AN EPIDEMIOLOGICAL STUDY ON DISEASE OCCURRENCE AND MORTALITY IN DAIRY CALVES

THESIS

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BY

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TO

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....To My Beloved Parents

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CERTIFICATE

Certified that the research work embodied in this thesis entitled "AN EPIDEMIOLOGICAL STUDY ON DISEASE OCCURRENCE AND MORTALITY IN DAIRY CALVES", submitted by Dr. Tara Sankar Pan for the award of Master's Degree of Deemed University, Indian Veterinary Research Institute, is the original work carried out by the candidate himself under my supervision and guidance.

It is further certified that Dr. Tara Sankar Pan has worked for more than 24 months in the Institute and has put in more than 150 days attendance under me from the date of registration for the Master's Degree of the Deemed University, as required under the relevant ordinance.

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C E R T I F I C A T E

Certified that the thesis entitled "AN EPIDEMIOLOGICAL STUDY ON DISEASE OCCURRENCE AND MORTALITY IN DAIRY CALVES" submitted by Dr.Tara Sankar Pan in partial fulfilment of M.V.Sc. Degree of Indian Veterinary Research Institute, Izatnagar, U.P., embodies the original work done by the candidate. The candidate has carried out his work sincerely and methodically.

We have carefully gone through the contents of the thesis and are fully satisfied with the work carried out by the candidate, which is being presented by him for the award of M.V.Sc. degree of this Institute.

It is further certified that the candidate has completed all the prescribed requirements governing the award of M.V.Sc. degree of Indian Veterinary Research Institute, Izatnagar, U.P.

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[Tara Sankar Pan]

CONTENTS

ABBREVIATION

ATD	: Average treatment days
CMR	: Calf mortality rate
Hol.	: Holstein Friesian
MSS	: Mean sum of square
PMR	: Proportional morbidity rate
SD	: Standard deviation
SE	: Standard error
SMR	: Standard mortality ratio
SNVDO	: Standard nomenclature of veterinary diseases and operations

INTRODUCTION

INTRODUCTION

Recently a programme has been launched by the Govt. of India to increase milk production from the present 44 million tonnes to 61 million tonnes a year by 1995.Besides the other factor like breeding,management,etc.,a great emphasis should be laid on survival of calf crop because calf losses ultimately lead to reduction in potential milch cows.

Very meagre information is available in the country about the problem of calf diseases and calf mortality before seventies. The introduction of cross breeding programme for the development of national livestock production necessitated immediate attention to undertake research on the disease problems of newborn in order to achieve a healthy livestock population.

Survey of calf diseases and mortality carried out in India during last 30 years by different workers in the different states comprising of 100 herds revealed that an average mortality rate among cow calves was 10.59% (range 1.54 to 24.24%) for the age group of 1 day to 1 year old calves.

Introduction of exotic animals to improve the genetic potential of our indigenous stock has introduced a number of diseases/disease condidtions which were either not existing in our country or were not recognised hither to. Some of the diseases are

responsible for heavy mortality in young stock and inflict direct production loss and in some cases the mortality may be low but due to high morbidity the economy of raising young stock is very much hampered. It is therefore imperative to minimise the high incidence of morbidity and mortality in young farmstock during early life to reduce the production losses as far as possible for instituting suitable and effective health care measures.

It is well known that occurrence of neonatal diseases and mortality is a complex one which is influenced by a variety of factors such as climate, nutrition, heridity, infection, toxicity, management etc. A number of these factors determine the probability of survival of a new born animal in it's new environment at birth.

A few studies have been made in this field indicating an increasing trend of mortality and morbidity with increasing exotic inheritance (Amble and Jain, 1967; McDowell, 1972; Shrivastava and Agarwala, 1973; Jain and Sharma, 1982). However little is known about the extent and causes of these differences (National Academy of Science, 1968).

Seasons play an important role variation in calf mortality. Higher mortality between February and April was reported by Wither (1952). In Great Britain, Leech et al. (1968) reported higher mortality in winter than summer months and the similar type of observations were also noticed by Speicher and Heep (1973) and Martin et al. (1975).

Age may be viewed as an inherent characteristic of an individual. In general calves has greater risk of dying at early age and the risk decreases subsequently as the calf ages. Wither

(1952) reported that 48% of calf deaths occurred in first week of life in below 6 months old calves where as from Britain, Leech et al. (1968) reported 41% of deaths in first week of life in below 1 year of old calves. In California Martin et al.(1975) observed 55% deaths during first week of life in their study in below 5 week old calves. Perinatal mortality is closely related to birth weight. Mortality is very high in lower birth weights, falls to a minimum within the range of most frequent birth weights but rises again for heaviest birth weight (Wilcox and Russell, 1983). Hearnshaw et al. (1984) reported that birth weight was an important cause of higher mortality in early age of calves. Several workers experienced the same trends.

In India higher incidence of mortality in young calves were mainly due to specific diseases like colibacillosis, septicaemia, pneumonia, gastro-enteritis etc. Besides the above infections, many other agents like Mycoplasma, Chlamydia, haemo-protozoan are responsible for calf losses. Conditions like arthritis, navel ill and pneumo-enteritis are also common for causing high mortality in calves.

The information regarding the incidence of calf diseases and mortality is well documented in the developed countries but in India data on these aspect is rather scanty and fragmentary. As such no clear cut picture indicating magnitude of the problem is available in this country.

Nowadays some standard statistical techniques are applied in epidemiology which are used to analyse the different factors associated with the calf mortality. The principal object of

proposed study is therefore (a) to estimate the magnitude of the problem of neonatal morbidity and mortality in young farmstock. (b) to estimate influence of various factors on the commonly occurring diseases associated with the neonatal morbidity and mortality (c) to compare the patterns and frequencies of occurrence of diseases and mortality in different genetic groups of farmstock. All the above information eventually help in recommending suitable health care package and means to be adopted for prevention and control of diseases in young stock for better viability.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

2.1. MORBIDITY IN CALVES :

A number of diseases/disease syndromes are found to be responsible for morbidity in dairy calves (0-3 months). Out of different causes of morbidity, major important causes are (i) Diarrhoea (ii) Pneumonia, (iii) Wounds and (iv) Debility/Weakness.

Rajya (1974) investigated in detail on patho-anatomical and microbiological aspects of calf mortality and observed the pattern of diseases that caused major morbidity which were diarrhoea, dysentry, pneumonia, septicaemia, navel ill, arthritis, kerato-conjunctivitis, dermatitis, ascariasis, babesiosis and theileriasis.

Khera (1980) studied a total of 125 calves below 3 months of age and found that 88 (70.4%) calves were affected by rinderpest. He also found that morbidity rates were higher in 0-3 months in F_1 and G_2 stock of calves than any other age group.

Roy (1980) studied the factors affecting susceptibility of calves to diseases. He observed that mortality and morbidity could be reduced to negligible proportion by providing adequate colostrum in the first day of life followed by milk substitute made from mildly heat-treated milk powder.

A review of environmental factors influencing respiratory diseases was made by Roe (1982) and he observed that good housing and managemental practices might help in preventing outbreaks of calf pneumonia.

Andrews and Read (1982) expressed that it was difficult to quantify the severity of disease i.e. duration and degree of illness of animals. He estimated the cost per sick calf and

cost per place using a standard whole sale drug cost.

Britney, et al. (1984) observed poorer survival pattern in calves developing a navel-joint illness within the first 4 months of life than their other 4 cohort groups in a study of 460 calves born into 2 dairy herds from January 1, 1971 to December 1, 1978. The cohorts of calves indentified as having either respiratory, gastro-enteritis, septicaemia, or other disease, did not have survival function significantly different from each other, or from the cohort group.

Waltner et al. (1986) screened faecal samples from calves on 78 randomly selected Holstein dairy farms in South-Western Ontario and found that 20% of the farms had calf infected with Salmonella, 13% with Campylobactor jejuni/coli, 4% with entero-pathogenic Escherichia coli, 19% with rota-virus and 5% with corona virus.

Waltner and Toews (1986) studied that morbidity rate per season were skewed in calves during 1980 to 1983 in Ontario Holstein herds. The 20% and 15% of calves were treated for scours and pneumonia before weaning respectively.

Naylor & Bailey (1988) examined 1261 calves under 2 months of age and found out 51 (4%) had abdominal pain or distension, 44 (3.5%) had colic alone, and 7(0.5%) had abdominal distension alone. Atresia was common in calves under 8 days. Survival rate of cases was 57% (29) and duration of treatment was generally 1-8 days.

Yadav & Sharma (1983) studied morbidity and mortality in 130 calves, out of which 63 (48%) were affected by various diseases like theilariasis, trypanosomiasis, coccidiosis, calf scours, pneumonia, weakness, debility etc. Maximum morbidity 23% occurred

in calves aged 0-3 months and subsequently declined with age. Crossbred calves had higher morbidity rate 66% as compared to 38% in Hariana calves. Among various diseases, theilariasis, pneumonia and calf scours were commonest.

2.2 MORTALITY IN CALVES

2.2.1 Effect of Breeds on calf mortality :

A number of factors such as birth weight, parity of dam, age and sex of the calf, seasons and diseases influence the calf mortality. Available scientific reports describing the influence of various factors responsible for calf mortality by different workers in India and abroad have been reviewed. Ormiston (1949) found no significant difference on mortality between the five different breeds of heifer calves upto 1 year of age. Asker & El-Itriby (1957) observed the mortality rate of native, short horn Friesian and crossbred animals during a period of 15 years in experimental farms in Egypt. Mortality rates of exotic breeds were significantly higher than that of native cattle and crossbred animals. Short horn cattle, showed higher mortality than the Friesian breed and with the increase of pure breed gene the death rate was gradually increased.

Dickinson and Touchberry (1961) observed significant difference in mortality between pure breeds and crossbred calves within 1 year of age. Similar difference was observed by Kassir and Jumo(1968) that calf losses in pure breed was twice than that of crossbreds.

Srivastava and Agarwal (1973) reported the effect of breed on mortality on 724 crossbred female calves up to 6 months of age

during 1950-1970 in Institute of Agriculture, Allahabad . The highest death rate was noticed in triple crosses (30.83%) and lowest in Red Sindhi crosses (19.14%) . Brown Swiss X Red Sindhi calves showed 24.19% mortality.Apparently there were differences in mortality rates between breeds but statistically the differences were not significant.

Tomar (1973) recorded 11.57% calf mortality in Hariana calves at Hissar farms.

Sharma et al. (1975) recorded death rates of Tharparkar, Sahiwal and Red Sindhi breed together with Murrah buffaloes and Brown Swiss X Sahiwal and Brown Swiss X Red Sindhi on 6,267 calves during 1952-1971. A significant breed difference was found in the Brown Swiss crosses and buffaloes suffered higher losses as compared to zebu herds.

Buvanendran (1977) observed higher death rate in Ayrshire crosses (13.2%) with the Sinhala breed as compared to Jersey crosses (5.31%) in Sri Lanka whereas Bali et al. (1980) observed higher death rate in Hariana calves (29%) as compared to it s crosses (13%) with Brown Swiss, Jersey, Holstein Friesian and Red dane up to one year of ege.

Rao and Nagarcenkar (1980) analysed the records of 607 cross-bred calves (Tharparkar X Brown Swiss, Jersey and Holstein Friesian) for a period of 6 years at NDRI, Karnal and observed the higher rate of mortality in crosses with 75% of B. taurus inheritance.

Kaushik et al. (1980) reported the three types of Hariana halfbred (with Holstein, Brown Swiss, Jersey) and four second generation Harianacrosses during the period of 4 years (1975-1978).

The 50% Friesian, 25% Jersey, 25% Hariana calves appeared to be the most susceptible of the four second generation crosses and Jersey crosses were the most susceptible among halfbreds although mortality due to breed difference was in-significant.

Khera (1981) recorded a significant difference in calf mortality in different breed groups. Up to 3 month of age, 16.82% calf losses were observed in zebu-taurus crossbreds, 6.28% in pure taurus breed, 6.3% in pure breed zebus and 4.5% in zebu cross breds.

Survivorship of 602 crossbred calves was studied by Parekh and singh (1981). The mortality rate in female calves was 9.0% in Gir X Holstien Friesian crosses and 10.0% in Jersey X Gir crosses although this difference was statistically in-significant.

Rao (1983) reported the mortality among Ongole, Hallikar, Sindhi, Murrah, Jersey, exotic X zebu and zebu crossbred calves up to 1 year of age at Andhra Pradesh Livestock Farm. The rate of mortality was less in indigenous breeds (Ongole,Sindhi, and zebu X zebu crosses) than Murrah, Hallikar and Jersey calves.

Batabyal et al. (1984) observed comparatively higher mortality rate in calves having genetic groups containing Brown Swiss inheritance than the calves without crosses, in Hissar Farm from 1976-1980.

Choudhuri et al. (1984) analysed calf mortality amongst 3021 Jersey x Hariana and 3124 Holstein x Hariana crossbred calves up to 6 months of age during 1966-1970. They found some significant breed differences in mortality rate.

Kulkarni et al. (1985) observed increased mortality rate with increase of exotic inheritance. Two breed crosses had better

adoptibility in arid and semi-arid climate than 3 breed crosses. Halfbred Holstein x Girs are more adoptable than Jersey x Girs crosses. The crossbred of Jersey and Holstein Friesian had lower death rate as compared to Brown Swiss crosses.

2.2.2 Influence of age on calf mortality.

Age has got profound influence on the calf mortality. Ormiston (1949) in his study of 809 heifer calves born during 1935 to 1945, observed that stillbirths and abortions accounted for 6% of calf losses. Among the normal heifer calf losses, 24% died within one year of age but 70% of this calf losses occurred within 60 days of life. Ragab and Asker (1959) on a study of 784 Friesian calves noticed that the losses were more (39.6%) within a few months after birth.

In India, in a military dairy farm and some other dairy farms in Merrut and Mathura, Amble and Jain (1967) observed that the highest mortality was recorded in the lower grade of animal (25%). While other workers Singh and Singh (1973) noticed that the highest death rate in Hariana calves in the first month was 2.64% followed by second (1.43%) and third (0.65%) month of life.

Kassir and Juma (1968) observed the mortality pattern of Friesian and it's crosses with indigenous breed in Abu-Ghraib experimental farm. Death rate in pure breed (10.5%) was higher than crossbred (5.8%). Approximately 40% of all deaths occurred before 3 month of age of calves.

Mortality rates declined with the increase of age of calves which have been observed by several workers (Srivastava and Agrawal, 1973; Oxender et al. 1973; Sharma and Jain, 1976). Similar

observation was made by Prasad and Singh (1975) who noticed that death rate in Tharparkar calves was 34.5% within the first month of age, followed by the lower death rate with increase of age.

Sharma et al.(1975) analysed the data upto one year of age (0-1, 1-3, 3-6, and 6-12 months) during 1952-1971 in different indigenous and crossbred calves and calves from Murrah buffaloes and observed that highest losses recorded in first month of life then it declined in subsequent age groups.

Martin (1975) observed the risk of age in mortality of 6 months old heifer calves in 16 dairy farms for seven years in California. Highest death rate recorded in the first week of life which accounted for 55% of total deaths and subsequently it declined to 27% in second week of life. All the death in calves occurred within 5 weeks of age .

A higher calf mortality rate was observed by Mishra et al. (1977) in early age of calves (up to 3 months) and between 6 to 12 months of age at Government Dairy cattle herds in north, south West and coastal zone of Orissa. The buffalo calves showed higher mortality in early age (0-2months) whereas mortality in cow calvs obsewed in late age (6 to 12 monts).

Nagarcenkar et al (1979) analysed the records of 1059 crossbred calves up to 6 months of age at N.D.R.I., Karnal. The age specific mortality rates were recordeds as 3.87%, 2.22% in 0-1, 1-3, 3-6 months of age group respectively. The three fourth crossbred showed higher death eate as compared to halfbreds.

Based on post mortem reports of 406 dead calves in eight Agricultural Institute farms, Greene (1979) observed that 88 (3.1%) and 202 (7.2%) were due to abortion and still birth

respectively. Number of deaths occurring between birth and 3 weeks of age was 116 (4.6%).

Bali et al. (1980) observed mortality in calves of Hariana and it s crosses with other exotic breeds upto one year of age during 7 years (1972-1978). Losses were higher during the first 15 days (11.7%) of life and the mortality rate was decreased with advancement of age.

Patil and Gupta (1980) studied the effect of age on mortality on the 280 records of Red Sindhi calves born during the period of 1968-1979 at Agriculture college, Dhule. Singificantly higher mortality observed in 0-1 month of age group and mortality rate was decreased gradually with advancement of age and it was as low as 0.35% in 3-4 month of age.

The mortality pattern within one month of age in female Murrah buffalo calves was also noticed by Singh et al. (1980). The death rate from 0-1 week was 15.17% ; 1-2 week,-7.98% ; 2-3 weeks, 2.70% & 3-4 weeks, 1.4% ; The pattern of deaths on month basis from 1-12 months was as 0-1 month, 23.20% ; 1-2 months-3.39% ;. 2-3 months, 12.32%; 3-4 months, 12.50% ; 4 5 months, 3.5% ; 5-6 months, 0.0% ; 6-9 months 0.0% and 9-12 months, 3.71% .

Khera (1981) compared the age distribution of mortality in cattle and buffalo calves in different farms of India. More than half of all calf deaths i.e. 55.79% in cattle calves and 51.72% in buffalo calves occurred within a month after birth then the death was decreased with the increase of age.

Parekh and Singh (1981); Sekhar, et al. (1981); Rao and Nagarcenkar, (1981); Jain and Sharma (1982) and Singh and Parekh (1982) studied on calf mortality. All of them found that

the highest mortality rate was in 0-3 month of age and the rate decreases with the advancement of age.

Umoh (1982) observed the relative survivorship in Nigerian dairy calves upto 12 weeks of age using life table methods. The probability of death was greater during the third week of life which decreased with the age after 4 weeks.

Rao (1983) compared the calf mortality between crossbred and indigenous calves up to one year of age at five State Livestock Farms in Andhra Pradesh. The mortality rate was lower in indigenous breed as compared to zebu x exotic calves.

Singh and Parekh (1983) observed the highest calf mortality (16.48%) in 6-12 month age group of three breed crosses at Jabalpur. Within a month after birth 75% of death occurred during first 2 weeks of life.

Yadav and Sharma (1983) studied calf mortality rate in a population of 130 calves. Highest mortality (16%) was noticed during 0-3 month of age. Choudhuri et al. (1984) in a study of calf mortality comprising of 3124 FH crossbred calves in four herds of State Livestock Farm (Kalayani), recorded that mortality rate upto 6 months of age was significantly higher in Friesian x Hariana (F H) calves as compared to Jersey x Hariana (JH) calves

Gusbi and Hird (1983) described the calf mortality using life table method in five Libyan dairy herds for the period of 1976-1980. The average calf mortality ranged from 2.5 to 26% from 0-30 day of age where average death rate for five station was observed as 18.8%.

Batabyal et al. (1984) analysed the mortality for four

genetic groups of calves, viz 1/2F 1/4B + 1/4H; 1/2B + 1/4F + 1/4H; 1/2J + 1/4F + 1/4 H and 1/2F + 1/4J + 1/4H. Up to 1 year overall calf mortality rates were 19.4%, 31.44%, 20.93% and 18.07% respectively.

Month wise distribution of death of 182 crossbred calves was worked out by Ambatkar et al. (1985) during 1980-83 at Agriculture college, Dipoli. The highest death rate (15.93%) was observed in first month of age followed by second (8.5%) and third (3.57%) month of age but no deaths was observed after 180 days of life. In 6 months period about 84% of total deaths occurred within first 3 months and 16.7% of deaths occurred in the remaining three months.

Tikku (1985) analysed the record of 167 crossbred calves (Jersay x Jersey crosses in chanspa during the speriod of 1979-1983. The maximum death (45.22%) among 167 calves observed in 0-3 months of age.

Chaudhury et al (1986) observed highest mnortality rate (11.63%) during 3-6 month of age group in Kankrej calves born in Livestock Research Station, Sardar Krushinagar during 1978-1984. Higher mortality in 3-6 months age group might be due to nonadjustment of weaners when skim milk was replaced by hay and concentrate after 3 months.

Reddy et al. (1987) studied the influence of age on 1416 Ongole x exotic (Kersey on Frinesian or Brown Swiss bull) crossbred calves for 6 yeas (1980-1985). They observed that in both male and female calves, a significantly higher mortality rate was noticed in the 0-1 month age group than any other groups. In male calves, 1-2 months of age group had significantly higher

mortality as compared to 2-3 and 6-12 months age groups and it was significantly lower than that in 3-6 months age group. In female calves 6-12 months age group showed higher mortality than 3-6 months age group though the differences were not significant.

2.2.3. Birth weight :

The birth weight is one of the important factor influencing survivorship of calves. Calves born with average low birth weight are greater at risk to infection and mortality as compared to heavier birth weight.

A higher mortality of low birth weight in heifer calves was observed by Ragab and Asker (1959), using the record of Friesian calves at Tahreer province, Cario, UAR, during 1954 to 1958. The female calves of average 28.78 Kg birth weight group showed higher mortality as compared to average 31.36 Kg. birth weight group. The differences of birth weight between dead and live female calves were not statistically significant but in case of male calves these were highly significant. According to author's view, the calves within the average range of the birth weight of the herd had better probability of survival than those with lower birth weight.

Purser and Young (1961) observed the optimum birth weight above mean was associated with minimum mortality. Singh and Singh (1973) found out the relationship between birth weight and death rate of the 1400 Hariana calves at Babugarh and Mudhurikund (UP), during the period 1964 to 1971. Birth weight being 6.7 Kg. less than the normal birth weight of 26.7 Kg , calves weighing on an average 20 Kg. at birth, died within the first month of life.

A significant increase in the life span was found with an increase in birth weight. But Rodriguez and Escriva(1976) Rao and Nagarcenkar (1980) could not find any significant difference with birth weight and mortality.

Frisch (1973) observed relatively lower or higher birth weight from the average, associated with high perinatal calf losses in 4678 crossbred (Hereford & Brahman) calves at Central Queenlang during 1954 to 1964.

Nagarcenkar et al. (1977) studied the effect of birth weight on 1083 female calves of six breed groups viz. 1/2 Friesion (F) X 1/2 Tharparkar (T); 1/2 Brown Swiss (B)x1/2 Tharparkar; 1/2 Jersey (J)x1/2 Tharparkar; 3/4 Fx1/4T; 1/2F x 1/4B x 1/4 T and 1/2F x 1/4J x 1/4 T at NDRI, Karnal. A significant difference (by chisquare test) in mortality and birth weight was observed in 1/2 B x 1/2T group in 0-1, 0-3 and 0-6 month of age group and the differences in birth weight and mortality was also observed in 1/2 Fx1/4 Bx1/4 T group. Calves bellow 26 kg.as well as over 30 kg. birth weight were more in risk for death. Mortality rate was increased with the increase of birth weight which was observed by Milagres et al. (1978) using 477 records of Hereford calves, at North Carolina State University Roleigh, USA.

Rao (1981) showed the effect of birth weight on mortality of 2385 crossbred calves born in 8 livestock and University Farms in Andhra Pradesh for 5 years. The highest death rate (43.1%) was observed in be low 15 kg. of birth weight followed by 21.94% in 15-20 Kg., 15.19% in 20-30., and 13.77% in above 30 kg. These differences in mortality with birth weight groups were highly significant.

In a study of mortality on 602 crossbred calves at Jabalpur Livestock Farm, Parekh and Singh (1981) noticed insignificant association of birth weight and mortality but weaner calves had higher mortality rate in crossbred female calves (Jersey x Gir croess)

In some other studies on mortality in crossbred calves, Parekh and Singh (1981) and Singh and Parekh (1983) did not observed any significant relationship of birth weight and mortality, but they noticed relatively lighter calves had higher death rates.

Hearnshaw et al. (1984) reported the effect of birth weight on mortality in Hereford and it's crossbred calves during 5 years at Grafton, New South Wales, Australia. The calves having birth weight, about 2.9 kg. less than average (34.20 kg.) attributed highest losses during first week of life.

Reddy et al (1987) observed the influence of birth weight on calf mortality rate in crossbred calves of Ongole cows with Jersey, Holslein Friesian or Brown Swiss germplasm at AICRP in cattle, Lam Farm, Guntur, A.P., during 1980-85. Birth weight less than 10 kg. was detrimental for the survivorship of crossbred calves and birth weight 31-35 kg. appears to be best for the survival of crossbred calves.

2 .2.4 Influence of parity on calf mortality

Parity of the dam (lactation number) had significant influence on the mortality rate among both male and female calves.

Rodriguez and Escriva (1976) analysed the data obtained on 1569 calving during 1960-69 at farm in the Gulf Coast of Mexico

and observed the significant effect of parity on mortality.

In another study, Simensen (1983) noted that higher stillbirth occurred in 1st, 6th and above parturition in Ist and above where as lowest death rates were recorded in 3rd to 5th parturition.

Reddey et al. (1987) roported the influence of dam parity on mortality in 1416 Ongole crossbred calves at [illegible] cattle farm. Guntur,A.P. during 1980 to 1985. They observed that male calves born to heifer had higher mortality rate in comparison to calves obtained from primiparous cows. However, there was no significant differences on the mortality rate of male calves obtained from cows of second to seventh lactations.

2.5.5 Influence of season on the calf mortality

Several workers at different times observed effect of season on the calf mortality. Wither(1952) and Dhanda and Khera, (1957) observed the influence of season on the mortality of calves. They recorded the high mortality in June, July, and August. The rate of death during the rest of the months was more or less same. Dhanda and Khera (loc.cit) attributed higher mortality rate during the above period due to dampness consequent to heavy rainfall and also due to unhygienic condition in crowded calf pens. Amble, et al. (1958) could not find any significant difference on the effect of season in 1450 zebu x exotic crosses.

Ragab and Asker(1959) in their study on 784 Friesian calves during 1954-1958 found the heaviest loss due to calf mortality [illegible] in April (18.3%) and in May (14.3%) while the lowest death rate was observed during January (1.7%) and February (3.20%). The difference between months was highly significant.

Heavy loss was due to increased susceptibility in new born calves because of sudden change of weather.

Ranatunga (1965) reported highest mortality in November and December in some of the Government farms in Ceylon having European and zebu crosses.

Singh and Singh (1971) reported the incidence of mortality on 570 calves (216 buffalo and 354 cow calves) in Tarai area over a period of 1966 to 1969. He found that mortality was more in winter (35.5%) and rainy season (38.71%) than in summer (22.79%). In winter the animals might be more susceptible to infection due to cold temperature where as in rainy season it was due to dampness and unhygienic condition of calf pens.

Matta (1973) analysed the records of 312 cross-bred Holstein Friesian x (zebu x Guernse) calves in the state of Rio de Janeiro, in 1959-1970. His observation revealed that calf born in the dry season (March-August) had significantly higher rate of survivorship than the calves born during rainy season (September - February). Calves born between March and May had higher rate of survivorship than calves born in other months.

Singh and Singh (1973) observed the seasonal effect on the survivorship of Hariana calves in livestock cum Agricultural Farm Babugarh (Merrut) and Madhurikund (Mathura) during seven years (1964-1971). The percentage of calf mortality during summer, rainy and winter seasons was 4.78%, 4.76% and 7.61% respectively. The highest mortality observed in winter (67.61%) seasons as compared to summer (4.78 %) and rainy (4.76 %) season.

Analysing the information obtained through questionnaire from 379 dairy farms in Michigan, USA, Speicher and Heep (1973) estimated the average annual loss (13.50%) due to calf mortality, out of which 17.1% and 10.31% losses were observed in winter and summer respectively. Srivastava and Agarwala (1973) while analysing the data on calf mortality for 12 years could not find any statistical significance on the mortality between months but highest mortality was observed in monsoon followed by winter and summer. Tomar (1973) found highest mortality in winter (55.5%) and lowest during autumn (8.0%). In winter the predisposing factor for calf mortality was thought to be due to pneumonia. Similar observation was noticed by Singh and Singh (1974) in the buffalo calves. The relative frequency of deaths was higher in winter months as compared to summer and rain. Prasad and Singh (1975) observed the highest death rate in rainy season (39.9%) in Tharparkar breed in Bihar Veterinary College which was probably due to soil dampness, unhygienic condition of pens and surrounding and feed supply.

Martin et al. (1975) studied the seasonal veriation of mortality using time series methods. The extent of mortality losses increased in the mid summer (June, July, August) and mid winter (November, December and January). The death rate in winter was 20% greater than summer. Losses in October and March were highly variable, where losses in October exceeded the yearly average but in March it was less than average. Relative change of mortality rate during two consecutive autumn, winter, and summer were also observed.

While studying the effect of season and year, Sharma et al

(1975) observed the significant year effect on 6227 calves during 1952-1971 but there was no significant difference in death rate in different seasons. Sharma and Jain (1976) made the similar observation on pure breed zebu and zebu crosses in National Dairy Research Institue, Karnal during 1964-1973. They did not observe any seasonal variation but there was significant variation with mortality rate over the years.

Elwood (1975) studied the seasonal trend on the number of stillbirth and death due to encephalitis and observed that death rate was maximum in October and December.

Basing on data of five years, Mishra et al. (1977) observed the effect of ambient temperature on deaths of dairy calves in Government cattle and buffalo farm in North, South, West and Coastal zone of Orissa. The calving rate was higher between June and September while it was lowest between April and May. The mortality rate in buffalo calves between months was significant. Death rates were higher in rainy and winter months. In cow calves, the mortality rate was comparatively higher from June to February whereas in buffalo calves it was from September to February.

Rodriguez and Escriva (1976) analysed the data on 1969 calving in a farm of Gulf Coast, Mexico. They observed that preweaning death was 4.3% in calves born in December to April and 6.0% death for those born in May to November where overall death rate accounted for 5.10%.

Odedra (179) did not find any significant effect of season on mortality rate in Gir calves from 794 records maintained at Government Cattle Breeding Farm, Morvi, Gujarat for 15 years

(1962-1976).

Sreemannarayana and Yusuf (1979) studied the effect of meteorological factors on calf mortality in Nizamabad Goshala, Nizamabad, for 5 years period (1972-76). The calving rate was higher during January, February and reached lower level in May and July. The mortality rate then went up from July to maximum level in November and December.

Bali et al. (1980) observed the effect of season on death rates of young Holstein calves upto one year of age and it s crosses with other exotic breeds. Maximum mortality observed in summer followed by winter, autumn and spring.

Patil and Gupta (1980) studied the effect of season based on 280 records of Red Sindhi calves over a period of 16 years (1964-1979). The highest percentage of birth occurred during summer (36.42%) followed bywinter (34.29%) and rainy season (29.29%) but higher death rate was observed during winter (34.29%) followed by rainy season (18.29%) and summer (13.72%). Death rates between months were found to be highly significant.

Khera (1981) observed the seasonal distrubution of calf mortality upto 3 months of age calves of various exotic-zebu crosses and buffalo breeds from dairy farms of different parts of the country during a period of 3 years(1973-1975). The foetal deaths in cattle herd were fairly distributed all over the year, although the minor increase of rate found during March, July and September. The calf mortality was higher in third (28.52%) and second (28.46%) quarter of year as compared to first (22.57%) and fourth (22.46%) quarter of year.

Parekh and Singh (1981) observed the seasonaleffects in 602

crossbreed calves (Gir x Friesian and Gir x Jersey) at Jabalpur Livestock Farm during 1973 to 1977. Although there was no significant difference between seasons, yet higher mortality was observed during spring (7.44%) followed by summer (3.95%) and winter (3.79%) season and lowest death rate also recorded during the rainy (1.79%) season.

Rao (1981) studied the effect of months on calf motality on 3003 records of crossbred calves from 8 Government and University farm in Andra Pradesh during the 5 years (1974-1979). The death rate increased gradually from April (5.1%) to November (11.12%) and from January it declined gradually.

Jain and Sharma (1982) studied the age-wise seasonal effect on mortality in Brown Swiss x zebu crossbred calves. Significant difference of death rate was found in 0-1 month age group of calves, accounting for highest mortality in winter (9.73%), followed by summer (8.30%) and monsoon (3.99%) but no significant seasonal difference was noticed in 0-6 months age group of calves. Singh and Parekh (1982) evaluated the effect of season on 278 crossbred calves at Livestock Farm, Jabalpur, for [illegible] 6 years (1976-1981). Calf losses were influenced by season significantly, analysis of data indicated highest mortality in rainy (44.7%) season and lowest in spring (17.07%). In rainy season, dampness, over crowding and unhygienic conditions were considered to be the predisposing factors for high percentage of mortality.

Vaccaro and Vaccaro (1982) worked out the influence of season on calf mortality in tropics using 1,656 records of zebu x exotic (Brown Swiss and Friesian) crossbred calves. The calves

born in August to November were more vulnerable to death from calves born in April to July. The mortality rates for these periods were 21.9% and 12.6% respectively.

Dwivedi et al. (1983) reported the effect of season on death rate of Holstein Friesian calves in India. Among 275 Holstein Friesian calves, the highest(25.93%) death rate was observed in winter season, although there was no significant difference in death between the months.

Choudhrui et al. (1984) analysed the 3031 records of Jersey x Hariana and 3124 records of Holstein x Hariana crossbred calves up to 6 months of age in 4 herds of livestock farm in Kalyani, during 1966-1970. In both of the two crossbreds,highest death rates were observed in winter (50.8% and 41.9% respectively) followed by summer (26.31% and 26.4%) and rainy (26.3% and 26.44%) season.

Ambatkar et al. (1985) studied the effect of season on mortality on crossbred calves up to 6 months of age from the years 1980 to 1983 at Dipoli.The highest mortality accounted for 36.11% during rainy season followed by 30.43% and 21.95% for winter and summer respectively.

Tikku (1985) observed the highest mortality in summer months (28.6%) in Jersey crossbred calves at Chanspa (3900m.high altitude) where death rate at winter season was 22.9%.

Choudhary et al. (1986) studied the effect of season on mortality in Kankrej calves at Sardar Krushi nagar, Gujarat during 1978 to 1984. Highest mortality recorded in winter (14.96%) followed by summer (7.11%) but there was no statistical significant difference of season effect on mortality.

2.2.6. Causes of calf mortality

Various causes of deaths in calves have been encountered by different workers.Based on the post mortem Johnson et al. (1948) observed white scours ,respiratory disease, bloat, weekness at birth as the principal causes of calf mortality. Losses due to white scour accounted for 43.6% , death within a week after birth where as respiratory problem accounted for 20.5%, weakness 9.0% and bloat 7.7% within a week of birth

Ormiston (1949) found calf pneumonia was the important cause for the death in calves within a year of age.

Miller and Gilmore (1949) identified pneumonia and calf-scours were the two important causes of deaths among 542 calves born alive.

Ragab and Asker (1959) were of the view that by reducing pneumonia and scours with the improved sanitation and managemental condition, substantial reduction in calf losses could be made.

Withers (1952) reported the mortality rate and disease incidence in 44 herds in England, Wales and South Scotland for 4 years (1946-1949). He observed that the principal cause of deaths was scours and septicaemia and it was not less than 40% of total sickness. The main etiological agent of infection was Escherichia coli bacteria.

Singh and Singh (1971) investigated the incidence of calf mortality in 216 buffalo and 354 cow calves during 1966-1969 in Tarai area . The postmortem report of 39 buffaloes and 26 cow calves revealed that maximum death occurred due to pneumoenteritis (40%) followed by calf scours (15.38%), F.M.D., joint ill, navel ill, (7.6% each) while pulmonary tuberculosis and adenomatosis was

1.5% for each.

Oxender et al (1973) reported the causes of dairy calf mortality in Michigan dairy herd between birth to 60 days of life. The major problems encounted were diarrhoea (70% of the herd) and peumonia (41% of the herd) in young calves.

Srivastava and Agrawal (1973) observed causes of deaths in 6 months old calves for 20 years at Institute of Agriculture, Allah bad. Highest mortality occurred due to weakness and debility (38.9%) followed by bloat (14.3%). Other causes were foot and mouth disease, gastro-enteritis, haemorrhagic septicaemida etc.

Sharma et al (1975) studied the causes of mortality in Tharparkar, Sahiwal, Red Sindhi, Murrah buffloes and Brown Swiss crosses for the 1 year of age during 1952-1977, The major cause of losses was pneumonia (30.40%) upto 6 months followed by scours and enteritis (15.35%)

Sharma and Jain (1976) reported the causes of calf mortality among Brown Swiss X zebu crosses vis a vis the zebu counter parts, Sahiwal and Red Sindhi breeds at Karnal. Besides the different causes, pneumonia and scours/enteritis were the principal causes of mortality and it accounted for 53% of deaths.

Chandra and Nayak (1977) observed the mortality in 300 calves of which 43% death were due to digestive problems followed by 23.3% death due to respiratory problems. Death due to disease of urinary system and miscellaneous condition were 8% and 13% respectively. Death due to debility accounted for 23.3%

Greene (1979) observed the causes of dairy calf mortality in eight Agricultural Institute farms, Ireland, during 1976-1978. Among 2824 calves 406 calves died. Postmortem examination

classified the cases as abortion 88 (3.1%), stillbirth 202 (7.2%) and neonatal deaths (between birth and 3 weeks of age) 116 (4.6%). The principal diagnosis in each category were brucellosis in 30- (34%) out of 88 abortion, anoxia in parturition in 148 (73%) of 202 stillbirths, enteritis and septicaemia in 81 (70%) out of 116 neonatal deaths. According to authors conclusion, imp roved hygiene, individual pens for newly introduced calves, strict segregation of age group and use of predetermined treatment programme for sick animals were some important impediment for reduction of calf losses.

Evermann (1979) studied the prevalence of viral infections in calves in Washington during 1978. Neonatal calf scours accounted for 24% of total cases; calf diarrhoea (12%), calf pneumonia (19%), pneumoenteritis (5%) and weak calf syndrome (11%) were also recorded. Virus identified from 103 calf scours cases included corona virus (33%), rota virus (9%), bovine viral diarrhoea virus (7%). Viurs identified from 80 pneumonia cases included parainfluenza type 3 (8%), bovine viral diarrhoea virus (5%) and infectious bovine rhinotracheitis virus (4%). Bovine viral diarrhoea (B.V.D.) virus was isolated from 26% in pneumo-enteritis cases, 10% in weak calf syndrome case and 22% in calf diarrhoea cases.

Bali et al. (1980) reported the major causes of calf mortality in Hariana and their crosses with exotic breeds upto 1 year of age. The most important causes of deaths were diarrhoea and enteritis (49%) followed by pneumonia (20%). Other causes encountered were pneumo-enteritis (15%) and gastritis (10%).

Kaushik et al. (1980) and also Rao & Nagarcenkar in the same year observed that the major causes of deaths were due to pneumo-enteritis, jaundice, hepatitis, pleuritis, nephritis. Upto 6 months of age, deaths were

due to digestive (34.3%) and respiratory disorders (31.4%).

William et al. (1980) found the common causes of deaths were coliform gastro-enteritis, salmonellosis, viral pneumonia with secondary bacterial infection and colisepticaemia.

Khera (1981) surveyed the causes of calf mortality using 1312 records of cow and 435 records of buffalo calves from 116 cattle and 24 buffalo herds in India. The largest proportion of death caused by digestive disorders including E.coli infection among cattle and buffalo calves (32.21% vs. 49.66%) followed by respiratory disorders (22.74% vs. 20.46%). Deaths due to weakness, debility and anaemia were accounted for cattle and buffalo calves as 6.95% and 9.90% where as for septicaemia, pyrexia and toxaemia, it was 4.42% and 5.75% respectively. The causes of deaths remained unkown in 11 to 16% of the calf deaths.

Rao (1981) observed the causes of calf mortality in crossbred calves in Andhra Pradesh as infectious diseases (74.89%), miscellaneous causes (16.5%), managemental errors (7.14%) and congenital abnormalities (1.38%). Diarrhoea (45.35%) and pneumonia (31.69%) were the two most important problem amongst infectious causes.

Simensen (1982) studied the cause of deaths in 311 herds on 6285 calves in Norwegian dairy herds. Acute unspecified symptoms, chronic unspecified symptoms and diarrhoea were the main three causal groups. Major deaths occured in enteric disorder and comparatively lower deaths occurred in other groups. Death due to pneumonia was significant.

Batabyal et al. (1984) studied the causes of calf mortality in four genetic groups on 1370 calves during 1976-1980. Up to 1 year of age, the deaths due to enteritis were 23.07, 36.58, 26.10, and 26.84% for five genetic groups and for pneumonia the death rates were 15.13, 21.75, 6.94 and 12.06% respectively.

Bhuyan and Mishra (1985) observed the disease incidence in hot humid climate of Orrisa. Among 280 calves, a significant difference of calf moratlity was found between pneumonia (6.34%) and gastro-intestinal disorders (4.80%).

Kulkarni et al (1985) reported the major causes of deaths in 5 cross breed calves at AICRP in cattle, MPAU-Rahuri during the period of 7 years (1976-1981) as enteritis/calf scours (15.20%) and underweight/ debility/anaemia (12.13%). The other causes were pneumonia (5.6%), pneumo-enteritis (3.5%) and joint ill (2.3%).

Tikku (1986) observed the causes of deaths in calves kept at high altitude (3900m.). The major causes of deaths were pneumonia and enteritis followed by gastro-enteritis, Besides these, brisket disease was also observed.

Choudhary et al. (1986) reported the higher mortality rate in Kankrej calves in Gujarat for 7 years (1978-1984) due to gastro-intestinal disorders and tympany which were accounted for 40.32% and 28.04% respectively. Other causes of deaths were pneumonia, 16.13% ; urinary syndrome, 14.52% ; congenital abnormalities, 5.38% and poisoning, 1.61%.

Curtis (1987) indicated the risk of disease incidence and mortality was using path model on 1171 calves born between July 1983 and April 1985, Calves born in loose housing system were more prone to diarrhoea and pneumonia before 90 days of age. Diarrhoea

within 14 days of age increased the death rate than 15 to 90 days of age.

MATERIALS AND METHODS

MATERIALS AND METHODS

3. 1 SOURCES OF INFORMATION

The present study was conducted based on information on crossbred calves comprising of different genetic groups and pure breed Holstein Friesian calves maintained at Livestock Production and Research (LPR;cattle & buffalo)under All India Coordinated Research Project on cattle (AICRP), Indian Veterinary Research Institute (U.P.). By adopting artificial insemination using exotic (Friesian- F, Jersey-J and Brown Swiss-B) germ-plasm with the foundation stock of Hariana (H), the half-bred calves (FH, JH and BH group) were produced. Second generation crossbred were produced by the mating of females (BH & JH group) with semen of Holstein-Friesian (F) to produce FBH, FJH group of calves as per breeding programme while the FH females were inseminated with the semen of Brown Swiss (B) and Jersey (J) to produce BFH and JFH group respectively. These three breed crosses(FBH,FJH,BFH,JFH) were intersemated to produce further generations E group (FBH, FJH, BFH, JFH), A group (FBH, FBH, BFH, JFH) and C group (FBH, FJH, BFH, JFH). The halfbreds were also intersemated to produce next generation halfbred of different groups (FH, BH, & JH).

In addition to the above information, data on the disease conditions and mortality of pure breed Friesian calves were also collected from Central Cattle Breeding Farm, Lakhimpur, Kheri (U.P.).

3. 2. MANAGEMENTAL PRACTICES :

Standard scientific managemental practices were followed at

the farms. The calves were weaned from birth as a routine practice. The iodine painting to sterilize the navel cord to prevent infections was done immediatley after birth. Age wise milk feeding schedule of the calves was followed as per the recommendation of AICRP is given bellow:

Milk Feeding Schedule

Age of Claves	Colostrum	Whole milk
0 - 4 days	1/10th of the body weight	-
5 - 56 days	-	1/10th of the body weight
57 - 63 days	-	1/20th of the body weight
64 - 70 days	-	1/40th of the body weight

The total quantity of milk scheduled for each calf was fed two times per day i.e. morning and evening in equal half.

The calf starter was supplied to calves ad libitum, introducing sound feeds from 5 days of age onwards.

The composition of calf starter :-

Maize	-	32 parts
Ground nut cake	-	30 parts.
Wheat bran	-	8 parts.
Fish meal	-	7 parts.
Mineral mixture with vit. A, B_2 & B_3	-	3 parts.

The green fodder was also offered ad libitum from the 10th day onwards.

The calves (0-3 months) were housed in the individual calf

pens with sufficient space. They were also allowed to move freely in the open area during comfortable time of day. After 3 months of age,,the calves were seperated from calfshed and maintained in loose housing system of management.

3.3. COLLECTION OF INFORMATION :-

Different information was collected as mentioned below for each calf.

(I) Calf number.

(II) Genetic group.

(III) Date of birth.

(IV) Sex.

(V) Birth weight.

(VI) Parity of birth.

(VII) Date of death or disposal.

(VIII)Cause of death.

Information regarding date of birth and birth weight were collected from Birth Register and Stock Register maintainted at the farm. The date of death and causes of death for dead calves were collected from mortality register maintained by Health Unit of LPR(Cattle & Buffalo). Parity of each birth was recorded from history sheet of dams. All the above information were collected in specially designed proforma as mentioned above by personal visit to the farms.

The total calves born from Ist January 1980 to 30th December 1987 were considered as population for the mortality study. The male calves were excluded from the study because most of these calves were transferred or disposed off at the early

stage of their life.

For the calculation of morbidity, records of diseases were available in 0-3 months of calves (male and female) for the year 1986 and 1987, in LPR (cattle and buffalo) at I.V.R.I. Information was collected for disease and health disorders from sickness register, maintained in calf section of the farm.

3.4. CLASSIFICATION OF DATA :-

The data were initially categorised to different genetic groups. The grouping of data was also done for the convenience of different types of analysis according to age, months (season), birth weight and parity of birth etc.

3.4.1. Genetic group :-

For convenience of analysis, the data partaining to calves of various breed combination were grouped as follows:-

(i) The X group which represented the three breed crosses comprising of following breed groups FBH(X_1), FJH (X_2), BFH(X_3) and JFH (X_4) with 75% exotic inheritance combination of two exotic breeds and 25% inheritance of one zebu breed.

(ii) The E group which consisted of FBH(E_1), FJH(E_2), BFH(E_3), JFH(E_4) which were next generation interse crosses of X_1, X_2, X_3 and X_4 groups respectively and contained the same genetic combination as possessed by the x group,

(iii) The A group that comprised of FBH(A_1), FJH(A_2, BFH(A_3), and JFH(A_4) which were the next generation crosses of E_1, E_2, E_3, E_4 groups respectively possessing the same genetic combination of E group.

(iv) The halfbred ($\frac{1}{2}$F.$\frac{1}{2}$H, $\frac{1}{2}$B.$\frac{1}{2}$H and $\frac{1}{2}$J.$\frac{1}{2}$H) groups which were combined with

FH, BH, JH groups along with intersemated FH(F_2) group. This group possessed 50% exotic inheritance alongwith 50% genome of Hariana breed.

(v) The HoL, group which included only pure breed Holstein Friesian calves.

(vi) The Miscellaneous group which containedafew number of advance interse crosses of X group and FH groups.

3.4.2. Age Grouping :-

The calves upto 1 year of age were included for analysis of mortality rate but for estimation of death rate using 'life table' method, the calves were followed from birth upto 26 weeks of age. For construction of life table 26 weeks were divided in different age groups with 1 week interval upto 12 weeks of age followed by interval of 4 weeks and 6 weeks from 12 to 26 weeks of age as mentioned below:-

Age group (in weeks) :-

0 - 1

1 - 2

- - -

- - - . .

11 - 12

12 - 16

16 - 20

20 - 26

The total population of life table considered as number of live births from January 1980 to May 1987. The animal born in May 1987 required to be followed upto 6 months i.e. upto December 1987

since the animal became six months old during that period.

3.4.3. Season :-

The analysis of seasonal influence on morbidity and mortality was done based on the information of 12 different months, instead of grouping 12 months into specific season. The seasonal influence of mortality was studied using 'time series' method which was described under the heading of 'Statistical methods' in this chapter. Seasonal trend of mortality was worked out for neonatal deaths and deaths for calves upto 1 year of age group. The formula for estimating two rates used are given bellow :-

$$\text{Neonatal death rate (month specific)} = \frac{\text{No. of calves died within 35 days that born in a particular month.}}{\text{Total no. of calves born on that particular month.}}$$

(Martin et al, 1975)

$$\text{Calf mortality rate (month specific)} = \frac{\text{No. of calves died upto 1 year of age in a particular month.}}{\text{No. of calves at risk upto 1 year of age present during that month.}}$$

Proportional morbidity rates (PMR) were worked out to determine the usual effect of month on particular disease / health disorder in relation to the other months.

3.4.4 Birth Weight :-

Calves were grouped in different categories according to birth weight, to ascertain the influence of birth weight on mortality. The grouping was done with the interval of one (approximately) standard deviation (S.D) of birth weight. In each classes of birth weight group total no of live births and deaths (within 6 months of age) were tabulated. The calves whose birth weights were not available, excluded from this study population.

The average birth weight(in kgs.) with standard deviation and birth weight groups for three breed crosses, halfbred and pure breed Friesian are tabulated below :-

Groups	Average birth weight	S.D.
Three breed crosses- (X, E, A)	25.96	4.34
Halfbred crosses - (HF, BH, JH)	28.16	4.06
Pure breed Friesian - (Hol.)	25.40	4.41

Birth weight groups(kgs.) :-

Groups No.	Three breed crosses.	Halfbred crosses	Friesian
1	$\leq$ 16	$\leq$ 18	$\leq$ 15
2	17 - 20	19 - 22	16 - 19
3	21 - 24	23 - 26	20 - 23
4	25 - 28	27 - 30	23 - 27
5	29 - 32	31 - 34	28 - 31
6	33 - 36	35 - 38	32 - 38
7	37 $\geq$	39 $\geq$	36 $\geq$

3.4.5 Parity of Birth :

The parity of each birth for all calves under study were recorded, The parity ranged from 1 to 12 but for convenience of analysis, it was grouped from 1 to 9 and 9 + . For each parity, total number of still birth (S.B.) and live births of different breeds for all the years together (1980-1987) were tabulated. Number of liveborn calves that died within 6 months of age of respective parity groups were also recorded. The calves whose

parity of birth were not available excluded from this study . The significance of S.B. and mortality rate with the parity was tested by X^2 method given under the heading of'Statistical Methods.'

3.4.6 Causes of morbidity and mortality :-

Morbidity analysis was made from the available data on young calves of 0-3 months of age, for the last two years i.e. 1986 and 1987. All the cases recorded were classified into four major disease conditions :

(i) Diarrhoea.

(ii) Pneumonia.

(iii) Wounds.

(iv) Debility/Weakness.

For analysis of mortality, the causes of deaths were obtained from the postmortem reports submitted by Division of Pathology, IVRI. Classification of the causes of deaths could not be made as per S.N.V.D.O. standard due to lack of availablity of detail information required for this classification. Therefore clssification of deaths were categorised in following 11(eleven) categories.

The disease categories are as follows :-

(a) Diarrhoea/digestive problems

(b) Pneumonia/respiratory problems

(c) Digestive with respiratory problems

(d) Debility and weekness.

(e) Arthritis and joint ill.

(f) Tuberculosis.

(g) Septicaemia and Toxaemia.

(h) Injury and trauma.

(i) Blood protozoan parasites.

(j) Miscellaneous.

(k) Undiagnosed.

Under the 'undiagnosed' category, the deaths due to nonspecific causes and the carcasses which were autolysed were included. Cause specific mortality in different age group of 0-1 year old females calves was calculated by taking the ratio of total number of animals (0-1 year) died in the particular age group due to specific cause to average number of female calves lived in this age group.

$$\text{Cause and Age specific mortality rate (per 1000)} = \frac{\text{No. of calves died due to specific cause in a particular age group.}}{\text{No. of animals present at initial stage of age group-1/2 No. of animals withdrawn in that age group.}} \times 1000$$

The cause specific mortality in different months was calculated as given bellow :-

$$\text{Cause specific mortality in a particular month (per 1000)} = \frac{\text{Total no. of animals died due to specific cause in a month during the entire period.}}{\text{Average population (Pi) during the entire period in 0-1 year age group in that particular month.}} \times 1000$$

where, $Pi = Bi + a'i.Ni$

Bi = No. of birth in ith months

Ni = No. of animals in 0-1 year age group born in some other months but alive upto ith months.

$a'i$ = Fraction of time lived in 0-1 year age group in ith months.

The cause specific mortality in a particular year was calculated as follows :

$$\text{Mortality rate (per 1000)} = \frac{\text{Total no. of animals died due to specific cause in a particular year.}}{\text{Average population (Px) in the farm 0-1 year age group in that year.}} \times 1000$$

where, $Px = Nx - Dx + ax.Dx$

Nx = No. of animals lived in age group (0-1year) in that yea

Dx = No. of animals died in age group (0-1year) in that year.

ax = Fraction of time lived by Dx animal in the age group (0-1year) in that year.

3.5 STATISTICAL METHODS

3.5.1 Life Table Methods :

Life table methods are common in human vital statistics and have been used in animal sciences for studying the economics of calf mortality and for estimating the viability of cows in dairy herd. This method becomes more useful and important when comparison of pattern of deaths by age is desired. The mortality ratio calculated by life table technique is certainly a better proposition than age specific death rate etc. to have a better comparison and distribution of mortality in different age groups of calves. Follow up life table technique (Colton,1974) has been used in this study for the analysis of mortality pattern in dairy calves.

The analysis of calf mortality data by life table technique requires explanation of heads or columns used in the life table as different research workers followed different assumptions and

notations for the calculation of probability of survivality of an animal in a particular age group. To clarify the procedure followed in this test,different terms are explained in detail below.

Column I :-

Age interval,(x,x+h): Each interval in the column is defined by two exact age stated in life table and each of them is half open from the right. The interval considered in the life table was at one week from 0-12 week but for higher age, the variable intervals of width more than one week were considered to avoid zero value in most of the intervals as mortality rate reduced substantially in the calves over 12 weeks of age.

Column II :-

Number alive at age x,x+h, Ox: The first number in this column 'O_0' is the total number of calves to be followed upto 6 weeks of age for construction of life table while each successive figures represent the number of survivors at the exact age x. For example 'O' shows the numbers of calves survived upto age of one week provided they are subjected to the same mortality experience.

Column III :-

Numbers of dying in interval (x,x+h), hdx: Numbers of calves dying between x and x+h age from the reference point in this study, where h = 1, 4 and 6 weeks.

Column IV :-

Numbers of withdrawls in the interval (x, x+h), hWx : In a dynamic population, transfer and sale of calves are common phenomenon which change the base population in different age groups at risk hence effect the estimation of hqx . To give

proper weightage to these, removal from the population for precise estimation hWx, the number of withdrawls observed in the age group (x,x+h) has been accounted for in the life table.

Column V :-

Fraction of last week stay for age x, hax : Each of the hWx calves who was withdrawn from the population during the interval (x, x+h) has stayed x complete weeks plus some fraction of hax of the week (x, x+h). Most of the researchers made the assumption about the animals, who were alive and were withdrawn from the study during the interval in computation of life table, that they are withdrawn precisely at the mid point of the interval of observation. They further assumed that during the half of the interval that they were not observed. They were subjected to half the chance of death for the entire interval. In the present study, the real value of fraction hax was estimated from the average fraction of weeks lived in a interval (x, x+h) by an animal before withdrawn.

Under the assumption that they were not observed during the (1-hax) interval so effective denominator was determined by substracting (1-hax) of the number withdrawn from the initial number at risk, So format for hqx given bellow:-

$$hqx = \frac{dx}{Ox - (1-hax).hWx}$$

For each interval hqx is determined according to above formula.

Column VI :-

Proportion of dying in the interval (x, x+h) h q x . Each h q x is the estimate of the probability that an individual alive at the exact age X will die during the interval (x, x+h). The h q x

:: is estimated using the formula given in (11). The figures in this column are derived from the columns (11), (111), (IV) and (V). To avoid the decimals, they are some times expressed as the number of deaths 1000 population.

Column VII :-

Proportion of calves surviving in interval (x, x+h) h p x. Each h p x is an estimate of probability that a calf alive at exact age X will survive during the interval (x, x+h). The figures in each column are derived as bellow from corresponding age specific probability of dying

So, hpx = (1-hqx).

Column VIII:-

Proportion of calves surviving X weeks, Px : Each is an estimate of probability that a calves will survive from birth to begining of interval (survivorship).

Column IX :-

Standard error of Px.

$$S.E.\ (Px) = Px \cdot \sqrt{\frac{hqx}{Ox-(1-hax)hWx-hdx}}$$

3.5.2 Regression model :-

Regression model was considered to explain the pattern of mortality in different weeks during the early age of calves by taking the probability of dying as dependent variable and age as independent variable. Mathmatically the model can be defined as,

$$Yi = a + bXi + ei$$

Where, Yi = Probability of dying of a calf in the it interval of age.

i = 1, 2, 3,..... 15

b = rate of change of mortality for per unit change in age.

Xi = mid value of ith interval of age.

ei = error associated with probability of death Yi and assumed to be normally and idependently distributed with mean zero and same variance r^2.

3.5.3 Indirect standardization of mortality data :

Comparison of age specific death rate in pure breed Holstein-Frisian female calves between two farms (Lakhimpur Kheri cattle breeding farm and I.V.R.I. cattle farm) was done by indirect standardization (Fleiss. 1981). The standard death rates in different age groups were estimated by pooling deaths and actual population of two farms. Standard Mortality Ratio (SMR) in each age group was estimated using the formula,

$$SMR = \frac{\text{Observed crude death rate}}{\text{Expected death rate}}$$

where expected death rate = actual population x standard death rate.

3.5.3. Chi-square (X^2) test :-

The association of mortality with birth weight groups and parities of birth of calves were tested by Chi-square (X©I2) test (Sendecor and Cochran, 1967).

$$X^2 = \frac{N^2}{C_1 C_2}\left[\sum_{i=1}^{k} \frac{a_i^2}{Ri} - \frac{C_1^2}{N}\right] \qquad \text{on } (k-1) \text{ d.f}$$

where, C_1 = Total number of calves died.

C_2 = Total number of calves survived

N = Total number of calves in the farm.

Ri = Number of calves in ith age group or parity.

ai = Number of calves died in ith age group or parity.

In this case the X^2 values calculated by using above formulae were significantly different at 5% probability level ($p \leq 0.05$) on (k-1) d.f. The mortality data were further subjected to statistical analysis by using t test. The formulae is given below :

$$t = \frac{pi - pj}{\sqrt{pq(1/ni+1/nj)}} \quad \text{on } (ni+nj-2) \text{ d.f.}$$

where, pi = proportion of calves died in ith group.

pj = Proportion of calves died in jth group.

$$p = \frac{ni.pi-nj.pj}{ni+nj}$$

q = 1-p.

ni = number of calves in ith group.

nj = number of calves in jth group.

3.5.4. Time Series Analysis :

Most of the disease show some temporal distribution which is dependent upon the following factors such as density of susceptible population, infecting agent, contact rates and suitable environment enabling the organisms to multiply. If we know the exact pattern of mortality in different month of the year, we can minimise losses due to mobidity and mortality by adopting optimum managemental practices, prevention, cure and immunisation methodsin the month in which it is most frequent. To estimate the precise effect of different month of the year on the mortality data spread over a period of 8 years (1980-1987) in this

study, the time series analysis (Croxton et al., 1969) was adopted to fulfil the requirement of mortality analysis.

Since the data in this study comprised of 8 years, it was thought proper to estimate only the sesonal effects as this could be estimated effectively than other components of the time series.

The centred 12 month moving average was calculated to remove the secular and cylic movements from the data. The original data was divided by 12 months moving averages to have an estimate of seasonal and irregular movements combined following the formula mentioned below-

$$\frac{TxCxSxI}{T \times C} = S \times Y$$

where, Y = value of time series

T = secular trend

C = cyclic movement

S = seasonal movement

I = irregular movement.

RESULTS

RESULTS

4.1 MORBIDITY

A number of diseases/disease syndromes have been observed among dairy calves (0-3 months) during the period under study of which following 4 disease conditions were accounted for morbidity in dairy calves -(1) Diarrhoea (2) Pneumonia (3) Wounds and (4) Debility/Weakness.

Diarrhoea :

It would be seen from the Table 1 that during 1986 a total of 366 cases of diarrhoea occurred in different months. Maximum morbidity of 13.11% was observed in the month of December (48/366) and the minimum morbidity 2.46% (9/366) recorded in May. It is seen from the above table that morbidity rate was gradually increased from May (2.46%) to December (13.11%). In other months i.e: from January to April, the morbidity rates ranged from minimum 5.19% to maximum 9.02%. Higher proportion of morbidity rate were observed from the month of August (10.66%) to December (13.11%) as compared to the morbidity rate recorded in April to July (ranged 2.46% to 6.28%) with a slight increase in morbidity in the month of February (8.74%) and March (9.02%). Some what different trends of morbidity was observed in 1987. A definite decreasing trend in morbidity was observed from January to July in 1987 i.e. 16.52% to 3.42% with highest morbidity recorded in January. In other months morbidity were more or less same except in October and November when the morbidity was recorded as 9.12% and 10.54% respectively.

A definite pattern of morbidity was noticed when the

information of both the years (1986-1987) were compiled. Higher rate of morbidity was recorded in cold climates i.e. November (11.15%) December (10.32%) January (11.57%), February and March (9.34%), and the lower morbidity rate was observed in hot climate i.e. in the month of May (4.32%), June (4.04) and July (4.88%).

Moderately higher rates of morbidity were observed in the month of April, August and September i.e. 6.41%, 9.06%, and 9.20% respectively.

Average number of treatment days with standard deviation for diarrhoea referred in Table 1. In 1986, average treatment days in August was calculated as 3.89 with SD (2.54) which was the highest amongst the different months. In other months average treatment day did not show much variation, it ranged from 3.00 days, S.D. (2.30) in March to 3.76 days, S.D.(3.33) in June. Similarly in 1987, the average treatment days were calculated for different months. Highest number of treatment days was observed in November 4.48 days, S.D.(3.10) followed by August [4.42 days, S.D. (2.33)], and January [3.83 days, S.D. (1.38)]. In other months of the year the number of treatment days were more or less same (range 3.26 to 3.62days) except in September where lowest number of treatment days [3.11 days,S.D.(1.86)] was noticed.

When the information regarding average treatment days was pooled for both the years it was observed that highest number of treatment days was found in August 4.10 days,S.D. (2.46) followed by January 3.72 days, S.D. (1.93); November 3.69 days, S.D. (2.44); June, 3.68 days,S.D.(3.12) and October (3.65 days, S.D. (2.28). In other months average treatment days ranged from 3.18 days to 3.57 days and lowest average treatment days was found in

December,3.18 days,S.D.(2.20).

Pneumonia :

Pneumonia was also found to be one of the important causes of calf mortality in younger age groups (0-3 months). As evident from the Table 2 out of 104 cases in 1986, though the cases were distributed throughout the year, highest morbidity was observed in December (17.31%), followed by March (13.46%) and February (12.5%). No definite pattern of morbidity was observed on the occurrence of the disease during the year. In 1987, a total of 171 cases of pneumonia encountered in different months of the year, and highest P.M.R. recorded in February (16.96). Lower rates of morbidity was observed in June and July i.e. 3.51% and 5.26% respectively. When the number of cases were pooled together for the years 1986 and 1987, a decreasing trend of proportional morbidity rate was observed from February to June i.e. from 15.27% to 4.00%. In other months i.e. from July to November, not much variation was noticed in morbidity rate and in December the morbidity rate raised to 11.64%. In 1986, gradual increase in number of average treatment days for pneumonia was found from the month of June [3.40 days S.D.(0.80)] to November [8.75 days,S.D. (3.01)]. While in April and December average treatment days were estimated as 3.50 days, S.D.(2.5) and 3.78 days, S.D. (2.99) respectively. In other months i.e. from January to March not much variation was observed i.e. the average treatment days, ranged from 4.08 days, S.D. (2.84) to 4.60 days, S.D.(3.38).

Highest number of average treatment days was recorded in the month of May [5.4 days, S.D. (2.8)] and September [5.4 days, S.D. (3.47)] in 1987. While lower number of average treatment days

were recorded in December [3.90 days,S.D. (2.37)] and January [3.73 days, S.D. (2.83)]. In other months slight variation was observed in number of average treatment days.

By pooling the information of 1986 and 1987 it was observed that higher range of ATD were recorded in November [5.99 days, S.D. (4.48)] followed by September [5.28 days, S.D. (3.39)] and May [5.04 days, S.D. (3.18)]. The lower range of ATD was found in December [3.83 days, S.D. (2.74)], January [3.94 days, S.D. (2.96)] and April [3.84 days, S.D. (2.83)]

Wounds :

Wounds were also accounted for a higher morbidity in young calves. The wounds included joint wound, navel wound, wounds arising by injury and dehorning etc.

On perusal of the Table 3, it was revealed that number of wound cases varied considerably in different months of 1986. Higher trends of morbidity were recorded in the months of August, September and October i.e. 15.69%, 17.93% and 14.79% respectively. Comparatively less number of wound cases were recorded in January, February, March, and April of 1986 (P.M.R. ranged 3.58% to 4.93%) than other months of the Year.

In 1987, the higher proportional morbidity rates were recorded in the month of May (12.92%), January (11.23%), March 10.11% and August (10.11%) as compared to the morbidity rates of September, November, December and April (P.M.R. ranged 2.81% to 6.74%).

When the information for both the years were pooled, a definite higher trend of morbidity was observed during August(13.22%) to October (11.72%), in other months, not much

variation in morbidity rate was observed (P.M.R., ranged from 5.23% to 9.47%).

Average treatment days with standard deviation for different months in 1986 were worked out for the wound cases. Highest average treatment days was calculated for November [11.73 days, S.D. (9.88)], followed by October [9.54 days, S.D. (6.64)], September [7.77 days, S.D. (8.19)] and August [7.68 days, S.D. (6.89)]. The treatment days was found to be shorter in January, February, March, May and June and it varied from 2.67 days,S.D.(2.87) to 5.82 days,S.D. (3.76). Similarly, in 1987, the highest average treatment days was recorded in May [12.56 days, S.D. (7.43)] followed by September [12.2 days, S.D. (7.88)], November [10.75 days, S.D. (8.73)] and October [10.50 days,S.D.(6.27)].

When the information regarding wound cases for 1986 and 1987 were combined, it was observed that highest number of average treatment days was noticed in the month of September [14.15 days,S.D.(9.77)] and moderately lower teatment days were noticed in March, April,June,and December.

Weakness :

Weakness was also attributed for one of the important causes of morbidity in calves. As mentioned in Table 4, out of a total 118 cases of weakness recorded in 1986, maximum number of cases were recorded in December (P.M.R, 24.58%), followed by November (16.10%) and October (11.02%), while number of minimum cases were observed in September (1.69%).

In 1987. higher percentage of morbidity was noticed in Ist

quarter of the year i.e. from January to March (P.M.R.-10.79% to 12.23%). In other months P.M.R. ranged from 6.11% to 7.91% with a little rise of P.M.R. in November (10.43%).

So far the average treatment days are concerned, highest number of treatment days was recorded in December, 1986 [9.75 days, S.D. (7.02)] followed by November [8.31 days, S.D. (6.95)]. In other months, not much variation was observed in average treatment days, it ranged from 4.25 days [S.D., 4.81] to 7.87 days [S.D; 4.54)].

In 1987, higher range of average treatment days were recorded in the month from January to April and i.e. from 9.23 days (S.D; 4.94) to 14.47 days (S.D; 9.07) and again the average treatment days was observed to be increased from May to September. However when the information for average treatment days were pooled together it was observed that the average treatment days in different months ranged from 6.18 days to 14.15 days.

By compiling the data regarding the occurrence of diseases in dairy calves for two years i.e. 1986 and 1987, as referred in Table 5, the major causes of morbidity were found to be due to (a) Diarrhoea (b) Pneumonia (c) Wounds and (d) Weakness.

Out of the total 1789 morbidity cases, 717 (40.08%) accounted for diarrhoea only, next in order was wound cases 22.41% (401/1789), weakness 22.14% (396/1789), and pneumonia 15.37% (275/1789). When we consider all the cases of morbidity due to diarrhoea, pneumonia, wound cases and weakness/debility together (Table 5) it was observed that out of 811 cases recorded in 1986 due to above condition distributed in different months. It was

observed that maximum cases occurred in December (14.92%) followed by October (11.84%), September (10.85%) and August (10.11%). In other months, the morbidity varied from 3.95% to 10.11% . Again when we considered the total number of cases for the above causes, monthwise, it was noticed that diarrhoea accounted for 54.35% in January and the morbidity due to other diseases in January ranged form 10.87 to 17.39% . It was also found that cases of diarrhoea recorded maximum in all the months in comparison with other causes during the year while higher morbidity recorded for wound cases in the month of August, September, and October i.e. 42.68; 45.45; and 34.38% respectively. In the same way, lowest morbidity was observed for pneumonia cases in February, March, April, May and June, with highest morbidity in Novbember i.e. (4.94%). Almost similar pattern of the occurrence of morbidity cases due to diarrhoea, pneumonia, etc were observed in 1987 also.

While we consider all the morbidity cases month-wise due to above disease conditions, the cases due to diarrhoea became predominant in all the months in comparison with other causes. Cases due to pneumonia were observed higher in February (23.46%) while wound cases accounted for highest morbidity in May (30.89%) and in June, wound cases were observed maximum, 28.57%

4.2. MORTALITY

4.2.1. Influence of age on calf mortality :

(Based on life table technique)

Information was obtained from 1546 live born birth in female calves during the referrence period 1980-1987 at I.V.R.I. Cattle farm. These female calves belonged to X, E, A, Halfbred, Holstein-

Friesian and miscellaneous groups/ breed (detailed as mentioned in materials and methods) comprising of 438, 537, 201, 183, 128, and 49 numbers of female calves respectively. Age specific mortality rates, proportional survivality pattern etc. were estimated using follow up life table technique, described in materials and methods, for each groups/breed seperately except miscellaneous group. The life tables of the above 5 groups of animals presented in the Table 6,7,8,9 and 10.

Besides these 5 life tables, another life table was also constructed to ascertain the overall probability of dying, pattern of survivality etc. for different age groups, taking all the female calves together. For simplification of the result and presentation, one week interval age groups i.e. 0-1, 1-2, 2-3, weeks as given in the life table were represented as 1st, 2nd, 3rd, weeks etc and either of the two systems would be followed through out this chapter for all purposes to make the result in more practically convincing form.

In 'X' group of female calves, though the probability of dying was higher in first week of age than 4th week but if we take into account, the system of propagation of this curve over the continuum of age groups and the maxima of the curve, it could be easily concluded that the probability of dying was greatest in the 3rd and 4th week of life (Table 6). After the 4th week of age the probability of dying decreased. The highest rate of change in decreasing order of survivality was observed in 3rd and 4th week of life. The proportion of calves surviving upto 10, 12 and 26 weeks were 83.83$\pm$1.77%, 82.86$\pm$1.81 and 81.19 $\pm$ 1.9% respectively. The rate of change of survivality decreased as age increased which

concluded that with the advancement in age though overall survivality decreased but the chance of dying of a calf reduced substantially.

The low order values of °hax' indicated transfer of calves in the beginning of week of an age group where as high order value showed transfer in last part of the week, of an age gruop. The value near to half indicated transfer of animals evenly through out the period of an age group.

Female calves in 'E' group showed highest probability of dying (Table 7) during 3rd week of age (5.21%) followed by 2nd week (4.58%), 1st week (4.2%) and 7th weeks (3.04%) respectively. The chances of mortality subseguently declined after 7th week of age. The survivality pattern indicated that 69.58 $\pm$ 1.97% calves survived upto 26 week of age as compared to 71.23 $\pm$ 1.94% upto 12 th week of age.

Probability of dying of 'A' group of animals in different age groups presented in Table 8. The greatest dying probability was noticed in 4th week of age (5.98%), the next greatest probability of dying in descending order of magnitude was observed in 5th, 2nd, and 1st week of life. The highest rate of declining survivality was observed during age group 3-4 week followed by calves in age group 4-5 week. The proportional calf survivality was considerably decreased to the order of 68.20 $\pm$ 3.24% upto 26 weeks of age. Proportion of calves survivality upto 5 and 12 weeks of age were 81.09$\pm$2.47% and 71.52 $\pm$ 3.14% respectively.

Age specific mortality indicated that highest order deaths in halfbred group calves during 4-5 weeks (5.77%) of age followed by 2-3 weeks (5.26%) and 6-7 weeks (4.93%) of age (Table 9). This

table also showed condiderably low survivality (66.06 ± 3.48%) for halfbred Hariana than Holstein Friesian pure breed upto 26 week of age. This half bred showed, 80.3±2.94% and 68.85 ± 3.42% chances of survivality upto 5 and 12 weeks of life respectively.

The highest probability of mortality in Holstein Friesian pure breed calves was recorded in the age groupof2-3 weeks (5.88%) of age followed by 1-2 weeks (4.03%), 4-5 weeks (3.60%) and 0-1 (3.12%) weeks of age (Table 10). The rate of change of survivality was observed to be higher upto 3rd week of life than the calves of other age groups. In latter part of life, the proportion of calves surviving upto age 5,12 and 26 weeks of life were 83.59 ± 3.27% , 76.57±3.27%, 74.23 ± 3.87% respectively.

An overall life table (Table 11) combining mortality data of all the groups and pure bred Holstein Friesian calves together showed again that the third week of life is the period of highest mortality in female calves. The high risk of dying was also noticed during 1st (3.56%), 4th (3.51%), 2nd (3.42%) and 5th (3.34%) week of life. The chances of deaths reduced greatly after 8th week of age. The proportion of calves survived upto neonatal age group (0-35 days) was 82.88±0.95%. There was a generalised declined in proportional survivality rate with the decrease of age upto 12 weeks. The chance in the proportional survivality of calves upto 12 weeks of age was 74.32±1.11% and in the subsequent age interval i.e.upto 16 weeks and 20 weeks and 26 weeks, the survivality were 73.18±1.13%, 72.91±1.13% and 72.14±1.15% respectively. It was observed that the rate of change of proportional survivality in the age of interval of 16-20 and 20-26 weeks were insignificant in spite of the larger age intervals.

Fig.1 shows that proportion of calves surviving for different age group upto 26 week of age, for X, E, A, half bred and Holstein-Friesian grades/breed of female calves. Proportional survivality curve of each grade/breed indicated that there was a sharp decline of curve upto 5th week of age. The proportion of calves surviving for first 5 weeks 87.35±1.59% for X grade., 81.14±1.67% for E grade 81.09±2.74% for A grade, 80.32±2.94% for halfbred and 83.59±3.27% for Holstein Friesian pure bred female calves.

Among the survivorship curves of 5 grades/breed of female calves, the highest overall calf mortality upto 26 week of age observed in Halfbred calves as compared to other grades/breed of calves. Similarly the lowest overall calf mortality observed in 'X' grade of female calves (Fig. 1).

The degree of variation of mortality due to different age groups and genetic groups of calves were estimated by linear regression model (Table 12a) as described in materials and methods The analysis of variation revealed that linear regression is capable of significantly ($p \leq 0.05$) explaining the mortality data. The R^2 value concluded that this model express about variability of mortality data (Table 12a). The estimated value of b (Table 12a) clearly indicated that the probability of dying decreased with advancement in the age of calves from birth to 26 week of age. The rate of decrease of mortality in 'X' grade of calves was in the order of -0.122 ± 0.042. In 'E' grade of calves the linear regression is highly significant ($p \leq 0.01$), The R^2 value indicated that there was marked decrease in mortality of calves with increase of age, at the rate of 0.22±0.043. Similar type of

significant effect of mortality ($p \leq .05$) with the increase of age was observed in Holstein Friesian calves. The regression coefficient was estimated as - 0.150 $\pm$ 0.063 and -0.140 $\pm$ 0.067 in the two breeds respectively. The highest decreasing pattern of mortality noticed in "Halfbred" calves (Fig. 1) and the rate of decreasing upto 26th week of age was -0.230$\pm$0.065 which was highly significant ($p < 0.01$)

The overall proportional curve (Fig. 2) taking all the grades/breeds together, the rate of decrease of mortality was highly significant ($p \leq 0.01$) where the overall regression coefficient was in the order of -0.179$\pm$0.034. The proportion of calves survived from birth to 26 weeks of age varied in different grades/breeds of calves (Fig. 1) although this variation was not statistically significant at 5% ($p > 0.05$) level of significance (Table 12b).

It is clear from the Table 13 that in 0-1 week of age, the expected death rate at farm 'A' (Lakhimpur Kheri) was lower as compared to crude death rate [standard mortality ratio (S.M.R.) 1.380]. The expected death was higher at farm B (I.V.R.I. cattle farm) than the crude death rate and the SMR was worked out as 0.802.

In 2-3 weeks of age group, the results were quite different than those observed in 0-1 week age group. In this group, expected death rate was more than crude death rate in Lakhimpur Kheri Farm. At I.V.R.I. farm results were found to be just opposite in comparison with Lakhimpur farm i.e. expected death rate was lower than crude death and SMR was estimated as 1.149.

It is apparent from the SMR reflected in Table 13

that the observed death rate was consistantly higher up to 10th week of age except 1st and 7th week where observed death rates were lower than expected death rates. In last two age group i.e. 16-20 and 20-26 weeks, the age interval was more i.e. 4 and 6 weeks respectively in comparison with earlier age group where age interval was taken as one week. The SMR 16-20 and 20-26 weeks were estimated as 1.705 and 1.730 respectively.

4.2.2 Influence of birth weight on mortality

Perusal of Table 14 revealed that the influence of birth weight on mortality rate upto 6 months of age was found to be highly significant ($p<0.01$) in 'X' group and 'E' group of female calves where as it was insignificant in 'A' group of calves. When these three breed crosses (X,E,A) were pooled together to see the effect of birth weight the overall X^2 value (20.76) was found to be statistically significant ($p<0.01$) which was presented in Table 16a.

On perusal of Table 14, it was revealed that the birth weight less than 16 Kg. and above 37 Kg. were detrimental for survivality of the 'X' group of female calves. The lowest mortality (15.00%) observed in 29-31 Kg. of birth weight group and birth weight of 25 to 36 Kg. appeared to be the suitable for optimum survivality of 'X' group calves. The same type of influence on the mortality rate was also found in 'E' group of calves weight 25-28 Kg. (25.13%) as compared to calves of other birth weight groups. In 'A' group of calves mortality recorded in

different birth weight groups was variable and it was found to be statistically nonsignificant ($p \geq 0.05$).

In halfbred crosses(Table 15), the influence of birth weight on mortality within 6 months of age was lower in higher birth weight groups, where minimum death rate noticed in 35-38 kg. (20.00%) of birth weight. The birth weight $\leq$ 18 kg. was found to be detrimental for survivality of calves upto 6 months of age.

In Holstein Friesian group, the birth weight had no influence on mortality rate (Table 15) yet highest death rate (80.00%) was observed in $\leq$15 kg. birth weight groups, then death rates started to decline with the increase of birth weight.The lowest death rate (20.00%) noticed in 28-31 kg. birth weight group although there was no death of calves above 36 kg of birth weight.

Influence of birth weight on mortality in three breed crosses (X, E & A groups) shown in Table 16a. The findings of mortality in different birth weight group of three breed crosses indicated that birth weight of 25-32 kg. was better for survival of these calves. When porportion of deaths in differenrt birth weight groups were further analysed (Tabele 16b) it was noted that less than 16 kg. has been inflicted high mortality.

4.2.3 Influence of parity on mortality:-

In order to ascertain the influence of dam's parity on mortality rate, information from 1299 total live births of different paritis was studied. It is seen from the Table 17 that highest mortality rate (44.44%) observed in seventh parity. It was further noticed that the rate of survivality in the 5th and 9th parity was more than other parities, i.e. 23.77% and 23.53%

respectively. In other parities there was not much variation. Although apparently there were differences in mortality due to different parities but when the variations were analysed statistically it was found that the differences were not significant ($P \geq 0.05$).

Information regarding stillbirth rates with the dam's parity has been presented in Table 18. Data obtained from 1303 total births of all the breed/groups together during 8 years (1980-87) revealed that highest rate of mortality (6.25%) in stillbirth was noticed in the 8th parity and next in order was 5.7% in the 6th parity. Lower rates of stillbirth were observed in Ist, 4th and 5th parity as 2.07%, 2.80% and 2.40% respectively.Although apparently the above differences were noticed in the stillbirth rate but the X^2 value (6.95) did not show any significant ($P \geq 0.05$) difference in stillbirth rates with the number of parity.

4.2.4. Influence of Season on calf mortality :-

The crude neonatal (0-35 days) mortality rate of female calves along with values of moving averages are presented in Fig.3. Perusal of the Fig.3 revealed that the higher mortality rate was generally observed during the month of November to February. The same trend was also noticed in each year from 1980 to 1987. Proportional mortality was predominant in the month of September and July.The curve depecting the 12 months moving average showed cyclic movement with minor variation in amplitude and time period. The average time period was approximately 2.0 years.

In other words,we could say that same mortality pattern

would likely to be repeated after a gap of 2.0 years. The average amplitude of mortality harmonic curve was 1 year, i.e. the time lapse between the maximum and minimum mortality during the entire reference period of mortality (1980-87) would be one year. Once the mortality attained the minimum it started increasing and reached to maximum mortality rate followed by decreasing to reached to minimum mortality after a lapse of one year.

As percentage increase in actual mortality rate in comparison with moving average, the seasonal and random movement of neonatal mortality varied from year to year (Fig.4) .The higest mortality rate occurred mostly in the month of November though January,July and March were also recorded for highest increase in mortality during the years 1981, 1983 and 1984 respectively. This finding concluded that more attention should be given on health of the young calves in winter season.

Seasonal indices of neonatal mortality for all the calves born during 1980-1987 are plotted in Fig.5. Calculation of seasonal indices for 8 years revealed that the highest seasonal index was observed in the month of November (121.03) followed by January (118.32), December (117.74), September (111.57) and February (104.75), The lowest seasonal indices was recorded in the month of August (76.97). But young females calves were in more comfortable condition with respect to mortality during March to June,as the low order seasonal indices were observed in these months. Trend of seasonal indices revealed that young female calves experienced less mortality from March to June but this rate increased spontaneously in the month of July and reached to lowest in the month of August.

It is apparent from this study i.e. months of winter season (November to February) posed serious mortality problems of young calves than summer season (March-June) and middle of rainy season (August).

Fig. 6 showed calf mortality rate (CMR) along with 12 months moving average of female calves for all the genetic grades during 1980 to 1987. The combined CMR in each month and each year of calves upto 1 year of age revealed that CMR tended to increase from June 1980 to August of 1982, again started rising from January 1984. Then the curve slowly decreased upto the June 1985, from June the curve raised slighly in the middle of 1986. There after there was very little variation of curve upto 1987. The overall curve tended to decrease from 1982 to the middle of 1987. No such definite trend of mortality was observed during 1980 to 1987. The mortality was generally higher in winter months (with some exceptional cases) in comparison to other months.

The percentage of calf mortality in each month with respect to 12 months moving averages from July 1980 to June 1987 given in the Fig. 7. Considering all the years, the higher percentage of calf mortality observed during November to February with some exception. The percent value of mortality was high in February for all the year except in 1984 and 1985.

Seasonal indices for the calf mortality from birth to 1 year of age for all the calves were calculated. The Fig.8 revealed that there was an increasing pattern of mortality from August to Decemb er and declining mortality pattern was also observed from February to May. The highest peak of mortality was observed in month of December followed by February. Another high peak of mortality

observed in July in 12 months moving averages of calf mortality. The 12 months moving averages also revealed the percentage of high mortality (½100) in February, March, October, November and December.

4.2.5. Causes of mortality :-

The important cause (mentined in materials and methods) of death in 0-1 year age group of female calves and their respective mortality rates in different age groups, months and years are presented in Table 20 to 22.

The overall proportional mortality rate (%) during 1980-1987 due to diarrhoea (27.71%), pneumonia (25.00%), diarrhoea and pneumonia (2.08%), debility (5.21%), arthritis (3.13%), tuberculosis (2.29%), septicaemia and toxaemia (1.88%), injury/trauma (1.46%); blood protozoan parasites (1.25%), miscellaneous (7.08%) and undiagnosed cases (12.92%) are depicted in Table 19.

Mortality data of calves in 0-1 year age group was categorised in small interval of age (Table 20) to identify disease, most prevalent in a particular age group. Perusal of the Table 20 indicated that the diarrhoea (81.80/1000) was the most predominant cause of deaths in young calves (0-1 year). This is followed by pneumonia (73.80/1000), diarrhoea and pnumonia (35.67/1000) and debility (15.38/1000a excluding miscellaneous and undiagnosed cases. Deaths due to other causes like arthritis, tuberculosis, septicaemia, toxaemia and injury etc. were not of much important in comparison with diarrhoea, pneumonia etc. All

the disease together caused 295.20 deaths per 1000 animals in 0-1 year of age group. Maximum mortality rate 48.39, was observed in 14-21 days followed by 21-28 days (38.37), 0-7 days (38.13), 7-14 days (32.64) and 28-35 days (31.94) of age groups. The higher death rates due to diarrhoea (10.16 to 21.12 per 1000 calves) as compared to other causes were noticed up to 35 dyas. Deaths due to pneumonia was predominant as compared to other causes from 42 to 360 days (1.83 to 12.34 per 1000 calves) except 112 to 140 days where death rate was zero.

The highest mortality rate due to diarrhoea was observed in 7-14 days (21.12) followed by 14-21 days (15.91) and 21-28 days (12.56) whereas the highest mortality rate due to pneumonia noticed in 42-49 days (12.34) followed by 14-21 days (11.27) and 21-28 days (9.07). The decreasing trend of mortality with the advancement of age was noticed from 7-14 days due to diarrhoea and 42-49 days due to pneumonia, barring some exception which were due to age group of large calls interval.

Season:

The occurrence of deaths due to various causes and their distribution in different months are given in Table 21. Diarrhoea, pneumonia, debility, joint ill and septicaemia were the major causes of deaths. The number of deaths due to these major causes in different month varied considerably. An increasing death rate due to diarrhoea (35.00 to 67.35 per 1000) was noticed from July to December although the highest rate was observed in February (71.49 per 1000). The death rate due to diarrhoea was in decreasing order from March to May (ranged 59.21 to 16.85 per 1000). The mortality rate due to pneumonia was higher during

March, July, August, November and December (ranged 51.50 to 65.62 per 1000) where as lower mortality rate noticed from April to July (25.16 to 37.58 per 1000). The relative proportion of deaths due to digestive disorder was consistently higher than respiratory disorder through out the distribution of 12 months except in January, May, August and September when deaths due to respriatory disorder was comparatively higher than digestive disorder. There was no seasonal trend of mortality in digestive or respiratory disorder yet higher frequency of deaths noticed in cold climate as compared to hot climate. Some animals died due to diarrhoea with complication of pneumonia. Mortality rates in such type of cases were observed maximum in December (47.54 per 1000). Lowest mortality rate was observed in June (5.30/1000). In other months the mortality rate ranged fron 9.53 to 32.21 per 1000. The higher frequency of deaths due to debility were observed in April, July, August, November and December with the range of 11.88 to 17.50 per 1000 calves than the lower frquencies in other months with range of 0 to 9.53 per 1000 calves.

Year:

Patterns of calf mortality due to different causes during the period for 1980 to 1987 have been shown in Table 22.

Mortality rate was calculated in each year by taking the population at risk which was described in materials & methods and experessed per 1000 population.

Maximum mortality rate of 252.00 per 1000 was recorded in 1982 followed by 212.46 per 1000 in 1986 and 206.67 per 1000 in 1987 and minmum mortality rate 140.04 per 1000 was observed in 1985.

Deaths due to diarrhoea during 1980 to 1982 was higher than pneumonia but in subsequent years i.e. in 1983 and 1985, mortality due to pneumonia was more than diarrhoea.

Higest mortality rate due to pneumonia was obsrved in 1986 (62.32/1000) followed by 1987 (61.36/1000). In other years it ranged from 28.05 to 52.04 per 1000 calves.

The mortality rate due to pneumonia was increased from 1984 (28.05/1000) to 1986 (62.32/1000) but in 1987 the mortality rate was slightly lower than 1986 (61.36/1000).

The death rate due to digestive and respiratory disorder was increasing order from 1980 to 1982 (4.33/1000 to 38.35/1000) and no death occurred in 1983 due to digestive and respiratory disorders but again from 1984 to 1987 increase in death rates were observed i.e. 10.20 to 61.35 per 1000 calves.

The highest mortality rate due to debility was observed in 1983 i.e. 20.09 per 1000 and there was not much variation in mortality due to debility in 1981 and 1982. The mortality rates for the above two years were recorded as 18.37 and 16.43 per 1000 calves respectively. In other years the mortality rates ranged from 2.83 to 7.65 per 1000 calves.

Higher death due to tuberculosis was recorded in 1985, 1986 and 1987. The mortality rates were worked out as 5.84, 5.67 and 9.69 per 1000 calves respectively in the above 3 years.

TABLE 1 PROPORTIONAL MORBIDITY RATE (%) AND AVERAGE TREATMENT DAYS IN DIFFERENT MONTHS OF DAIRY CALVES (0 -3 MONTHS) DUE TO DIARRHOEA (1986-87)

Months	Years						Total (1986-87)		
	1986			1987					
	No.cases (PMR)	A.T.D	S.D.	No.cases (PMR)	A.T.D	S.D.	No.cases (PMR)	A.T.D	S.D
Jan.	25 (6.83)	3.48	2.83	58 (16.52)	3.83	1.38	83 (11.57)	3.72	1.93
Feb.	32 (8.74)	3.03	1.57	35 (9.97)	3.6	2.4	67 (9.34)	3.33	2.05
Mar.	33 (9.02)	3.00	2.3	34 (9.68)	3.26	2.39	67 (9.34)	3.13	2.35
Apr.	19 (5.19)	3.42	3.01	27 (7.69)	3.59	2.57	46 (6.41)	3.52	2.76
May	9 (2.46)	3.44	1.26	22 (6.26)	3.6	1.8	31 (4.32)	3.55	1.67
Jun.	13 (3.55)	3.76	3.33	16 (4.55)	3.62	2.95	29 (4.04)	3.68	3.12
Jul.	23 (6.28)	3.56	3.52	12 (3.42)	3.6	2.32	35 (4.88)	3.57	3.17
Aug.	39 (10.66)	3.89	2.54	26 (7.14)	4.42	2.33	65 (9.06)	4.10	2.46
Sep.	40 (10.93)	3.63	2.22	26 (7.14)	3.11	1.86	66 (9.20)	3.42	2.08
Oct.	42 (11.48)	3.48	2.15	32 (9.12)	3.87	2.45	74 (10.32)	3.65	2.28
Nov.	43 (11.75)	3.02	1.67	37 (10.54)	4.48	3.10	80 (11.15)	3.69	2.44
Dec.	48 (13.11)	3.08	2.15	26 (7.14)	3.36	2.29	74 (10.32)	3.18	2.20
Total	366			351			717		

PMR : Proportional morbidity rate
ATD : Average treatment days
SD : Standard deviation

TABLE 2 PROPORTIONAL MORBIDITY RATE (%) AND AVERAGE TREATMENT DAYS IN DIFFERENT MONTH OF DIARY CALVES (0-3 MONTHS) DUE TO PNEUMONIA (1986-87).

Months	Years						Total (1986-87)		
	1986			1987					
	No.cases (PMR)	A.T.D	S.D.	No.case (PMR)	A.T.D	S.D.	No.case (PMR)	A.T.D	S.D
Jan.	5 (4.81)	4.60	3.38	15 (8.77)	3.73	2.83	20 (7.27)	3.94	2.96
Feb.	13 (12.50)	4.08	2.84	29 (16.96)	4.58	3.67	42 (15.27)	4.42	3.44
Mar.	14 (13.46)	4.43	3.41	14 (8.19)	4.28	3.57	28 (10.18)	4.35	3.49
Apr.	8 (7.69)	3.50	2.50	17 (9.94)	4.00	2.97	25 (9.09)	3.84	2.83
May.	9 (8.65)	4.44	3.77	15 (8.77)	5.40	2.8	24 (8.73)	5.04	3.18
Jun.	5 (4.81)	3.40	0.80	6 (3.51)	4.17	2.73	11 (4.00)	3.82	2.10
Jul.	9 (8.65)	4.22	3.04	9 (5.26)	4.78	3.99	18 (6.55)	4.50	3.55
Aug.	5 (4.81)	4.60	3.07	11 (6.43)	4.36	3.74	16 (5.82)	4.44	3.56
Sep.	6 (5.77)	5.00	3.16	15 (8.77)	5.40	3.47	21 (7.64)	5.28	3.39
Oct.	8 (7.69)	5.00	2.45	12 (7.01)	4.25	3.36	20 (7.27)	4.55	3.04
Nov.	4 (3.85)	8.75	3.01	14 (8.19)	5.21	4.76	18 (6.55)	5.99	4.48
Dec.	18 (17.31)	3.78	2.99	14 (8.19)	3.90	2.37	32 (11.64)	3.83	2.74
Total	104			171			275		

PMR : Proportional morbidity rate
ATD : Average treatment days
SD : Standard deviation

TABLE 3 PROPORTIONAL MORBIDITY RATE (%) AND AVERAGE TREATMENT DAYS IN DIFFERENT MONTHS OF DAIRY CALVES (0 -3 MONTHS) DUE TO WOUND CASES (1986-87).

Months	Years						Total (1986-87)		
	1986			1987					
	No.cases (PMR)	A.T.D	S.D.	No.cases (PMR)	A.T.D	S.D.	No.cases (PMR)	A.T.D	S.D
Jan.	8 (3.58)	4.75	6.53	20 (11.23)	7.85	7.31	28 (6.98)	8.97	4.89
Feb.	10 (4.48)	3.00	3.77	17 (9.55)	9.53	7.06	27 (6.73)	7.88	5.61
Mar.	11 (4.93)	5.82	3.76	18 (10.11)	7.22	5.6	29 (7.24)	9.11	5.25
Apr.	9 (4.03)	6.89	8.74	12 (6.74)	3.25	2.28	21 (5.23)	12.99	8.64
May	15 (6.72)	2.67	2.87	23 (12.92)	12.56	7.43	38 (9.47)	7.43	5.18
Jun.	10 (4.48)	5.20	4.38	15 (8.43)	6.87	6.09	25 (6.23)	8.34	6.03
Jul.	11 (4.93)	7.36	4.18	14 (7.87)	9.21	7.65	25 (6.23)	9.84	6.49
Aug.	35 (15.69)	7.68	6.89	18 (10.11)	8.22	6.97	53 (13.22)	11.86	8.55
Sep.	40 (17.93)	7.77	8.19	5 (2.81)	12.20	7.88	45 (11.22)	14.15	9.73
Oct.	33 (14.79(	9.58	6.64	14 (7.86)	10.50	6.27	47 (11.72)	9.82	3.76
Nov.	15 (6.72)	11.73	9.88	12 (6.74)	10.75	8.73	27 (6.73)	6.18	5.36
Dec.	26 (11.65)	7.26	8.36	10 (5.62)	4.90	4.80	36 (8.97)	9.14	6.81
Total	223			178			401		

PMR : Proportional morbidity rate
ATD : Average treatment days
SD : Standard deviation

TABLE 4 PROPORTIONAL MORBIDITY RATE (%) AND AVERAGE TREATMENT DAYS IN DIFFERENT MONTH OF DAIRY CALVES (0-3 MONTH) DUE TO WEAKNESS (1986-87).

Months	Years						Total (1986-87)		
	1986			1987					
	No.cases (PMR)	A.T.D	S.D.	No.case (PMR)	A.T.D	S.D.	No.case (PMR)	A.T.D	S.D
Jan.	8 (6.78)	7.87	4.54	34 (12.23)	9.23	4.97	42 (10.61)	8.97	4.89
Feb.	13 (11.02)	4.77	4.24	30 (10.79)	9.23	6.17	43 (10.85)	7.88	5.61
Mar.	10 (8.47)	5.50	4.61	34 (12.23)	10.17	5.42	44 (11.11)	9.11	5.25
Apr.	4 (3.39)	5.25	5.76	21 (7.55)	14.47	9.07	25 (6.31)	12.99	8.64
May.	8 (6.78)	4.25	4.81	22 (7.91)	8.59	5.31	30 (7.57)	7.43	5.18
Jun.	4 (3.39)	5.25	4.32	22 (7.91)	8.90	6.28	26 (6.56)	8.34	6.03
Jul.	5 (4.24)	4.40	2.80	15 (5.39)	11.66	7.55	20 (5.05)	9.84	6.49
Aug.	3 (2.54)	7.00	4.89	19 (6.83)	12.63	8.96	22 (5.55)	11.86	8.55
Sep.	2 (1.69)	5.50	3.50	17 (6.11)	15.17	10.12	19 (4.80)	14.15	9.73
Oct.	13 (11.02)	4.92	1.54	15 (5.39)	14.06	5.67	28 (7.07)	9.82	3.76
Nov.	19 (16.10)	8.31	6.95	29 (10.43)	4.79	4.34	48 (12.12)	6.18	5.36
Dec.	29 (24.58)	9.75	7.02	20 (7.19)	8.25	6.51	49 (12.37)	9.14	6.81
Total	118			278			396		

PMR : Proportional morbidity rate
ATD : Average treatment days
SD : Standard deviation

TABLE 5- MONTH-WISE PROPORTIONAL MORBIDITY RATE (%) IN DAIRY CALVES (0-3 MONTHS) DUE TO DIFFERENT *DISEASE CONDITIONS*.

Months	Years										Total (1986-87)			
	1986					1987								
	Diarr hoea	Pneu monia	Woun ds	Weak ness	Total	Diarr hoea	Pneu monia	Woun ds	Weak ness	Total	Diarr hoea	Pneu monia	Woun ds	Weak ness
Jan.	25	5	8	8	46	58	15	20	34	127	83	20	28	42
	54.35	10.87	17.39	17.39	5.67	45.67	11.81	15.75	26.77	12.99	47.98	11.56	16.18	24.28
Feb.	32	13	10	13	68	35	29	17	30	111	67	42	27	43
	47.05	19.11	14.70	19.11	8.38	31.53	26.13	15.32	27.03	11.35	37.43	23.46	15.08	24.02
Mar.	33	14	11	10	68	34	14	18	34	100	67	28	29	44
	48.52	20.58	16.17	14.70	8.38	34.00	14.00	18.00	34.00	10.22	39.88	16.67	17.26	26.19
Apr.	19	8	9	4	40	27	17	12	21	77	46	25	21	25
	47.50	20.00	22.50	10.00	4.93	35.06	22.08	15.58	27.27	7.87	39.32	21.37	17.95	21.37
May.	9	9	15	8	41	22	15	23	22	82	31	24	38	30
	21.95	21.95	36.59	19.51	5.06	26.83	18.29	28.05	26.83	8.38	25.20	19.51	30.89	24.39
Jun.	13	5	10	4	32	16	6	15	22	59	29	11	25	26
	40.63	15.63	31.25	12.50	3.95	27.12	10.17	25.42	37.29	6.03	31.87	12.09	27.47	28.57
Jul.	23	9	11	5	48	12	9	14	15	50	35	18	25	20
	47.92	18.75	22.92	10.42	5.92	24.00	18.00	28.00	30.00	5.11	35.71	18.37	25.51	20.41
Aug.	39	5	35	3	82	26	11	18	19	74	65	16	53	22
	47.56	6.10	42.68	3.66	10.11	35.14	14.86	24.32	25.68	7.57	41.67	10.26	33.97	14.10
Sep.	40	6	40	2	88	26	15	5	17	63	66	21	45	19
	45.45	6.82	45.45	2.27	10.85	41.27	23.81	7.94	26.98	6.44	43.71	13.91	29.80	12.58
Oct.	42	8	33	13	96	32	12	14	15	73	74	20	47	28
	43.75	8.33	34.38	13.54	11.84	43.84	16.44	19.18	20.55	7.46	43.79	11.83	27.81	16.57
Nov.	43	4	15	19	81	37	14	12	29	92	80	18	27	48
	53.09	4.94	18.52	23.46	9.99	40.22	15.22	13.04	31.52	9.41	46.24	10.40	15.61	27.75
Dec.	48	18	26	29	121	26	14	10	20	70	74	32	36	49
	39.67	14.88	21.49	23.97	14.92	37.14	20.00	14.29	28.57	7.16	38.74	16.75	18.85	25.65
Total	366	104	223	118	811	351	171	178	278	978	717	275	401	396
	45.12	12.82	27.49	14.54		35.89	17.48	18.20	28.42		40.08	15.37	22.41	22.14

Figures mentioned in second line in each month denote proportional morbidity rate in percentage.

TABLE 6 FOLLOW UP LIFE TABLE SHOWING SURVIVOHIP FOR X GROUP FEMALE CALVES AT I.V.R.I. CATTLE FARM, 1980 THROUGH 1987.

x,x+h	Dx	hdx	hWx	hax	hqx	hpx	Px	SE(Px)
0-1	438	15	0	0.0000	0.03425	0.96575	0.9658	0.0087
1-2	423	7	2	0.8571	0.01656	0.98341	0.9498	0.0104
2-3	414	18	3	0.4761	0.04364	0.95636	0.9082	0.0138
3-4	393	10	1	0.7142	0.02546	0.97454	0.8851	0.0153
4-5	382	5	1	1.0000	0.01309	0.98691	0.8735	0.0159
5-6	376	6	1	0.4286	0.01598	0.98402	0.8595	0.0167
6-7	369	3	2	0.5714	0.00815	0.99185	0.8525	0.0170
7-8	364	2	1	0.4286	0.00550	0.99450	0.8478	0.0172
8-9	361	3	4	0.3929	0.00837	0.99163	0.8407	0.0176
9-10	354	1	3	0.9524	0.00283	0.99717	0.8383	0.0177
10-11	350	2	5	0.5714	0.00575	0.99425	0.8335	0.0179
11-12	343	2	4	0.5000	0.00587	0.99413	0.8286	0.0181
12-16	337	3	25	0.4871	0.00925	0.99075	0.8209	0.0185
16-20	309	0	24	0.5712	0.00000	1.00000	0.8209	0.0185
20-26	285	3	22	0.5011	0.01095	0.98905	0.8119	0.0190

TABLE 7 FOLLOW UP LIFE TABLE SHOWING SURVIVOHIP FOR E GROUP FEMALE CALVES AT I.V.R.I. CATTLE FARM, 1980 THROUGH 1987.

x,x+h	Ox	hdx	hWx	hax	hqx	hpx	Px	SE(Px)
0-1	547	23	0	0.0000	0.04205	0.95795	0.9580	0.0086
1-2	524	24	1	0.7142	0.04583	0.95417	0.9140	0.0120
2-3	499	26	0	0.0000	0.05210	0.94790	0.8664	0.0145
3-4	473	18	0	0.0000	0.03805	0.96195	0.8334	0.0159
4-5	455	12	0	0.0000	0.02637	0.97363	0.8114	0.0167
5-6	443	15	0	0.0000	0.03386	0.96614	0.7839	0.0176
6-7	428	13	0	0.0000	0.03037	0.96963	0.7601	0.0183
7-8	415	8	0	0.0000	0.01928	0.98072	0.7454	0.0186
8-9	407	2	1	0.7142	0.00492	0.99508	0.7417	0.0187
9-10	404	8	0	0.0000	0.01980	0.98020	0.7270	0.0191
10-11	396	2	0	0.0000	0.00505	0.99495	0.7233	0.0191
11-12	394	6	0	0.0000	0.01523	0.98477	0.7123	0.0194
12-16	388	6	1	0.2500	0.01549	0.98451	0.7013	0.0196
16-20	381	1	0	0.0000	0.00262	0.99738	0.6995	0.0196
20-26	380	2	0	0.0000	0.00526	0.99474	0.6958	0.0197

TABLE 8 FOLLOW UP LIFE TABLE SHOWING SURVIVOHIP FOR A GROUP FEMALE CALVES AT I.V.R.I. CATTLE FARM, 1980 THROUGH 1987.

x,x+h	Ox	hdx	hWx	hax	hqx	hpx	Px	SE(Px)
0-1	201	4	0	0.0000	0.01990	0.98010	0.9801	0.0098
1-2	197	8	0	0.0000	0.04061	0.95939	0.9403	0.0167
2-3	189	5	0	0.0000	0.02646	0.97354	0.9154	0.0196
3-4	184	11	0	0.0000	0.05978	0.94022	0.8607	0.0244
4-5	173	10	0	0.0000	0.05780	0.94220	0.8109	0.0274
5-6	170	3	0	0.0000	0.01765	0.98235	0.7966	0.0282
6-7	164	6	0	0.0000	0.03659	0.96341	0.7675	0.0295
7-8	161	3	0	0.0000	0.01863	0.98137	0.7532	0.0301
8-9	159	2	0	0.0000	0.01258	0.98742	0.7437	0.0305
9-10	157	1	0	0.0000	0.00637	0.99363	0.7389	0.0306
10-11	156	3	0	0.0000	0.01923	0.98077	0.7247	0.0311
11-12	153	2	0	0.0000	0.01307	0.98693	0.7152	0.0314
12-16	151	4	0	0.0000	0.02649	0.97351	0.6962	0.0320
16-20	147	2	0	0.0000	0.01361	0.98639	0.6867	0.0322
20-26	146	1	0	0.0000	0.00685	0.99315	0.6820	0.0324

TABLE 9 FOLLOW UP LIFE TABLE SHOWING SURVIVOHIP FOR HALF-BRED FEMALE CALVES AT I.V.R.I. CATTLE FARM, 1980 THROUGH 1987.

x,x+h	Ox	hdx	hWx	hax	hqx	hpx	Px	SE(Px)
0-1	183	6	0	0.0000	0.03279	0.96721	0.9672	0.0132
1-2	177	6	0	0.0000	0.03390	0.96610	0.9344	0.0183
2-3	171	9	0	0.0000	0.05263	0.94737	0.8852	0.0236
3-4	162	6	0	0.0000	0.03704	0.96296	0.8525	0.0262
4-5	156	9	0	0.0000	0.05769	0.94231	0.8033	0.0294
5-6	147	5	0	0.0000	0.03401	0.96599	0.7760	0.0308
6-7	142	7	0	0.0000	0.04930	0.95070	0.7377	0.0325
7-8	135	5	0	0.0000	0.03704	0.96296	0.7104	0.0325
8-9	130	0	0	0.0000	0.00000	1.00000	0.7104	0.0335
9-10	130	2	0	0.0000	0.01538	0.98462	0.6995	0.0335
10-11	128	2	0	0.0000	0.01563	0.98437	0.6885	0.0339
11-12	126	0	0	0.0000	0.00000	1.00000	0.6885	0.0342
12-16	126	4	1	0.7857	0.03180	0.96820	0.6666	0.0342
16-20	121	0	0	0.0000	0.00000	1.00000	0.6666	0.0348
20-26	121	0	0	0.0000	0.00000	1.00000	0.6666	0.0348

TABLE 10 FOLLOW-UP LIFE TABLE SHOWING SURVIVORSHIP OF HOLSTEIN-FRIESIAN FEMALE CALVES AT IVRI CATTLE FARM, 1980 THROUGH 1987.

x,x+h	Dx	hdx	hWx	hax	hqx	hpx	Px	SE(Px)
0-1	128	4	0	0.0000	0.03125	0.96875	0.9688	0.0154
1-2	124	5	0	0.0000	0.04032	0.95968	0.9297	0.0226
2-3	119	7	0	0.0000	0.05882	0.94118	0.8750	0.0292
3-4	112	1	0	0.0000	0.00893	0.99107	0.8672	0.0299
4-5	111	4	0	0.0000	0.03604	0.96396	0.8359	0.0327
5-6	107	2	0	0.0000	0.01869	0.98131	0.8203	0.0339
6-7	105	1	0	0.0000	0.00952	0.99048	0.8125	0.0345
7-8	104	2	0	0.0000	0.01923	0.98077	0.7969	0.0356
8-9	102	3	0	0.0000	0.02941	0.97059	0.7735	0.0370
9-10	99	1	0	0.0000	0.01010	0.98990	0.7657	0.0374
10-11	98	0	0	0.0000	0.00000	1.00000	0.7657	0.0374
11-12	98	0	0	0.0000	0.00000	1.00000	0.7657	0.0374
12-16	98	0	0	0.0000	0.00000	1.00000	0.7657	0.0374
16-20	98	1	0	0.0000	0.01020	0.98980	0.7579	0.0378
20-26	97	2	0	0.0000	0.02062	0.97938	0.7423	0.0387

TABLE 11 FOLLOW-UP LIFE TABLE SHOWING OVERALL SURVIVORSHIP FOR EXOTIC AND CROSSBRED FEMALE CALVES, AT IVRI CATTLE FARM, 1980 THROUGH 1987.

x,x+h	Ox	hdx	hWx	hax	hqx	hPx	Px	SE(Px)
0-1	1546	55	0	0.0000	0.03558	0.96442	0.9644	0.0047
1-2	1491	51	3	0.8095	0.03422	0.96578	0.9314	0.0064
2-3	1437	66	3	0.4761	0.04598	0.95402	0.8886	0.0080
3-4	1368	48	1	0.7142	0.03510	0.96490	0.8574	0.0089
4-5	1319	44	1	1.0000	0.03336	0.96664	0.8288	0.0095
5-6	1274	32	1	0.4286	0.02513	0.97487	0.8080	0.0100
6-7	1241	34	2	0.5714	0.02742	0.97258	0.7858	0.0105
7-8	1205	20	1	0.4286	0.01661	0.98339	0.7728	0.0107
8-9	1184	12	5	0.4572	0.01016	0.98984	0.7649	0.0108
9-10	1167	14	3	0.9524	0.01200	0.98800	0.7557	0.0110
10-11	1150	9	5	0.5714	0.00784	0.99216	0.7498	0.0110
11-12	1136	10	4	0.5000	0.00882	0.99118	0.7432	0.0111
12-16	1122	17	27	0.4894	0.01534	0.98466	0.7318	0.0113
16-20	1078	4	24	0.5712	0.00375	0.99625	0.7291	0.0113
20-26	1050	11	22	0.5011	0.01059	0.98941	0.7214	0.0115

TABLE 12a ANALYSIS OF VARIANCE REGRASSION COEFFICIENTS OF MORTALITY RATE IN DIFFERENT GRADEBREED OF FEMALE CALVES.

Sourses of variance	d.f	M.S.S.					Grades/bred	b	S.E	r^2
		X	E	A	Halfbred	Hol.				
Due to regre.	1	8.15	26.93	12.37	29.03	10.87	X	-0.122	0.042	.389
Residual	13						E	-0.220	0.043	0.676
Total	14						A	-0.150	0.063	0.304
							Halfbred	-0.230	0.065	0.489
							Hol.	-0.140	0.067	0.255

TABLE 12b ANALYSIS OF VARIANCE OF MORTALITY RATE TAKING *THE SIGNIFICANCE OF REGRESSION COEFFICIENTS IN* DIFFERENT GRADES/BREAD OF CALVES.

Sourses of variation	d.f	M.S.S.	F	
			Cal.	Tab.
Between slope	4	1.374	0.715	2.53
Within slope	60	1.921		
Total	64			

TABLE 13 : STANDARD MORTALITY RATIO IN DIFFERENT AGE GROUPS OF HOLSTEIN FRIESIAN FEMALE CALVES IN TWO FARMS.

Age group (week)	Std. death rate %	Farm A				Farm B			
		Popul.	Crude death rate %	Expt. death rate%	SMR	Popul.	Crude death rate %	Expt. death rate %	SMR
0-1	3.04	69	2.898	2.100	1.380	128	3.125	3.898	0.802
1-2	2.62	67	0.000	1.750	0.000	124	4.032	3.249	1.241
2-3	4.30	67	1.493	2.881	0.518	119	5.882	5.117	1.149
3-4	0.56	66	0.000	0.371	0.000	112	0.893	0.627	1.424
4-5	2.26	66	0.000	1.492	0.000	111	3.604	2.509	1.436
5-6	1.16	66	0.000	0.766	0.000	107	1.896	1.241	1.506
6-7	1.17	66	1.515	0.772	1.960	105	0.952	1.228	0.775
7-8	1.18	65	0.000	0.767	0.000	104	1.923	1.227	1.570
8-9	1.79	65	0.000	1.168	0.000	102	2.941	1.826	1.610
9-10	0.61	65	0.000	0.396	0.000	99	1.010	0.604	1.670
10-11	0.00	65	0.000	0.000	0.000	98	0.000	0.000	0.000
11-12	0.00	65	0.000	0.000	0.000	98	0.000	0.000	0.000
12-16	0.00	65	0.000	0.000	0.000	98	0.000	0.000	0.000
16-20	0.61	65	0.000	0.396	0.000	98	1.020	0.598	1.705
20-26	1.23	65	0.000	0.990	0.000	97	2.062	1.193	1.730

Farm A = Lakhimpur cattle breeding farm
Farm B = I.V.R.I. cattle farm
SMR = Standard mortality ratio

TABLE 14 EFFECT OF BIRTH WEIGHT ON MORTALITY RATE OF INDIVIDUAL THREE BREED CROSSES (X,E,A) FEMALE CALVES.

Birth Wt (in kg.)	No.Births			No.Deaths			Mortality %		
	X	E	A	X	E	A	X	E	A
≤16	3	16	4	3	5	3	100.0	31.25	75.00
17-20	19	46	30	5	24	3	26.31	52.17	23.08
21-24	105	143	47	31	34	18	29.52	30.76	38.29
25-28	153	199	76	32	52	90	20.91	26.13	25.00
29-32	40	84	37	6	25	9	15.00	29.76	24.32
33-36	13	41	13	2	11	5	15.38	26.82	38.46
37≥	1	9	3	1	6	0	100.00	66.66	0.00
X^2 value							** 17.61	** 17.57	NS 8.96

** Singnificant at P≤ 0.01 NS. Non-significant

TABLE-15 EFFECT OF BIRTH WEIGHT ON MORTALITY RATE OF TWO BREED CROSSES (FH,BH,JH) AND PURE BREED FRIESIAN FEMALE CALVES.

Two breed crosses				Holstein Friesian			
Birth wt.(kg)	No. births	No. deaths	Mortality %	Birth wt.(kg)	No. births	No. deaths	Mortality %
≤ 18	4	4	100.00	≤ 15	5	4	80.00
19-22	12	5	41.67	16-19	5	2	40.00
23-26	49	19	38.77	20-23	20	6	30.00
27-40	56	18	30.14	23-27	53	17	32.00
31-34	27	9	33.33	28-31	30	6	20.00
35-38	15	3	20.00	32-35	9	2	22.22
39 ≥	4	1	25.00	36 ≥	1	0	00.00
X^2 value			9.82^{NS}				8.39^{NS}

NS Non-significant at P<0.05

TABLE 16a : EFFECT OF BIRTH WEIGHT ON MORTALITY RATE OF THREE BREAD CROSS (X, E, A) FEMALE CALVES.

Birth wt. (in kg)	No. births	No. Deaths	Mortality (%)
< 16	23	11	47.83
17-20	78	32	41.03
21-24	295	93	31.52
25-28	428	103	24.06
29-32	161	40	24.84
33-36	67	18	29.51
36>	13	7	53.85
χ^2 value			20.76**

** Significant at (P<0.01)

TABLE 16b : T-TEST FOR MORTALITY RATE OF THREE BREED CROSSES (X,E,A) FEMALE CALVES DUE TO BIRTH WEIGHT.

Birth wt. (in kg.)	< 16	17-20	21-24	25-28	29-32	33-36	37 >
< 16		1.52	0.04 *	0.43 **	0.94 **	2.43 *	1.81
17-20			2.57	3.26	2.52	2.51	0.84
21-24				0.94	0.16	0.50	2.22
25-28					0.62	0.09	2.53
29-32						0.34	2.24
33-36							2.32

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

TABLE 17. : EFFECT OF DAM'S PARITY (LACTATION NO.) ON MORTALITY RATE OF FEMALE CALVES.

Dam's parity No.	NO. live births	NO. deaths	NO. alive	Death rate (%)
1	331	107	224	32.33
2	242	73	169	30.17
3	179	50	129	27.93
4	176	47	129	26.70
5	122	29	93	23.77
6	100	28	72	28.00
7	63	28	35	44.44
8	45	11	34	24.44
9	21	4	17	23.53
10+	20	6	14	30.00
X^2 Value of X				NS 12.65

NS : Non significant

TABLE 18 : EFFECT OF DAM'S PARITY (LACTATION NO.) ON STILLBIRTH RATE OF FEMALS CALVES

Dam's Parity No.	NO. births	NO. stillbirth	NO. live births	Stillbirth rate %
1	7	331	338	2.07
2	12	242	254	4.72
3	7	197	186	3.76
4	5	176	181	2.80
5	3	122	125	2.40
6	6	100	106	5.70
7	2	63	65	3.09
8	3	45	48	6.25
2				NS
Value of X				6.59

NS : Non significant

TABLE 19 : OVERALL PROPORTIONAL MORTALITY RATE (%) DUE TO DIFFERENT CAUSES UPTO 1 YEAR OF AGE (1980--1987).

Sl.No.	Causes	No. Death	Proportional mortality rate (%)
1	Diarrhoea	133	27.71
2	Pneumonia	120	25.00
3	Diarrhoea & Pneumonia	58	12.08
4	Debility	25	5.21
5	Arthritis	15	3.13
6	Tuberculosis	11	2.29
7	Septicaemia & Toxaemia	9	1.88
8	Injury / trauma	7	1.46
9	Blood protozoan,parasite	6	1.25
10	Miscellaneous	34	7.08
11	Undiagnosed	62	12.92
	Total	480	

TABLE 20 : AGE SPECIFIC DEATH RATE PER 1000 IN FEMALE CALVES (0-1YEAR DUE TO DIFFERENT CAUSES (1980-1987).

Age groups (days)	Popula-tion at Risk	Causes: Diarr-hoea	Pneu-monia	Dia. & Pneu.	Debi-lity	Athr.& joint ill	Tuber-culosis	Septic-aemia	Injury	Bl.protz parasite	Miscel laneous	Undiga nosed	Total
0-7	1626	17	5	4	4	1	0	5	4	0	8	14	62
		10.46	3.08	2.46	2.46	0.62	0.00	3.08	2.46	0.00	4.92	8.61	38.13
7-14	1562.5	33	3	2	1	2	1	0	0	0	6	3	51
		21.12	1.92	1.28	0.64	1.28	0.64	0.00	0.00	0.00	3.84	1.92	32.64
14-21	1508.5	24	17	9	6	2	0	1	0	2	4	8	73
		15.91	11.27	5.97	3.98	1.33	0.00	0.66	0.00	1.33	2.65	5.30	48.39
21-28	1433.5	18	13	11	2	0	0	0	0	0	2	9	55
		12.56	9.07	7.67	1.40	0.00	0.00	0.00	0.00	0.00	1.40	6.28	38.37
28-35	1377.5	14	12	11	2	0	0	2	0	0	0	3	44
		10.16	8.71	7.99	1.45	0.00	0.00	1.45	0.00	0.00	0.00	2.18	31.94
35-42	1332.5	9	9	7	1	1	0	0	0	0	2	5	34
		6.75	6.75	5.25	0.75	0.75	0.00	0.00	0.00	0.00	1.50	3.75	25.52
42-49	1297	8	16	0	0	2	0	0	0	0	1	6	33
		6.17	12.34	0.00	0.00	1.54	0.00	0.00	0.00	0.00	0.77	4.63	25.44
49-56	1262.5	4	11	3	0	1	0	0	0	0	0	2	21
		3.17	8.71	2.38	0.00	0.79	0.00	0.00	0.00	0.00	0.00	1.58	16.63
56-63	1238.5	1	7	3	0	1	1	0	0	0	0	2	15
		0.81	5.65	2.42	0.00	0.81	0.81	0.00	0.00	0.00	0.00	1.61	12.11
63-70	1219.5	1	6	1	0	2	1	0	0	0	1	1	13
		0.82	4.92	0.82	0.00	1.64	0.82	0.00	0.00	0.00	0.82	0.82	10.66
70-77	1202.5	0	4	3	0	0	0	0	0	0	0	1	8
		0.00	3.33	2.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.83	6.65
77-84	1190	0	4	0	1	1	0	0	0	0	2	1	9
		0.00	3.36	0.00	0.84	0.84	0.00	0.00	0.00	0.00	1.68	0.84	7.56
84-112	1165.5	3	6	2	0	0	1	0	0	0	1	2	15
		2.57	5.15	1.72	0.00	0.00	0.86	0.00	0.00	0.00	0.86	1.72	12.87
112-140	1125	0	0	1	0	1	2	0	0	0	2	0	6
		0.00	0.00	0.89	0.00	0.89	1.78	0.00	0.00	0.00	1.78	0.00	5.33
140-182	1096	1	2	0	1	1	2	0	0	1	1	4	13
		0.91	1.82	0.00	0.91	0.91	1.82	0.00	0.00	0.91	0.91	3.65	11.86
182-360	1033	0	5	1	7	0	3	1	3	3	4	1	28
		0.00	4.84	0.97	6.78	0.00	2.90	0.97	2.90	2.90	3.87	0.97	27.11
Total		133	120	58	25	15	11	9	7	6	34	62	480
		81.80	73.80	35.67	15.38	9.23	6.77	5.54	4.31	3.69	20.91	38.13	295.20

Figures mentioned in second line in each age group denote rate per thousand calves.

1 : MONTHWISE DEATH RATE PER 1000 IN FEMALE CALVES (0-1YEAR) DUE TO DIFFERENT CAUSES (1980-87).

Popula-tion at Risk	Causes											Total
	Diarr-hoea	Pneu-monia	Dia. & Pneu.	Debi-lity	Athr.& joint ill	Tuber-culosis	Septic-aemia	Injury	Bl. Pr. parasite	Miscl-laneous	Undig-nosed	
260.42	9	12	4	2	0	0	1	0	0	4	12	44
	34.56	46.08	15.36	7.68	0.00	0.00	3.84	0.00	0.00	15.36	46.08	168.96
209.83	15	8	2	2	1	1	1	1	1	8	4	44
	71.49	38.13	9.53	9.53	4.77	4.77	4.77	4.77	4.77	38.13	19.06	209.69
202.67	12	11	2	1	2	1	0	1	0	1	2	33
	59.21	54.28	9.87	4.93	9.87	4.93	0.00	4.93	0.00	4.93	9.87	162.83
172.33	6	5	4	3	2	1	2	0	0	3	1	27
	34.82	29.01	23.21	17.41	11.61	5.80	11.61	0.00	0.00	17.41	5.80	156.68
186.25	5	7	6	0	3	2	0	3	0	2	3	31
	26.85	37.58	32.21	0.00	16.11	10.74	0.00	16.11	0.00	10.74	16.11	166.44
188.83	9	6	1	0	0	0	0	1	0	1	6	24
	47.66	31.77	5.30	0.00	0.00	0.00	0.00	5.30	0.00	5.30	31.77	127.10
198.75	10	5	4	3	4	0	1	0	0	4	3	34
	50.31	25.16	20.13	15.09	20.13	0.00	5.03	0.00	0.00	20.13	15.09	171.07
228.58	8	15	4	4	0	1	1	0	2	1	9	45
	35.00	65.62	17.50	17.50	0.00	4.37	4.37	0.00	8.75	4.37	39.37	196.87
223.17	11	13	9	1	1	1	1	1	2	0	2	42
	49.29	58.25	40.33	4.48	4.48	4.48	4.48	4.48	8.96	0.00	8.96	188.20
228.92	13	10	6	2	0	0	0	1	0	5	7	44
	56.79	43.68	26.21	8.74	0.00	0.00	0.00	4.37	0.00	21.84	30.58	192.21
266.58	18	15	4	4	2	3	1	0	0	5	5	57
	67.52	56.27	15.00	15.00	7.50	11.25	3.75	0.00	0.00	18.76	18.76	213.82
252.42	17	13	12	3	0	0	1	0	1	0	8	55
	67.35	51.50	47.54	11.88	0.00	0.00	3.96	0.00	3.96	0.00	31.69	217.87

mentioned in second line in each month denote rate per thousand

TABLE 22 : YEAR-WISE DEATH RATE PER 1000 IN FEMALE CALVES (0-1YEAR) DUE TO DIFFERENT CAUSES (1980-1987).

Year	Popula-tion of Risk	Causes											
		Diarr-hoea	Pneu-monia	Dia. & Pneu.	Debi-lity	Athr.& joint ill	Tuber-culosis	Septic-aemia	Injury	Bl.protz parasite	Miscel laneous	Undiag nosed	Total
1980	230.83	14	9	1	1	0	0	1	2	2	4	1	35
		60.65	38.99	4.33	4.33	0.00	0.00	4.33	8.66	8.66	17.33	4.33	151.63
1981	326.58	19	12	6	6	1	1	1	0	0	6	6	58
		58.18	36.74	18.37	18.37	3.06	3.06	3.06	0.00	0.00	18.37	18.37	177.60
1982	365.08	32	19	14	6	3	1	3	1	2	6	5	92
		87.65	52.04	38.35	16.43	8.22	2.74	8.22	2.74	5.48	16.43	13.70	252.00
1983	298.67	9	14	0	6	1	1	0	1	1	9	5	47
		30.13	46.87	0.00	20.09	3.35	3.35	0.00	3.35	3.35	30.13	16.74	157.36
1984	392.11	11	11	4	3	6	0	1	1	1	3	20	61
		28.05	28.05	10.20	7.65	15.30	0.00	2.55	2.55	2.55	7.65	51.00	155.54
1985	342.75	9	14	4	1	0	2	0	0	1	2	15	48
		26.26	40.85	11.67	2.92	0.00	5.84	0.00	0.00	2.92	5.84	43.76	140.04
1986	353	28	22	10	1	3	2	0	0	1	2	6	75
		79.32	62.32	28.33	2.83	8.50	5.67	0.00	0.00	2.83	5.67	17.00	212.46
1987	309.67	11	19	19	1	1	3	0	3	1	2	4	64
		35.52	61.36	61.36	3.23	3.23	9.69	0.00	9.69	3.23	6.46	12.92	206.67
Total		133	120	58	25	15	10	6	8	9	34	62	480

Figures mentioned in second line in each year indicate rate per thousand calves.

FIG.1: PROPORTION OF FEMALE CALVES OF FIVE GENETIC GRADES/BREED SURVIVING IN DIFFERENT AGE GROUPS AT IVRI CATTLE FARM.

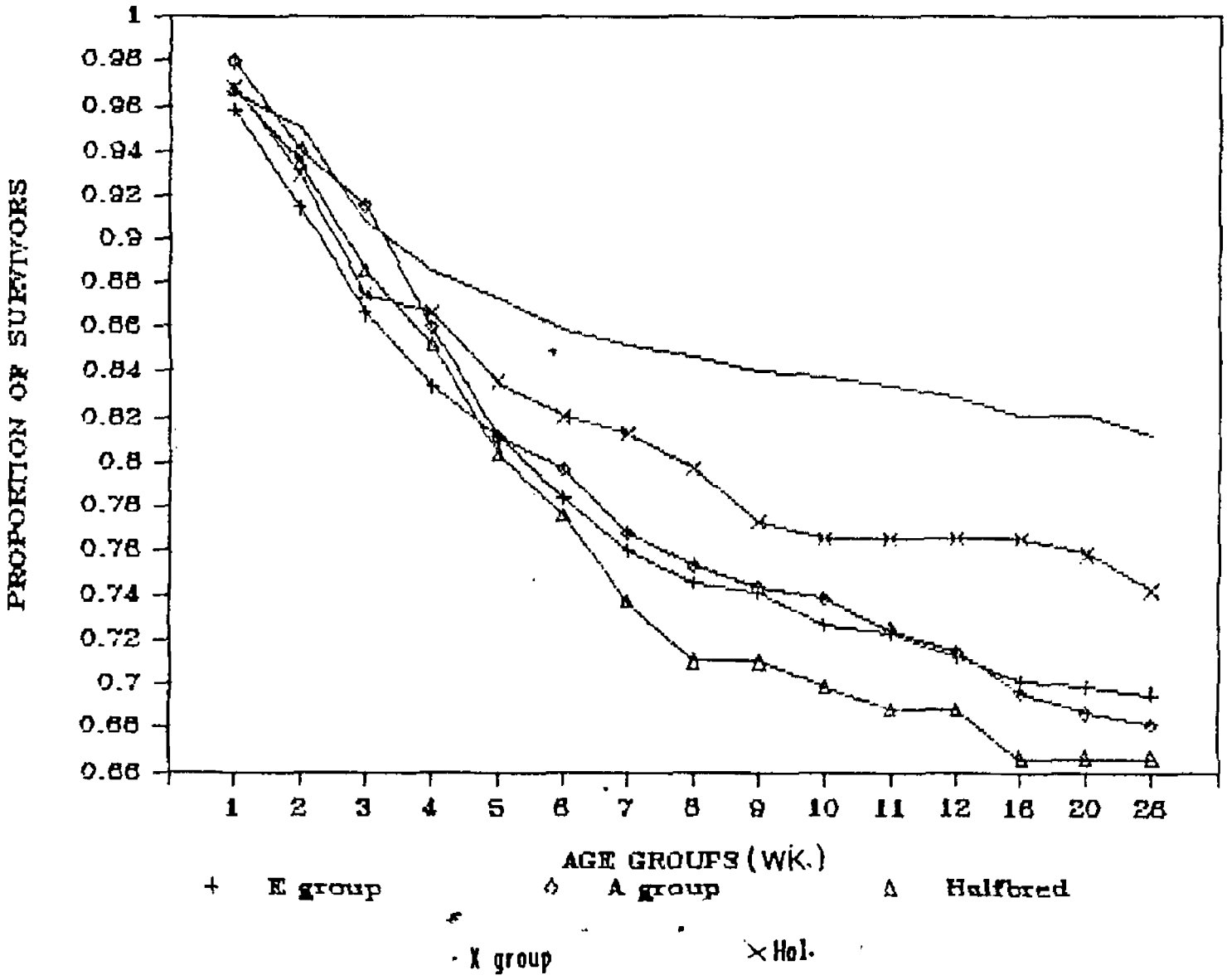


FIG.2: OVERALL PROPORTION OF FEMALE CALVES SURVIVING DIFFERENT AGE GROUPS AT IVRI CATTLE FARM.

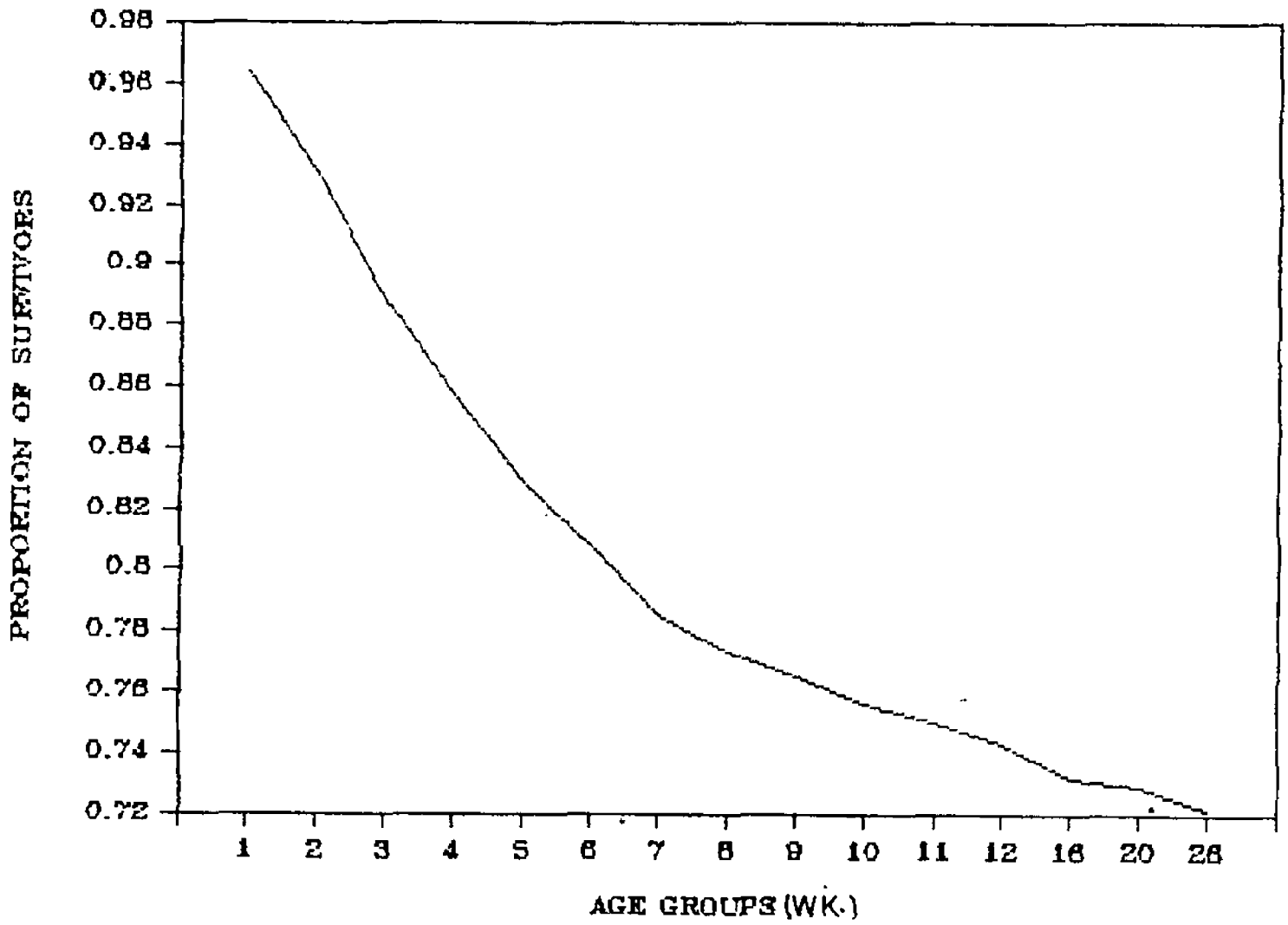


FIG.3: NEONATAL CALF MORTALITY RATE AND IT S 12 MONTH MOVING AVERAGES AT IVRI CATTLE FARM, 1980-87.

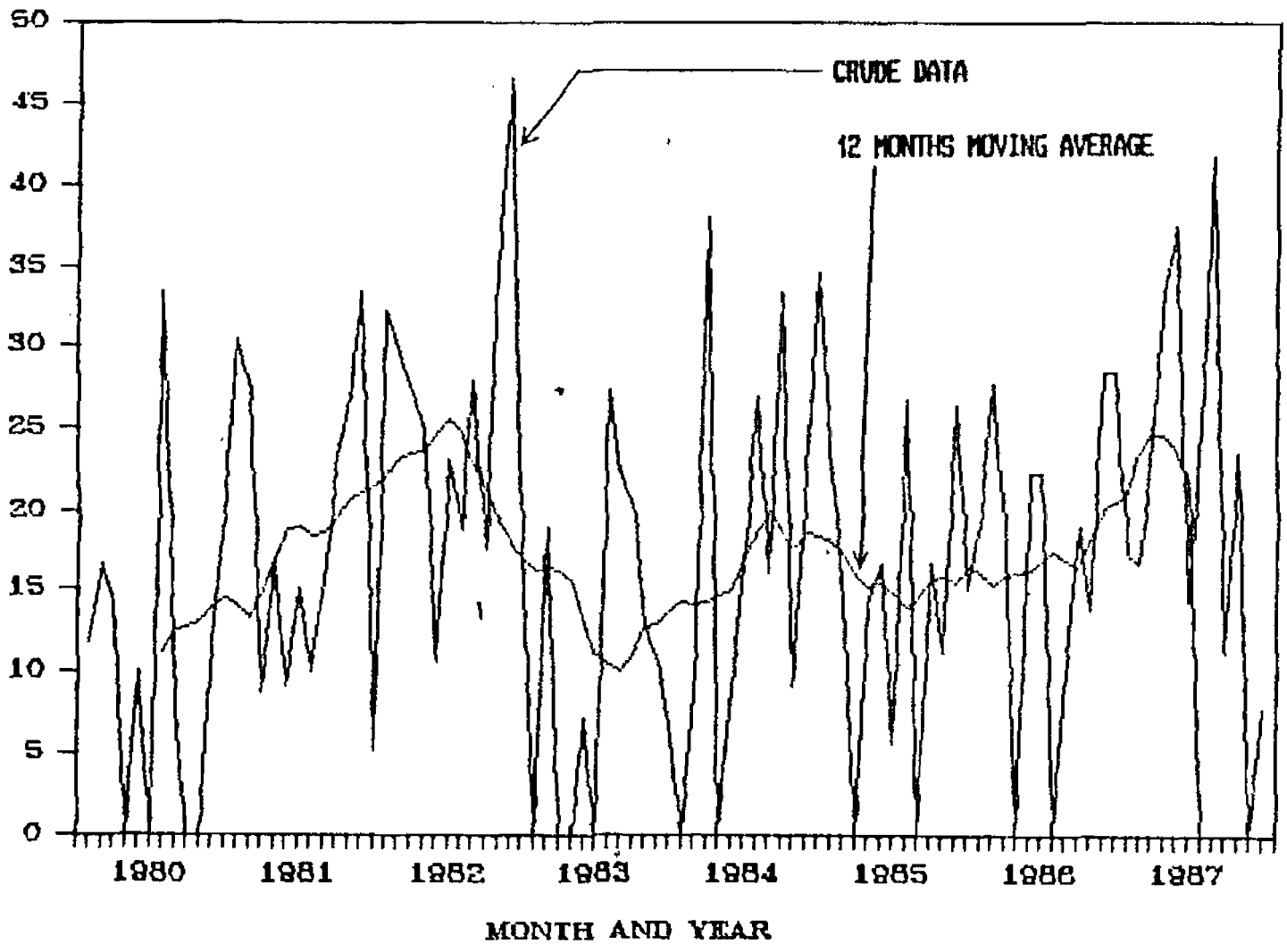


FIG.4: PERCENTAGES OF CENTERED 12 MONTH MOVING AVERAGES FOR NEONATAL FEMALE CALF MORTALITY AT IVRI CATTLE FARM, 1980-87.

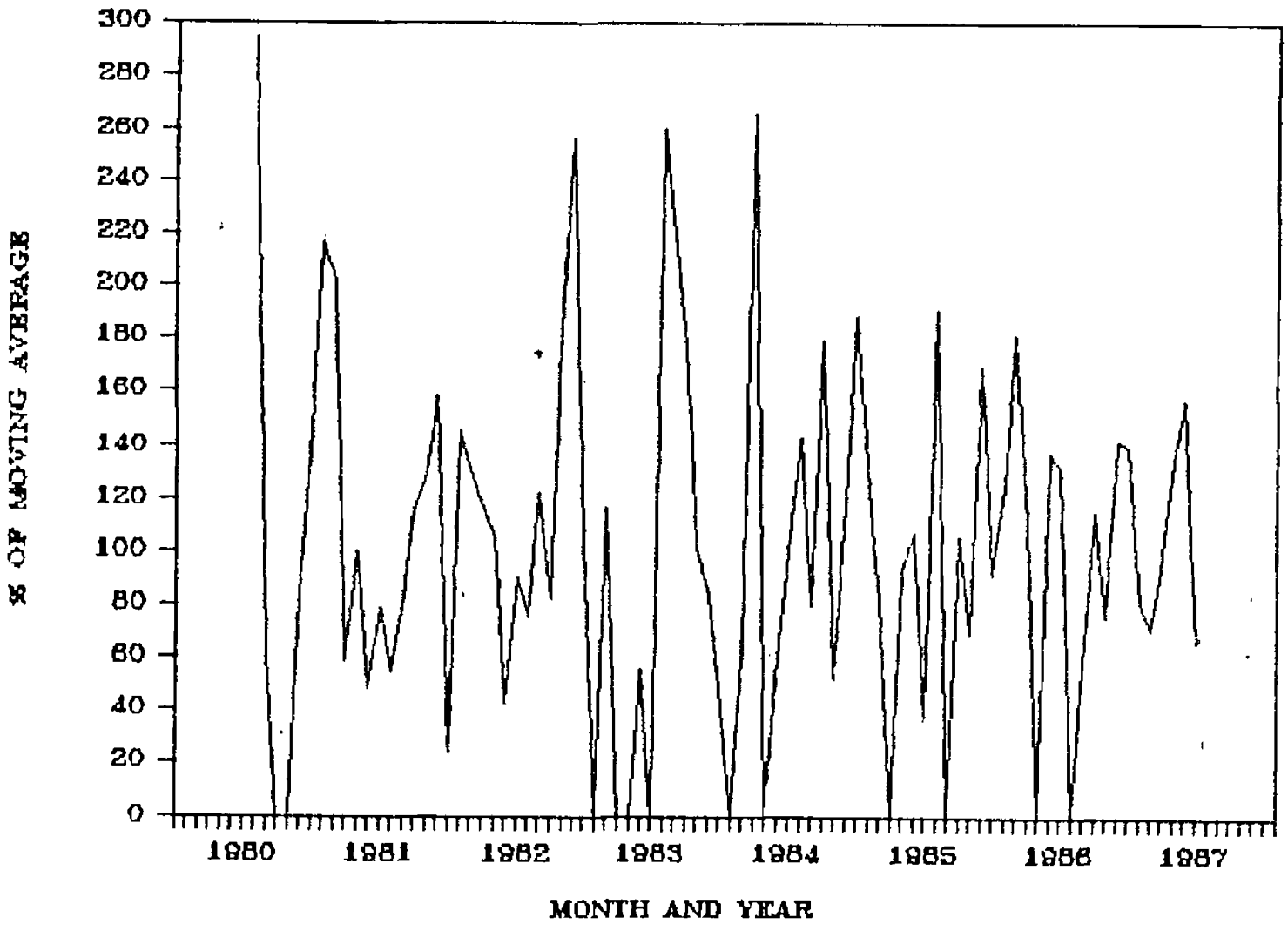


FIG.5: SEASONAL INDEX OF NEONATAL CALF MORTALITY RATE AT IVRI CATTLE FARM FOR THE PERIOD, 1980-87.

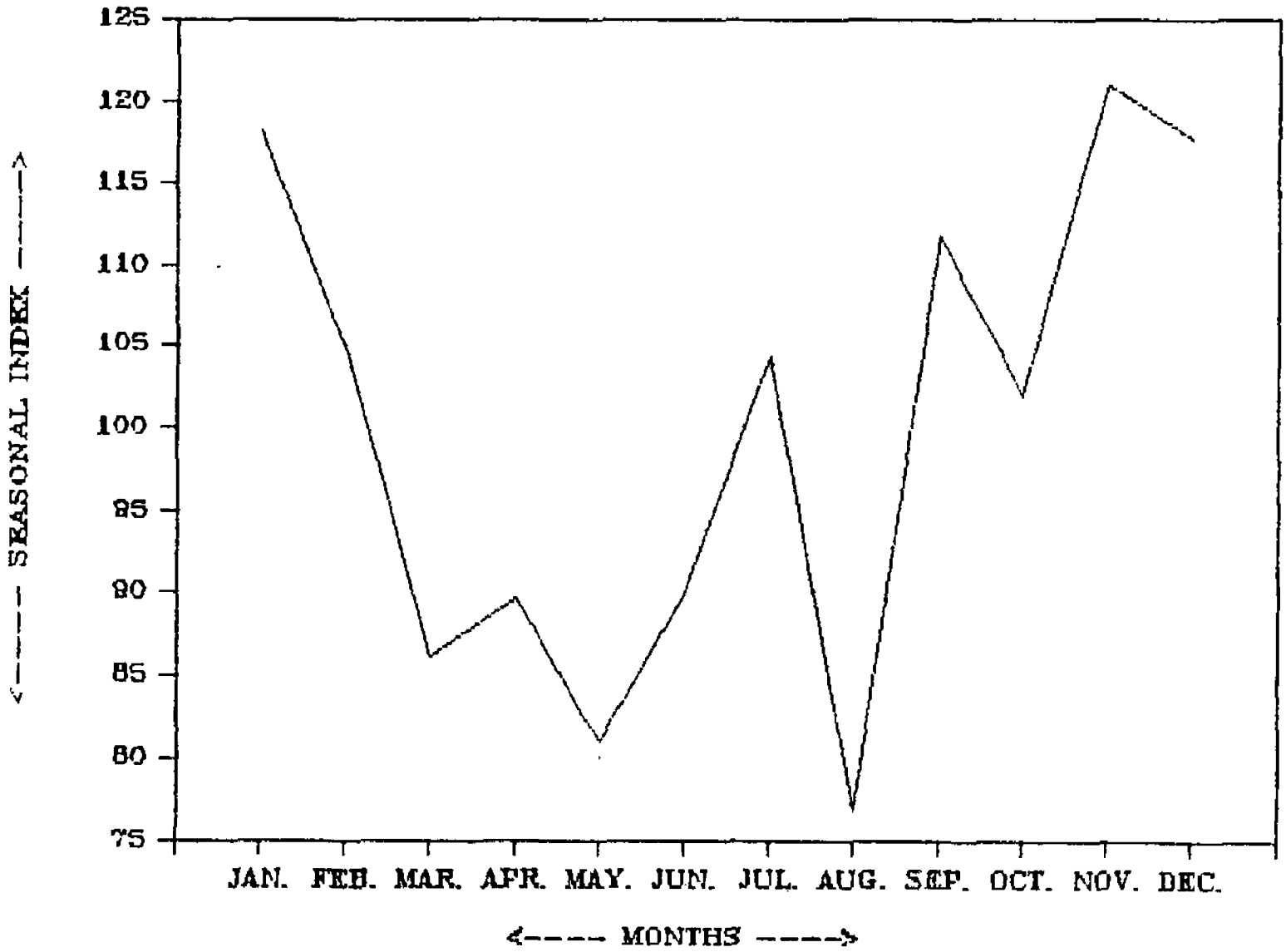


FIG.6: CALF MORTALITY RATE (0-1YEAR) AND IT S 12 MONTH MOVING AVERAGES AT IVRI CATTLE FARM, 1980-87.

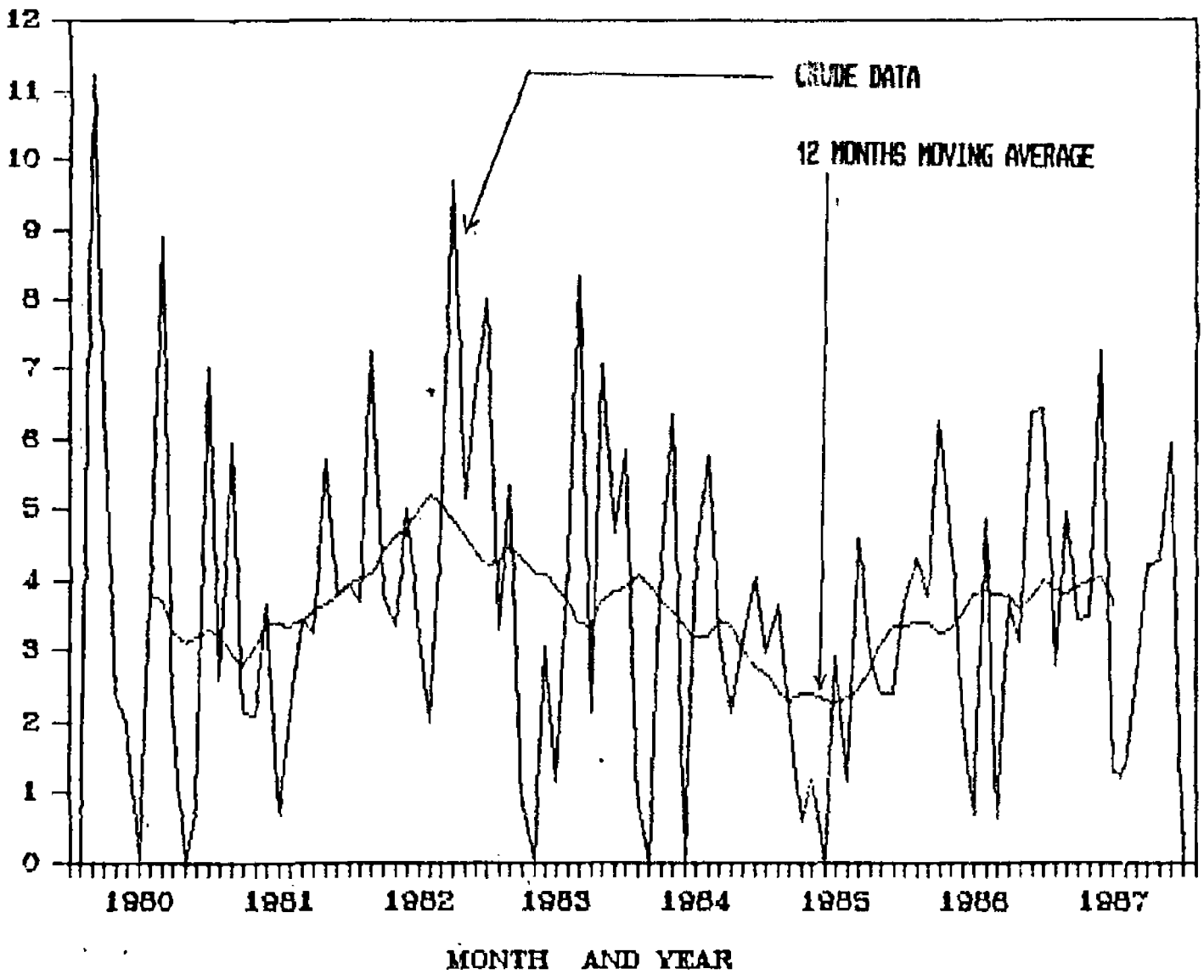


FIG.7: PERCENTAGES OF CENTERED 12 MONTH MOVING AVERAGES FOR CALF MORTALITY RATE (0-1YEAR) AT IVRI CATTLE FARM, 1980-87.

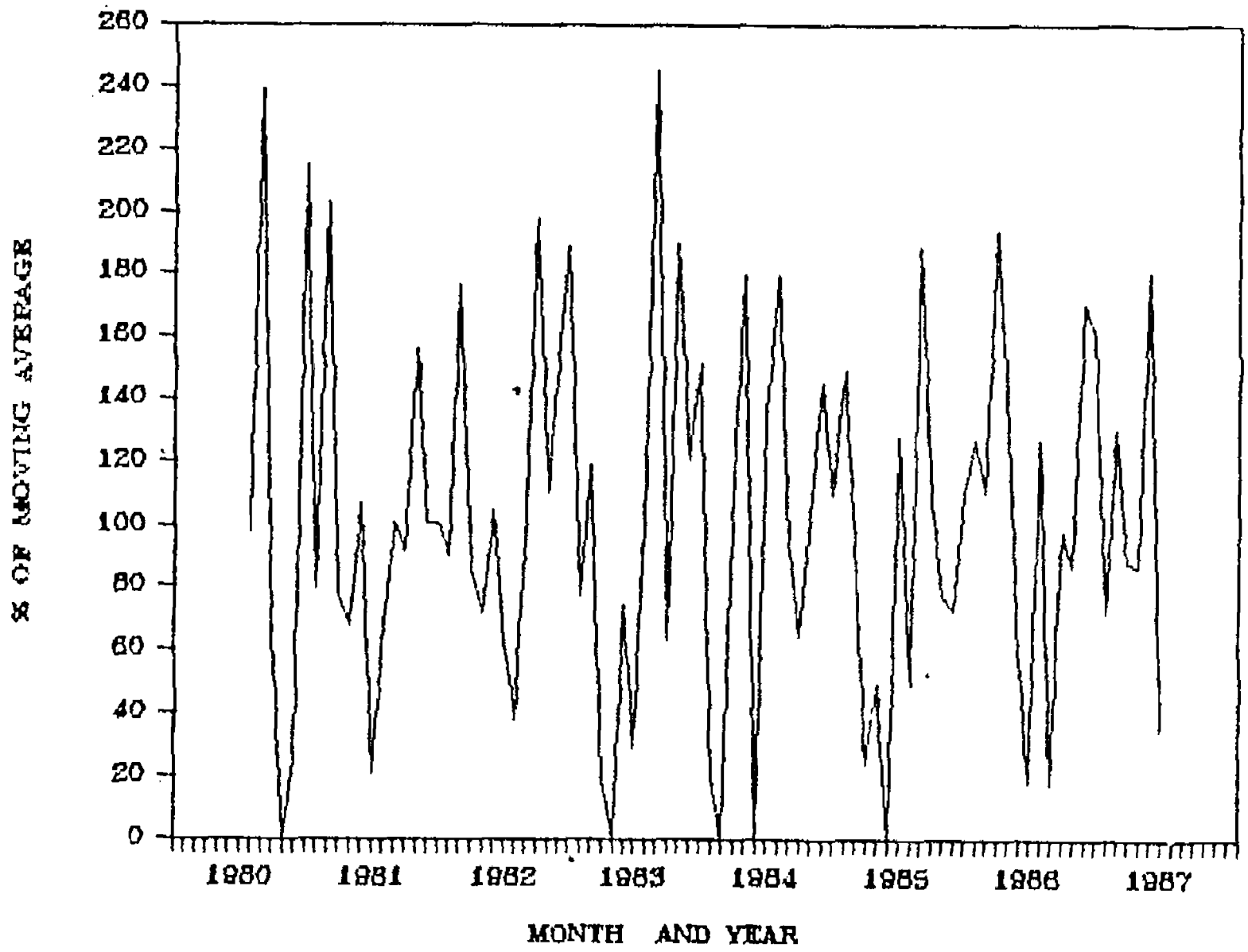
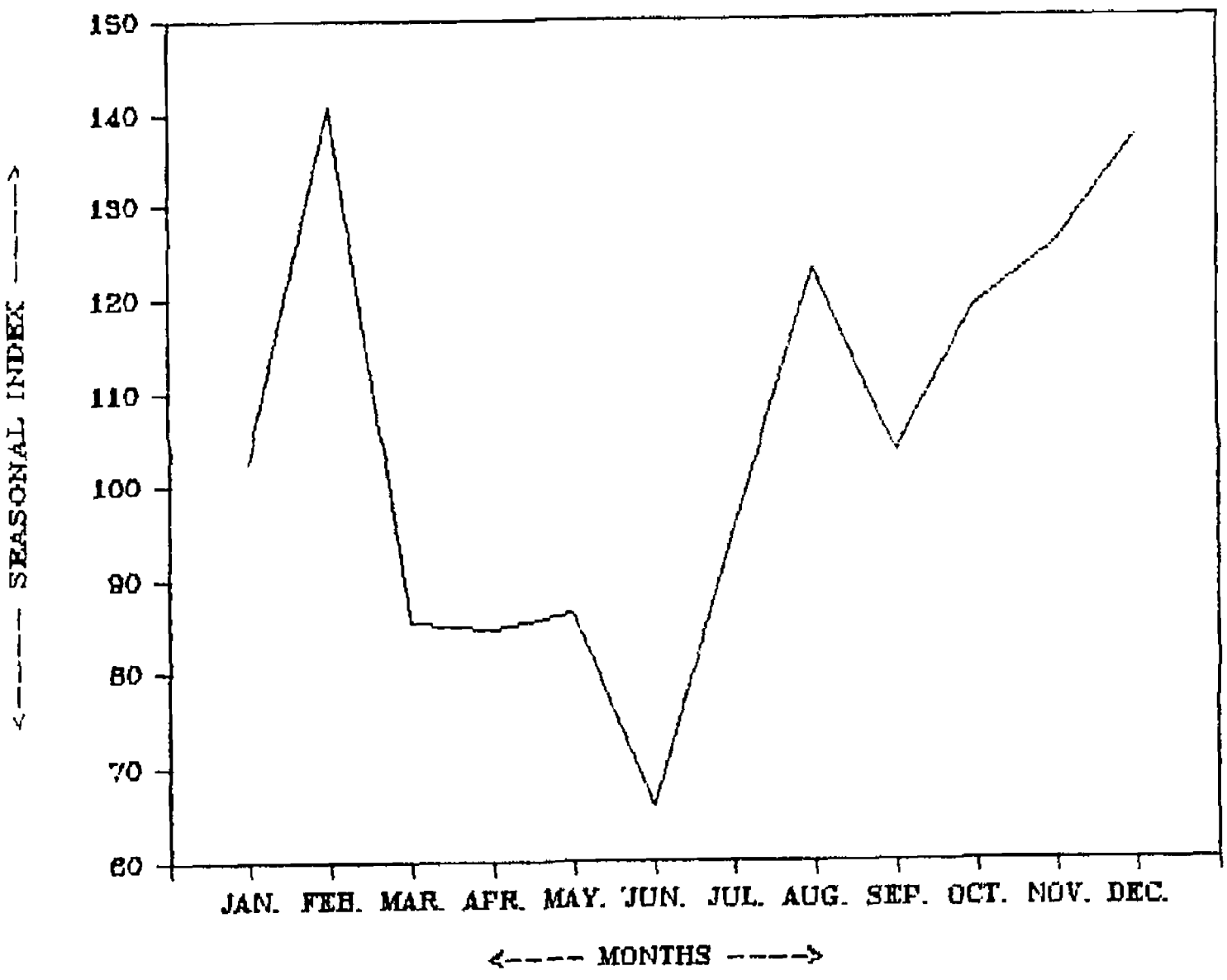


FIG.8: SEASONAL INDEX OF CALF MORTALITY RATE (0-1YEAR) AT IVRI CATTLE FARM FOR THE PERIOD, 1980-87.



DISCUSSION

DISCUSSION

5.1 MORBIDITY OF CALVES :

Disease is an important constraint to increase production of animal food for human consumption in all parts of the world. Attempts to increase the world production of animal protein, therefore, must involve improvement in the productivity of livestock through intensified research in disease control as well as in nutrition and genetics. In the absence of effective disease control, a large number of unproductive animals are coming up which can not fulfil its genetical potential in the utilization of feeds for growth and reprodution.

Principal use of morbidity statistics is the description and investigation of the patterns of occurrence of disease and the use of health care measurements which would eventually help to maintain the livestock in a good state of health.

The occurrence of many diseases is strongly associated with particular host variable. This variable influences on animal susceptibility or resistance to a disease. A number of diseases important causes affecting the dairy calves is digestive disorder, (diarrhoea). Diarrhoea alone accounted for 40.08% of the total morbidity in calves which is the most important cause amongst morbidity.

So far the temporal pattern of distribution of morbidity due to diarrhoea was concerned, a higher and lower morbidity rates were observed in cold and hot climates respectively. The possible reason for comparatively high morbidity.

rate in calves born in cold might be due to the fact that a higher proportion of calves were born during winter period. In order to reduce the morbidity in calves during winter it would be desirable to give proper shelter as well as sufficient milk, required for the proper growth of the calves.

Selman (1981) also observed calf diarrhoea as a major problem in all countries specially where there is an intensification of cattle enterprises. Rajya (1974) also observed that diarrhoea due to colibacillosis and colisepticemia to be the most devastating in younger growing calves. Similar observation was made by Waltner-Toews *et al.* (1986) who observed highest morbidity rate due to diarrhoea in 1968 live heifer birth, of this about 20% were treated for diarrhoea and about 15% were treated for pneumonia.

The high rate of diarrhoea in calves is also attributed to the availability of colostrum to the young calves and early feed of colostrum is essential if the calf is to survive the neonatal period without any serious illness. Depriving calves of colostrum regularly results in severe neonatal diseases and/or deaths. The health and fate of new born calves during the first month of life is directly related to how much immunoglobulin is absorbed from its dam's colostrum. A marked seasonal decline in milk calf immunoglobuin level occurred when the winter housing commenced followed by an abrupt change in mean values immediately due to abrupt change in the feed in the summer. This is probably one of the most plausible explanation for higher rate of diarrhoea in calves.

It has been observed in this study, that the diarrhoea was the most

predominant cause of the morbidity in calves. Consistently higher proportion of morbidity due to diarrhoea was noticed in different months with different years so extra care should be taken in the managements of calves in the farm to reduce the morbidity due to this disease.

Pneumonia was also accounted for higher morbidity in this study. Similar observation was made by other workers like Waltner-Toews et al. (1986) and Rajya (1974).

Highest proportinal morbidity rate was observed in pneomunia in December which may be due to incliment weather. Calves of young age groups are easily affected by cold weather. Similar observation was also made by Mishra (1987). The incidence of the disease was found to be in gradual decreasing order from February to June because of better environmental condition. It has been considered that the pneumonia is a managemental problem. It is possible to minimise the pneumonia cases to a great extent if the managemental conditions in the farms are improved. Average treatment days were also estimated and these were used as an indicator of calf morbidity in the farm.

Wound cases including navel wound, joint wound and wounds arising by injury and dehorning ranked 2nd out of the different causes of morbidity in calves. By improving the managemental condition, number of cases could be minimised.

Weakness / Debility was one of the greatest problem in dairy herd. The condition may occur due to some non-specific causes.

Here also managemental conditions play an important role for minimising the incidence to great extent.

Treatment days per calf can be used an indicator of

morbidity. It also reflects the severity and duration of illness of cases and gives an idea about the average cost involved in treatment of calves due to different diseases in different periods. This approach will also help in working out a model for the study of cost benefit analysis of the different causes of morbidity.A method using cost per sick calf presented by Andrews and Read (1982). It seems that their is no report available regarding the application of this approach to study the morbidity or diseases by any worker in India.

It appears that this is a newer approach which can be applied for evaluating cost involvement in the health care measure adopted in the farm for controlling the disease.

Attempts have therefore been made to apply this newer approach in studying the calf diseases in India.

5.2. MORTALITY

5.2.1 Influence of age on calf mortality :-

Comparative study of age specific mortality pattern and survivality in female calves of different grades/breed by using life table technique revealed that out of five grades/breed, three were recorded for highest probability of dying during 3rd week of life (Table- 6,7,8,9,10). Remaining grades A and Halfbred showed minor deviation with respect to week of highest death and the highest probability of dying recorded in 4th and 5th week of life respectively. To draw an uniform conclusion and indentify the week of highest probability of dying for female calves a follow up life table was constructed combining mortality data of all the grades and Holstein Friesian breed together (Table-11). Distribution of

deaths over different weeks of life, as per convention life table technique, the highest mortality in female calves was recorded again in 3rd week of life. The highest probability of dying in 3rd week of life also mentioned by Umoh (1982) and high risk of death in 2nd week noticed by Thurmond, (1986). This high risk of mortality in 3rd and 4th week of age of calves may likely to be due to lack of passive immunity from the dam's colostrum. As the ages of the calves increased, the level of immunoglobulin (IgM,IgA) started declining and reached to the minimum concentration in about 21 days (Blood et al. 1983) thereby making the calves more prone to infection. The circumstantial evidence suggested that feeding of colostrum for more than 4 days may reduce the calf mortality. By collecting the prospective data to find out the factors which may be responsible for high probability of deaths during the 3rd week of life can be further investigated.

This life table approach can also be applied to estimate the economics of calf mortality as done by Martin and Wiggins (1973).

The differences in CMR patterns among the five grades/breed female calves (0-26 weeks of age) were observed in this study. The 'X' grade calves had the lowest CMR (from birth to 26 week of age) as compared to other grades. It may be due to high rate of transfer of animals from the 4th to 26th week of life. The pattern of mortality in 'A'grade (3rd generation of three breed cross of X grade) and 'E'grade(2nd generadtion of three breed cross of X grade) of calves were more or less same. The halfbred groups (FH,BH,JH) had higher overall CMR (0-26 weeks of age) than Holstein Friesian pure breed. This variation may be due to effect of exotic inheritance. Similar type of observation was noticed by

Baliet al. (1980) who observed higher death rate in Hariana calves as compared to it 's crosses with exotic breed upto 1year of age. So proper attention for crossbred calves are suggested to reduce the CMR in this groups of female calves.

Monetary loss due to calf mortality increases with the age at death. For any specific age, the monetary return at death is the sum of the market value at the end of the preceeding week plus the cost of raising the calf to that age (Martin, 1975). The money involved in the general calf management increase with the age of the calf.

The age specific mortality rates in this study were calculated using life table methods. This method actually expresses the force and pattern of mortality at different age in a consistent probability manner. This approach is an important tool which allows us for comparison of force or pattern of mortality by different intervals of age, for each sex group, breed group method of rearing etc. This approach was adopted by Umoh (1982). This technique is also may be used in devising a model for the study of economic losses due to calf mortality.

In India and other countries it is essential to improve the low productive existing indegenous herd by selecting breeding programme. The survival of calves is important for the success of such livestock programme since female calves are needed for replacing and for increasing the size of the dairy herd.

It is essential to keep the accurate health records in the farm specially when life table techniques are applied to work out the survivality rates etc. which will ultimately help in pinpointing the particular age group when the calves are more

vulnerable to death. A model can be developed to reveal the probability of dying within a paricular age group, the proportion of calves surviving in different age groups in the herds and economic loss due to calf mortality. Management techniques therefore, accordinglymay be instituted to reduce the losses.

From our study, it is therefore, recommended that more attention be given to the management of calves derived from improved breeds particularly during the first five weeks of life. It is recommended that the management condition of a particular farm should be reviewed seriously when there is a problem of high calf mortality in the farm . Since there is a correlation between serum immunoglobulin levels of calves and sur-vival (Gay, et al.1965; Penhale, et al.1970), it is suggested that a study to estimate the colostrum in-take by the calf born in the farm to correlate the calf mortality, with the colostrum feeding. It is also worth while to study the breed variability in survivality of calves due to colostrum intake as the capacity of abosorbing colostrum by differet breeds are variable.

Although some studies have been made in abroad regarding the survivality pattern of calves by using life table methods but probably no such study has been undertaken in veterinary sciences in India and no literature is also available in this regard. It appears that this life table techniques has been applied first time in India by the author to work out precisely the survivality pattern of calves. The study will eventually help in minimising the calf mortality in India.

5.2.2 Influence of birth weight on mortality

Chance of surviving of a calf in the post natal period is closely related to its weight at birth. The influence of birth weight on mortality was reported by several workers (Wilcox and Russell, 1983; Reddy et al., 1987; Ragav and Asker, 1959; Purser and Young 1961, Singh and Singh, 1973; Nagarcenkar et al., 1977; Rao, 1981). In the present study, mortality was recorded higher in all most all the gentic groups in the birth weight group higher than average birth weight. The calves having the birth weight close to the average of the specific groups had better probability of survival than those which had lower birth weight than average. These findings are in agreement with the observations made by the above worker. However Rodriguez and Escriva (1976); Parekh and Singh (1981); and Singh and Parekh (1983) did not observe any significant difference of birth weight on mortality.. In our study we also could not find significant effect of birth weight on mortality in half bred crosses, Holstein calves and three breed crossed 'A' group. The reason could probably due to less number of animals were included in our study on the other hand when all the three breed crossed animals were combined the high significant effect of birth weight was noticed. Thus for different crossbred calves, it was possible to pin point the optimum age of the calves for better survivality. To prevent loss of young calves in a particular age group two assumptions may be taken into consideration (1) to increse the birth weight of calves by providing adequate and balance nutrition of dam. (2) better plane of feeding and managements should be recommended to the calves who are very much prone to

mortality.

5.2.3 Influence of parity on mortality :

The result of this study is in full agreement with the findings of Reddy and Sampath (1981) who also observed that birth parity order and age of dam at calving had no significant effect ($p>0.05$) on this mortality rates. Similar observation was also made by Bar-anan et al. (1976) who did not find any consistent association of perinatal mortality and difficult calving with parity. On the contrary, some workers found that parity had a highly significant effect on calf mortality (Verma et al. 1980, Vaccaro et al., 1987). Similar observation was made by Simenson (1982) who noticed that parity had significant effect on mortality in calves born from heifer and from the cows calved more than five times.

Although highest mortality rate (44.44%) was observed in 7th parity and rate of survivality in 5th and 9th parity was more than other parities but the results were not statistically significant.

5.2.4 Influence of season on calf mortality :

The seasonal differences on death rate have been reported by several authors both in India and abroad, (Singh and Singh, 1971, 1973; Srivastava and Agarwal, 1973; Patil and Gupta, 1980; Parekh and Singh 1981; Singh and Parekh 1982; Dwivedi et al. 1983; Choudhuri et al. 1984; Martin et al. 1975; Gusbi and Hind, 1983) but it appears that the characteristics of these differences have not been examined in detail by most of the workers. In the

present study, basic 'time series' analysis techniques were utilized for mortality data, to establish the evidence of seasonal pattern of mortality rate in calves. The 12 months moving averages for neonatal deaths (≤35 days) and deaths up to 1 year age groups of calves revealed that variation in monthly mortality rates were present in the both groups of calves. The higher death rates in neonatal calves and calves up to 1 year age group, were coincided with respect to time of occurrence in most of the cases.

In most of the years, the neontal deaths rates estimated were above the 12 month average in November, December and January (Fig. 4). It may be due to cold and inclement weather which predisposed the neonatal calves, to respiratory problems. The monthly fluctuation of mortality rates (Fig. 7) was not so pronounced in case of 0-1 year age groups of calves in comparison with neonatal calves.

This monthly fluctuation observed due to difference in base population at risk in both the groups. In 0-1 year age group of calves, chances of mortality were more as they are exposed to risk of mortality for longer period of time (birth to 1 year) in comparison to neonatal groups (birth to 35 days). So, chances of coming into 0% in mortality rate was less in 0-1 year age groups of calves.

The value of monthly crude death rates was higher in 0-1 year age groups of calves as compared to neonatal age groups of calves, as the base population for calculation of monthly mortality rate was higher in former group than later group. In 0-1 year age group of calves, denominator for death rate of particular month represents the number of calves (0-1 year of age) present in

that particular month where as in neonatal group, denominator represents number of live births in that particular month.

Basic time series techniques were utilized in examining the data from present study for evidence of seasonal patterns in the mortality rates. The plots of the 12 months moving averages of mortality rate for neonatal calves (Fig. 3) and for 0-1 year age groups of calves (Fig. 6) dampens the fluctuation of individual groups monthly calf mortality rate in different years. It allows to observe those cyclic changes in calf mortality rates. This results indicated that the mortality rate would reach higher level at an interval of 3 years in neonatal calves, so dairymen are advised to put special effort to control the mortality after a lapse of every three years.

Overall seasonal index of this study indicated that the period between November to February is very much unfavourable for neonatal calves. The significant effect of season of birth on mortality have been reported by Jain and Sharma, (1982) between birth and one month; Rao and Nagarcenkar (1980), between one and three months; Patil and Gupta (1980), Rao (1981) & Batabyal et al. (1984) between birth and 12 months and Choudhuri et al. (1984) between birth and first conception in crossbred calves.

The findings of seasonal effects on mortality is in consonance with the report of Ranatunga (1965) who reported highest mortality in November and December in some Govt. farms in Cylone.

The neonatal deaths in our study indicated that extent of calf mortality increased in winther (November, December, and January) and neonatal death rate (average, 29.68%) was

higher in winter than summer (May, June, July). Similar observations were made by Martin et al. (1975) who noticed calf mortality rate in winter (November, December, January) 20% greater than summer (June, July, August).

In 0-1 year age group of calves, mortality was higher (> 100%, Fig. 6) during October to March except in January. Comparatively low death rate in January than November and December probably was due to maximum number of deaths of calves occurred in December month that reduced the susceptible population at risk in January. The calf mortality rate started declining from February and reached lowest in May. From July there was an increasing trend of mortality which reached to maximum level in December, It generally increased from July and reached to maximum level in December. These findings are also in accordance with Sreemannarayana and Yusuf (1979).

High mortality rates in both the groups (Neonatal and 0-1 year age group of calves) during the winter period, might be due to cold weather. Calves in younger age groups were easily affected by the adverse cold weather during winter months which increased the incidence of pneumonia and other associated diseases. So it would be desirable to give proper protection from inclement weather by providing bedding and warming facilities and also by providing optimum milk and vitamins for overcoming these conditions.

The mortality rates from March to August in neonatal group of calves were lower (<100%) execpt July when moratlity was 4.3% higher than average value. In 0-1 year groups of calves though the mortality during that period was nominal, yet highest peak of

mortality also noticed in the months of July. This higher death rate in July probably associated with high rainfall and high humidity, that created dampness and unhygienic condition of calf shed. So the month of July caused stress condition in animals and made them more prone to bacterial, viral and parasitic infections. In the present study, the 'time series' approach was applied successfully for working out the characteristics responsible for the differences in calf mortality. The author tried to adopt this technique first time in India to show precisely temporal distribution of mortality in dairy calves.

5.2.5 *Causes of calf mortality :*

In dairy calf, losses are most concerned to breeders. The death of calves causes serious and irrecoverable losses to cattle industry. To make the dairy enterprise a renumerative industry, it is essential to reduce the losses of calf crop to minimum. Various intrinsic and extrinsic factors are responsible for heavy calf mortality.

In this study, overall proportion of mortality rate due to diarrhoea was found to be maximum i.e. 27.71% and next in order was pneumonia 25.00%. This higher mortality rate due to white scours/diarrhoea, respiratory problem/pneumonia are in accordance with the finding of Ragab and Asker (1959) who observed pneumonia and scours 55.00% and 14.3% respectively. Some finding was also observed by Johnson, et al. (1948), Ormistion (1949), Miller and Gilmor (1949), Oxender et al (1973) and Sharma et al. (1975). Maximum deaths 33.00% was due to digestive problem followed by 25.30% due to respiratory problem workout by Chandra and Nayak (1977) which

was in accordance with observation made in this study.

In this study, mortality rates were calculated taking a very short interval of age group and based on actual risk of the animals exposed of that particular age group. This gives naturally more precise estimate than simply working out the mortality basing on the total population at risk over a long period of time. The rates in most of the cases expressed per 1000 animal head. Most predominant cause of deaths 0-1 year age groups due to diarrhoea was (81.80%) followed by pneumonia (73.80%) and diarrhoea with pneumonia (35.67%) per 1000 heads of calves. Age specific mortality rates in calves were estimated and it was found that maximum mortality occurred in the age group of 14-21 days, followed by 21-28 days (38.37%) and 7-14 days (32.64%) and 28-35 days (32-92). Although maximum mortality occurred in 14-21 days (48.39), there was not much difference with the mortality in the age group of 0-7 and 7-14 days which was little less than that observed in 14-28 days. This may due to the fact that during this period, the calves were getting sufficient amount of colostrum that gave some degree of protection to the calves in first few days of life (0-7 days). Most vulnerable age was observed as 7-14 days for diarrhoea, may possibly due to their great susceptibility to certain infections like Escherichia coli, Salmonella etc including some viral infection like coronavirus, rotavirus, bovine viral diarrhoea etc. William et al. 1980 and Khera (1981) also observed that above infections were responsible for maximum number of calf deaths.

In the present study the mortality rate in particular age group was observed less than that of the worker like Rao and

Nagarcenkar (1980) found maximum percentage of mortality due to respiratory disease in calves from birth to one month of age group while digestive disorders accounted for more deaths in 3-6 months age group. The observation of Khera (1981) was different who noticed that digestive disorders (including E.coli infection) accounted for the largest proportion of mortality among cattle and buffalo calves of all age groups.

The highest mortality rate was observed between 7 to 14 days of age which decreased thereafter with the increase in age. This is in accordance with the findings of many workers (Ormiston 1949; Sepicher and Heep, 1973; Srivastava and Agrwal, 1973; Sharma et al. 1975; Mishra et al 1977; Natarajan et al. 1980; Singh and Parekh, 1982; Batabyal et al. 1984 and Kulkarni et al. 1985).

On the contrary, highest death rate was observed by Choudhary et al. (1986) in 3-6 months of age groups in Kankrej calves at Livestock Research Station, Sarda Krushinagar, Gujarat.

Mortality rates due to various causes and their distribution in different months varied considerably and no definite trend of mortality was noticed between the months. However, an increasing trend of mortality due to diarrhoea was noticed from July to December (35.00 per 1000 to 67.52 per 1000) while a decreasing trend of mortality was noticed during March to May.The reason for higher mortality was noticed during March to May. The reason for higher mortality for diarrhoea in winter may be due to cold temperature when calves were most susceptible to infection where as in rainy season it was due to dampness and unhygienic condition of calf pens. Death rate for diarrhoea was in decreasing order from March to May (ranged 59.21 to 26.84 per 1000) which may be due to dry

season. These observations are in accordance with the findings of Singh and Singh (1971) and Matta (1973).

Similarly, no definite trends in mortality pattern was observed in respect of different causes in various months. These findings are in accordance with the observations of several workers (Amble et al., 1958; Singh and Singh, 1973; Srivistava and Agarwal, 1977; Sharma et al., 1975; Bhuyan and Mishra, 1985 and Choudhary et al., 1986). But in contrary the influence of season on mortality rates have been reported by many workers (Ranatuga, 1974 ; Prasad and Singh, 1975; Martin et al., 1975; Sharma and Jain, 1976; Jain and Sharma, 1982; Rao, 1981 and Batabyal et al., 1984).

Mortality rates were also calculated during last 8 years (1980-1987) to see the year effect on the causes of calf mortality. The overall mortality rates varied considerably in different years with maximum mortality recorded in 1982 (251.99/1000) and minimum mortality (140.04/1000) was observed in 1985. Similarly great variation was observed in different years with different causes of mortality. Death due to diarrhoea during 1980 to 1982 was higher than that of pneumonia but in subsequent years the picture was quite different i.e. mortality due to pneumonia was more during the above period. Similar differences were also found for other causes of mortality. These variations may reflect the managemental condition in the farm or may be due to certain environmental factors.

Diarrhoea, pneumonia, wounds and debility were found to be the major causes of calf morbidity which may reflect the effect of managemental conditions and/or environmental factors for the above

causes. This could only be ascertain by undertaking detail studies to validate the observations. Calf mortality due to different variable like influence of age, birth weight, parity, season, year and cause have been studied. It was possible to work the effect of all the above factors employing life table technique and time series analysis to pinpoint precisely the survivality pattern of calves. Therefore, the present studies have been able to successfully apply the above techniques for working the mortality pattern in defined population.

SUMMARY

SUMMARY

The present epidemiological study was conducted to investigate different characteristics responsible for heavy calf loss in dairy herd due to health disorder and mortality in young calves. Data on calf mortality for 8 years (1980-1987) and morbidity for 2 years (1986-1987) were collected from I.V.R.I. cattle farm for the purpose of above study. Besides, epidemiological information collected from Central Cattle Breeding Farm, Lakhimpur Kheri, also included in this study. To ascertain the demographic and temporal characteristics associated with the occurrence of calf diseases and mortality, different techniques such as life table methods, time series analysis and other statistical approaches were applied in this study.

The principal object of this study was directed to estimate the magnitude of health problem and mortality in young calves, to estimate the influence of different factors responsible for this problem by different epidemiological and statistical methods and to compare the pattern and frequencies of diseases in different genetic groups maintain in the dairy farm which will ultimately help in control of calf diseases and mortality.

Mortality records from 1626 female calves comprising of crossbred, pure breed animals and information about 1789 morbidity cases were included in this study.

Major diseases/disease syndromes observed in dairy calves were (i) diarrhoea (ii) pneumonia (iii) wounds (iv) debility/weekness. In 1986 maximum proportional morbidity rate due to diarrhoea was observed in the month of December (13.11%)and minimum morbidity of 2.45% recorded in May. A definite decreasing

trend in morbidity due to diarrhoea was observed from January to July in 1987. When the information of both the years (1986 and 1987) were combined, the higher morbidity was noticed in cold climate while lower morbidity was recorded in warm climate. Highest average treatment days due to diarrhoea was calculated as 3.89 days with S.D. 2.53 while in August 1986. In 1987, highest number of treatment days was observed in November(4.48 days with S.D. 3.10). By pooling the information for both the years it was observed that highest number of treatment days estimated as 4.10 days, S.D. 2.46 in August and lowest average treatment days was estimated in December as 3.18 days, S.D. 2.20.

In 1986, in case of pneumonia, highest morbidity was observed in December, 17.31% while in 1987 highest proportional morbidity rate recorded in February (16.96%). When the number of cases pooled together for the years 1986 and 1987, a decreasing trend of proportional morbidity was observed from February to June (15.27 to 4.00%). Gradual increase in number of average treatment days for pneumonia was found from the month of June to November in 1986 and in 1987 highest number of treatment days were recorded in the month of May and September . By combining information regarding the treatment days for both the years (1986 and 1987, higher range of treatment days recorded in November (5.99 days, S.D. 4.48) followed by September and May and lower range of average treatment days were found in December (3.83 days, S.D. 2.74), January (3.94 days, S.D. 2.96) and April (3.84 days, S.D. 2.83).

Similarly morbidity rate and average treatment days due to wounds and weakness were worked out for 1986 and 1987.

By compiling the data regarding the occurrence of diseases in dairy calves for two year, i.e. 1986 and 1987, it was observed that out ofatotal 1789 morbidity cases, 717, (40.8%) accounted for diarrhoea only, next in order was wound cases 22.41%, weakness 22.14% and pneumonia 15.37%. Out of the total 811 cases due to different causes recorded in 1986 distributed in different months, it was observed that maximum cases occurred in December (14.92%). When total number of cases were considered monthwise, it was noticed that diarrhoea accounted for 54.35% in January and morbidity due to this disease in July ranged from 10.87 to 17.39%. Similarly higher morbidity was observed for pneumonia cases in February, March, April, May, June with highest morbidity in September (45.45%).

Although overall high risk of dying noticed during Ist (3.56), 4th (3.57%), 2nd (3.42%) and 5th (3.34%) week of life, the highest mortality in female calves was noticed in the 3rd week. The chances of death reduced substantially after the 8th week of age. The proportion of calves survived upto neonatal age group (0-35 days) was 82.88 $\pm$ 0.95%. In general, there was decline in proportional survivality rate with the decrease of age upto 12th week.

Proportion of calves surviving for different age groups upto 26 weeks of age of X, E, A, halfbred and Holstein Friesian grades/breed female calves for the first 5 weeks were 87.35% $\pm$ 1.59% ; 81.14 $\pm$ 1.67% ; 81.09 $\pm$ 2.74% $\pm$ 80.33 $\pm$2.94% ; 83.59 $\pm$ 3.27% respectively.

The highest overall calf mortality upto 26 weeks of age observed in halfbred calves as compared to other grades/breed of

calves, while the lowest overall calf mortality observed in X grade of female calves.

The degree of variation of mortality due to different age groups and genetic groups of calves were estimated by linear regression model. The estimated value of regression coefficient clearly indicated that the probability of dying decreased with the advancement in the age of calf from birth to 26th week of age.

The overall proportional survivality curves indicated that the rate of decrease of mortality was highly significant ($p \leq 0.01$) with the overall regression co-efficent in the order of 0.179 ± 0.034.

Standard mortality ratio (SMR) in different age groups of Holstein Friesian calves for two farms (Lakhimpur and I.V.R.I.) were estimated . S.M.R. in most of the age group was higher at I.V.R.I. farm as compared to Lakhimpur farm.

Influence of birth weight on mortality rate in different genetic groups/breed were variable. In X and E groups, the influence of birth weight was found to be highly significant while in A group it was non-significant.

In halfbred crosses, the influence of birth weight on mortality was lower in higher birth weight group. The birth weight less than 18 kg, was found to be detrimental for survivality of calves in this group. In Holstein Friesian group, the birth wieght had no influence on mortality rate. Birth weights less then 16 kg and avove 37 kg. were detrimental for survivality of 'X' group of female calves.

In three breed crosses, birth weight of 25-32 kg. was better for survival of calves.

Highest mortality rate in calves was observed in the 7th parity and the rates of survivality in 5th and 9th parity were more than other parities. Differences in mortality due to different parities were not statistically significant ($p \leq 0.05$). Highest rate of mortality (6.25%) in stillbirth was noticed in the 8th parity and lower rates of stillbirth were observed in 1st, 4th and 5th parities but the x^2 value did not show any significant ($p \leq 0.05$) difference in stillbirth rate with the number of parities.

Times series analysis of the data on the calf mortality indicated that higher mortality rate was generally observed during the month of November to February in both neonatal and 0-1year age group of calves.

The highest seasonal index in neonatal calves was observed in the month of November (129.03) followed by January (118.32), December (117.74), September (111.57) and February (104.75). Though the lowest seasonal index was recorded in the month of August, young female calves were in more comfortable condition in respect of mortality during March to June, as low order seasonal indices were observed in these months.

An increasing pattern of mortality noticed in the calves (birth to 1 year of age) from August to December and declining trend of mortality pattern was observed from February to May. The 12 month moving averages revealed that the percentage of higher mortality ($\geq 100\%$) observed in February, March, October, November and December.

Based on the post mortem report, the important causes of death in calves 0-1 year of age were recorded as diarrhoea,

pneumonia, debility, tuberculosis etc. The proportional mortality rate due to the above causes were worked out as 27.7%, 25.00%, 12.08%, 5.21%, 2.9% respectively.

In 0-1 year age group, overall death rate due to different causes together was recorded as 295.20 per 1000 animals, with maximum rate of 48.39 per 1000 calves observed in 14-21 days. The highest mortality rate due to diarrhoea was observed in 7-14 days (21.12/1000) where as highest mortality due to pneumonia noticed in 42-49 days (12.34/1000).

The number of deaths due to major causes in different months varied considerably. An increasing death rate due to diarrhoea was noticed from July to December (35.00 to 67.50/1000) where as mortality rate due to pneumonia was higher during March, July, August, November and December (ranged 51.50 to 65.62/1000). Relative proportion of deaths due to disgestive disorder was consistently higher than respiratory disorder through out the distribution of 12 months except in January, May, August and September.

The overall maximum mortality rate was 251.99 per 1000 calves recorded in 1980 and minimum mortality 140.04 per 1000 was observed in 1985. Deaths due to diarrhoea during 1980 to 1982 was higher than pneumonia.

Highest mortality rate due to pneumonia was observed in 1986 (62.32/1000).The highest mortality due to debility was accounted in 1983 (20.09/1000) where as higher death due to tuberculosis was recorded in 1985, 1986 and 1987.

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