data on the Leucocytes (WBCs) in different seasons in Non-Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | SS | MSS | FC | C D value at | |
|---------------------|-------|---------|------|---------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 8.3603 | 2.09 | 9.50 ** | 0.35 | 0.51 |
| Error | 45 | 9.9621 | 0.22 | | | |
| Total | 49 | 18.3224 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -13 (l) : Analysis of variance of data on the Packed Cell Volume (PCV) in different seasons in Non-Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | SS | MSS | FC | C D value at | |
|---------------------|-------|--------|------|---------|--------------|----|
| | | | | | 5% | 1% |
| Between Season | 4 | 8.08 | 2.02 | 0.99 NS | - | - |
| Error | 45 | 92.06 | 2.05 | | | |
| Total | 49 | 100.14 | | | | |

NS = Non-Significant

TABLE -13 (m) : Analysis of variance of data on the Blood Urea in different seasons in Non-Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|-------|---------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 153.324 | 38.33 | 10.33 ^{**} | 1.45 | 2.08 |
| Error | 45 | 167.044 | 3.71 | | | |
| Total | 49 | 320.368 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -13 (n) : Analysis of variance of data on the Blood glucose in different seasons in Non-Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|--------|-------|-------------------|--------------|----|
| | | | | | 5% | 1% |
| Between Season | 4 | 109.25 | 27.31 | 2.98 [*] | 2.27 | — |
| Error | 45 | 412.77 | 9.17 | | | |
| Total | 49 | 522.02 | | | | |

*** = Significant at 5% level (P < 0.05)**

TABLE -13 (o) : Analysis of variance of data on the Serum cholesterol in different seasons in Non-Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | SS | MSS | FC | C D value at | |
|---------------------|-------|--------|-------|--------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 246.11 | 61.53 | 8.27** | 2.05 | 2.95 |
| Error | 45 | 334.99 | 7.44 | | | |
| Total | 49 | 581.10 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -13 (p) : Analysis of variance of data on the Serum Protein in different seasons in Non-Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | SS | MSS | FC | C D value at | |
|---------------------|-------|--------|-------|--------------------|--------------|----|
| | | | | | 5% | 1% |
| Between Season | 4 | 0.055 | 0.014 | 0.29 ^{NS} | - | - |
| Error | 45 | 22.055 | 0.490 | | | |
| Total | 49 | 22.110 | | | | |

NS = Non-Significant

TABLE -13 (q) : Analysis of variance of data on the Haemoglobin in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|-------|---------|--------------|----|
| | | | | | 5% | 1% |
| Between Season | 4 | 8.3296 | 2.08 | | | |
| Error | 45 | 56.532 | 1.26 | 1.65 NS | | |
| Total | 49 | 64.8616 | | | | |

N S = Non-Significant

TABLE -13 (r) : Analysis of variance of data on the Erythrocytes (RBCs) in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|-------|---------|--------------|----|
| | | | | | 5% | 1% |
| Between Season | 4 | 2.4481 | 0.61 | | | |
| Error | 45 | 19.9409 | 0.44 | 1.39 NS | | |
| Total | 49 | 22.389 | | | | |

N S = Non-Significant

TABLE -13 (s) : Analysis of variance of data on the Leucocytes (WBCs) in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|-------|----------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 9.7998 | 2.45 | 10.65 ** | 0.35 | 0.51 |
| Error | 45 | 10.3290 | 0.23 | | | |
| Total | 49 | 20.1288 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -13 (t) : Analysis of variance of data on the Packed Cell Volume (PCV) in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|-------|-------|---------|--------------|----|
| | | | | | 5% | 1% |
| Between Season | 4 | 9.25 | 2.313 | 1.40 NS | - | - |
| Error | 45 | 74.27 | 1.650 | | | |
| Total | 49 | 83.52 | | | | |

NS = Non-Significant

TABLE -13 (u) : Analysis of variance of data on the Blood Urea in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | SS | MSS | FC | C D value at | |
|---------------------|-------|---------|-------|--------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 180.609 | 45.15 | 9.23 ^{**} | 1.66 | 2.39 |
| Error | 45 | 219.961 | 4.89 | | | |
| Total | 49 | 400.570 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -13 (v) : Analysis of variance of data on the Blood glucose in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | SS | MSS | FC | C D value at | |
|---------------------|-------|--------|-------|--------------------|--------------|----|
| | | | | | 5% | 1% |
| Between Season | 4 | 114.59 | 28.65 | 3.74 ^{**} | 2.08 | - |
| Error | 45 | 345.23 | 7.67 | | | |
| Total | 49 | 459.82 | | | | |

*** = Significant at 5% level (P < 0.05)**

TABLE -13 (w) : Analysis of variance of data on the Serum cholesterol in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | SS | MSS | FC | C D value at | |
|---------------------|-------|---------|--------|-----------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 3165.43 | 791.36 | 100.05 ** | 2.12 | 3.04 |
| Error | 45 | 355.76 | 7.91 | | | |
| Total | 49 | 3521.19 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -13 (x) : Analysis of variance of data on the Serum Protein in different seasons in Non-Pregnant-lactating cross-bred cows.

| Source of variation | d. f. | SS | MSS | FC | C D value at | |
|---------------------|-------|---------|--------|----------|--------------|----|
| | | | | | 5% | 1% |
| Between Season | 4 | 0.0268 | 0.0067 | 0.019 NS | - | - |
| Error | 45 | 16.0918 | 0.3576 | | | |
| Total | 49 | 16.1186 | | | | |

NS = Non-Significant

TABLE -13 (y) : Analysis of variance of data on the Haemoglobin in different seasons in Pregnant-Non-lactating cross bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|-------|--------------------|--------------|----|
| | | | | | 5% | 1% |
| Between Season | 4 | 6.9961 | 1.75 | 1.70 ^{NS} | -- | -- |
| Error | 45 | 46.3802 | 1.03 | | | |
| Total | 49 | 53.3763 | | | | |

NS = Non-Significant

TABLE -13 (z) : Analysis of variance of data on the Erythrocytes (RBCs) in different seasons in Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|-------|--------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 8.5420 | 2.14 | 6.11 ^{**} | 0.44 | 0.63 |
| Error | 45 | 15.8416 | 0.35 | | | |
| Total | 49 | 24.3836 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -13 (Aa) : Analysis of variance of data on the Leucocytes (WBCs) in different seasons in Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | SS | M S S | FC | C D value at | |
|---------------------|-------|---------|-------|---------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 7.0548 | 1.76 | 5.18 ** | 0.44 | 0.63 |
| Error | 45 | 15.2055 | 0.34 | | | |
| Total | 49 | 22.2603 | | | | |

** = Significant at 1% level (P < 0.01)

TABLE -13 (Ab) : Analysis of variance of data on the Packed Cell Volume (PCV) in different seasons in Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | SS | M S S | FC | C D value at | |
|---------------------|-------|--------|-------|---------|--------------|----|
| | | | | | 5% | 1% |
| Between Season | 4 | 7.63 | 1.91 | 0.85 NS | - | - |
| Error | 45 | 100.73 | 2.24 | | | |
| Total | 49 | 108.36 | | | | |

NS = Non-Significant

TABLE -13 (Ac) : Analysis of variance of data on the Blood Urea in different seasons in Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|-------|--------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 86.855 | 21.71 | 4.40 ^{**} | 1.66 | 2.39 |
| Error | 45 | 221.893 | 4.93 | | | |
| Total | 49 | 308.748 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -13 (Ad) : Analysis of variance of data on the Blood glucose in different seasons in Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|--------|-------|--------------------|--------------|----|
| | | | | | 5% | 1% |
| Between Season | 4 | 108.73 | 27.18 | 2.57 ^{NS} | - | - |
| Error | 45 | 476.14 | 10.58 | | | |
| Total | 49 | 584.87 | | | | |

NS = Non-Significant

TABLE -13 (Ae) : Analysis of variance of data on the Serum cholesterol in different seasons in Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|---------|----------------------|--------------|------|
| | | | | | 5% | 1% |
| Between Season | 4 | 4957.50 | 1239.38 | 151.70 ^{**} | 2.15 | 3.09 |
| Error | 45 | 367.66 | 8.17 | | | |
| Total | 49 | 5325.16 | | | | |

**** = Significant at 1% level (P < 0.01)**

TABLE -13 (Af) : Analysis of variance of data on the Serum Protein in different seasons in Pregnant-Non-lactating cross-bred cows.

| Source of variation | d. f. | S S | M S S | F C | C D value at | |
|---------------------|-------|---------|-------|---------------------|--------------|----|
| | | | | | 5% | 1% |
| Between Season | 4 | 0.0533 | 0.013 | 0.035 ^{NS} | - | - |
| Error | 45 | 16.4479 | 0.37 | | | |
| Total | 49 | 16.5012 | | | | |

NS = Non-Significant

DISCUSSION

DISCUSSION

Feed Consumption

Dry matter consumption in winter, spring, summer, rainy and autumn seasons was 2.50 ± 0.11 , 2.25 ± 0.09 , 2.15 ± 0.09 , 2.40 ± 0.10 and 2.32 ± 0.10 Kg/day in calves under one year of age, 7.64 ± 0.35 , 6.96 ± 0.36 , 6.70 ± 0.34 , 7.40 ± 0.35 and 7.15 ± 0.35 Kg/day in Non-Pregnant-Non-lactating, 10.05 ± 0.26 , 9.07 ± 0.30 , 8.74 ± 0.28 , 9.55 ± 0.29 and 9.21 ± 0.30 Kg/day in Non-Pregnant-lactating and 10.83 ± 0.20 , 9.79 ± 0.17 , 9.32 ± 0.18 , 10.41 ± 0.20 and 10.00 ± 0.18 Kg/day in Pregnant-Non-lactating cross-bred cows, respectively (Table-3). There was non-significant difference in dry matter consumption in calves under one year of age and Non-Pregnant-Non-lactating cross-bred cows among different seasons of the year. Dry matter consumption in Non-pregnant-lactating and Pregnant-non-lactating cross-bred cows was significantly differed ($P < 0.05$) and ($P < 0.01$) in different seasons of the year, respectively. There are various factors, which affect the dry matter intake such as type, age, sex and stage of production and reproduction of animals. Very young and very old animals are less efficient to their digestion of fibrous food. Declining health might adversely affect DM intake at an advance stage. Young calves and lactating animals required more energy for growth and production of milk. Similar reports have been given by Banerjee (1989) and Verma (1995).

The decline in feed consumption with increasing environmental temperature was significant (Raghavan *et al.*, 1963; Lal *et al.*, 1986; Verma and Husain, 1986 b and Verma and Husain, 1988 a). Low voluntary feed consumption in summer season might be due to lower energy requirement for

various metabolic processes feed consumption actually varies with temperature and humidity (Verma *et al.*, 1988).

Verma *et al.* (2000) reported that the feed intake by buffaloes was reduced when environmental temperature increased. The decline was highest in summer season and lowest during winter season. Similar observations were also reported by Mishra (1995); Verma *et al.* (1999) and Om Prakash (1999).

Digestibility of Nutrients

Dry matter digestibility

The digestibility coefficient of dry matter in winter, spring, summer, rainy and autumn seasons was 69.10 ± 0.23 , 66.01 ± 0.19 , 61.54 ± 0.18 , 64.72 ± 0.28 and 67.46 ± 0.29 in calves under one year of age, 66.96 ± 0.11 , 63.88 ± 0.22 , 58.18 ± 0.19 , 58.46 ± 0.25 and 64.91 ± 0.19 in non-pregnant-non-lactating, 67.42 ± 0.12 , 64.17 ± 0.16 , 59.57 ± 0.16 , 62.67 ± 0.26 and 65.32 ± 0.29 in non-pregnant-lactating and 67.09 ± 0.07 , 64.07 ± 0.17 , 59.53 ± 0.15 , 62.70 ± 0.27 and 65.29 ± 0.29 in pregnant-non-lactating cross bred cows, respectively (Table-4). Significantly higher ($P < 0.01$) dry matter digestibility was observed in winter season than other seasons of the year. The decline in dry matter digestibility with increasing environmental temperature was significant. Similar observations were also reported by Raghavan *et al.* (1963); Mishra *et al.* (1963); Verma and Husain (1986 b); Verma *et al.* (1988) and Verma and Husain (1988 a).

Low voluntary feed consumption in summer season might be due to the fact that the total energy expenditure varies considerably with temperature and feed intake is determined by total energy expenditure. Since the heat increment of feeding is very large in ruminants, it appears that the animals reduced the feed intake with increasing environmental temperature Collier *et*

al. (1982); Verma and Husain (1988 a); Verma and Ram (1992); Mishra (1995); Om Prakash (1999) and Verma *et al.* (2000).

Crude protein digestibility

The digestibility coefficient of crude protein in winter, spring, summer, rainy and autumn seasons was 67.64 ± 0.17 , 63.25 ± 0.15 , 52.26 ± 0.20 , 59.36 ± 0.19 and 62.91 ± 0.12 in calves under one year of age, 66.85 ± 0.16 , 61.80 ± 0.18 , 50.45 ± 0.17 , 55.94 ± 0.13 and 61.63 ± 0.14 in Non-Pregnant-Non-lactating, 67.54 ± 0.17 , 63.15 ± 0.14 , 52.18 ± 0.21 , 59.31 ± 0.19 and 62.84 ± 0.12 in Non - Pregnant - lactating and 67.45 ± 0.17 , 62.99 ± 0.12 , 52.02 ± 0.20 , 59.14 ± 0.18 and 62.71 ± 0.11 in Pregnant - Non - lactating cross - bred cows, respectively (Table-5). The crude protein digestibility was significantly higher ($P < 0.01$) in winter season than other seasons of the year. Similar observations were also reported by Verma and Husain (1988 a); Mishra (1995); Verma *et al.* (1999); Om Prakash (1999) and Verma *et al.* (2000).

Mullick and Kakkar (1961) recorded that at higher air temperature animals voluntary took less of crude protein and more of carbohydrates in the form of roughages. Harvey (1963) reported the effect of temperature on digestion in buffaloes during summer when environmental temperature reached 40-55°C, abomasal secretion declined and acidity decreased. In the end, free hydrochloric acid disappeared and secretion lost its digestive activity. This would amount for the loss of appetite in hot weather. Under tropical conditions lower ingestion and digestion of protein having higher specific dynamic action (Best and Taylor, 1945) and fat with twice the calorogenic value are necessary to reduce thermogenesis which is beneficial for the animals Verma and Husain (1986 b).

Ether extract digestibility

Digestibility of ether extract in winter, spring, summer, rainy and autumn seasons was 71.28 ± 0.16 , 69.92 ± 0.14 , 68.58 ± 0.28 , 67.60 ± 0.22 and 70.43 ± 0.14 per cent in calves under one year of age, 70.55 ± 0.12 , 68.87 ± 0.20 , 67.97 ± 0.21 , 67.22 ± 0.18 and 69.94 ± 0.13 per cent in Non-Pregnant-Non-lactating, 71.10 ± 0.15 , 69.75 ± 0.13 , 68.34 ± 0.30 , 67.54 ± 0.18 and 70.24 ± 0.15 per cent in Non-Pregnant-lactating and 70.69 ± 0.12 , 69.08 ± 0.18 , 68.14 ± 0.19 , 67.43 ± 0.16 and 70.15 ± 0.14 per cent in Pregnant-Non-lactating cross-bred cows, respectively (Table-6). Significant seasonal variation of ether extract was observed in different seasons of the year. The digestibility coefficient of ether extract was significantly higher ($P < 0.01$) in winter season than other seasons of the year. Similar observations were also reported by Raghavan *et al.* (1963); Lal *et al.* (1986); Verma and Husain (1986 b); Verma *et al.* (1998); Verma and Husain (1988 a); Om Prakash (1999); Verma *et al.* (1999) and Verma *et al.* (2000).

Crude fibre digestibility

Digestibility coefficient of crude fibre in winter, spring, summer, rainy and autumn seasons was 55.96 ± 0.10 , 60.63 ± 0.07 , 61.74 ± 0.05 , 59.04 ± 0.07 and 59.62 ± 0.10 in calves under one year of age, 54.88 ± 0.18 , 59.87 ± 0.11 , 60.59 ± 0.11 , 58.43 ± 0.11 and 59.06 ± 0.14 in Non-Pregnant-Non-lactating, 55.65 ± 0.13 , 60.35 ± 0.12 , 61.48 ± 0.08 , 58.73 ± 0.10 and 59.45 ± 0.19 in Non-Pregnant-lactating and 55.08 ± 0.18 , 60.10 ± 0.12 , 60.89 ± 0.14 , 58.65 ± 0.13 and 59.25 ± 0.15 in Pregnant-Non-lactating cross-bred cows, respectively (Table-7). Critical difference analysis showed that crude fibre digestibility was significantly higher ($P < 0.01$) in summer season than spring, autumn, rainy and winter seasons. These results also tally with the findings of Verma and

Husain (1986 b); Verma *et al.* (1988); Mishra (1995); Om Prakash (1999) and Verma *et al.* (2000).

Nitrogen free extract digestibility

The digestibility of nitrogen free extract in winter, spring, summer, rainy and autumn seasons was 70.87 ± 0.16 , 69.94 ± 0.12 , 72.33 ± 0.24 , 72.62 ± 0.23 and 69.77 ± 0.14 per cent in calves under one year of age, 69.96 ± 0.19 , 69.15 ± 0.09 , 71.42 ± 0.30 , 71.56 ± 0.39 and 69.05 ± 0.12 per cent in Non-Pregnant-Non-lactating, 70.40 ± 0.14 , 69.55 ± 0.10 , 71.95 ± 0.27 , 72.25 ± 0.31 and 69.46 ± 0.14 per cent in Non-Pregnant-lactating and 70.28 ± 0.18 , 69.31 ± 0.10 , 71.74 ± 0.26 , 71.93 ± 0.36 and 69.20 ± 0.13 per cent in Pregnant-Non-lactating cross-bred cows, respectively (Table-8). The digestibility coefficient of nitrogen free extract was observed significantly higher ($P < 0.01$) in rainy season followed by summer, winter, spring and autumn seasons. These results also tally with the findings of Verma *et al.* (2000). Voluntary feed intake falls with rising environmental temperature and beginning coincides with the beginning of the rise in body temperature. The depression of nitrogen free extract digestibility in summer months may be due to poor contraction of smooth muscles in all parts of the digestive tract which becomes weak and infrequent and hence the process of digestion was depressed Aliev (1961).

Organic Matter digestibility

Digestibility of organic matter in winter, spring, summer, rainy and autumn seasons was 60.91 ± 0.42 , 60.60 ± 0.41 , 58.24 ± 0.37 , 60.27 ± 0.40 and 60.35 ± 0.42 per cent in calves under one year of age, 60.02 ± 0.43 , 59.66 ± 0.39 , 57.20 ± 0.46 , 59.33 ± 0.32 and 59.57 ± 0.41 per cent in Non-Pregnant-Non-lactating, 60.56 ± 0.42 , 60.24 ± 0.41 , 57.70 ± 0.46 , 59.97 ± 0.41 and 60.14 ± 0.41 per cent in Non-Pregnant-lactating and 60.29 ± 0.42 , 59.98 ± 0.41 , 57.51

± 0.42 , 59.67 ± 0.40 and 59.95 ± 0.41 per cent in Pregnant - Non - lactating cross - bred cows, respectively (Table-9). Organic matter digestibility was found significantly higher ($P < 0.01$) in winter season than other seasons of the year.

Harvey (1963) reported the effect of temperature on digestion during summer months, when environmental temperature reached $40-45^{\circ}\text{C}$, the gastric gland secretion depressed and lost its digestive activity. If the animals body temperature maintained through cooling the gastric secretion was improved, hence, digestibility of organic matter improved significantly. Similar observations were also reported by Collier *et al.* (1982) and Verma and Husain (1986 b).

Nitrogen balance

The nitrogen balance in winter, spring, summer, rainy and autumn seasons was 25.34 ± 0.18 , 23.62 ± 0.22 , 17.23 ± 0.48 , 22.45 ± 0.18 and 24.38 ± 0.33 g/day in calves under one year of age, 12.20 ± 0.07 , 10.48 ± 0.21 , 7.92 ± 0.09 , 9.23 ± 0.24 and 11.24 ± 0.41 g/day in Non-Pregnant-Non-lactating, 23.48 ± 0.19 , 21.76 ± 0.26 , 15.68 ± 0.43 , 20.57 ± 0.21 and 22.52 ± 0.22 g/day in Non - Pregnant-lactating 21.86 ± 0.21 , 20.14 ± 0.38 , 14.12 ± 0.22 , 18.89 ± 0.57 and 20.90 ± 0.52 g/day in Pregnant-Non-lactating cross-bred cows (Table-10). The nitrogen balance was significantly higher ($P < 0.01$) in winter season than autumn, spring, rainy and summer seasons. Similar observations were also reported by Verma *et al.* (2000).

Voluntary food and nitrogen intake falls with rising environmental temperature and beginning of fall coincides with beginning of the rise in body temperature. Mishra *et al.* (1963) found that nitrogen intake in the buffalo was reduced above an ambient temperature of 32°C .

Rectal temperature and cardio - respiratory responses

Rectal temperature

Rectal temperature at 04 hours in winter, spring, summer, rainy and autumn seasons was 38.4 ± 0.01 , 38.6 ± 0.01 , 38.6 ± 0.01 , 38.6 ± 0.01 and $38.6 \pm 0.01^{\circ}\text{C}$ in calves under one year of age, 38.1 ± 0.02 , 38.3 ± 0.003 , 38.3 ± 0.004 , 38.3 ± 0.006 and $38.3 \pm 0.007^{\circ}\text{C}$ in Non-Pregnant-Non-lactating, 38.3 ± 0.02 , 38.4 ± 0.01 , 38.5 ± 0.006 , 38.6 ± 0.01 and $38.4 \pm 0.09^{\circ}\text{C}$ in Non-Pregnant-lactating and 38.1 ± 0.02 , 38.3 ± 0.007 , 38.4 ± 0.008 , 38.4 ± 0.01 and $38.3 \pm 0.005^{\circ}\text{C}$ in Pregnant-Non-lactating cross-bred cows, respectively. Rectal temperature at 16 hours in winter, spring, summer, rainy and autumn seasons was 38.5 ± 0.005 , 38.6 ± 0.006 , 38.9 ± 0.01 , 38.6 ± 0.01 and $38.6 \pm 0.05^{\circ}\text{C}$ in calves under one year of age, 38.3 ± 0.01 , 38.4 ± 0.006 , 38.5 ± 0.006 , 38.4 ± 0.01 and $38.3 \pm 0.006^{\circ}\text{C}$ in Non-Pregnant-Non-lactating, 38.4 ± 0.007 , 38.5 ± 0.01 , 38.8 ± 0.006 , 38.5 ± 0.01 and $38.5 \pm 0.007^{\circ}\text{C}$ in Non-Pregnant-lactating and 38.3 ± 0.01 , 38.4 ± 0.01 , 38.7 ± 0.01 , 38.4 ± 0.009 and $38.4 \pm 0.009^{\circ}\text{C}$ in Pregnant-Non-lactating cross-bred cows, respectively (Table-11). The differences between 04 hours and 16 hours rectal temperature was significant ($P < 0.01$) in all the seasons. Rectal temperature at 04 hours and 16 hours were observed significantly higher ($P < 0.01$) in summer season followed by rainy, spring, autumn and winter seasons. The evening values of rectal temperature were always higher than morning values. Similar observations were also reported by Mullick (1960); Raghavan and Mullick (1961); Pandey and Roy (1969 a & c); Verma and Husain (1985) and Om Prakash *et al.* (1995).

Pal (1952) reported that the rectal temperature in buffalo calves during the month of May and June was higher in young calves (below one

year) than those of about one year of age. He also observed that the temperature control in younger calves was poor than older ones.

The difference in rectal temperature between different seasons was significant ($P < 0.01$). The rectal temperature was significantly related to the ambient temperature and humidity. There was a significant linear increase ($P < 0.01$) in rectal temperature in summer season. Similar observations were also reported by Verma and Husain (1985); Verma and Husain (1986 a); Lal *et al.* (1986); Verma *et al.* (1987 a); Verma and Husain (1988 b); Verma *et al.* (1989); Verma and Ram (1992); Mishra (1995); Om Prakash (1999) and Verma *et al.* (2000).

Pulse rate

Pulse rate at 04 hours in winter, spring, summer, rainy and autumn seasons was 60.4 ± 0.54 , 63.2 ± 0.42 , 64.8 ± 0.33 , 64.3 ± 0.31 and 63.0 ± 0.45 per minute in calves under one year of age, 60.0 ± 0.47 , 62.9 ± 0.53 , 64.4 ± 0.32 , 64.0 ± 0.20 and 62.7 ± 0.30 per minute in Non-Pregnant-Non-lactating, 60.2 ± 0.44 , 63.1 ± 0.43 , 64.7 ± 0.30 , 64.2 ± 0.21 and 62.9 ± 0.23 per minute in Non-Pregnant-lactating and 60.1 ± 0.46 , 63.0 ± 0.45 , 64.6 ± 0.38 , 64.1 ± 0.24 and 62.8 ± 0.27 per minute in Pregnant-Non-lactating cross-bred cows, respectively. Pulse rate at 16 hours in winter, spring, summer, rainy and autumn seasons was 62.5 ± 0.58 , 64.3 ± 0.42 , 66.4 ± 0.43 , 65.8 ± 0.34 and 65.6 ± 0.40 per minute in calves under one year of age, 62.1 ± 0.50 , 63.7 ± 0.30 , 66.0 ± 0.41 , 65.1 ± 0.22 and 64.5 ± 0.32 per minute in Non-Pregnant-Non-lactating, 62.3 ± 0.50 , 64.2 ± 0.42 , 66.3 ± 0.50 , 65.3 ± 0.29 and 65.0 ± 0.28 per minute in Non-Pregnant-lactating and 62.2 ± 0.47 , 64.1 ± 0.46 , 66.1 ± 0.37 , 65.2 ± 0.28 and 64.9 ± 0.30 per minute in Pregnant-Non-lactating cross-bred cows, respectively (Table-11). Analysis of variance of data showed that significant

differences ($P < 0.01$) were found at 04 hours and 16 hours pulse rate in different seasons of the year. Significantly higher ($P < 0.01$) pulse rate at 04 hours and 16 hours in summer season than other seasons of the year. The evening values of pulse rate were always higher than morning values. These results also tally with findings of Lal *et al.*(1986); Om Prakash *et al.* (1995) and Verma *et al.* (2000).

Joshi *et al.* (1982) reported that pulse rate increased moderately during exposure to hot atmosphere from the reference cool environment. Similar observations were also reported by Verma and Husain (1986 a); Lal *et al.* (1986); Verma *et al.* (1987 a); Verma and Husain (1988 b); Verma and Ram (1992); Mishra (1995); Om Prakash *et al.* (1995); Om Prakash (1999) and Verma *et al.* (2000).

Respiration rate

Respiration rate at 04 hours in winter, spring, summer, rainy and autumn seasons was 15.2 ± 0.32 , 20.8 ± 0.50 , 27.8 ± 0.47 , 23.7 ± 0.51 and 20.3 ± 0.40 per minute in calves under one year of age, 14.0 ± 0.15 , 18.6 ± 0.49 , 26.0 ± 0.52 , 24.4 ± 0.40 and 18.2 ± 0.38 per minute in Non-Pregnant-Non-lactating, 14.5 ± 0.16 , 19.0 ± 0.38 , 26.6 ± 0.40 , 22.8 ± 0.46 and 18.8 ± 0.45 per minute in Non-Pregnant-lactating and 14.3 ± 0.14 , 18.7 ± 0.44 , 26.4 ± 0.53 , 22.6 ± 0.33 and 18.4 ± 0.33 per minute in Pregnant-Non-lactating cross-bred cows, respectively. Respiration rate at 16 hours in winter, spring, summer, rainy and autumn seasons was 16.7 ± 0.30 , 21.6 ± 0.50 , 33.1 ± 0.48 , 28.2 ± 0.49 and 22.6 ± 0.53 per minute in calves under one year of age, 15.2 ± 0.31 , 20.1 ± 0.38 , 31.8 ± 0.31 , 27.0 ± 0.43 and 20.7 ± 0.38 per minute in Non-Pregnant-Non-lactating, 15.6 ± 0.41 , 20.7 ± 0.54 , 32.2 ± 0.55 , 27.8 ± 0.47 and 21.4 ± 0.49 per minute in Non-Pregnant-lactating and 15.4 ± 0.28 , 20.3 ± 0.34 , 32.0 ± 0.48 , 27.5 ± 0.32

and 21.0 ± 0.39 per minute in Pregnant-Non-lactating cross-bred cows, respectively (Table-11). The analysis of variance of data showed that significant difference ($P < 0.01$) in respiration rate at 04 hours and 16 hours in different seasons. Significantly higher ($P < 0.01$) respiration rate at 04 and 16 hours were noticed in summer season than other seasons of the year. The evening values of respiration rate were always higher than morning values. These results also tally with the findings of Mishra (1995); Om Prakash *et al.* (1995); Om Prakash (1999) and Verma *et al.* (2000).

Badreldin *et al.* (1951) reported that higher respiration rate in young calves and lower in older buffaloes.

Seasonal variation in the respiration rate due to the change in the atmospheric temperature can be utilized suitably to measure the heat tolerance capacity of the animals. A marked increase in respiration rate during hotter season when the environmental temperature exceeded the critical limit was an indication that the animals were under thermal stress. However, due to variation in temperature when the nights are comparatively cooler, the heat load was not continuous and so the animals were not disturbed physiologically. Greater variation in respiration rate due to rise in the atmospheric temperature in any species will be considered as having an inferior mechanism of adaptation or acclimatisation under regional climatic conditions (Verma and Husain, 1986 a; Lal *et al.*, 1986; Verma *et al.*, 1987 a; Verma and Husain 1988 b; Verma and Ram, 1992, Om Prakash *et al.*, 1995; Mishra, 1995; Om Prakash, 1999 and Verma *et al.*, 2000).

Milk Production and its Composition

Milk production and its composition in Non-Pregnant-lactating cross-bred cows in different seasons have been presented in Table-12. The average

milk production was 10.33 ± 0.25 , 9.57 ± 0.23 , 7.56 ± 0.18 , 9.33 ± 0.23 and 9.60 ± 0.18 Kg in winter, spring, summer, rainy and autumn seasons, respectively. Analysis of variance of data showed that significant difference ($P < 0.01$) existed in milk yield, 4% FCM yield, water, fat, lactose, ash, total solid and solid not fat in different seasons of the year. Milk yield was reduced in summer season as compared to other seasons of the year. Verma and Husain, 1988 a, reported that milk yield was reduced in summer season as compared to other seasons of the year. Milk yield and its composition, as affected by seasons has been studied by Bhatnagar and Choudhary (1960); Dutt and Singh (1961); Agrawala (1962); Gosh and Ananta Krishnan (1963); Batra and Desai (1964); Sidhu (1964); Sunderesen *et al.* (1965); Sharda *et al.* (1967); Lal *et al.* (1986); Verma *et al.* (1987 b); Verma and Husain (1988 a); Verma *et al.* (1988); Verma *et al.* (1989); Verma and Ram (1992); Mishra (1995); Om Prakash (1999); Verma *et al.* (1999) and Verma *et al.* (2000).

Very little work has been done in India regarding the effect of heat stress caused by high environmental temperature. Milk yield is reduced by high temperature and recovers as condition improve. Mishra *et al.* (1963) reported that milk yield and maximum daily air temperature were correlated. It is clear that high temperature depressed appetite and subsequently reduced the milk yield.

High environmental temperature for many years have been considered as an important factor contributing to lower yield and in bringing change in milk composition with rising environmental temperature (Verma and Husain, 1988 a).

Milk protein showed non-significant differences in different seasons of the year. similar observations were also reported by Lal *et al.* (1986); Verma *et*

al. (1987 b); Verma and Husain (1988 a); Verma *et al.* (1988); Verma *et al.* (1989); Verma and Ram (1992); Mishra (1995); Om Prakash (1999) and Verma *et al.* (2000).

Haematological and bio-chemical parameters of blood

Haemoglobin

Haemoglobin content in winter, spring, summer, rainy and autumn seasons was 13.00 ± 0.34 , 12.85 ± 0.40 , 12.10 ± 0.30 , 12.36 ± 0.30 , and 12.67 ± 0.32 gm/100 ml blood in calves under one year of age, 12.00 ± 0.35 , 11.87 ± 0.35 , 11.12 ± 0.34 , 11.34 ± 0.38 and 11.71 ± 0.35 gm/100 ml blood in non-pregnant-non-lactating, 11.50 ± 0.35 , 11.20 ± 0.40 , 10.35 ± 0.31 , 10.68 ± 0.36 and 11.10 ± 0.33 gm/100 ml blood in non-pregnant-lactating and 11.00 ± 0.34 , 10.90 ± 0.31 , 10.03 ± 0.32 , 10.23 ± 0.32 and 10.56 ± 0.31 gm/100 ml blood in pregnant-non-lactating cross-bred cows (Table-13). Non-significant differences were observed in haemoglobin in different seasons of the year. Higher haemoglobin content was found in winter season than other season of the year. These results also tally with the findings of Sagar (1962); Singh (1987); Verma and Ram (1992); Bagha *et al.* (1995) and Verma *et al.* (2000).

Mullick and Kehar (1959) studied the haemoglobin values of exotic and Indian crosses and of pure-bred Harynan cattle. They found that haemoglobin content had negative correlation with ambient temperature and also reported lowest haemoglobin value in exotic crosses when air temperature ranged between 11°C and 39°C and relative humidity between 15 and 85 per cent. The haemoglobin was lower in summer than in winter probably due to higher plasma and blood volume found in summer as reported by Murti and Mullick (1961). Our values of haemoglobin content are within the range of figures

reported by Verter and Morsk (1963) 11.50; Husain and Ahmed (1968) 9.37; Patel *et al.* (1969) 10.5; Singh (1987) 11.30 and Verma *et al.* (2000) 12.18.

Total Erythrocytes Count (R.B.Cs)

Total erythrocyte count in winter, spring, summer, rainy and autumn seasons were 9.50 ± 0.17 , 9.25 ± 0.19 , 8.15 ± 0.23 , 8.44 ± 0.21 and 8.71 ± 0.20 million/mm³ in calves under one year of age, 8.00 ± 0.22 , 7.84 ± 0.25 , 6.90 ± 0.18 , 7.30 ± 0.20 and 7.63 ± 0.21 million/mm³ in non-pregnant-non-lactating, 7.50 ± 0.22 , 7.22 ± 0.20 , 6.81 ± 0.21 , 7.10 ± 0.20 and 7.19 ± 0.22 million/mm³ in non-pregnant-lactating, 7.40 ± 0.20 , 7.15 ± 0.21 , 6.24 ± 0.21 , 6.55 ± 0.17 and 6.86 ± 0.14 million/mm³ in pregnant-non-lactating cross-bred cows (Table-13). Total erythrocytes count was found higher in winter season than other seasons of the year. These results also tally with the findings of Singh (1987); Verma and Ram (1992) and Verma *et al.* (2000).

Verma and Ram (1992) observed the seasonal changes in certain haematological characters of Murrah buffaloes in different seasons. Total erythrocytes count was found reduced during summer when ambient temperature was high. Similar observations were also reported by Khajuria and Razdan (1966 a); Pandey *et al.* (1978); Singh (1987) and Verma *et al.* (2000).

Total leucocytes count (W.B.Cs)

Total leucocytes count in winter, spring, summer, rainy and autumn seasons was 5.64 ± 0.12 , 6.33 ± 0.15 , 6.75 ± 0.14 , 6.56 ± 0.14 and 5.92 ± 0.13 thousand/mm³ in calves under one year of age, 6.82 ± 0.14 , 7.45 ± 0.15 , 7.95 ± 0.15 , 7.78 ± 0.12 and 7.16 ± 0.18 thousand/mm³ in non-pregnant-non-lactating, 7.10 ± 0.16 , 7.93 ± 0.12 , 8.25 ± 0.10 , 8.12 ± 0.14 and 7.35 ± 0.20

thousand/ mm³ in non-pregnant-lactating and 7.49 ± 0.18 , 8.00 ± 0.20 , 8.50 ± 0.16 , 8.21 ± 0.21 and 7.60 ± 0.17 thousand/ mm³ in pregnant-non-lactating cross-bred cows (Table-13). Statistical analysis of data showed that significant difference ($P < 0.01$) were observed in total leucocytes count among different season of the year. Significantly higher leucocytes count was found in summer season than other seasons of the year. These results also tally with the findings of Singh (1987).

Verma *et al.* (2000) observed the seasonal changes in haematological characters in buffaloes. Reported that total leucocytes count increased during summer indicating summer stress condition. Similar observations were also reported by Patel *et al.* (1965).

Packed Cell Volume (PCV)

Packed cell volume in winter, spring, summer, rainy and autumn seasons was 45.00 ± 0.37 , 44.82 ± 0.43 , 43.94 ± 0.35 , 44.25 ± 0.41 and 44.58 ± 0.46 per cent in calves under one year of age, 49.00 ± 0.49 , 48.75 ± 0.41 , 47.90 ± 0.38 , 48.12 ± 0.44 and 48.50 ± 0.52 per cent in non-pregnant-non-lactating, 51.00 ± 0.36 , 50.84 ± 0.42 , 49.85 ± 0.42 , 50.20 ± 0.45 and 50.72 ± 0.38 per cent in non-pregnant-lactating and 56.00 ± 0.41 , 55.77 ± 0.58 , 54.88 ± 0.44 , 55.30 ± 0.43 and 55.63 ± 0.48 per cent in pregnant-non-lactating cross-bred cows (Table-13). Non-significant differences were observed in different seasons of the year. Packed cell volume was found higher in winter season than other seasons of the year. These results also tally with the findings of Singh (1987); Verma and Ram (1992); Bahga *et al.* (1995) and Verma *et al.* (2000).

Rowlands *et al.* (1979) observed the blood composition of cows in commercial dairy herd and its relationship with season and lactation and

reported that the concentration of PCV were consistently higher in non-lactating than lactating cows.

Packed Cell Volume had reduced during summer season when ambient temperature was high (Singh, 1987; Verma and Ram, 1992 and Verma *et al.*, 2000)

Blood Urea

Blood urea in winter, spring, summer, rainy and autumn seasons was 6.50 ± 0.12 , 7.45 ± 0.18 , 9.42 ± 0.23 , 8.78 ± 0.19 and 7.10 ± 0.20 mg/100 ml blood in calves under one year of age, 21.65 ± 0.47 , 23.27 ± 0.66 , 26.13 ± 0.78 , 25.58 ± 0.54 and 22.44 ± 0.55 mg/100 ml blood in non-pregnant-non-lactating, 24.00 ± 0.63 , 25.96 ± 0.60 , 29.21 ± 0.71 , 28.30 ± 0.75 and 25.51 ± 0.78 mg/100 ml blood in non-pregnant-lactating and 22.50 ± 0.52 , 24.22 ± 0.83 , 26.16 ± 0.68 , 25.64 ± 0.84 and 23.75 ± 0.59 mg/100 ml blood in pregnant-non-lactating cross-bred cows (Table-13). Analysis of variance of data revealed that significant differences ($P < 0.01$) were found in different seasons. Blood urea was significantly higher in summer season than other seasons of the year. These results also tally with the findings of Singh (1987); Verma and Ram (1992) and Verma *et al.*, (2000).

Setty and Razdan (1966) reported significantly high blood urea nitrogen during humid season than winter season. Similar observations were also reported by Singh (1987); Verma and Ram (1992) and Verma *et al.* (2000).

Blood Glucose

Blood glucose (mg/100 ml blood) in winter, spring, summer, rainy and autumn seasons was 60.50 ± 0.88 , 59.10 ± 0.99 , 55.40 ± 0.85 , 57.21 ± 0.88 and 58.30 ± 1.04 in calves under one year of age, 54.00 ± 1.08 , 53.18 ± 1.12 , 49.82 ± 0.91 , 51.36 ± 0.78 and 52.80 ± 0.85 in non-pregnant-non-lactating, $51.75 \pm$

0.80, 50.62 ± 1.00 , 47.30 ± 0.83 , 48.94 ± 0.67 and 49.33 ± 1.03 in non-pregnant-lactating and 48.60 ± 0.95 , 47.70 ± 0.96 , 44.20 ± 0.85 , 46.59 ± 1.19 and 46.95 ± 1.15 in pregnant-non-lactating cross-bred cows (Table-13). Blood glucose was found higher in winter season than other season of the year. These results also tally with the findings of Singh (1987); Verma and Ram (1992) and Verma *et al.* (2000).

Verma *et al.* (2000) reported that lower blood glucose was found in summer season than in winter season. Similar observations were also reported by Raghavan and Mullick (1962); Bhosrekar *et al.* (1967); Singh (1987) and Verma and Ram (1992).

Serum Cholesterol

Serum cholesterol (mg/100 ml blood) in winter, spring, summer, rainy and autumn seasons were 55.00 ± 0.93 , 52.37 ± 0.84 , 34.50 ± 0.83 , 40.55 ± 0.82 and 48.72 ± 0.84 in calves under one year of age, 76.28 ± 0.93 , 74.13 ± 0.90 , 69.47 ± 0.85 , 72.81 ± 0.82 and 73.67 ± 0.80 in non-pregnant-non-lactating, 83.15 ± 0.91 , 80.00 ± 0.85 , 60.35 ± 0.99 , 72.84 ± 0.93 and 77.49 ± 0.75 in non-pregnant-lactating and 126.26 ± 0.82 , 110.40 ± 0.96 , 95.83 ± 0.86 , 104.60 ± 0.91 and 107.22 ± 0.96 in pregnant-non-lactating cross-bred cows (Table-13). Statistical analysis of data revealed that significant differences ($P < 0.01$) were observed in different seasons of the year. Blood cholesterol was found higher in winter season than other seasons of the year. These results also tally with the findings of Bhosrekar *et al.* (1967); Mehta and Gangwar (1985); Singh (1987); Verma and Ram (1992) and Verma *et al.* (2000).

Setty and Razdan (1966) reported that serum cholesterol was significantly higher in humid season than winter season.

Verma and Pandey (1975) observed that blood cholesterol level in the different physiological states on adult female buffaloes viz., non-lactating-pregnant, lactating-non-pregnant and non-lactating-non-Pregnant buffaloes. Differences for cholesterol between the three physiological groups were highly significant.

Serum Protein

Serum protein (gm/100 ml blood) in winter, spring, summer, rainy and autumn seasons were 7.65 ± 0.81 , 7.62 ± 0.20 , 7.53 ± 0.20 , 7.58 ± 0.19 and 7.60 ± 0.17 in calves under one year of age, 7.45 ± 0.23 , 7.40 ± 0.22 , 7.32 ± 0.20 , 7.37 ± 0.21 and 7.38 ± 0.25 in non-pregnant-non-lactating, 7.55 ± 0.21 , 7.52 ± 0.17 , 7.48 ± 0.21 , 7.50 ± 0.18 and 7.51 ± 0.18 in non-pregnant-lactating and 7.60 ± 0.19 , 7.57 ± 0.19 , 7.50 ± 0.19 , 7.55 ± 0.19 and 7.56 ± 0.19 in pregnant-non-lactating cross-bred cows (Table-13). Non-significant differences were observed in serum protein in different seasons. Serum protein was found higher in winter season than other seasons of the year. These results also tally with the findings of Singh (1987); Verma and Ram (1992) and Verma *et al.* (2000).

Pandey and Roy (1969 a) reported that total proteins and α , β , γ globulins were more in blood serum of buffalo exposed to high environmental temperature than in protected groups.

Murtuza (1977) observed the serum protein in Haryana cattle under various physiological states. Serum protein concentration did not show significant differences between various physiological states. Seasonal changes in biochemical constituents of blood of Murrah buffaloes. Reported that the lower protein was found in summer than in winter season (Verma and Ram, 1992; and Verma *et al.*, 2000).

SUMMARY
AND
CONCLUSION

SUMMARY AND CONCLUSION

The present investigation entitled "Effect of seasons on biological responses and productivity of cross-bred cows" was conducted at the Instructional live-stock farm of Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad. Forty cross-bred cows (Haryana x Holstein Friesian) were selected for the present study. The cows were divided into four groups, consisting of ten in each, according to their physiological states viz., calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and Pregnant-Non-lactating. Five sets of experiments were conducted in different seasons viz., winter, spring, summer, rainy and autumn seasons, respectively. In all sets of experiments, the animals were fed wheat straw and concentrate mixture as per ICAR (1985) recommendation. Before experiment, all animals had been receiving the experimental rations for six weeks and thereafter, a metabolism trial of seven days duration was conducted in different seasons of the year and to estimate the dry matter intake and digestibility of nutrients principles were adopted those of recommended by AOAC (1960). Various physiological responses were measured at 04 hours and 16 hours a day for consecutive seven days in winter, spring, summer rainy and autumn seasons. Milk samples were collected for chemical analysis. The samples were analysed for fat, protein, ash, lactose, total solids and solid not fat in winter, spring, summer, rainy and autumn seasons according to method discussed by Agrawala and Sharma (1964). Blood samples were collected from experimental animals through glass syringe under aseptic conditions in tubes containing anticoagulant (EDTA).

Haematological characters viz., Haemoglobin, Total erythrocytes count, Total leucocytes count and PCV were recorded according to method given by Drobkin (1944), Gupta *et al.* (1992) and Olsen (1937) and biochemical characters viz., serum cholesterol, serum protein, blood urea and blood glucose were estimated according to methods described by Zack (1957); A.O.A.C. (1960); Oser (1965) and Folin and Wu (1920).

Dry matter consumption (Kg per day) in winter, spring, summer, rainy and autumn seasons was 2.50 ± 0.11 , 2.25 ± 0.09 , 2.15 ± 0.09 , 2.40 ± 0.10 , and 2.32 ± 0.10 in calves under one year of age, 7.64 ± 0.35 , 6.96 ± 0.36 , 6.70 ± 0.34 , 7.40 ± 0.35 and 7.15 ± 0.35 in Non-Pregnant-Non-lactating, 10.05 ± 0.26 , 9.07 ± 0.30 , 8.74 ± 0.28 , 9.55 ± 0.29 and 9.21 ± 0.30 in Non-Pregnant-lactating and 10.83 ± 0.20 , 9.79 ± 0.17 , 9.32 ± 0.18 , 10.41 ± 0.20 and 10.00 ± 0.18 in Pregnant-Non lactating cross-bred cows. Non-significant differences were found in different seasons in calves under one year of age and Non-Pregnant-Non-lactating cross-bred cows. Significant differences ($P < 0.05$) and ($P < 0.01$) were observed in Non-Pregnant-lactating and Pregnant-Non-lactating cross-bred cows in different seasons, respectively. Dry matter consumption was observed higher in winter season than other seasons of the year. There was significant difference ($P < 0.01$) in dry matter intake per 100 Kg body weight and per Kg metabolic body weight in different seasons of the year in calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and Pregnant-Non-lactating cross-bred cows.

Dry matter, crude protein, ether extract and organic matter digestibility in calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and Pregnant-Non-lactating cross-bred cows were significantly higher ($P < 0.01$) in winter season than other seasons of the year.

Whereas, crude fibre and Nitrogen free extract digestibility in calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and Pregnant-Non-lactating cross-bred cows were significantly higher ($P < 0.01$) in summer and rainy season than other seasons of the year, respectively.

The nitrogen balance (gram/day) in winter, spring, summer, rainy and autumn seasons was 25.34 ± 0.18 , 23.62 ± 0.22 , 17.23 ± 0.48 , 22.45 ± 0.18 and 24.38 ± 0.33 in calves under one year of age, 12.20 ± 0.07 , 10.48 ± 0.21 , 7.92 ± 0.09 , 9.23 ± 0.24 and 11.24 ± 0.41 in Non-Pregnant-Non-lactating, 23.48 ± 0.19 , 21.76 ± 0.26 , 15.68 ± 0.43 , 20.57 ± 0.21 and 22.52 ± 0.22 in Non-Pregnant-lactating and 21.86 ± 0.21 , 20.14 ± 0.38 , 14.12 ± 0.22 , 18.89 ± 0.57 and 20.90 ± 0.52 in Pregnant-Non-lactating cross-bred cows, respectively. There was significant difference ($P < 0.01$) in nitrogen balance in the different seasons of the year. Significantly higher ($P < 0.01$) nitrogen balance was found in winter season than other seasons of the year.

Significant difference ($P < 0.01$) in rectal temperature ($^{\circ}\text{C}$), Pulse rate (per minute) and respiration rate (per minute) at 04 hours and 16 hours were observed in different seasons of the year in calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and Pregnant-Non-lactating cross-bred cows. Rectal temperature, pulse rate and respiration rate at 16 hours values were always higher than 04 hours values. Significantly higher ($P < 0.01$) rectal temperature, pulse rate and respiration rate at 04 hours and 16 hours were found in summer season than other seasons of the year.

The average milk production in Non-Pregnant-lactating cross-bred cows was 10.33 ± 0.25 , 9.57 ± 0.23 , 7.56 ± 0.18 , 9.33 ± 0.23 and 9.60 ± 0.18 Kg. in winter, spring, summer, rainy and autumn seasons, respectively.

Significant differences ($P < 0.01$) were observed in milk production in different seasons of the year. There was significant difference ($P < 0.01$) in 4% FCM yield in different seasons of the year.

Milk samples were analysed for water, fat, protein, lactose, ash, total solid and solid not fat. There was significant difference ($P < 0.01$) in percentage of water, fat, lactose, ash, total solid and solid not fat in different seasons of the year. Analysis of variance of data showed that non-significant difference in percentage of protein in different seasons of the year.

Haemoglobin content in calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and Pregnant-Non-lactating cross-bred cows were found to be non-significant in different seasons of the year. Higher haemoglobin content was found in winter season than other seasons of the year. Significant differences ($P < 0.01$) were observed in total erythrocytes count in different seasons in calves under one year of age, Non-Pregnant-Non-lactating and Pregnant-Non-lactating cross-bred cows. There was non-significant difference in total erythrocytes count in Non-Pregnant-lactating cross-bred cows in different seasons. Total erythrocytes count were found higher in winter season than other seasons of the year. Significant differences ($P < 0.01$) were observed in total leucocytes count in different seasons in calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and Pregnant-Non-lactating cross-bred cows. Significantly higher ($P < 0.01$) total leucocytes counts was found in summer season than other seasons of the year. There was non-significant difference in packed cell volume in different seasons in calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and Pregnant-Non-lactating cross-bred cows.

Significant differences ($P < 0.01$) were observed in blood urea in different seasons in calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and Pregnant-Non-lactating cross-bred cows. Significantly higher ($P < 0.01$) blood urea was found in summer season than other seasons of the year. Significant differences ($P < 0.01$) were observed in blood glucose in different seasons in calves under one year age. Significant differences ($P < 0.05$) were observed in blood glucose in different seasons in Non-Pregnant-Non-lactating and Non-Pregnant-lactating cross-bred cows. There was non-significant difference in different seasons in Pregnant-Non-lactating cross-bred cows. Blood glucose was found higher in winter season than other seasons of the year.

Significant differences ($P < 0.01$) were observed in serum cholesterol in different seasons in calves under one year of age, Non-Pregnant-Non-lactating, Non-Pregnant-lactating and Pregnant-Non-lactating cross-bred cows. Serum cholesterol was found significantly higher ($P < 0.01$) in winter season than other seasons of the year. Non-Significant differences were observed in serum protein in different seasons in calves under one year of age, Non-Pregnant- Non-lactating, Non-Pregnant-lactating and Pregnant-Non-lactating cross-bred cows. Higher serum protein was observed in winter season than other seasons of the year.

On the basis of the experiment it was observed that nutrient intake, digestibility of nutrients, nitrogen balance, physiological responses, milk production & its composition, haematological and bio-chemical constituents of blood responded well in winter season than other seasons of the year. From the above information we can concluded that the different physiological states of cross-bred cows are adversely affected by high environmental temperature and humidity which reduces appetite, and ultimately the productivity of cross-bred cows. Finally it was concluded that cross-bred cows performed better in summer season by appropriate nutrition and reducing the environmental temperature.

LITERATURE
CITED

CHAPTER-VII

LITERATURE CITED

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