EVALUATION OF BOER HALFBREDS FOR DEVELOPMENT OF MEAT GOAT STRAINS SUITED FOR KERALA

By

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DECLARATION

I hereby declare that this thesis entitled **"EVALUATION OF BOER HALFBREDS FOR DEVELOPMENT OF MEAT GOAT STRAINS SUITED FOR KERALA"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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Certified that the thesis entitled **"EVALUATION OF BOER HALFBREDS FOR DEVELOPMENT OF MEAT GOAT STRAINS SUITED FOR KERALA"** is a record of research work done independently by **Dr. Jeeva .L.**, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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Introduction

INTRODUCTION

Domestication of goats took place in the near east during 7500-7000 BC, the ancestor being the wild goat *Capra aegragrus*. Small ruminants can contribute significantly to increase food production of animal origin, and improving the livelihood of the rural poor. Among small ruminants, goats form an important economic and ecological niche in South-East Asian and African countries.

Goats are small-sized animals and most prolific ruminant of all domesticated ruminants under tropical and sub-tropical conditions. They possess limited subcutaneous fat and have exceptional tolerance to heat stress (Shelton, 1978). Goats have high digestive efficiency for dry matter and are resistant to many helminthic infection (Mandonnet *et al.*, 1997; Pralomkarn *et al.*, 1997).

Augmentation of livestock production in the rural sector of the country is a basic pre-requisite in poverty alleviation and for the economic upliftment of the poor. Goat production possesses promising prospects for employment generation, financial autonomy and improvement in living standard of the rural poor. Women benefit from goat rearing as a source of self-employment, income generation, food security and household nutrition.

India has an estimated goat population of 123 million and ranks first among the countries of the world. This accounts to about 17 per cent of the world total goat population (FAO, 2001). Goat thrives better in the arid and semi-arid agro ecological zones and requires little amount of capital inputs. Under low production system in India, goats forms a very important species of livestock and about ninety percentage of them are maintained mostly by landless labourer and marginal farmers (Acharya, 1990). Goat rearing generated an income of Rupees 1972, 7978 and 17,500 in small (<5 heads), medium (5-10 goats) and large (>10 heads) respectively (Devendra, 2001).

Goats are a source of milk, meat, skin and to some extent fleece and manure. Goat meat is in greater demand among consumers and fetches maximum price among livestock products. Chevon is leaner than other red meat and is comparable in nutritional constituents. Hence people who look for a low-fat red meat alternative prefer chevon. There exist no cultural or religious taboos limiting the consumption of goat meat and possibly also taste preferences. Hence, goat has been designated as the national meat animal in India (Pal and Agnihotiri, 1996). About fifty-seven percentage of the meat produced in the country comes from sheep and goat.

Eventhough India has abundant goat population; it is not sufficient to meet the domestic requirement. India earn only a meagre of 0.6 million dollars from exporting chevon. Australia is the world's largest exporter of chevon and it has a goat population of only about 2.2 million (FAO, 2001). India exports its goat meat to Middle East countries and this accounts to less than 7 per cent compared to 70-80 per cent for buffaloes and 20 per cent for mutton (Pal and Agnihotiri, 1996). The greater demands for goat meat and higher price together with uncontrolled breeding and poor selection have resulted in increased slaughter rate. Surveys in India indicated that 50 to 73 per cent of the goats slaughtered were below six months of age and 26 to 50 per cent were 6 to 12 months of age (Naidu *et al.*, 1991). There exists no superior meat strain goat in India. Mostly animals slaughtered were males from local dairy goat breeds, feral goats and cull animals. These together have contributed to lower meat production per head in this species.

Kerala state in India lying in humid tropics has an estimated goat population of about 1.8 million (NCA, 1976). The unique agro-climatic condition prevailing in the state can support sustainable goat production with adequate vegetation and biomass available in the state. Potential impact of small ruminants in Kerala state appears to be promising. This is constrained due to the non-availability of meat type of goats suited to climatic conditions, poor strategies for improved natural resource management and weak marketing system.

Goat production in Kerala is centered mainly on the native, medium sized breed, Malabari. Malabari, dual-purpose goat, developed on North Kerala is a mixture of native feral goats with sufficient mixture of Arab and Surti and Mesopotamian goats (Kaura, 1952; Mukundan, 1980; Raghavan, 1980) along with the native goats of western coast. The average body weight of Malabari at third month and six month were 5 kg and 8.5 kg respectively (Mukundan, 1980). To enhance the production potential, growth rate and reproductive performance Alpine and Saanen inheritance were introduced into Malabari under All India Co-ordinated Research Project implemented in the period 1974-1988 in Kerala Agricultural University, Mannuthy. Alpine Malabari and Saanen Malabari were superior to pure Malabari in growth rate. Stephen and Rai (1995) analyzed the performance of Alpine Malabari and native breed and found that body weight of Malabari and its crosses were between 9 to 11 kg at six months of age and 16 to 20 kg at 12 months of age. This basically focuses on the need for further improvement in the growth rate in the development of meat strain of goats to enhance the returns from the intensive goat production programmes in the state.

The potential of goat meat production and impact of goat meat industry can be fully exploited only through superior genotypes which can grow to a weight of 20 to 25 kg at six months and capable of producing twins and triplets per kidding. Most of the developed countries have embarked upon ambitious goat development and production programmes utilizing Boer inheritance. Boer is considered primarily as a meat-producing animal. Studies have shown that Boer goats are improver breed for the tropics because of its outstanding meat production potential and adaptability to tropical climatic condition. These goats were derived from indigenous goats of Hottentot's and of the southward migration with a possible infusion of Indian and European bloodlines.

Boer goats and its crosses have higher production performance in the tropics and exhibit growth rate under adverse climatic conditions. The development of Boer crosses is expected to bring in a tremendous impact on the goat production systems in the state. Commercial exploitation of Malabari and its crosses as a meat animal is severely hampered due to its inferior growth rate. However, adaptability, disease resistance and prolificacy of this breed can be effectively blended with Boer inheritance.

With this background information, a study involving the genetic and non-genetic factors influencing the litter traits and body weights of meat strain of goats suited to Kerala becomes necessary. The effect of breed, sire, sex and month of birth on litter traits and body weight and survivability has to be assessed.

The present investigation was undertaken on Boer x Alpine Malabari crosses, in order to evaluate its suitability as a meat strain suited to Kerala state under University Goat and Sheep Farm, Kerala Agricultural University, Mannuthy. The objectives of the research programme was

1. To evaluate the type of birth, birth weight, body weight at weaning, litter size at weaning and pre-weaning mortality.

2. To assess the growth rate from birth to six months of age among Boer crosses.

3. To identify the genetic and non-genetic factors influencing the litter traits and growth among Boer crosses.

4. To evaluate the viability and adaptability of Boer crosses.

Review of Literature

REVIEW OF LITERATURE

2.1 LITTER SIZE AND WEIGHT AT BIRTH

2.1.1 Litter Size at Birth

The goat is a prolific animal often producing twins and triplets. The multiple births and litter size influence the genetic gain and economy of Goat Production and are of immense value in Goat Breeding. Shanmughasundaram (1957) reported the high prolificacy rate in Malabari goats with 58.5% incidence of twins and triplets and 42%single births out of 103 kiddings. Amble *et al.* (1964) analyzed the data on Beetal goats maintained at Government Livestock Farm, Hissar and observed that out of the total number of 3914 kids born during the period, singles, twins, triplets and quadruplets were 24, 63, 11.5 and 1.5%respectively.

Moulick *et al.* (1966) analyzed the data from records of 703 kiddings of Black Bengal goats from 1954-1961 to study the effect of environment and genetic factors on multiple birth. The average litter size at birth varied from 1.5 ± 0.5 to 2.53 ± 0.12. According to Devendra and Burns (1970) the prolificacy of goats expressed by the number of kids per birth or number of kids born or die per year is one of the most important economic traits in goats.

According to Campbell (1984), the average litter size of 1.93 kidding among Boers. Selection for fecundity, coupled with good management could raise this value to2.25or more and was proved using 100 does producing 24 singles, 116twins, 45 triplets and 4 quadruplets. This was similar to the reports of Correa *et al.* (1994).

The study of Tomar *et al.* (1995) on 215 parturition records of 97 goats of Jamunapari and Barbari breeds concluded that the average litter size was1.4 with 38.15% twins and 2.3%triplets. The study on 2315 nondescript and graded

Sirohi goats concluded that 87.14% does have singles, 12.67% gave twins while less than 0.19% had triplets.

According to Biswas *et al.* (1995) twinning rate in Pashmina goats were not common and was about 3.25%.

Stephen and Rai (1995) studied the prolificacy of Malabari goats and its crosses with Alpine and Saanen breeds and recorded the average litter size at birth was 1.4 in all genetic groups.

Raghavan *et al.* (1999a) reported that the average litter size at birth in Malabari was 1.98 ±0.081.

Seabo *et al.* (1999) studied the reproductive performance of Tswana ewes and boer does in South Eastern Bostwana reared under semi-intensive system. They observed that the birth weight was 3.2 ± 0.87 kg and the frequency of single, twins, triplets and quadruplets were 28.29%, 53.28%, 16.45%, 1.32% respectively.

According to Singh *et al.* (2000) lactation yield was higher in dams producing multiple kids than those producing single kids indicating that the number of foetus regulates mammary tissue growth during pregnancy.

According to Nandakumar *et al.* (2003) the average litter size at birth in Malabari goats based on 232 kiddings was 1.5 ±0.01.

Factors Influencing Littter Size at Birth:

2.1.1 Genetic Group

Khan *et al.* (1981) reported 38% incidence of twins and triplets in Jamunapari. The incidence of twins and triplets were significantly more in Barbari than in Jamunapari according to Prakash *et al.* (1986).

According to Tomar *et al.* (1995) the effect of breed of buck within dam's breed was not significant. The incidence of multiple births increased when the goats of Jamunapari and Barbari was mated to exotic bucks like Alpine and Saanen.

According to Tomar (1996) the average number of kids born for Barbari was found to be 3.6 ± 0.31 and was significantly higher than Jamunapari.

2.1.2 Sire

Moulick *et al.* (1966) analysed the data from records of 703 kiddings of Black Bengal goats from 1954-1961 and concluded that the sire had highly significant effect on litter size at first kidding of 83 daughter dam pairs, the estimation of heritability was found to be 0.088 ±0.252. According to Mourad (1996) sire had significant influence on litter size on analyzing the records of local and Alpine goats. According to Nandakumar *et al.* (2003) the sire effects were not significant on litter size at birth.

2.1.3 Month of Birth

According to Dutt (1968) the distribution of single male, single female and twins was31.4, 35.6, and 33 percent out of 118 kiddings in Barbari goats in Mission farm, Etah. The maximum birth (58.5%) took place during autumn season i.e., from August to October and least kidding (1.7%) occurred in February to April.

Tomar *et al.* (1995) reported a litter size of 1.4 in November and April in 108 parturition records and a litter size of 1.5 in least kidding period on 26 records.

According to Raghavan *et al.* (1999a) the litter size at birth was not significantly been influenced by the month of kidding.

According to Arunkumar *et al.* (2001) month of birth had significant effect on twinning percentage and was found to be 10.4% in most kidding seasons (October –March) and was 29.3% in the least kidding seasons (April-September). According to Nandakumar *et al.* (2003) month of birth exerted a significant influence on litter size in pigs.

2.1.4 Sex

According to Lawar *et al.* (1991) the twins born as female and male combination was more than the combinations of male to male and female to female in a study of goats based on the data from 1972 to 1986 from All India Co-ordinated Research Project, Rahuri.

According to Tomar (1996) the number of female kids produced by Barbari goats were 1.5±0.18 and did not differ significantly from the female kid productions of Jamunapari but male kids born were 55.4% higher in Barbari goats than in Jamunapari.

2.1.2 Litter Weight at Birth

Raghavan *et al.* (1999a) analysed the effect of parity, type of birth, day length and season of date of successful service and date of parturition on average birth weight and litter weight in 188 kiddings of purebred Malabari goats maintained at Regional Research Station, Pilicode. They observed that the highest litter weight at birth was seen in triplets with a mean of 3.82 ± 0.277 kg. The litter weight for singlets was 1.84 ± 0.11 kg and for twins was 3.183 ± 0.107 kg.

Raghavan *et al.* (1999b) analysed the data on Malabari kids for the effect of parity, type of birth, season and day length of date of breeding, season and day length of date of kidding on litter weight. They observed that the month of kidding had no significant effect on litter weight at birth. They observed that the least squares mean for litter weight at birth was 2.607 ± 0.137kg. Nandakumar *et al.* (2003) analysed the data for the effect of sire, parity and month of mating on gestation length, litter size and litter weight at birth and birth weight. They documented that the effect of sire was not significant on litter weight.

2.2 PRE-WEANING TRAITS

2.2.1 Birth Weight

Birth weight in goats is important for evaluating the rate of live weight gain, which is an important meat trait. Birth weight influences productivity to a large extent because of its strong correlation with growth rate and kid viability. Haas (1978) compared the growth rate of Boer crosses to indigenous Small East African goats in Kenya and found that the birth weight in Boer goat crosses and Small East African goats were 2.6 kg and 2.3 kg respectively.

Mukundan (1980) analysed the records of birth weight of 473 kids belonging to two genetic groups Malabari (MM) and Saanen (SM) halfbred born over a period of four years, 1974 to 1977. He documented that the birth weight of Malabari kids (1.71 ± 0.06kg) was lower than that of Saanen halfbreds (1.88 ± 0.1 kg). But the difference in birth weight was not statistically significant.

Raghavan (1980) observed that the average birth weight of Malabari was 1.71 ± 0.03 kg and birth weight of Alpine Malabari was 2.04 ± 0.02 kg.

Nagpal and Chawla (1984) analysed the data on the birth records of 294 Beetal and 216 Alpine goats raised under stall-fed conditions in National Dairy Research Institute, Karnal. They observed that the birth weight in Beetal and Alpine goats were 3.15 ± 0.06 kg and 3.22 ± 0.13 kg respectively in intensive system of management.

Mishra and Ghei (1989) observed that the birth weight of local Sikkim goats was 1.6 ± 0.05 kg and males with a mean birth weight of 1.6 ± 0.8 kg were significantly heavier than their female counterparts (1.51 ± 0.05 kg).

Mishra (1991) studied the performance traits in a flock of Sikkim local goats for a period of three years. He observed that the birth weight in Sikkim local goats (1.6 kg) was comparable with that of Assam local and Malabari .

Mohapatra and Nayak (1996) studied the growth in crossbred Black Bengal x Ganjam kids and observed that the average birth weight in crossbred kids was 2.15 ± 0.07 kg and was intermediate between Black Bengal and Ganjam goats.

Khan *et al.* (1998) recorded the data on the growth and reproductive traits in Barbari goats maintained in rural areas under village farming system. Body weights of 137 kids were recorded from birth to one year of age at the interval of three months. The mean population body weights of the kid at birth were found to be 2.03 ± 0.09 kg. Single kids were heavier at birth than the twins and triplets.

Singh (1998) conducted a study on the production performance of Sirohi breed of goats under intensive, semi-intensive and extensive systems of breeding management. Performances of does with respect of feed intake, live weight changes and milk production and for kids in respect of birth and weaning weights were documented. The male and female kids at birth weighed 3.2 ± 0.16 kg and 2.6 ± 0.18 kg respectively. The birth weight of both the sexes had significantly ($P<0.05$) higher birth weight under semi-intensive system followed by intensive and extensive systems.

Sivakumar and Thiagarajan (1999) recorded the bodyweights of Tellicherry goats from birth to 18months of age maintained at the Livestock Research Station in Kattupakkam between 1991 and 1994 and observed that the birth weight of goats were 2.06 ± 0.03 kg and 1.7 ± 0.04 kg for males and females respectively. The growth rate was faster from birth to third month of age and slowed down in later stages.

Factors Influencing Birth Weight

2.2.1.1 Genetic Group

According to Mukundan (1980) after analyzing the birth weight of 473 kids of two genetic groups – Malabari, Alpine Malabari and Saanen Malabari. He observed that the genetic group had no significant effect on birth weight. He observed that the birth weight in Malabari was 1.7 ± 0.058 kg and 1.87 ± 0.101 kg in Saanen Malabari.

According to Raghavan (1980) the influence of genetic group was not significant in Malabari but was highly significant in Alpine Malabari and Saanen Malabari. He recorded the birth weight of Malabari, Alpine Malabari and Saanen Malabari as 1.71 ± 0.03 kg, 2.04 ± 0.02kg and 2.31 ± 0.03 kg respectively.

The study on the performance of Beetal x Black Bengal goats and their crosses by Kanaujia *et al.* (1989) revealed that the genetic group differed significantly for birth weight. Highest birth weight was observed in purebred Beetal of 2.77 kg followed by Black Bengal x Beetal halfbreds (2.26 kg). Lowest birth weight was observed in purebred Black Bengal (1.13 kg).

Jagtap *et al.* (1990) conducted a study on the influence of non-genetic factors on birth weight of local goats, Angora goat and in a cross between them. They found that the birth weight in Local x Angora kids were significantly heavier than its either parental breeds.

According to Sanchez *et al.* (1994) the genetic group had significant effect on birth weight. High-grade kids of Toggenburg (3.33 kg), Alpine (3.32 kg) and Saanen breeds (3.26 kg) were heavier than high-grade kids of Nubians (3.09) and high-grade Granadina kids.

Goonewardene *et al.* (1997) studied the growth performance and carcass quality traits of Alpine and Boer bucks crossed with dairy and dual purpose breeds such as Alpine, Saanen and Spanish. They observed that the breed of the sire affected the birth weight significantly.

According to Mia and Bhuiyan (1997) the genetic group had a highly significant effect on birth weight of kids. The data on birth weight of 381 kids born during 1989 to 1991 at Gazipur documented a higher birth weight in Anglo-Nubian kids than Barbari and Barbari x Black Bengal.

According to Singh and Singh (1998) the effects of genetic group were not significant on birth weight on the basis of the study conducted on306 kids of Black Bengal and its cross with Beetal in the plateau region of Bihar.

Banait *et al.* (2002) recorded that the breed effects was highly significant for birth weight in different breeds of goats maintained in Nagpur. Fifty adult goats of each of Jamunapari, Barbari, Osmanabadi, Sirohi and local breeds of goats formed the experimental animals. The birth weight was highest in Sirohi (2.67 ± 0.06 kg) and lowest in Barbari (2.35 ± 0.06 kg) whereas overall average birth weight was 2.47 ± 0.03 kg.

2.2.1.2 Sire

Amble *et al.* (1964) carried out the statistical analysis of data collected from Beetal goats at the Government Livestock Farm, Hissar, Haryana sponsored by ICAR. The data was collected from two herds of Beetal goats – A and B. The estimates of heritability of birth weight were calculated for both herds of each sex by doubling the intrasire regression of daughter's performance on that of its dam's. The pooled value of heritability for herd A was 0.19 ± 0.07 based on 1,195 degrees of freedom and was negative for herd B.

Guha *et al.* (1968) analysed the data on growth rate from birth to 52 weeks of age, of 234 Black Bengal goats and reported that the overall birth weight of males was 1.31 kg as against 1.15 kg for females. The data of 234 progenies of 13 sires was analysed using intrasire regression, heritability estimate was found to be 0.067 ± 0.006.

Data on birth weight of Black Bengal goats born from January 1970 to December 1975 were analysed by Ali and Hasmath (1977) to determine the heritability of birth weight. The heritability estimate of birth weight of male kids was found to be 0.76 ± 0.52 from sire component and 2.86 ± 0.42 from dam component. The estimates for females for both components were 0.55 ± 0.64 and 3.19 ± 0.51 respectively.

According to Mukundan (1980) the sire had no significant influence on the birth weights of Malabari and Saanen Malabari. He analysed the data for the effect of nongenetic factors on birth weights of 473 kids belonging to two genetic groups.

Raghavan (1980) documented that the effect of sire was significant in Alpine Malabari kids but not in Malabari and Saanen Malabari. The heritability estimate for birth weight in Malabari was zero, 0.0498 ± 0.027 in Alpine Malabari and –0.0276 ± 0.108 in Saanen Malabari.

According to Sanjeevkumar *et al.* (1992) concluded that the sire effects were not significant on the birth weight of Jamunapari goats.

According to Sanchez *et al.* (1994) the heritability estimate for birth weight in high grade kids and low-grade kids were 0.40 ± 0.14 and 0.44 ± 0.18 respectively.

According to Goonewardene *et al.* (1997) Alpine sired kids were observed to grow 15 per cent faster than Boer sired kids. They documented that a 9 per cent increase in birth weight was obtained by using Boer as the sire.

Roy *et al.* (1997) studied the growth in Jamunapari goats by utilizing the data recorded on body weights from birth up to 12 months of age on 876 kids maintained at the central Institute for Research on Goats, Makhdoom, UttarPradesh during the years 1982 to 1992. The analysis of variance revealed that the sire had no significant effect on birth weight.

2.2.1.3 Month of Birth

Raghavan (1980) reported that the season of birth had no significant influence on birth weight in Malabari, Alpine Malabari and Saanen Malabari. However, Malabari and Alpine Malabari kids born in winter registered higher birth weight than in summer and rainy season.

Mukundan (1980) documented that the month of birth had no significant influence on the birth weights. But kids born in June and December within Malabari breed was significantly lower than those in November.

Month of birth showed significant influence on the birth weight in a study conducted on 294 Beetal and 216 Alpine goats by Nagpal and Chawla (1984). Beetal kids born in winter season were significantly heavier than those born in autumn whereas the Alpine kids born in autumn were heavier than those born in summer and winter.

The least square mean for birth weight in Jakharana goats was 2.15 ± 0.06 kg and month of kidding had no significant effect on birth weight (Tyagi *et al.*, 1992).

According to Sanjeevkumar *et al.* (1992), on analysis of genetic and non - genetic factors affecting body weight of Jamunapari goats observed that the month of birth had significant influence on birth weight. Mostly kids born in February-April were heavier than those born in other months.

Analysis of the data of 97 Jamunapari kids maintained in the farm of Indian Veterinary Research Institute documented that the month of birth had no significant effect on birth weight and body weight upto three months (Sharma and Das, 1995). This was similar to the reports of Roy *et al.* (1997) in Jamunapari goats. The effect of month of birth on birth weight was highly significant in

Sirohi goats maintained at the Western Regional Research Centre, Avikanagar. The kids born in September-November wee significantly heavier at birth than those born in February-April (Mehta *et al.,* 1997). According to Singh and Singh (1998) the kids born in monsoon were heavier than kids in winter and summer. This was similar to the reports of Taparia *et al.* (1999).

Jithendrakumar (2003) documented that the month of birth had no significant effect on birth weight of Malabari kids. However, kids born in July weighed heavier (2.05 ± 0.15 kg) and lowest birth weight was noticed in September (1.58 ± 0.17kg).

2.2.1.4 Sex

Mukundan (1980) recorded the birth weights of 473 kids belonging to two genetic groups – Malabari Alpine Malabari and Saanen Malabari. He observed that the male kids (1.89 ± 0.063kg) weighed significantly heavier than females (1.69 ± 0.064kg).

Raghavan (1980) recorded the body weights of 1227 kids belonging to three genetic groups, Malabari, Alpine Malabari and Saanen Malabari. He observed that the sex differences were highly significant in Alpine Malabari and Saanen Malabari but not significant in Malabari. Khan and Sahni (1983) observed that the male kids of Sirohi goats maintained at Western Regional Research Centre, Avikanagar was significantly heavier than females.

Nagpal and Chawla (1984) reported that the male kids registered significantly higher birth weight than females of Beetal and Alpine kids.

Lawar *et al.* (1991) studied the birth weights of twins with respect to their sex in local, Angora and their crossbred goats. They indicated that the birth weight was higher in twins as male: male in local and Angora goats. However, in crossbred i.e., ½ Angora and ¾ Angora, the twins born as male: female was heavier than female: female.

Tyagi *et al.* (1992) reported that the male kids of Jakhrana goats were born heavier than the females and the sex differences were significant on birth weight.According to Sanjeevkumar *et al.* (1992) the sex differences were significant on the birth weight of Jamunapari kids and the males were significantly heavier than females.

According to Sanchez *et al.* (1994) birth weight means for high grade and low grade kids were respectively 3.3 kg and 3.2 kg in Alpine, 3.1 kg and 3.2 kg in Nubian, 2.7kg and 2.9 kg in Granadina, 3.3 kg and 3.3 kg in Saanen and 3.3kg and 3.1 kg in Toggenburg. In his study, they observed that the sex of the kids had significant influence on birth weight and males were significantly heavier than females.

According to Mathew *et al.* (1994), the analysis of data on 2317 kids of Malabari, Alpine Malabari (AM) and Saanen Malabari (SM) and Alpine x (AM), Saanen x (SM) Alpine x (SM) and Saanen x (AM) goats revealed that the birth weight averaged 1.7 kg, 2 kg, 2.2 kg, 2 kg, 2.2 kg, 2.2 kg and 2.1 kg respectively. They documented that the sex of the kid had significant influence on the birth weight.

Analysis of variance for the effect of sex on birth weight were not significant in Jamunapari kids reared at Indian Veterinary Research Institute in intensive system of management. Sharma and Das (1995) observed that the mean birth weight of Jamunapari kids averaged to be 3.19 ± 0.07 kg. Gokhale *et al.* (1996) documented that the significant influence of sex on birth weight based on the data of 770 nondescript and graded Sirohi kids. Here also, the male kids were heavier than females at all age groups.

According to Sheikh *et al.* *(1996)* the birth weights of Changthangi goats of Ladakh born during 1982-1985 were analysed for the influence of sex. They documented that sex differences were highly significant on birth weight. Males with a least square mean of 1.8 ± 0.01 kg were heavier than females (1.74 ± 0.01 kg).

Nagpal and Chawla (1984) observed that the male kids of Sirohi goats maintained at Western Regional Research Centre, Avikanagar was significantly heavier than females. This was similar to the reports of Mehta *et al.* (1997) and Roy *et al.* (1997).

Mahgoub (1997) studied the growth and carcass composition of thirty Omani Dhofari goats from birth to slaughter. He observed that the birth weight averaged 2.4 kg. He concluded that the males (2.8 kg) were significantly heavier than females (2.28 kg). This was similar to the reports of Singh and Singh (1998) in purebred Black Bengal and its cross with Beetal.

Singh (1998) observed significant influence of sex on the birth weight of Sirohi goats. Male kids were significantly higher than female kids. He observed that the males and females reared under semi-intensive system had significantly higher birth weight than reared under intensive and extensive systems.

According to Taparia *et al.* (1999), the sex of the kids had significant influence on the birth weight of goats maintained under field conditions of Rajasthan. Males had a birth weight of 3.51 ± 0.04 kg and in females were 3.34 ± 0.2 kg.

According to Jithendrakumar (2003) the analysis of variance revealed that the sex differences were significant on birth weight in Malabari kids. The birth weight in males and females were 1.87 ± 0.059 kg and 1.73 ± 0.046 kg respectively.

2.2.2 Pre-weaning Body Weights

National Mutton Sheep and Goats Performance Testing Scheme in South Africa 1970 reported that when selection is made purposeful for growth rate, weaning weight and post weaning weight gain in Boer goats, as much as 20% or more increase in ADG can be established. Average weaning weight for bucks and doe kids were respectively. The production performance of the Boer goats exported from Namibia to Germany documented an average weaning weight of 24 kg in Boer goats whereas it attained only 23.5 kg in Namibia (Casey and Niekerk, 1978).

According to Mukundan (*1980*) the pre-weaning body weights in Malabari and Saanen Malabari was 4.99 ± 0.19kg and 6.57 ± 0.184kg respectively. The body weight of Malabari and its Saanen half bred at first month was 2.98 ± 0.09kg, 3.89 ± 0.09kg and in second month was 3.96 ± 0.136kg and 5.19 ± 0.13 kg respectively.

According to Raghavan (1980) the mean body weight at one month in Malabari and its halfbreds with Alpine and Saanen was 2.83 ± 0.05 kg, 3.9 ± 0.05 kg and 3.78 ± 0.05 kg respectively.

According to Morand -Fehr (1981) the weaning at an early age before obtaining a satisfactory live weight affected the subsequent growth rate .He observed this fact in his study on French Alpine kids. Male kids were more susceptible to adverse effects of early weaning than female kids.

Nagpal and Chawla (1984) analysed the data on 294 Beetal and 216 Alpine males and females raised under stall-fed conditions in NDRI, Karnal. The body weight of Alpine and Beetal at 3 months was 9.62 ± 0.36kg and 8.03 ± 0.20 kg respectively.

According to Bajhau and Kennedy (1990) the body weight in kids was significantly affected by breed, maternal nutrition and sex from 2 to 13 weeks of age, in a study based on the body weights of Feral and Feral x Anglo Nubian cross bred goats

According to Tyagi *et al.* (1992) the least-square mean of body weight at weaning in Jakhrana goats maintained under semi-intensive system in semi-arid zone of Jakhrana village of Alwar district of Rajasthan was 8.64 ± 0.25 kg. The weaning weight in Osmanabadi goats was 7.34 ± 0.06 kg (Acharya, 1992).

Studies of Malik *et al.* (1993) on the environmental factors like year, season, sex and type of birth on the growth of the Black Bengal goats up to 6 months of age documented that the body weight at first month and third month was 2.64 ± 0.21 kg and 5.41 ± 0.14 kg respectively. Singles born had higher birth weight than twins and triplets and maintained this superiority up to weaning age.

Mathew *et al.* (1994) reported that the weaning weight of Malabari, Alpine Malabari (AM), Saanen x Malabari (SM), Alpine x AM, Saanen x SM, Alpine x SM and Saanen x AM goats were 5.4kg, 6.7kg, 6.6kg, 6.6kg, 6.5kg, 7.2kg and 6.9 kg respectively. They concluded that the body weight at three months was significantly affected by season of birth, year, period of birth and sex.

According to the study conducted by Yao *et al.* (1994) on the growing and fattening performance of native goats, Mongolian goats and their crossbred, the weaning weight at 3 months of age in Native goats, Mongolian goats and Mongolian x native goats were 14 ± 1.05kg, 13.46 ± 1.039 kg and 9.96 ± 1.03 kg respectively. They concluded that crossing with Mongolian goats could be used to improve native goats.

Ebozoje and Ngere in Nigeria (1995) studied the genetic analysis of body weight and maturing patterns between birth and 150 days of age in West African Dwarf (WAD) goats and WAD x Red Sokoto goats. They concluded that the variability in body weight and degrees of maturity was higher among WAD kids as compared to half bred. The mean body weight t 30 days, and 90 days were 2.87 kg and 4.87 kg in WAD kids and 3.80 kg and 6.05 kg in half bred kids.

Yadav and Singh (1995) documented that weaning at 60 days had no adverse effect in growth rate and better growth rate in weaners can be achieved by maintaining them in small groups for early maturity.

Gokhale *et al.* (1996) documented that the mean bodyweight at first, second and third month were 5.29 ± 0.6 kg, 6.47 ± 0.87kg and 10.44 ± 1.19kg respectively on analysis of the body weight data on 770 nondescript and graded Sirohi goats born between 1992-93 belonging to 300 farmers in Bhilwara district of Rajasthan.

The average body weight of crossbred kids of Black Bengal and Ganjam at first, second and third month was 4.13 ± 0.34kg, 5.93 ± 0.58kg and 7.81 ± 0.83kg respectively. This was based on the study of Mohapatra and Nayak (1996) on 27 half bred kids of Black Bengal and Ganjam goats maintained at Western Regional Research Station, Orissa. The weaning weight in local goats of Maharastra was 9.4 ± 0.5 kg (Nimbkar *et al.*, 1996)

Mahgoub (1997) analysed the body weight data on thirty Omani Dhofari goats from birth to slaughter and examined for the effect of sex, slaughter weights and their interaction. He documented that the body weight at second month was 2.89kg in bucks and 2.28kg in does and in third month was 11.96kg in bucks and 10.86kg in does. He concluded that the kids of both sexes grew with a faster rate during the pre-weaning period.

According to Goonewardene *et al.* (1997) the weaning weight of Alpine x Alpine, Alpine x Saanen, Alpine x Spanish, Boer x Alpine, Boer x Saanen and Boer x Spanish were 18.78 kg, 17.86 kg, 15.82 kg, 17.65 kg, 16.1 kg and 14.81 kg respectively. According to Khan *et al.* (1998) recorded the data on growth and reproductive trait in 137 Barbari kids maintained in rural areas under village farming system. They documented that the body weight of Barbari kids at 3 month of age was 8.10 ± 0.31 kg. Male kids had higher bodyweights at three months than females.

Singh (1998) compared the performance of thirty does of Sirohi breed of goats maintained under intensive, semi-intensive and extensive systems. He concluded that the pre-weaned kids performed the best under the semi-intensive system followed by intensive and extensive system. Weaning weights of male kids (14.6 ± 0.96kg) were significantly ($P<0.05$) heavier than female kids (12.4 ± 0.39kg).

Bungo *et al.* (1999) recorded the bodyweight of Tokara native goats from birth to 10 weeks of age and documented that the body weight of male kids were significantly ($P<0.01$) heavier than females from birth to 10 weeks of age. Among the male kids, the greatest body weights were found for males in male-female twins from birth to 6 weeks of age but male singles showed the highest body weight after 8 weeks of age. In female kids, the body weight of the female in male-female twins was highest than that in female-female twins.

Barros (1999) documented that the Anglo-Nubian males and females with a minimum body weight of 12 kg and 10 kg respectively should be weaned at 56 days and Saanen and Brown Alpine males and females weighing 14kg and 12 kg respectively should be weaned at 56 days.

Luo *et al.* (2000) compared the growth performance of Spanish, Boer x Angora and Boer x Spanish kids during the pre-weaning period. Boer crosses weighed significantly heavier than Spanish kids at 6 and 8 weeks of age. But there existed no significant differences between Boer crosses in body weights

Nimbkar *et al.* (2000) recorded the three month weights of 282 Boer x local kids maintained in the village conditions of Maharastra and weaning weight in Boer x local kids was 13.1 ± 0.7 kg. They compared the weaning weight of Boer x local kids with that of local kids, Osmanabadi and Sangamneri kids.

Factors Influencing Pre-weaning Body Weights

2.2.2.1 Genetic Group

According to Mukundan (1980) the genetic group had significant influence on pre-weaning body weights on analyzing the body weight records on 275 kids of two genetic groups, Malabari and Saanen halfbreds. It was observed that the Saanen halfbreds were heavier than Malabari at first, second and third month.

Raghavan (1980) documented the highly significant effect of breed on body weight at first month. Alpine Malabari had the highest body weight at one month (3.90 ± 0.05 kg) followed by Saanen Malabari (3.78 ± 0.05 kg) and the lowest in Malabari (2.83 ± 0.05 kg). Kanaujia *et al.* (1989) studied the growth, survivability and reproductive performance of 2094 kids belonging to purebred Beetal and Black Bengal and their reciprocal crosses born between 1979 and 1985. They observed that there exists significant difference in genetic group for body weight at three months of age. Beetal goats had the highest body weight at three months of age (9.7 ± 0.24kg) and maintained its superiority up to 12 months. Beetal x Black Bengal had a body weight of 6.38 ± 0.13 kg at three month and least body weight at three months was observed in Black Bengal goats (5.4 ± 0.06 kg).).

Singh and Singh (1998) compared the performance of Black Bengal and its cross with Beetal under village conditions. The study was conducted on 306 kids maintained on extensive grazing tree leaves and kitchen left over and body weight was recorded from birth upto 6 months of age. They analysed the variance for the effect of breed on pre-weaning body weight and was found to be significant for first month and second month. The effect of breed was not significant on the body weight at third month. Beetal x Black Bengal kids were significantly heavier compared to purebred Black Bengal. The superiorities for body weights of Beetal x Black Bengal over purebred Black Bengal were 26.52%, 31.68 %and 2.12% respectively.

2.2.2.2 Sire

Raghavan (1980) after analyzing the body weights of three genetic groups of goats, Malabari, Alpine Malabari and Saanen Malabari documented that sire had highly significant effect on the body weight of Malabari goats at one month of age. Sire differences were not recorded in the body weights of Alpine Malabari and Saanen Malabari at one month of age. The highest estimate of heritability for bodyweight at first month could be obtained in Malabari (0.329 ± 0.285) followed by that in Alpine Malabari (0.1289 ± 0.2288). For Saanen Malabari the heritability was found to be zero.

The data on body weights of 275 kids belonging to two genetic groups, Malabari (M) and Saanen halfbreds (SM) born over a period of 4 years from 1974 to 1977 was analysed by Mukundan (1980). He found that the effect of sire within Malabari breed was significant on body weight at third month only. The heritability estimate of body weights from 1 to 3 months were 0.19 ± 0.25, 1.54 ± 0.78 and 1.08 ± 0.75 for Malabari, 0.12 ± 0.24, 0.09 ± 0.22 and 0.03 ± 0.08 for Saanen halfbreds.

According to Sanjeevkumar *et al.* (1992) the sire had highly significant influence on body weight at third month on analysis of variance components for the effect of sire, month of birth, year of birth and sex on the body weight from birth up to 12 months of age.

Ebozoje and Ngere (1995) reported that heritability estimate for body weight at third month in West African Dwarf Goats and in West African Dwarf x Red Sokoto was 0.63. They concluded that crossbred with heavier weights at all preweaning ages would attain an ideal market weight at relatively younger age than the purebred kids.

According to Mehta *et al.* (1997) the heritability estimate for the body weight at third month in Sirohi goats was 0.26 ± 0.13.

Roy *et al.* (1997) studied the growth in Jamunapari goats by utilizing the data recorded on body weight from birth up to 12 months of age in 867 kids maintained at the Central Institute for Research on Goats, Makhdoom, Uttarpradesh during the years 1982 to 1992. The analysis of variance revealed that the effect of sire on body weight at third month was highly significant. The heritability estimate for the body weight at third month was 0.30 ± 0.10 and was determined by paternal half-sib method. Nimbkar *et al.* (2000) concluded that the significant effect of sire on pre-weaning weight on analyzing the data recorded on the body weight of Boer x local kids from birth up to sixth months of age.

2.2.2.3 Month of Birth

Mukundan (1980) concluded that the effect of month of birth was significant on body weight at second and third month only. Kids born in March to September had the maximum weights at second and third month.

Raghavan (1980) concluded that the effect of month of birth was not significant on body weight at first month on analyzing the body weight of 1227 kids from birth to 12 months of age in Malabari kids and its halfbreds with Saanen and Alpine. According to Nagpal and Chawla (1984) the influence of season was more pronounced in the early age and dwindled away with the advancement of age. They analysed the data on 294 Beetal and 216 Alpine kids born in NDRI, Karnal and recorded the body weight from birth to 24 months of age at 3 months interval. Beetal and Alpine kids born in winter had higher birth weight at third month than those born in spring and summer. Even though Alpine kids were heavier in winter; they do not have significant difference in body weight at three month of age.

Malik *et al.* (1986) analysed the data on weight and measurements from birth to 12 months of age at 3 month interval on 524 Jamunapari goats sired by 12 bucks maintained at CIRG, Makhdoom. They documented that the month was significant on body weight at third month. Mostly kids born in February-April were heavier than those born in other months. This was similar to the reports of, Roy *et al.* (1989) and Sanjeevkumar *et al.* (1992) in Jamunapari goats.

Tyagi *et al.* (1992) analysed the date on 134 Jakhrana kids born from 1986 to 1989 maintained under semi-intensive feeding management. They recorded that the influence of month of kidding had significant effect on pre-weaning body weights. Kids born during October – December were significantly heavier than those born during March – May.

Malik *et al.* (1993) on analysis of the data on Black Bengal goats born in 1980 to 1982 in two kidding seasons observed that the effect of month of birth was highly ($P<0.01$) significant on first month body weight. Month of birth was significant ($P<0.05$) on body weight at second and third month. Kids born in February and April were heavier than those born during September to November.

Sharma and Das (1995) concluded that the month of birth had no significant influence in pre-weaning bodyweights on analysis of the variance components. The study was based on the data of 97 Jamunapari kids born at Indian Veterinary Research Institute during 1988-1989 in two kidding seasons.

Das *et al.* (1995) reported that the season of birth had significant influence on body weight at pre-weaning stages. Kids born in October-February weighed higher than those born during March – September.

Month of birth had highly significant influence on body weight at first month, second month and third month on analyzing the effect of month of birth on body weight data of 770 nondescript and graded Sirohi goats of Rajasthan (Gokhale *et al.*, 1996).

Mehta *et al.* (1997) examined the effect of non-genetic factors on the body weight from birth to 12 month of age in 576 Sirohi kids born in February – April and September – November at Western Regional Research Centre, Avikanagar. They concluded that the effect of season of kidding had significant influence in body weight at weaning period. Kids born in September – November were significantly heavier in pre-weaning period.

Roy *et al.* (1997) analysed the data on body weights of 867 Jamunapari kids from birth to 12 months of age to evaluate the growth trend in Jamunapari goats. They concluded that the season of birth had highly significant influence on the body weight at third month. Kids born during October – November were heavier than those born in February – March.

Singh and Singh (1998) observed that the month of birth of the kids had no significant influence on the body weight at first, second and third month on analyzing the body weights of 160 Black Bengal kids and 146 Beetal x Black Bengal kids in the plateau region of Bihar. However monsoon born kids weighed heavier than those of winter and summer. Taparia *et al.* (1999) analysed the body weight and growth rate from birth to 360 days of age of goats of Araveli region in Rajasthan and documented that the influence of season of birth was highly significant on pre-weaning body weight. Kids born in summer season were heavier than those born in rainy and winter season, at first month of age. Kids born during rainy season were significantly heavier than those born during summer and winter at second month of age. In third month, the kids born during winter were heavier than those born during rainy and summer season.

2.2.2.4 Sex

Mukundan (1980) documented that the effect of sex was significant on body weights at first, second and third month of age. Males were found to be heavier than females at all ages.

Raghavan (1980) analysed the data pertaining to 1227 kids belonging to Malabari, Saanen x Malabari and Alpine x Malabari during the period from April 1974 to March 1979 maintained in Kerala Agricultural University Goat and Sheep Farm, Mannuthy for the effects of genetic and nongenetic factors on body weight from birth up to 12 months of age. The influence of sex on body weight at first month was not significant in Alpine Malabari and Malabari breeds and was significant in Saanen Malabari ($P<0.01$). Males (3.92 ± 0.02kg) were heavier than females (3.65 ± 0.02kg) in Saanen Malabari.

According to Nagpal and Chawla (1984) the effect of sex was significant on third month in Beetal goats whereas the effect of sex was not significant in Alpine kids at three months of age. In Beetal, the male kids were significantly heavier than female kids at three months of age. According to Taneja *et al.* (1992) the influence of sex was not significant on body weight at third month and recorded an average body weight of 9.91 kg in Marwari type goats through survey data of body weights in farmer's flock kept around Bikaner.

Sex of the kid had highly significant ($P<0.01$) influence on the body weight at third month. Males were found to be heavier than females in the reports of Roy *et al.* (1989), Sanjeev Kumar *et al.* (1992).

Tyagi *et al.* (1992) studied the effects of various non-genetic factors on the growth trend of Jakhrana goats. About 134 kids born from 1986-1989 in two kidding seasons reared under semi-intensive system formed the experimental animal. On analysis of the data, they observed that the effect of sex was significant ($P<0.05$) on pre-weaning body weights. Males were heavier than females.

Malik *et al.* (1993) studied the influence of environmental factor year, season, sex and type of birth on the growth of Black Bengal goats up to marketable age. Data utilized for the study was based on 577 Black Bengal goats born during 1980 to 1982 in two kidding seasons at CCS Haryana Agricultural University. The influence of sex was highly significant on the body weight at first, second and third month. Male kids were 20 percentages heavier than females and maintained this superiority up to post-weaning period.

Sharma and Das (1995) analysed the factors affecting the growth of 97 Jamunapari goats reared under intensive condition in Indian Veterinary Research Institute, Uttarpradesh and concluded that there exist significant difference between the two sexes in its pre-weaning stage. Males were significantly heavier than females in all the pre-weaning stage.

Das *et al.* (1995) analysed the data on the body growth of 160 Barhari goats from birth to 12 months of age born during the period from 1985 to 1989 in two kidding seasons. Body weight of males were significantly heavier than female at weaning period.

Analysis of variance components of monthly body weights of 770 nondescript and graded Sirohi goats in Rajasthan by Gokhale *et al.* (1996) revealed that the sex of the kid had significant influence on body weight at first, second and third month. The male kids were heavier than females in pre-weaning body weights.

Sheikh *et al.* (1996) analysed the effect of some non-genetic factors in the body weight of Changthangi goats of Ladakh on the basis of 678 kids born between 1982 and 1985 at the Pashmira Goat Farm, Nuyama. They concluded that the sex of the kid had no significant influence on weaning weight and average weaning weight was 8.34 ± 0.01 kg in Changthangi kids.

Mehta *et al.* (1997) studied the effect of non-genetic factors on body weights from birth to 12 month of age in 576 Sirohi kids born in two kidding season raised at Western Regional Research Centre, Avikanagar, from 1986 to 1991. The effect of sex was highly significant on pre-weaning body weight.

Significant influence of sex of the kids on body weight at first and second month was documented by Singh and Singh (1998). They observed that the influence of sex on body weight at third month was not significant. Male kids weighed heavier than females at all ages but the differences were not significant for weights at birth.

Influence of the sex on body weight at first, second and third month was documented by Taparia *et al.* (1999) on analyzing the performance of the goats of the Aravali region in Rajasthan. Males were significantly heavier than females at all ages.

Nimbkar *et al.* (2000) analysed the effect of year of birth up to six months of age. They concluded that the sex effects were significant on weaning weight ($P<0.01$).

Roy *et al.* (2001) analysed the data on body weight of 287 Jamunapari kids maintained at Central Research Institute for Goat, Uttar Pradesh from 1985 to 1996 and found that the sex of the kid had highly significant influence on pre-weaning body weights.

2.3 INCIDENCE OF DISEASES, PRE-WEANING MORTALITY AND LITTER SIZE AT WEANING

Neonatal mortality is one of the major constraints influencing the goat production. Heavy loss of genetic material not only affects the economy of goat rearing but also lessens the scope of improvement through selection. Mortality in kids' up to one month of age had been reported to be as high as 44.5% in Indian goats (Chawla *et al.*, 1982). Sharma *et al.* (1984) documented that the percentage mortality in kids from birth to 1 month was about 60. Major neonatal diseases noticed include Pneumonia, Enteritis and Colisepticaemia. It was observed that the death due to Pneumonia, debility and Enteritis was higher in Sirohi goats than in Beetal x Sirohi kids. Kid mortality is comparatively high during pre-weaning period (Gupta and Sangar, 1985).

Sanyal *et al.* (1987) analysed the data on 216 Malabari kids maintained at Southern Regional Research Centre, Mannavarur and highest mortality (17.3%) was recorded during the first month of age. The mortality percentage decreased with the advancement of age and recorded 3.24% at three months of age. They reported that the kids below three months are susceptible to disease of respiratory systems and enteritis in Malabari goats in the sub-temperate regions of Tamil Nadu. About 3.2 percentage suffered due to enteritis and 4 percentage suffered from parasitic gastroenteritis. About 9.8 percentage of the kids suffered various respiratory distress.

Factors Influencing Incidence of Diseases, Pre-weaning Mortality and Litter Size at Weaning

2.3.1 Genetic group

According to Mittal (1976), the mortality rates in kids was highest in age group below 1 month. Major disease encountered were mainly Pneumonia, Enteritis and these two accounts for about two-thirds of the death in Barbari and three-fourth of deaths in Jamunapari According to Malik *et al.* (1990) mortality rate was decreased in crossbred kids than in purebreds. They studied the data on 1205 kids and found that mortality rate in Black Bengal x Beetal kids was only 21% while 38% in purebred Beetal and 45% in purebred Black Bengal. They observed that the genetic group had significant influence on the incidence of various diseases. The major diseases observed was Pneumonia and Gastroenteritis in Beetal, Black Bengal and their reciprocal crosses. Mortality due to Pneumonia and Gastro enteritis was more in pure bred than in crossbred animal. Mortality due to Pneumonia was 19% in Beetal, 20% in Black Bengal. 14% in Beetal x Black Bengal and 6.6% in Black Bengal x Beetal. Mortality due to enteritis was 8 percentage in Beetal, 9% in Black Bengal, 8.3% in Beetal in Black Bengal and 6.61% in Black Bengal x Beetal. Mishra (1991) observed that specific viral and bacterial infections including bacterial enteritis were responsible for 52 percentage of the mortality in flock of Sikkim local goats recorded for a period three years. Obidu *et al.* (1995) analyzed for the incidence of diseases in goats reared at University of Ibadan teaching and research farm. They observed that the mortality rate were highest in the Red Sokoto goats (92.3%). Intermediate in the West Africa Dwarf Goats (89.8%) and least among its crosses (32%). Pneumonia (35.6%), Helminthosis (9.7%) and Starvation (9.9%) were the most common causes of disease. Bhadoria (1996) observed 11.03% mortality in local Malwi goats whereas 10.6% mortality in Barbari goats and in their crosses in the Malwa region of Madhyapradesh. Tomar *et al.* (1999) documented that mortality rate in purebred Beetal female kids were higher than crossbred female kids of Beetal x Alpine and Beetal x Saanen kids. Nimbkar *et al.* (2000) concluded 5% mortality in Boer crosses maintained in the village conditions of Maharastra. Gupta and Saxena (2002) documented that the percentage incidence of enteritis was 56among goats while pneumonia was about 3.57% in Thiruchirapally district of Tamilnadu.

2.3.2 Sire

Roy *et al.* (1995)analyzed the data on the mortality on 959 Jamunapari kids and studied the sire-wise mortality pattern in kids. They observed that the differences among sire progeny groups were significant at all ages. They concluded that the heritability at 12months had to be considered for the further use of sires inbreeding programmes. Tomar *et al.* (1999) observed that the effect of buck was significant on mortality on analysing the data on1202kiddings of Beetal goats.

2.3.3 Month of Birth

Khan *et al.* (1978) and Mazumdar *et al.* (1980) observed that month of birth had significant influence on pre-weaning mortality. Chawla *et al.* (1982) reported highest mortality in kids during December and lowest during August. This was similar to findings of Sharma *et al.* (1984) and lowest mortality was observed during October – November. Sanyal *et al.* (1987) observed highest mortality in Malabari kids during July to October and lowest during November – February in the sub-temperate regions of Tamilnadu. Malik *et al.* (1990) observed highest mortality in September to November months in Black Bengal goats on analyzing the mortality pattern in Beetal and Black Bengal goats and their reciprocal crosses. According to Singh *et al.* (1994) month of birth had significant effect on pre-weaning mortality of Jamunapari and Black Bengal kids.

2.3.4 Sex

Analysis of variance components for the influence of sex on preweaning mortality were not found to be significant by Mittal (1976). But Sanyal *et al.* (1987) observed that sex had significant influence on pre-weaning mortality. They documented 18.98% mortality in males and 12.5% in female kids of Malabari goats. Malik *et al.* (1990) analysed the data on 1205 kids of Black Bengal and Beetal and their reciprocal crosses and documented that sex had no significant effect on mortality. This result is similar to the findings of Singh *et al.* (1994).

2.4 POST-WEANING BODY WEIGHTS

Haas (1978) had compared the growth rate of Boer goat crosses to that of indigenous Small East African goats in Kenya. He documented that the body weight of Boer goat crosses and Small East African goats at 150 days were 19.7 kg and 14.9 kg respectively. The body weight at 180 days in Boer goat crosses and Small East African goats were 21.8 kg and 16.2 kg respectively.

Nagpal and Chawla (1984) analysed the data on the body weight of 294 Beetal and Alpine goats maintained at National Dairy Research Institute, Karnal spanning over a period from 1972 to 1982. The body weights at 6 months in Beetal goats were 14.05 ± 0.59 kg and 14.46 ± 0.81 kg in Alpine goats.

Kanaujia *et al.* (1989) compared the performance of purebred Beetal and Black Bengal with their reciprocal crosses born during1979 to 1985. They analysed the data on 2094 kids for the effect of genetic group on growth traits, reproduction and survivability. They observed that the bodyweight at six months was more in pure bred Beetal and is followed by reciprocal crosses.

Ageeb *et al.* (1992) recorded the production and reproduction characteristics of a block of Baggara goats of South Kordofan and observed that the body weight at six months averaged 11.9 kg for males and 10.5 kg for females.

Taneja *et al.* (1992) analysed the survey data of body weights of Marwari type goat in farmer's flock from birth to twelve months of age kept around Bikaner, Rajasthan. They documented that body weight at six month in Marwari type goats was 37.52 kg.

Malik *et al.* (1993) conducted a study on the growth of 577 Black Bengal goats born during the year 1980 to 1982 at Haryana Agricultural University. They studied the influence of environmental factors like year, season, sex and type of birth on the growth of the kids' up to six months of age. They documented that the body weight at fourth, sixth month was 8.58 ± 0.41 kg. They concluded that the dams having higher body weights at kidding would produce heavier kids and the kids weaned heavier would maintain higher body weights at subsequent ages.

Sharma and Das (1995) studied the effect of certain non-genetic factors causing variation in body weights of 97 Jamunapari kids reared under intensive production system Indian Veterinary Research Institute, Uttar Pradesh. They recorded the body weights and body measurements of kids from birth to 1 year of age at three-month interval. They documented that the body weight of Jamunapari at sixth month of age in intensive system was 15.54 ± 0.41 kg.

Stephen and Rai (1995) analysed the data on the body weight at sixth and 12 months age of kids of Malabari goats and its crosses with Alpine and Saanen, born during 1974-1988 at the All India Co-ordinated Research Project on Goats, Mannuthy, Kerala for the effect of genetic group, seasons, periods and types of birth and sex of kids. They documented that the body weight at six months in Purebred Malabari, Alpine x Malabari (AM), Saanen x Malabari (SM), Alpine x AM, Saanen x SM and Saanen x AM were 9.3 ± 0.16 kg, 10.9 ± 0.11 kg, 11.3 ± 0.14 kg, 10.8 ± 0.39 kg, 6.9 ± 0.34 kg, 11.4 ± 0.34 kg and 11.2 ± 0.38 kg respectively.

Gokhale *et al.* (1996) recorded the body weight data on 770 nondescript and graded Sirohi goats born between 1992-1993 belonging to 300 farmers in Bhilwara district of Rajasthan. They documented that the body weight of Sirohi goats at fourth, fifth and sixth month were 12.85 ± 1.51 kg, 14.95 ± 2.07 kg and 15.33 ± 3.08 kg respectively.

Mohapatra and Nayak (1996) studied the growth in crossbred (Black Bengal x Ganjan kids) reared at the goat unit of Regional Research Station, Orissa. Recording their body weights from birth to 180 days at monthly interval monitored the growths of individual halfbreds. They documented that the body weights of half bred kids at 120 days, 150 days and 180 days were 9.48 ± 0.97 kg, 11.19 ± 1.05 kg and 12.59 ± 1.15 kg respectively.

Mahgoub (1997) analysed the data on thirty Omani Dhofari goats reared from birth to slaughter at 12 kg and 18 kg body weight. The objective of the study was to investigate the growth and carcass composition in Omani Dhofari goats under intensive management. The body weight of buck and doe at four month of age were 13.96 kg and 12.12 kg respectively. The body weight of buck and doe at fifth month was 16.20 kg and 13.62 kg respectively. He concluded that the Dhofari goats raised under intensive system performed better than traditional system. Khan *et al.* (1998) recorded the body weights of the Barbari goats maintained under village conditions from birth to one year of age at the interval of three months. They observed that the mean population body weight of the kids at 6 month of age was 11.95 ± 0.47 kg. Male kids had higher body weights at all the ages.

Deb (1998) studied the performance of Pashmina goats on Kumaron Himalayas. After analyzing the records of different breed groups of Pashmina goats maintained at Indian Veterinary Research Institute for two decades documented that average body weight at sixth month was 12.2 ± 0.21 kg.

Patel *et al.* (1999) conducted a comparative study to observe the productive performance of Marwari and Parbatsar, under extensive and semi intensive management. The body weight at 6 month in Marwari and Parbatsar were 15.69 ± 1.12 kg and 18.26 ± 0.77 kg respectively.

Tarparia *et al.* (1999) analysed the body weights and growth rate from birth to 360 days of age in goats reared in Aravati region of Rajasthan. They documented that the body weight at 180 days was 15.22 ± 0.12 kg.

Kaushih *et al.* (1999) compared the growth performance and blood metabolites of kids raised under organize management under semi-intensive conditions. For this study be utilized the data on 11 Jhakrana, 19 Kucchi, 8 Marwari and 17 Sirohi female kids. They documented that the body weight at 6 months in Jhakarana, Kucchi and in Sirohi goats were 19.91 kg, 16.84 kg, 18.45 kg and 21.85 respectively.

Nimbkar (2000) compared the live weight obtained at six month in Boer x local goats reared under village conditions of Maharashtra with the live weights of local goats, Osmanabadi and Sangamneri. He documented that the live weight at 6 months in Boer x local kids were 20.8 ± 1.9 and it was only 14.7 ± 0.9 kg in local 4.07 ± 0.05 kg in Osmanabadi and 10.06 ± 0.39 kg in Sangamneri.

Thiruvenkadan *et al.* (2000) studied the production performance of Kanni Adu goats of Tamil Nadu and recorded the body weight at 6 month was 12.70 ± 0.38 kg.

According to Cameron *et al.* (2001) compared the growth and slaughter traits of Boer x Spanish, Boer x Angora and Spanish goats consuming a concentrate breed diet. They concluded that the early post-weaning growth was similar between Boer x Spanish and Boer x Angora wether and greater for Boer crossbreds than for Spanish wethers.

Roy *et al.* (2001) analysed the data on the body weight records of 287 Jamunapari kids maintained at Central Institute for Research on Goats, Mathura from 1985 to 1986 for the effect of year of kidding, type of birth, sex and weight of dam at kidding and institutional factors on the body weight. They documented that the body weight of Jamunapari kids at sixth month of age was 14.86 ± 0.19 kg.

Factors Influencing Post-weaning Weight

2.4.1 Genetic Group

Mukundan (1980) analysed the data on the body weights of Malabari and its halfbred with Saanen for the effect of genetic group on post-weaning body weights. He observed that the effect of genetic group was highly significant at fourth, fifth and sixth month.

Raghavan (1980) analysed the data on Malabari, Alpine Malabari (AM) and Saanen Malabari for the effect of genetic group on body weight at post-weaning period. He documented that the effect of genetic group was highly significant on body weight at fourth month. The body weight at 4^{th} month in Malabari, Alpine Malabari and Saanen Malabari was 6.00 ± 0.15 kg, 9.92 ± 0.19 kg and 7.75 ± 0.14 kg respectively. Various other researchers had reported this significant difference in genetic group (Malik *et al.*, 1986).

Kanaujia *et al.* (1989) compared the performance of purebred Beetal and Black Bengal with their reciprocal crosses born between 1979 to 1985. They documented that the genetic group had highly significant influence on body weight at post-weaning stage. They observed that the highest body weight at six month was more for purebred Beetal (13.16 ± 0.30 kg) and Black Bengal x Beetal

(12.23 ± 0.32). Lowest body weight at six month was in Purebred Black Bengal. Data on the body weight at 6 and 12 months of age of Malabari and its crosses with Alpine and Saanen goats, born during 1974-1988 at the All India Co-ordinate Research Project on Goats, Mannuthy, Kerala were analysed for the effect of genetic group on body weights recorded. The crossbreds of Malabari weighed significantly higher at 6 months of age than the Purebred Malabari. Body weights of crossbreds varied but the differences existed between crossbreds was not significant. (Stephen and Rai, 1995)

Singh (1997) after analyzing the data on body weights of 749 kids observed that the genetic group had significant effect on post-weaning body weights. He used the records on post-weaning body weights. He used the records on post-weaning body weights of Black Bengal and it half breeds with Jamunapari and Beetal goats. Halfbreds weighed significantly heavier than Black Bengal but both halfbreds did not differ significantly among themselves. Superiority in body weight at six months of Jamunapari halfbreds over Black Bengal was 27.09% and Beetal halfbreds over Black Bengal was 27.98%. The body weight at six month in Black Bengal, Jamunapari x Black Bengal and Beetal x Black Bengal were 8.97 ± 0.14 kg, 11.40 ± 0.15 kg and 11.48 ± 0.15 kg respectively.

Singh and Singh (1998) compared the growth rate of Black Bengal and its cross with Beetal under farmer's managemental system. They studied the influences of genetic and nongenetic factors on bodyweights of 306 kids from birth to 6 months of age in the plateau region of Bihar. On analysis of the data, they observed that the effect of genetic group was significant on body weights at fourth, fifth and sixth month. Beetal x Black Bengal kids were significantly heavier compared to purebred Black Bengal. They documented that a sharp decline in the body weight of Beetal x Black Bengal kids t 2-3 months of age was increased between 3 and 6 months of age.

Singh (2002) conducted a study on the genetic and non-genetic affecting the body weights and body dimensional traits of kids at sixth month of age on 570 kids of Black Bengal, Jamurapari x Black Bengal, Beetal x Black Bengal. He documented that the effect of genetic group was significant on body weight at sixth months. Body weights of Black Bengal kids (8.97 ± 0.14 kg) were significantly heavier than Beetal x Black Bengal (11.48 ± 0.15 kg) and (11.40 ± 0.10 kg) and these halfbreds do not significantly between themselves.

2.4.2 Sire

Raghavan (1980) recorded the body weights of Malabari kids and its halfbred with Alpine and Saanen and data was analysed for the effect of sire on body weights during post-weaning period. He observed that the sire difference were highly significant for Malabari at fourth month of age. But the influence of sire was not significant in Saanen Malabari and Alpine Malabari. The heritability estimate for the bodyweight at fourth month was 0.251 ± 0.5368 in Malabari, 0.2692 ± 0.3816 in Alpine Malabari and 0.1421 ± 0.1302 in Saanen Malabari.

Mukundan (1980) recorded that the sire differences were significant in Malabari for bodyweights at fourth, fifth and sixth month. But the influences of sire within Saanen Malabari were not significant on body weights at fourth, fifth and sixth month.

According to Mbah (1988) the heritability estimate for the body weight at fifth month in tropical goat breeds falls within the range 0.23 to 0.48. This was however similar to the results obtained by Ebozoje and Ngere (1995). They *found that the heritability estimate for body weight at fifth month in* West *African* Dwarf goats and in West African Dwarf x Red Sokoto goats was 0.38. Sanjeevkumar *et al.* (1992) analysed the body weights of 524 Jamurapari kids for the effect of genetic and non-genetic factors affecting body weights from birth to 12 months of age. They observed that the sire differences were highly significant up to six months of age.

According to Mehta *et al.* (1997) the heritability estimate of body weight at sixth month in Sirohi goats were 0.30 ± 0.19. They concluded that based on the heritability estimates at sixth month body weights, selection can be made for higher body weights for optimizing meat production.

Roy *et al.* (1997) concluded that the heritability for body weight at six month was determined by paternal – half-sib method and was estimated as 0.51 ± 0.12. They reported that the heritability estimate for body weight at sixth month was high for Jamunapari goats on analyzing the data on body weight from birth to 12 months of age on 867 kids maintained at Centre Institute for Research on Goats. High heritability and its medium correlation with weight at subsequent ages make this trait a suitable selection criterion. Therefore, kids could be selected at six months of age for obtaining higher body weights at later stages. They documented that the sire differences were significant for body weight at six month.

Singh (1997) estimated the heritability of body weight at sixth month by paternal half-sib method. It was observed that the heritability estimate of body weight at sixth month was 0.58 ± 0.09 and was medium to moderate. He concluded that this medium to moderate heritability indicated the possibility of improvement in body weight through direct selection as well as by improving managemental system.

Nimbkar *et al.* (2000) recorded the body weights of Boer x local kids at sixth month of age and analysed for the effect of year of birth, type of birth, sex and sire on body weight. They concluded that the sire differences were not significant on body weight.

Jithendrakumar (2003) recorded the body weights of Malabari kids from birth to 6 months of age and analysed the data for the effect of sire on post-weaning body weights. He observed that the sire differences were not significant on post-weaning body weights.

2.4.3 Month of Birth

Raghavan (1980) analysed the data on the body weights of post-weaning period for the influence of month of birth on bodyweights of Malabari, Alpine Malabari and Saanen Malabari. He observed that the season of birth was highly significant in all the three genetic groups.

Mukundan (1980) after analyzing the body weights of post-weaning period in Malabari and Saanen Malabari for the effect of season of birth on bodyweights at fourth, fifth and sixth month. Season of birth was significant on body weight at sixth month only. Siddique *et al.* (1981) documented the significant effect of season of birth on post-weaning body weights.

Nagpal and Chawla (1984) analysed the nongenetic factors influencing the body weight of 294 Beetal and 216 Alpine goats from birth upto six months of age. They were maintained in stall fed conditions at National Dairy Research Institute, Karnal. They concluded that the effect of season of birth was more significant on body weight at six months in Beetal and Alpine goats. Beetal and Alpine kids born in winter had higher bodyweight at 6 months of age than those born in spring and summer.

Tyagi *et al.* (1992) recorded the body weights of 134 Jakhrana kids born during 1986 to 1989 in two kidding seasons from birth upto 12 months of age. They analysed the data for the effect of sex, type of birth and season on the growth trend of Jakhrana. The effect of season was significant on body weight at six months. Kids born during March to May could maintain their body weight up to 9 months of age and kids born in October – December recouped their body weights similar to kids born in March to May.

According to Sanjeevkumar *et al.* (1992) the effect of the month of birth was significant on body weight at sixth month. They analysed the data on body weights of 524 Jamunapari kids from birth to twelve month of age for the effect of genetic and non-genetic factors affecting body weights. They found that the kids born in February-April were heavier than those born in other seasons. This result is in conformity with the findings of Malik *et al.*, 1986, Roy *et al.*, 1989.

According to Malik *et al.* (1993) the influence of the season of birth on body weight at fourth, fifth and sixth month was highly significant in Black Bengal goats. They conducted his study on the recorded body weights of Black Bengal goats from birth to six months of age, which were born during the year 1980 to 1982 at Haryana Agricultural University. At 6 months of age, the kids born during September – November weighed heavier than kids born in February and April. It was observed that the kids born in February and April were heavier from birth to three months of age. The kids in September – November gradually recoup their body weights during post-weaning period.

Sharma and Das (1995) analysed the factors affecting the growth of 97 Jamunapari kids reared at Indian Veterinary Research Institute, Uttar Pradesh. They recorded that the kids born during October – February were heavier than those born during March – September at all post-weaning ages, the differences being significant at sixth month of age.

Das *et al.* (1995) studied the influence of non-genetic factors like sex, type of birth, year, season of birth on the body growth of 160 Barbari goats from birth to 12 months of age. These goats were born during the period from October 1985 to September 1989. Kids born during October – February (11.52 ± 0.27 kg) were significantly higher than those born during March – September (10.04 ± 0.28 kg).

Stephen and Rai (1995) studied the impact of crossbreeding of Malabari goats with Alpine and Saanen breeds on bodyweights at 6 months of age. Kids of Malabari and its crosses with Alpine and Saanen born during 1974-1988 at the All India Co-ordinated Research Project on Goats, Mannuthy were analysed for the effect of genetic groups, seasons, periods, type of birth and sex of kids on body weight at sixth month. They observed that the winter born kids had a significantly higher body weight at sixth month (11.3 ± 0.14 kg) than those born in summer (10.7 ± 0.14 kg) and rainy season (10.6 ± 0.16 kg).

Gokhale *et al.* (1996) analysed the data on bodyweights of 770 nondescript and graded Sirohi goat in the Bhilwara district of Rajasthan. They concluded that the effect of month of birth was highly significant in post-weaning period up to six months of age kids born during February to June showed lower body weights compared to those born between September and January. The kids born during September and October were the heaviest.

Mehta *et al.* (1997) analysed the records of 576 Sirohi kids born in two kidding seasons and raised at Western Regional Research Centre, Avikanagar for the effect of year and season of kidding, sex, type of kidding, year-sex interaction and weight of dam at kidding on body weights from birth to 12 months of age. They documented that the effect of season of kidding was highly significant in all post-weaning ages. Kids born in September-November were significantly heavier from birth to sixth months of age than those born in February – April.

Singh (1997) studied the influence of genetic and non-genetic factors on post-weaning body weights of purebred Black Bengal and its halfbreds with Jamunapari and Beetal raised under goat breeding project of Ranchi Veterinary College, Bihar. Singh documented that the influence of month of birth was highly significant on sixth month of age. Kids born during summer weighed significantly lower than those born during winter and monsoon. Singh and Singh (1998) studied the influence of genetic and non-genetic factors on the bodyweights of 306 kids of Black Bengal and its cross with Beetal from birth to 6 months of age. They observed that the season of birth had no significant effect on post-weaning body weights. However, monsoon born kids continue to weigh heavier than those of winter and summer

Taparia *et al.* (1999) analysed the bodyweights of goats in Aravali region of Rajasthan from birth to 12 months of age for the effect of region, sex, type of birth, season of birth, parity, and year of kidding on body weights. They documented that the month of birth were significant on body weight at sixth month. The kids born in summer were significantly heavier than those born during rainy and winter season.

Singh *et al.* (2003) documented that the month of birth had significant effect on body weight at sixth month on 128 Black Bengal kids, 285 Jamunapari x Black Bengal and 157 Beetal x Black Bengal born during 1981-1987 under All India Co-ordinated Research Project at Ranchi, Bihar. Kids born during summer month were heavier than kids born during winter and rainy seasons. Jithendrakumar (2003) recorded that the month of birth had no significant influence on the post-weaning period. Kids born in September month were higher than those born in June.

2.4.4 Sex

Raghavan (1980) analysed the data on the bodyweights of Saanen halfbreds and Malabari kids and Alpine halfbreds for the effect of sex on bodyweight at 4^{th} month. He documented that the sex was significant in Saanen halfbreds only. Males were heavier than females in Malabari and Alpine halfbreds but there exists no significant differences.

Mukundan (1980) analysed the data on the body weights of Malabari and Saanen Malabari for the effect of sex on post-weaning period. He observed that the sex was significant at fourth month only. Males weighed heavier than females in both genetic groups.

According to Nagpal and Chawla (1984) the influence of sex on bodyweight at six month was not significant in Alpine and Beetal goats. The data for the study was based on the body weight records of 294 Beetal and 216 Alpine goats maintained at National Dairy Research Institute, Karnal for a period of 11 years from 1972 to 1982.

Taneja *et al.* (1992) analysed the body weights of Marwari type goats in farmer's flock in Bikaner for the effect of sex and centre on body weights from birth to 12 months of age. They observed that the sex had no significant influence on the body weight at six months.

Tyagi *et al.* (1992) studied the effect of various non-genetic factors like sex, type of birth and season on the growth trend of Jakhrana goats. They recorded the body weights of 134 Jakhrana goats born from 1986 to 1989 in two kidding seasons and were maintained under semi-intensive managerial system. They documented that the effect of sex was significant on post-weaning growth. Male kids weighed heavier during 3-12 months of age (14.6 ± 0.49kg) in females (13.36 ± 0.44 kg).

Sanjeevkumar *et al.* (1992) documented the significant influence of the sex of the kid on body weight at six months on analysis of the effect of genetic and non-genetic factors affecting the bodyweights from birth up to 24 months of age in Jamunapari kids. Males with a least square mean of 13.28 ± 0.61 kg were heavier than females (11.83 ± 0.56 kg) at six month of age.

Malik *et al.* (1993) recorded the growth of 577 Black Bengal goats born during the year 1980-1982 at Haryana Agricultural University. They analysed the data for the effect of environmental factors on body weights and found out that the season of birth had highly significant effect on body weight at fourth, fifth and sixth month. The male kids were 20% heavier at birth than females and maintained this superiority up to six months of age.

Sharma and Das (1995) analysed the data on bodyweights and measurements on 97 Jamunapari kids reared in Indian Veterinary Research Institute, Uttarpradesh. They studied the effect of year, season, sex and type of birth on body weights from birth to 1 year of age. They found out that the difference between two sexes were significant at all ages except birth. Males with a least square mean of 16.82 ± 0.57 kg were significantly heavier than females 14.26 ± 0.54 kg.

Das *et al.* (1995) analysed the body growth in Barbari goats born during 1985 to 1989 and found out that the body weight of males were significantly higher than those of females at all post-weaning ages except body weight at nine months.

According to Stephen and Rai (1995) the sex differences were not significant on the body weight at sixth month of Malabari and its crosses with Alpine and Saanen.

Gokhale *et al.* (1996) analysed the data on the body weights of 770 nondescript and graded Sirohi goats born between 1992-93 belonging to 300 farmers in Bhilwara district of Rajasthan for the effect of certain environmental factors on body weights from birth to 6 months of age. They observed that the effect on sex was highly significant on body weight at 4 month and 6 month. But the effect of sex was significant ($P<0.05$) on body weight at fifth month. In all the ages, males were heavier than females.

Mahgoub (1997) analysed the data on the body weights of 30 Omani Dhofari goats from birth to slaughter age for the effect of slaughter weight and sex. He found out that the goat of all sexes grew with a faster rate during the pre-weaning period than post-weaning period. The effect of sex was significant only on the body weight at fifth month.

Mehta *et al.* (1997) analysed the records of 576 Sirohi kids born in two kidding season at Western Regional Research Centre, Avikanagar from 1986 to 1991 for the effect of year and season of kidding, sex, type of kidding and weight of dam at kidding on body weights from to 12 months of age. They documented that there was highly significant differences between two sexes. Male kids weighed heavier than the females at all ages.

Roy *et al.* (1997) analysed the data recorded on body weights from birth to twelve months of age on 867 Jamunapari kids maintained at Jamunapari farm of Central Institute for Research on Goats, Uttar Pradesh for the effect of sire, sex, year, season, type of birth and sex. They observed that males were significantly heavier than females at all ages.

Singh (1997) analysed the data on post-weaning body weights upto 12 months of age in purebred Black Bengal and it halfbreds with Jamunapari and Beetal maintained under semi-intensive system under Goat Breeding Project of Ranchi, Bihar. He analysed the data for the effect of genetic group, sex, season of birth and type of birth to study its influence on body weights. He concluded that the sex difference were significant on body weights at post-weaning period. Males (10.93 ± 0.11 kg) were significantly heavier than females at all ages (10.31 ± 10.11 kg). Males were 6.01% superior to females at six month of age.

Singh and Singh (1998) analysed the data on the body weights of Black Bengal and its cross with Beetal for the effect of genetic group, sex, type of birth and season of birth on body weights from birth to six months of age. They observed that the influence of sex was significant ($P<0.01$) on body weights at fourth, fifth and sixth month. Male kids weighed heavier than females during post-weaning period.

Taparia *et al.* (1999) analysed the growth of goats reared under field conditions in Aravali region of Rajasthan for the effect of certain non-genetic factors. They documented that the sex differences were highly significant at sixth month of age. Males were heavier than females during post-weaning period.

Influence of sex were highly significant on body weight at sixth month on analyzing the records of body weights of 136 Boer x local kids in the village conditions of Maharashtra (Nimbkar *et al.*, 2000).

Roy *et al.* (2001) after analyzing the body weight records of 287 Jamunapari kids maintained at the Central Institute for Research on Goat, Mathura had documented that the sex had significant influence on the body weight at sixth month. Males (15.95 ± 0.22 kg) were significantly heavier than females (13.7 ± 0.31 kg).

Singh (2002) analysed for the genetic and non-genetic factors affecting the body weights at sixth month 128 Black Bengal, 285 Jamunapari x Black Bengal and 157 Beetal x Black Bengal born during 1981 – 1987 under All India Co-ordinated Research Project at Ranchi, Bihar. He documented that males with a body weight at sixth month (10.93 ± 0.11 kg) were significantly heavier than females at sixth month (10.31 ± 0.11 kg).

Jithendrakumar (2003) analysed the data on Malabari for the effect of sex on post-weaning body weights. He found out that the effect of sex was significant on body weights at 112 days and 126 days. The effect of sex was highly significant on body weight at 140 days, 154 days and 168 days. The sex influences were not significant on the body weights at 98 days.

2.5 AVERAGE DAILY GAIN IN BODY WEIGHT

Haas (1978) compared the growth rates of Boer goat crosses to that of indigenous Small East African goats in Kenya. He found that the average daily gain was significantly better in the Boer goat crosses than in the indigenous Small East African goats. The average daily gain from birth to weaning in Boer goat crosses and in Small East African goats were 114g and 84g respectively. The average daily gains from weaning to 360 days in Boer goat crosses and Small East African goats were 65g and 32g respectively.

Casey and Niekerk (1978) recorded that the National Mutton Sheep and Goats Performance Testing Scheme in South Africa compared the growth rates of young Boer goats during 1986 and 1989. The average daily gain of fastest growers in 1986 and 1989 were 118g and 163g respectively. The average daily gain of slowest growers in 1986 and 1989 were 13g and 22g respectively. Average daily gain in bodyweight in Boer goats was 140-250 g and average bodyweight at six month was 30 kg .(Birkammer,1986). Meat production potential of Boer halfbreds was reported to be exceptionally high, with three kidding in two years having an average growth rate of 200g/day (Casey and Niekerk, 1978).

According to Barry and Godke (1991) compared the production parameters for the Boer goats in Namibia and Germany. They observed that the average daily gain after 100 days in singles, twins and triplets in Namibia were 230 g, 237 g and 218 g respectively. Even though the Boer goats in Germany were exported from Namibia, the average daily gain in singles, twins and triplets were 257 g, 193 g and 182 g respectively. They also found that the average daily gain after 100 days in male kids in Germany was 213 g and 184 g in females.

Tyagi *et al.* (1992) studied the effects of various non-genetic factors affecting the growth trend of Jakhrana goats. They analysed the data on 134 kids born from 1986 to 1989 in two kidding seasons and reared under semi-intensive managerial system. They documented that the least square mean of average daily gain from birth to weaning (73 ± 3g) reduced to 55 ± 3g and 52 ± 3g at 3-6, 6-9 months respectively.

Blackburn (1995) compared the performance of Boer with Spanish goats in America and found that Boer produced more sale weight per doe compared to Spanish ones.

Chesworth and Haston (1996) reported that the pre-weaning growth rates of Dhofari kids (0.105 kg/day) were lower than those of Batinab (0.137g/day) and Jehel Akhdar (0.139 kg/day). They concluded that the daily gain in body weight declined after about 60 days in Omani goats. They noticed that a drop in the mean overall growth rate from 0.120 ± 0.073 kg/day prior to 60 days to 0.073 ± 0.025 in the period between 60 and 105 days. They documented that the sex differences were not significant on average daily gain.

Mahgoub (1997) investigated the growth and carcass composition in Omani Dhofari goats under intensive management. He found out that the bucks were heavier than wethers and does which had a pre-weaning growth rate of 108 g/d and reached 20 weeks body weight earlier than wethers and does which had a pre-weaning growth rates of 96 and 88 g/daily. Singh (1998) studied the performance of goats under different systems of feeding management. The male kids of Sirohi goats attained an average daily gain of 121.1 ± 8.69, 126.7 ± 10.54 and 115.5 ± 9.28g respectively under intensive, semi-intensive and extensive system. The female kids of Sirohi goats attained an average daily gain of 105.6± 3.19g, 105.6 ± 5.28g and 98.9 ± 1.65g under intensive, semi-intensive and extensive systems.

Oman *et al.* (1999) compared the carcass traits of Spanish goats and its cross with Boer and found that the Spanish crossed with Boer yielded greater live weights and carcass weights than Spanish goats. Prieto *et al.* (2000) compared the nutrient requirement for meat production of Boer with Spanish goats and found that dietary requirement of two genetic groups were comparable .

According to Nimbkar *et al.* (2000) the crossbreeding of local goats in Maharashtra with the Boer goats observed to have a growth rate from birth to 3 months was 130.4 ± 8.3 g/day and from birth to 6 months was 126.6 ± 11.2 g. The growth rate from birth to three months in Osmanabadi and Sangamneri were 55 g and 60 g respectively. The growth rate from birth to six months in Osmanabadi and Sangamneri were 48 g and 46 g respectively. Prieto *et al.* (2000) compared the nutrient requirement for meat production of Boer with Spanish goats and found that dietary requirement of two genetic groups were comparable.

Roy *et al.* (2001) studied the growth trend of Jamunapari kids maintained under intensive system of management in semi-arid zone at Central Institute for Research on Goats, Mathura from 1985 to 1996. The daily weight gain during 3-6 and 6-9 months of age was 57.22 g/day and 82.11 g/day respectively in males and 43.22 and 59.77 g/day in females.

Cameron *et al.* (2001) evaluated the comparative efficiency of Boer × Spanish, Boer × Angora and Spanish and concluded that Boer crosses were excellent in average daily weight gain (ADG), dry matter intake (DMI) and ADG: DMI ratio and dressing percentage nearly indicated the superior performance of Boer crossbreds.

Dhanda *et al.* (1999) observed a significant decrease in average daily gains of kids with advancement of age. Weaning at an early age and replacement of milk feeding by solid foods resulted in the retardation of the daily gain. The growth rate in goats was dependant on mature size of a particular breed. The male kids from larger breeds like Boer and Saanen grew faster than kids born to smaller breeds like feral goats and Angora. The growth rate varies from around 50g per day for the small tropical breeds to over 200g per day for large European breeds and the South African Boer breed (Dhanda *et al.*, 2003).

Factors Influencing Average Daily Gain in Body Weight

2.5.1 Genetic Group

Mukundan (1980) analysed the effect of genetic group on the body weight records of 212 kids belonging to Malabari and its Saanen halfbreds born over a period of four years from 1974 to 1977. He observed that the Saanen halfbreds attained significantly higher weight gain during pre-weaning period and post-weaning period from three to six months of age. Pre-weaning daily gain in Malabari and Saanen halfbreds were 36.24 ± 2.78 g and 48.12 ± 2.89 g respectively. Average daily gain of Malabari and Saanen halfbreds in three to six months of age were 37.84 ± 3.83 g and 55.12 ± 3.98 g respectively. The effect of genetic group was highly significant on average daily gain from 0-6 months of age.

Radotra *et al.* (1998) studied the performance of kids of Barbari ,Kutchi, and Sirohi goats maintained under an intensive system of feeding and management. They observed that the average daily gain differ significantly among breeds. The drymatter intake and digestability was better in Sirohi than in Kutchi and Barbari.

2.5.2 Sire

Mukundan (1980) recorded the body weights of 212 kids belonging to Malabari and its Saanen halfbreds born over a period of four years from 1974 to 1977. He documented that the sires within Malabari group were significant on average daily gain from 0-3 months of age and highly significant ($P<0.01$) on average daily gain from 3-6 months of age and 0-6 months of age. He observed that the sires within Saanen group were not significant on average daily gain from 0-3 and 3-6 and 0-6 months of age.

Mehta *et al.* (1997) studied the growth rate of Sirohi goats maintained at Regional Research Centre, Avikanagar. They recorded the body weight of Sirohi goats from birth to twelve months of age. The heritability estimate for pre-weaning daily gain was 0.26 ± 0.13.

Goonewardene *et al.* (1997) studied the growth performance and carcass quality traits of Alpine and Boer bucks crossed with dairy and dual purpose breeds such as Alpine, Saanen and Spanish. They concluded that pre-weaning gains are not affected by including the Boer as the buck, bred to Alpine, Saanen or Spanish does. Primarily the breed of the doe determined the pre-weaning growth rate of kids.

Singh (2002) concluded a study on 200 Black Bengal kids of 14 sires born during 1981-1986 under All India Co-ordinated Research Project on Goat at Ranchi. Sire differences were not significant on relative growth rate.

2.5.3 Month of Birth

Mukundan (1980) analysed the records of 212 kids of Malabari and its half bred with Saanen and observed that the month of birth had significant effect on pre-weaning daily gain and was highly significant on average daily gain from

3-6 months of age and0-6 months of age. Kids born in September recorded higher body weights and the lowest in December born kids during pre weaning period. In 3-6 months of age, the kids born in month of December recorded highest daily gain and least value in April. During 0-6 months of age, highest weight gain was recorded in kids born in January and the lowest was in April born kids.

Tyagi *et al.* (1992) studied the effect of sex, type of birth, and season on the pre-weaning and post weaning daily gains of Jakhrana goats. According to them, the season of birth had significant effect on pre weaning and post weaning average daily gain. Kids born in March-May (80 ± 49) were significantly heavier than kids born in October-December (66 ± 39) during0-3 months of age. The kids born in March-May (63 ± 69) were significantly heavier than kids born in October to December (46 ± 39) during post weaning period from 3-6 months of age.

Malik *et al.* (1993) studied the growth in 577 Black Bengal goats born during the year 1980 to 1982 at Haryana Agricultural University. They analysed the data for the effect of year, season and sex on pre weaning daily gain and post weaning daily gain. According to their analysis, the month of birth had no significant effect on pre weaning daily gain. But month of birth had highly significant effect on post weaning daily gain. The average daily gains of kids born during September to November were significantly heavier than those born during February to April.

Sharma and Das (1995) analysed the data on body weights and measurements of 97 Jamunapari kids born at Indian Veterinary Research Institute, Uttar Pradesh recorded from birth to one year of age at three months interval. They recorded that the season of birth had significant influence on the average daily from 3-6 months of age. The average daily gains in the month of October to February (4.87 ± 0.35 g) were significantly higher than that in the month of March to September (2.15 ± 0.53 g).

Das *et al.* (1995) studied the body weight of 160 Barbari goats from birth to 12 months of age, and the influence of non-genetic factors like sex, birth type, year and season of birth on different growth traits. The goats were born during the period from October 1985 to September 1989. He found out that the months of birth had significant effect on body weight gain. Kids born during October to February had higher average daily gain than the kids born during March to September.

Mehta *et al.* (1997) studied the growth rate in Sirohi goats reared at Western Regional Research Centre, Avikanagar from 1986 to1991. They analyzed the data on the body weights from birth to 12 months of age and documented that the month of birth had significant effect on post weaning period only.

Singh (2002) estimated the variation in relative growth rate in pre weaning weight of Black Bengal kids due to sire, year of birth, season of birth, generation, sex, type of birth, birth weight and parity of kids. The relative growth rate in body weight during 0-4, 8-12 ($P<0.05$) and 0-12 ($P<0.01$) weeks varied significantly. The relative growth rate in weight of winter born kids was significantly higher than those of summer and monsoon seasons that did not differ significantly between themselves.

2.5.4 Sex

Tyagi *et al.* (1992) studied the effects of various non-genetic factors affecting the growth trend of Jakhrana goats. They analyzed the data on 134 kids born from 1986 to 1989 in two kidding seasons and reared under semi intensive system of management. They documented that the sex differences were not significant on average daily gain of Jakhrana goats during pre weaning and post weaning period from 3-6 months of age. Average daily gain in males and females from 0-3 months were 74 ± 3 g and 72 ± 3 g respectively. Average daily gains in males and females from3-6 months were 58 ± 4 g and 52 ± 4 g respectively.

Malik *et al.* (1993) conducted the study on the effect of the year, season, and sex on growth of Black Bengal goats born during the year 1980 to 1982 at Haryana Agricultural University. They found out that the sex had significant effect on pre weaning and post weaning daily gain. Males were significantly heavier than females in all the growth period.

Das *et al.* (1995) studied the body growth of 160 Barbari goats from birth to 12 months of age and the influence of non-genetic factors like sex, birth type, year and season of birth on different growth traits. They documented that the sex differences were not significant on average daily gain during 3-6 months of age but was significant on average daily gain during 0-3 months of age.

Mahgoub (1997) studied the growth rate and carcass composition in Dhofari goats reared under intensive management. Pre-weaning daily gain (0-12 weeks) in bucks and does were 108 g/d and 88 g/d. Post weaning daily gain from (12-20 weeks) in bucks and does were 76 and 70 g/d. The average daily gain from birth to 20 weeks in bucks and does were 95 and 81 g/day. He recorded that the sex difference were significant only on pre-weaning daily gain.

Mehta *et al.* (1997) studied the growth in Sirohi goats and examined the effect of non- genetic factors on body weights from birth to 12 months of age. The average daily gain in 0-3 months and 3-12 m were significantly heavier in males than in females. Pre-weaning daily gain in male and female were 119.2 g/day and 104.2 g/day respectively. Post weaning daily gain from 3-12 months in male and female were 49.8 g/day and 39.4 g/day respectively.

Singh (2002) studied the factors affecting relative growth rate in Black Bengal kids during pre-weaning period. He observed that the sex difference were not significant on growth rate during pre- weaning period.

2.6 PHENOTYPIC CORRELATION

Mukundan (1980) documented that the birth weight was positively correlated with other bodyweights. The relationship was stronger in early periods and decreased with the advancement of age in Malabari. The correlation did not show any definite trend in Saanen halfbreds.

Singh (1997) documented that the phenotypic association between bodyweight at third and sixth month were positive and significant for Black Bengal and its cross with Jamunapari and Beetal goats. The phenotypic association between bodyweight at third and sixth month in Black Bengal and its cross with Jamunapari and Beetal goats was 0.77 ± 0.066, 0.66 ± 0.12 and 0.68 ± 0.06 respectively. Roy *et al.* (1997) reported the phenotypic association between bodyweight at third and sixth month in Jamunapari goats was 0.4. Singh (1998) documented that the phenotypic association between bodyweights were positive and highly significant ($P \leq 0.01$) indicating that the kids could be selected for higher body weights at sixth month of age on the basis of weights at birth, 1,2 and 3 months of age.

Materials and Methods

MATERIALS AND METHODS

Experimental animals consisted of one hundred kids, fifty each belonging to two genetic groups viz, Alpine Malabari (AM) and Alpine Malabari x Boer (AMB) of both sexes maintained in University Goat and Sheep Farm, College of Veterinary and Animal Sciences, Kerala Agricultural University, Mannuthy. Animals were maintained under identical conditions of feeding and management. Kids have adlibitum access to colostrum and weaned at three months of age.

For production of Alpine Malabari kids, natural service was practiced. Alpine Malabari x Boer kids were produced adopting oestrus synchronizatioin protocol developed by Senthilkumar(2002) followed by insemination with frozen semen from pure Boer bucks.

Bodyweights of dam, month of insemination, litter size at birth, litter weight at birth, birth weight, sex of the kid, bodyweights at first, second, third, fourth, fifth and sixth month of the kids are recorded. Pre-weaning mortality was scored as 0and 1 with 1as the incidence of mortality. Incidence of enteritis and respiratory diseases were also scored as 0 and 1with 1 as incidence. Litter size at birth (LSB) and litter weight at birth (LWB) were also recorded .Sire of the kid, season of birth were also noted. Average daily gain in body weight (ADG) from birth to three months (ADG 0-3), average daily gain in body weight (ADG) from three to six months (ADG 3-6) and average daily gain (ADG) from zero to six months (ADG 0-6) were worked out.

3.1 STATISTICAL ANALYSIS

Least squares analysis using the LSW-LMW Package (Harvey, 1987) was performed to assess the effect of breed, litter size at birth, month of birth and sex on litter traits, growth and viability using the statistical model:

$$Y_{ijklm} = u + b_i + Sr_j{:}b_i + S_{xk} + L_l + M_m + e_{ijklmn}$$

Y_{ijklm} observation of m^{th} progeny of i^{th} breed with j^{th} sire nested in i^{th} breed with k^{th} sex of l^{th} type born on m^{th} month

u	-	population mean
b_i	-	effect of i^{th} breed
$Sr_j{:}b_i$	-	effect of j^{th} sire nested in i^{th} breed
S_{xk}	-	effect of k^{th} sex
L_l	-	effect of l^{th} type of birth
M_m	-	effect of m^{th} month of birth
e_{ijklmn}	-	random error

3.2 ESTIMATION OF HERITABILITY

Paternal half-sire correlation described by Becker (1975) was used to estimate the heritability of body weight at different ages.

The model used for the estimation of heritability was

$$Y_{ik} = u + L_i + e_{ik}$$

Y_{ik}	-	observation of k^{th} progeny of i^{th} sire
u	-	population mean
L_i	-	effect of i^{th} sire
e_{ik}	-	random error

Analysis of variance table

Source	df	SS	MSS	EMS
Between sire	S-I	SS_s	MS_s	$\sigma^2_w + k\sigma^2_s$
Progeny within sire	N-S	SS_w	MS_w	σ^2_w

$$K = \frac{1}{S-1}\left(N - \frac{\sum n_i^2}{N}\right)$$

K	-	average number of progeny per sire
S	-	number of sires

n_i	-	number of progeny within i^{th} sire
N	-	total number of progenies
σ^2_w	-	MS_N – random effect mean squares (variances among progeny within sires)
σ^2_s	-	$\frac{MS_S - MS_W}{K}$, sire component of variance

T, intraclass correlation between half sibs

$$= \frac{\sigma^2_s}{\sigma^2_s + \sigma^2_w}$$

Heritability, $(h^2) = 4t$

The standard error of heritability was estimated by the method described by Swinger *et al.* (1964).

$$SE\,(h^2) = 4\sqrt{\frac{2(N-1)\,(1-t^2)\,(1+[K-1]t^2}{K^2\,(N-S)\,(S-1)}}$$

For the estimation of correlation, the analysis of covariance models and procedures for X and Y (two characters considered at one time) are the same as given for the estimation of heritability. The variance component σ^2_s (x), σ^2(y), σ^2_e(x) and σ^2_e(y) were obtained as before.

Analysis of co-variance

Source	df	MSS	EMS
Between sire	S-I	MCP_s	$CoV_e + KCoV_s$
Progeny within sires	N-S	MCP_e	CoV_e

K was estimated as in the case of analysis of variance.

Cov_s - Sire component of co-variance

Cov_e - Co-variance among progeny within sires

MCP_s - Mean cross product due to sire

MCP_c - Mean cross product due to progeny

Phenotypic Correlation (r_p)

$$r_p(x,y) = \frac{Cov_e(xy) + Cov_s(xy)}{[\sigma^2_e(x) + \sigma^2_s(x)][\sigma^2_e(y) + 3\sigma^2_s(y)]}$$

Where,

$$Cov_e = MCP_e$$

$$Cov_s = \frac{MCP_s - MCP_e}{K}$$

Results

RESULTS

4.1 LITTER SIZE AND LITTER WEIGHT AT BIRTH

4.1.1 Litter Size at Birth

The overall mean and standard error for litter size at birth in Alpine Malabari x Boer cross (AMB) and Alpine Malabari (AM) was 1.79 ± 0.48 and is documented in Table 4.1.

Factors Influencing Litter Size at Birth

4.1.1 1 Genetic Group

Analysis of variance for the influence of genetic group on litter size at birth of kids was significant ($P \leq 0.05$) (Table 4.2). The least squares mean for Alpine Malabari x Boer cross (AMB) was 1.68 ± 0.10 and that for litter size at birth in Alpine Malabari was 2.12± 0.16(Table 4.3).

4.1.1.2 Sire

Least squares analysis of variance for the effect of sire on litter size at birth is summarised in Table 4.2 and was highly significant ($P \leq 0.01$). Least squares mean for the effect of sire on litter size at birth is presented in Table 4.3. Sire No.4 with a least square mean of 2.39 ± 0.24 had the largest litter followed by Sire No.8 (2.19 ± 0.21). Lowest litter size at birth was for Sire No. 104 (1.35 ± 0.16) followed by Sire No. 106 (1.73 ± 0.14). The heritability estimate for litter size at birth was 0.32± 0.15 (Table 4.12).

4.1.1.3 Month of Birth

The association between month of birth and litter size at birth was highly significant ($P \leq 0.01$) (Table 4.2). The highest litter size at birth was observed during July (2.22 ± 0.16) followed by April (2.05 ± 0.18). Lowest litter size at birth was observed during December (1.22± 0.14) followed by January (1.78 ± 0.01)(Table 4.3).

4.1.1.4 Sex

Analysis of variance for the effect of sex on litter size at birth was not significant and is documented in Table 4.2. The litter size at birth in males was 1.96 ± 0.08 and in females was 1.84 ± 0.10 (Table 4.3).

4.1.2 Litter Weight at Birth

The mean and standard error for litter weight at birth was 3.77 ± 0.99 kg (Table 4.1).

Factors Influencing Litter Weight at Birth

4.1.2.1 Genetic group

Analysis of variance for the effect of genetic group on litter weight at birth was not significant (Table 4.2). The litter weight at birth for Alpine Malabari x Boer cross was 3.88 ± 0.20kg and the least square mean of litter weight at birth for Alpine Malabari was 3.90 ± 0.33kg (Table 4.3).

4.1.2.2 Sire

Variance components for the effect of sire on litter weight at birth were highly significant ($P \leq 0.01$) and are presented in Table 4.2. Least squares mean of litter weight at birth for different sires are detailed in Table 4.3. Highest litter weight at birth was observed for Sire No. 109 (4.59 ± 0.38 kg) followed by Sire No.4 (4.11 ± 0.50 kg). Sire No. 104 (3.02 ± 0.33kg) had the lowest litter weight at birth followed by Sire No. 10 (3.42 ± 0.44kg). Heritability estimate for litter weight at birth was 0.14 ± 0.19 (Table 4.12).

4.1.2.3 Month of Birth

Table 4.2 details the least squares analysis of variance for the influence of month of birth on litter weight at birth. Month of birth exerted a highly significant ($P \leq 0.01$) effect on litter weight at birth .The least squares means of litter weight at birth for different month of birth are presented in Table 4.3. Litter weight at birth was higher in kids born during April (4.82± 0.37 kg) followed by July (4.72 ± 0.33kg). Lowest litter weight at birth was for kids born in December (2.57 ± 0.29kg) followed by February (3.38 ± 0.63kg).

4.1.2.4 Sex

Sex of the kid was not found to be associated significantly with litter weight at birth (Table 4.2). The litter weight at birth in males was 3.88 ± 0.16kg and in females was 3.89 ± 0.21kg(Table 4.3).

4.2 PRE-WEANING TRAITS

4.2.1 Birth weight

Data on mean birth weight of kids are documented in Table 4.1. Mean birth weight of kids was found to be 2.16 ± 0.43kg.

Factors Influencing Birth Weight

4.2.1.1 Genetic Group

Analysis of variance components for the influence of genetic group on birth weight of kids were highly significant ($P \leq 0.01$) (Table 4.2). The least squares mean for Alpine Malabari x Boer cross was 2.53 ± 0.09kg. The least square mean for birth weight in Alpine Malabari was 1.87 ± 0.15kg. (Table4.3)

4.2.1.2 Sire

Sire differences were highly significant ($P \leq 0.01$) on birth weight (Table 4.2). Least squares mean of birth weight for different sires are detailed in Table 4.3. Birth weight was higher in kids sired by Sire No. 103 (3.05 ± 0.52kg) followed by Sire No. 104 (2.63 ± 0.15kg). Lowest least square mean for birth weight was in Sire No. 4 (1.59 ± 0.22kg) followed by Sire No. 8 (1.66 ± 0.19kg). The heritability estimate for birth weight was 0.28 ± 0.15 (Table 4.12).

4.2.1.3 Month of Birth

Least squares analysis of variance component for the influence of month of birth on birth weight was not significant (Table 4.2). Table 4.3 presents the least squares mean of birth weight for different month of birth. Highest birth weight was for kids born during April (2.33 ± 0.16kg) followed by May (2.30 ± 0.12kg). Lowest birth weight was for kids born during January (1.97 ± 0.12kg) followed by February (2.04 ± 0.14kg).

4.2.1.4 Sex

Sex of the kid had no significant influence on birth weight (Table 4.2). Birth weight in males and females were 2.18 ± 0.07kg and 2.17 ± 0.09kg respectively (Table 4.3).

4.2.2 Pre-weaning Body Weights

The overall mean and standard error of body weight at first, second and third month for Alpine Malabari x Boer cross and Alpine Malabari was 4.36 ± 1.03kg, 6.31 ± 2.02kg and 8.27 ±2.73kg respectively (Table 4.1).

Factors Influencing Pre-weaning Body Weights

4.2.2.1 Genetic Group

Least squares analysis of variance for the effect of genetic group on pre-weaning body weights was highly significant ($P \leq 0.01$) (Table 4.4). Table 4.5 presents the least squares mean for pre-weaning body weights. The least square mean for body weights at first, second and third month in Alpine Malabari x Boer cross was 6.01 ± 0.20 kg, 8.92 ± 0.40 kg, 11.65 ± 0.54 kg respectively. Least square mean for body weights at first second and third month in Alpine Malabari was 2.87 ± 0.34 kg, 3.05 ± 0.67 kg, 4.30 ± 0.91 kg respectively.

4.2.2.2 Sire

Analysis of variance components for the influence of sire were significant ($P \leq 0.01$) on pre-weaning body weights (Table 4.4). Table 4.5 presents the least squares mean for pre-weaning bodyweights. Body weight at first month was highest for Sire No. 103 (8.94 ± 1.23kg) followed by Sire No. 109 (6.39 ± 0.40kg). Least square means was lowest in Sire No. 10 (2.39 ± 0.47kg) followed by Sire No.8 (2.44 ± 0.47kg).

Sire 103 with a least square mean of 17.95 ± 2.22 kg was heavier at second month and is followed by Sire No. 109 (9.50 ± 0.72 kg). Least body weight at second month was found in Sire No.9 (1.43 ± 0.81 kg) followed by Sire No. 4 (2.25 ± 0.96 kg). The body weight at third month was more in Sire No. 103 (23.04 ± 3.03 kg) followed by Sire No. 109 (11.99 ± 0.98 kg). Lowest body weight at third month was in Sire No. 9 (1.50± 1.11 kg) followed by Sire No. 8 (3.44 ± 1.15 kg).

Heritability estimates for body weight at first, second and third month was 0.59 ± 0.17, 0.71± 0.17 and 0.66 ± 0.17 respectively (Table 4.12.)

4.2.2.3 Month of Birth

The influence of month of birth on pre-weaning bodyweights was highly significant ($P \leq 0.01$) on analysis of variance components (Table 4.4). Least squares mean for the pre-weaning bodyweights for different months are detailed in Table 4.5. The kids born during April (5.57 ± 0.38 kg) had the highest body weight at first month followed by February (4.72 ± 0.65 kg). Lowest was in July (3.15 ± 0.33 kg) followed by January (3.85 ± 0.29 kg).

The kids born during April with a least square mean of 8.04 ± 0.74kg were heavier at second month and is followed by kids born during December (7.29 ± 0.59 kg). Lowest body weight at second month was for kids born during February (3.83 ± 1.28 kg). The body weight at third month was more in kids born during April (9.80 ± 1.01 kg) followed by December (9.68 ± 0.80 kg). Least square means was lowest during July (5.17 ± 2.89 kg) followed by February (6.39 ± 1.74 kg).

4.2.2.4 Sex

Variance components for the influence of sex on pre-weaning bodyweights were not significant on analysis (Table 4.4). Least square mean for males at first, second and third month were 4.45 ± 0.16 kg, 5.79 ± 0.32 kg and 7.84 ± 0.44 kg respectively. Least square mean for females at first, second and third month were 4.43 ± 0.22 kg, 6.18 ± 0.43 kg and 8.11± 0.58 kg respectively. (Table4.5).

4.3 INCIDENCE OF NEONATAL DISEASES, PRE-WEANING MORTALITY AND LITTER SIZE AT WEANING

The mean and standard error of enteritis was 0.39 ± 0.46. The mean and standard error of respiratory infections was 0.08 ± 0.26 .The mean and standard error of pre-weaning mortality was 0.07 ± 0.24 .The overall mean and standard error for litter size at weaning in Alpine Malabari x Boer cross (AMB) and Alpine Malabari (AM) was 1.67± 0.58 and are documented in Table 4.1.

Factors Influencing Incidence of Neonatal Diseases, Pre-weaning Mortality and Litter Size at Weaning

4.3.1 Genetic Group

Variance components for the influence of genetic group on enteritis and respiratory infections and pre-weaning mortality are presented in Table 4.6. Breed differences were significant ($P \leq 0.05$) on respiratory infections but not significant on enteritis. The incidence of respiratory infections for Alpine Malabari x Boer cross (AMB) cross was observed to be 0.02 ± 0.05. The incidence of respiratory infections in Alpine Malabari was 0.24 ± 0.08 .The incidence of enteritis for Alpine Malabari x Boer cross (AMB) cross was observed to be 0.55 ± 0.09. The incidence of enteritis in Alpine Malabari was 0.38 ± 0.15 (Table 4.7).

Breed differences were not significant on pre-weaning mortality. Pre-weaning mortality for Alpine Malabari x Boer cross (AMxB) cross was observed to be 0.06 ± 0.05. The pre-weaning mortality in Alpine Malabari was 0.15 ± 0.08 (Table 4.7). Analysis of variance components for the influence of breed on litter size at weaning of kids were not significant (Table 4.2). The least squares mean for Alpine Malabari x Boer cross (AMB) was 1.58 ± 0.11.The litter size at weaning in Alpine Malabari was 1.80 ± 0.19 (Table 4.3).

4.3.2 Sire

Sire differences were significant on respiratory infections ($P \leq 0.05$) and was not significant on enteritis (Table 4.6). The respiratory infections were more in Sire No. 9 (0.36 ± 0.12) followed by Sire No. 10. Respiratory infections were lower in Sire No. 103 (0.00 ± 0.31) followed by Sire No. 106 (0.005 ± 0.08) .The enteritis was more in Sire No. 107 (0.63 ± 0.24). Enteritis was lower in Sire No.

10 (0.25 ± 0.21) followed by Sire No. 4 (0.27 ± 0.24) even though there exists no significant differences (Table 4.7).

Sire differences were not significant on pre-weaning mortality (Table 4.6). From Table 4.15, the pre-weaning mortality was more in Sire No. 103 (0.42 ± 0.29) followed by Sire No. 9 (0.35 ± 0.11). Pre-weaning mortality was lower in Sire No. 104 (0.07 ± 0.08) even though there exists no significant differences (Table 4.7). Least squares analysis of variance for the effect of sire on litter size at weaning are summarised in Table 4.2 and was highly significant ($P \leq 0.01$). Least squares mean for the effect of sire on litter size at weaning are detailed in Table 4.3. Sire No.103 with a least square mean of 2.68 ± 0.88 had the largest litter weaned followed by Sire No.4 (2.01 ± 0.29). Lowest litter size at weaning was for sire No. 104 (1.22 ± 0.19) followed by Sire No. 9 (1.23 ± 0.24). The heritability estimate for respiratory infections was 0.17 ± 0.13. The heritability estimate for pre-weaning mortality was 0.34 ± 0.34. The heritability estimate for litter size at weaning was 0.73 ± 0.42 (Table 4.12).

4.3.3 Month of Birth

Table 4.6 represents the analysis of variance for the influence of month of birth on respiratory infections and enteritis. Month of birth had no significant influence on respiratory infections and enteritis. Even though there exists no significant differences least square mean of respiratory infections and enteritis was more in kids born during February (0.17 ± 0.17 and 0.87 ± 0.29 respectively). Least square means for respiratory infections was lesser during May (0.01 ± 0.07). Least square means for enteritis was lower during December (0.18 ± 0.13) (Table 4.7).

Table 4.6 represents the analysis of variance for the influence of month of birth on pre-weaning mortality. Month of birth had no significant influence on pre-weaning mortality. Even though there exists no significant differences least square mean for pre-weaning mortality was more in kids born during February

(0.35 ± 0.16) followed by May (0.15±0.07). Least square means was lowest during December (0.02 ± 0.07) (Table 4.7). Least squares analysis of variance component for the influence of month of birth on litter size at weaning was significant ($P \leq 0.05$) (Table 4.2). Table 4.3 presents the least squares mean of litter size at weaning for different month of birth. Highest litter size at weaning was for kids born during July (2.12 ± 0.19) followed by April (1.95 ± 0.22). Lowest litter size at weaning was for kids born during December (1.30 ± 0.17) followed by February (1.44 ± 0.37).

4.3.4 Sex

Association between sex and enteritis and respiratory infections was not significant (Table 4.6). The least square mean for enteritis in males and females were 0.52 ± 0.07 and 0.42 ± 0.10 respectively). The least square mean for respiratory infections in males and females were 0.06 ± 0.04 and 0.15± 0.06respectively (Table 4.7).

Association between sex and pre-weaning mortality was not significant (Table 4.6). The least square mean in males and females were 0.13 ± 0.04and 0.15 ± 0.06 respectively (Table 4.7). Sex of the kid was not found to be associated with litter size at weaning (Table 4.2). The litter sizes at weaning in males were 1.70 ± 0.09 and in females were 1.69 ± 0.12 (Table 4.3).

4.4 POST-WEANING BODY WEIGHT

The overall mean and standard error of body weight at fourth, fifth and sixth month for Alpine Malabari x Boer cross and Alpine Malabari was 10.34 ± 3.10kg, 11.96 ± 4.18 kg and 13.68 ± 4.82kg respectively (Table 4.1).

Factors Influencing post-weaning Body weights

4.4.1 Genetic Group

Table 4.8 represents the variance components for the influence of genetic group on body weight at fourth, fifth and sixth month. Breed differences were highly significant ($P \leq 0.01$) on post-weaning body weights. Body weight at fourth, fifth and sixth month for Alpine Malabari x Boer cross was observed to be 13.62 ± 0.62 kg, 15.74 ± 0.83 kg and 17.79 ± 0.96 kg respectively. The body weight at fourth, fifth and sixth month in Alpine Malabari was 5.76 ± 1.03 kg, 5.84 ± 1.40 kg and 6.81 ± 1.61 kg respectively (Table 4.9).

4.4.2 Sire

Analysis of variance components for the influence of sire were significant ($P \leq 0.01$) on post-weaning body weights (Table 4.8). Table 4.9 presents the least squares mean for post-weaning bodyweights. Body weight at fourth month was highest for Sire No. 103 (26.40 ± 3.35 kg) followed by Sire No. 109 (14.20 ± 1.08 kg). Least square means was lowest in Sire No. 9 (3.00 ± 1.23 kg) followed by Sire No. 8 (5.04 ± 1.27 kg).

Sire 103 with a least square mean of 27.57 ± 4.93 kg was heavier at fifth month and is followed by Sire No. 10 (16.37 ± 1.60 kg). Least body weight at fifth month was found in Sire No.9 (3.81 ± 1.81 kg) followed by Sire No. 10 (3.91± 1.89 kg) .The body weight at sixth month was more in Sire No. 103 (31.81 ± 5.70kg) followed by Sire No. 109 (18.31 ± 1.85 kg). Lowest body weight at sixth month was in Sire No. 9 (4.59kg ± 2.09kg) followed by Sire No. 10 (4.78 ± 2.18 kg).

Heritability estimates for body weight at fourth, fifth and sixth month was 0.66 ± 0.17, 0.48 ± 0.17 and 0.45 ± 0.17respectively (Table.4.12).

4.4.3 Month of birth

Month of birth had highly significant influence on body weight at fourth, fifth and sixth month ($P \leq 0.01$) and is presented in Table 4.8 Least squares mean for the post-weaning bodyweights for different months are detailed in Table 4.9. The kids born during April (12.11 ± 1.15 kg) had the highest body weight at fourth month followed by January (11.82 ± 0.89 kg). Lowest was in February (5.61 ± 1.97 kg) followed by July (7.98 ± 1.02 kg).

The kids born during December with a least square means of 14.87 ± 1.22 kg were heavier at fifth month and is followed by kids born during April (15.53 ± 1.49 kg). Lowest body weight at fifth month was for kids born during February (12.27 ± 1.55 kg). The body weight at sixth month was more in kids born during December (16.89 ± 1.41 kg) followed by January (13.93 ± 1.38 kg). Least square means at sixth month was lowest during February (6.23 ± 3.07 kg).

4.4.4 Sex

Association between Sex and post-weaning body weights was not significant (Table 4.8). The least square mean for males at fourth, fifth and sixth month were 9.72 ± 0.49 kg, 10.92 ± 0.67 kg and 12.57 ± 0.77 kg respectively. Least square means for females at fourth, fifth and sixth month were 9.67 ± 0.66 kg, 10.66 ± 0.88 kg and 12.02± 1.02 kg respectively (Table 4.9)

4.5 AVERAGE DAILY GAIN IN BODYWEIGHT

The mean and standard error of average daily gain in body weight from birth to third month was 71.36 ± 21.99 g. The mean and standard error of average daily gain from third to six month was 65.70 ± 24.19 g. The mean and standard error of average daily gain from birth to sixth month was 66.89 ± 20.46 g (Table 4.1).

Factors Influencing Average Daily Gain in Bodyweight

4.5.1 Genetic Group

Least squares analysis of variance for the influence of genetic group on average daily gain in body weight from birth to third month and from birth to sixth month was highly significant ($P \leq 0.01$) in Table 4.10. Analysis of variance for the influence of breed on average daily gain from third to sixth month was not significant. Table 4.11 presents the least squares mean of average daily gain. The least square mean of average daily gain from birth to third month and from birth to sixth month in Alpine Malabari x Boer cross was 104.39 ± 4.39 g and 86.58 ± 4.08 g respectively. Least square means for average daily gain from birth to third month and from birth to sixth month in Alpine Malabari was 35.19 ± 7.35 g and 33.85 ± 6.83 g respectively.

4.5.2 Sire

Analysis of variance for the influence of sire on average daily gain in body weight from birth to third month and from birth to sixth month was highly significant ($P \leq 0.01$) (Table 4.10). Least squares analysis of variance for the influence of sire on average daily gain from third month to sixth month was not significant. Sire 103 had the highest average daily from birth to third month (200.22 ± 24.29 g) and from birth to sixth month (150.54 ± 24.16 g). The post-weaning average daily gain was also higher in Sire No.103 even though there exists no significant differences. Least average daily gain from birth to third month (12.61 ± 8.90 g) and from birth to sixth month (20.27 ± 8.85 g) was found in Sire No.9. (Table 4.11) Heritability estimate for average daily from birth to third month was 0.48 ± 0.29 g. Heritability estimate for average daily from third to sixth month was 0.008 ± 0.23. Heritability estimates for average daily from birth to sixth month was 0.34 ± 0.15 (Table 4.12).

4.5.3 Month of Birth

Month of birth had highly significant influence on average daily from birth to sixth month and on pre-weaning and post-weaning daily gain ($P \leq 0.01$) and is presented in Table 4.10. Least squares mean for average daily gain is detailed in Table 4.11. The kids born during April had the highest average daily gain from birth to third month (85.18 ± 8.13 g) and from birth to sixth month (77.51 ± 8.94g) than kids born during December. Highest post weaning daily gain was higher in kids born during April and was lower for kids born during February (11.29 ± 15.39 g).

4.5.4 Sex

Sex influences were not significant on average daily gain (Table 4.10). Males possessed higher average daily gain than females during post weaning and pre-weaning period even though there exists no significant differences. The least squares mean for average daily gain from birth to third month in males and females were69.63 ± 4.65 g and 69.95 ± 4.66 g respectively. The least squares mean for average daily gain from birth to sixth month in males and females were62.60 ± 3.28 g and 57.83 ± 4.33 g respectively. The least squares mean for average daily gain from third to sixth month in males and females were 60.28 ± 3.88 g and 56.56 ± 5.12g respectively (Table 4.11).

4.6 PHENOTYPIC CORRELATION

Phenotypic correlation among different traits under study are documented in Table.4.13.Type of birth exerted a highly significant positive correlation ($P \leq 0.01$) between litter weight at birth and birth weight. But this trait had a highly significant negative correlation between birth weight and bodyweight at first month and bodyweight at sixth month. Birthweight exerted a highly significant positive correlation ($P \leq 0.01$) on the bodyweights up to sixth month, average daily gain from 0-3 month and. average daily gain from 0-6 months. Correlation between bodyweight at first month, second month, third month, fourth month, fifth month and sixth month, average daily gain from 0-3 month and average daily gain from 0-6 month were highly significant. There is no association between respiratory infections and enteritis but the correlation between pre-weaning and respiratory infections were highly ($P \leq 0.01$) significant (0.263). The incidence of respiratory disease was found to be negatively correlated average daily gain from 0-3 month (-0.301) and average daily gain from 0-6 month (-0.330). The correlation between pre-weaning mortality and average daily gain from 0-3 month were ($P \leq 0.01$) highly significant.

Table 4.1 Mean and Standard Error of litter traits, growth and pre-weaning mortality among crossbred goats

Traits	Mean	Standard Error
Litter size at birth	1.79	0.48
Litter size at weaning	1.67	0.583
Litter weight at birth (kg)	3.77	0.99
Birth weight (kg)	2.16	0.43
Body weight at first month (kg)	4.36	1.02
Bodyweight at second month (kg)	6.31	2.01
Bodyweight at third month	8.27	2.73
Bodyweight at fourth month (kg)	10.34	3.09
Bodyweight at fifth month (kg)	11.96	4.18
Bodyweight at sixth month (kg)	13.68	4.82
Enteritis	0.39	0.46
Respiratory infections	0.08	0.26
Pre-weaning mortality	0.07	0.24
Average daily gain (0-3) (g)	71.36	21.19
Average daily gain (3-6) (g)	65.70	24.18
Average daily gain (0-6) (g)	66.89	20.45

Table 4.2 Analysis of variance for the effect of breed, sires within breed, month of birth and sex on Litter size at birth, Litter size at weaning, Litter weight at birth and Birth weight

Source	Degrees of Freedom	TRAITS			
		Litter size at birth (MSS)	Litter size at weaning (MSS)	Litter weight At birth (MSS)	Birth weight (MSS)
Breed	1	0.96*	0.26 NS	0.0027 NS	2.47**
Sires with in breed	8	0.69**	0.81**	1.75**	0.56**
Month of birth	5	1.75**	1.11*	6.89**	0.14 NS
Sex	1	0.69 NS	0.16 NS	0.16 NS	0.0094 NS
Error	84	0.20	0.29	0.90	0.17

** $P \leq 0.01$
* $P \leq 0.05$
NS---Non-significant

Table 4.3 Least Squares Mean Partitioning for the effect of the breed, sires within breed, month of birth and sex on litter size at birth, litter size at weaning, litter weight at birth and birth weight

Source	No. of observations	Litter size at birth	Litter size at weaning	Litter weight at birth	Birth weight
Breed	100	P≤0.0466*	P≤0.3805NS	P≤0.0685NS	P≤0.0005**
Alpine Malabari	50	2.12±0.16	1.80±0.19	3.90±0.33	1.87±0.15
Boer x Alpine Malabari	50	1.68±0.10	1.58±0.11	3.88±0.20	2.53±0.09
Sires within Breed	100	P≤0.0018**	P≤0.0096**	P≤0.0038**	P≤0.0040**
SireNo:4	9	2.39±0.24	2.01±0.29	4.11±0.50	1.59±0.22
SireNo.8	17	2.19±0.21	1.81±0.25	3.86±0.44	1.66±0.19
Sireno.9	17	1.70 ±0.20	1.23±0.24	3.49±0.43	1.95±0.19
SireNo.10	7	2.17±0.21	1.87±0.25	3.42±0.44	1.69±0.20
Sireno.103	1	1.81±0.55	2.68±0.88	3.89±1.16	3.05±0.52
SireNo.104	12	1.35±0.16	1.22±0.19	3.02±0.33	2.63±0.15
SireNo.106	19	1.73±0.14	1.59±0.17	4.08±0.29	2.52±0.13
SireNo.107	7	1.84±0.23	1.63±0.28	3.43±0.49	2.10±0.22
SireNo.109	11	1.81±0.18	1.68±0.21	4.59±0.38	2.61±0.17
Month of birth	100	P≤0.0000**	P≤0.0514*	P≤0.0000**	P≤0.1770*
January	17	1.78±0.01	1.72±0.17	3.66±0.28	1.97±0.12
February	3	2.16±0.31	1.44±0.37	3.38±0.63	2.24±0.28
April	12	2.05±0.18	1.95±0.22	4.82±0.37	2.33±0.16
May	21	1.97±0.13	1.63±0.16	4.18±0.27	2.30 ±0.12
July	18	2.22±0.16	2.12±0.19	4.72±0.33	2.04±0.14
December	29	1.22±0.14	1.30 ±0.17	2.57±0.29	2.16±0.13
Sex	100	P≤0.2589NS	P≤0.9168NS	P≤0.9626NS	P≤0.9068NS
Male	59	1.96±0.08	1.70 ±0.09	3.88±0.16	2.18±0.07
Female	41	1.84±0.10	1.69±0.12	3.89±0.21	2.17±0.09

Table 4.4 Analysis of variance for the effect of breed, sires within breed, month of birth and sex on bodyweight at first month, bodyweight at second month and bodyweight at third month

Source	Degrees of Freedom	TRAITS		
		Bodyweight At First Month (MSS)	Bodyweight At Second Month (MSS)	Bodyweight At Third Month (MSS)
Breed	1	47.85**	166.93**	262.42**
Sires with in breed	8	7.26**	32.23**	53.08**
Month of birth	5	8.12**	31.11**	38.97**
Sex	1	0.0029 NS	3.77 NS	0.21 NS
Error	84	1.02	3.31	6.15

** $P \leq 0.01$

* $P \leq 0.05$

NS---Non-significant

Table 4.5 Least squares mean partitioning for the effect of the breed, sires within breed, month of birth and sex on bodyweight at first month, bodyweight at second month, bodyweight at third month

Source	No. of observations	Bodyweight at first month	Bodyweight at second month	Bodyweight at third month
Breed	100	P≤0.0000**	P≤0.0759NS	P≤0.0000**
Alpine Malabari	50	2.87±0.34	3.05±0.67	4.30±0.91
Boer x Alpine Malabari	50	6.01±0.20	8.92±0.40	11.65±0.54
Sires within breed	100	P≤0.0000**	P≤0.4310NS	P≤0.0000**
SireNo.4	9	2.53±0.53	2.25±0.96	8.88±0.41
SireNo.8	17	2.44±0.47	2.41±0.84	3.44±1.15
Sireno.9	17	2.65±0.45	1.43±0.81	1.50±1.11
SireNo.10	7	2.39±0.47	2.49±0.84	4.35±1.15
Sireno.103	1	8.94±1.23	17.95±2.22	23.04±3.03
SireNo.104	12	5.76±0.34	8.58±0.62	10.99±0.85
SireNo.106	19	5.96±0.30	8.77±0.55	11.56±0.75
SireNo.107	7	4.78±0.52	5.94±0.94	9.05±1.29
SireNo.109	11	6.39±0.40	9.50±0.72	11.99±0.98
Month of birth	100	P≤0.0000**	P≤0.0000**	P≤0.0004**
January	17	3.85±0.29	6.13±0.57	8.55±0.78
February	3	4.72±0.65	3.83±1.28	6.39±1.74
April	12	5.57±0.38	8.04±0.74	9.80±1.01
May	21	4.69±0.27	6.61±0.54	8.25±0.73
July	18	3.15±0.33	3.99±0.66	5.17±2.89
December	29	4.62±0.29	7.29±0.59	9.68±0.80
Sex	100	P≤0.9455NS	P≤0.4658NS	P≤0.2693NS
Male	59	4.45±0.16	5.79±0.32	7.84±0.44
Female	41	4.43±0.22	6.18±0.43	8.11±0.58

Table 4.6 Analysis of variance for the effect of breed, sires within breed, month of birth and sex on enteritis, respiratory infections and pre-weaning mortality

Source	Degrees of Freedom	TRAITS		
		Enteritis (MSS)	Respiratory Infections (MSS)	Pre-weaning Mortality (MSS)
Breed	1	0.13 NS	0.32*	0.04 NS
Sires with in breed	8	0.15 NS	0.14*	0.99 NS
Month of birth	5	0.15 NS	0.02 NS	0.08 NS
Sex	1	0.24 NS	0.11 NS	0.04 NS
Error	84	0.21	0.06	0.05

** $P \leq 0.01$
* $P \leq 0.05$
NS---Non-significant

Table 4.7 Least Squares Mean Partitioning for the effect of the Breed, sires within breed, month of birth and sex on Enteritis, Respiratory Infections and Pre-weaning Mortality

Source	No. of observations	Enteritis	Respiratory Infections	Pre-weaning Mortality
Breed	100	P≤0.4259NS	P≤0.0350*	P≤0.4163NS
Alpine Malabari	50	0.39 ± 0.15	0.24 ± 0.09	0.15 ± 0.08
Boer x Alpine Malabari	50	0.55 ± 0.09	0.02±0.05	0.06±0.05
Sires within breed	100	P≤0.6665NS	P≤0.0401*	P≤0.1036NS
SireNo:4	9	0.27 ± 0.24	0.09±0.14	0.11±0.13
SireNo.8	17	0.31 ± 0.21	0.06 ± 0.12	0.11 ± 0.11
Sireno.9	17	0.55 ± 0.20	0.36 ± 0.12	0.35 ± 0.10
SireNo.10	7	0.25 ± 0.21	0.26 ± 0.12	0.10 ± 0.11
Sireno.103	1	0.60 ± 0.56	0.00 ± 0.31	0.42 ± 0.29
SireNo.104	12	0.38 ± 0.16	0.01 ± 0.08	0.07 ± 0.08
SireNo.106	19	0.58 ± 0.14	0.00 ± 0.07	0.08 ± 0.07
SireNo.107	7	0.63 ± 0.24	0.03 ± 0.13	0.09 ± 0.12
SireNo.109	11	0.60 ± 0.18	0.00 ± 0.10	0.08 ± 0.09
Month of birth	100	P≤0.2334NS	P≤0.9197NS	P≤0.1613NS
January	17	0.53 ± 0.13	0.15 ± 0.08	0.03 ± 0.07
February	3	0.87 ± 0.29	0.17 ± 0.17	0.35 ± 0.16
April	12	0.41 ± 0.17	0.14 ± 0.10	0.04 ± 0.09
May	21	0.43 ± 0.12	0.01 ± 0.07	0.15 ± 0.06
July	18	0.41 ± 0.15	0.13 ± 0.09	0.04 ± 0.08
December	29	0.18 ± 0.13	0.05 ± 0.08	0.02 ± 0.07
Sex	100	P≤0.2974NS	P≤0.1089NS	P≤0.3189NS
Male	59	0.52 ± 0.07	0.06 ± 0.04	0.13 ± 0.04
Female	41	0.42 ± 0.10	0.15 ± 0.06	0.08 ± 0.05

Table 4.8 Analysis of variance for the effect of breed, sires within breed, month of birth and sex on bodyweight at fourth month, bodyweight at fifth month and bodyweight at sixth month

Source	Degrees of Freedom	TRAITS		
		Bodyweight at fourth month (MSS)	Bodyweight at fifth month (MSS)	Bodyweight at sixth month (MSS)
Breed	1	300.00**	475.58**	585.55**
Sires with in breed	8	67.95**	87.028**	108.58**
Month of birth	5	61.98**	70.40**	80.68**
Sex	1	0.00027 NS	0.0074 NS	2.28 NS
Error	84	7.51	16.34	21.83

** $P \leq 0.01$
* $P \leq 0.05$
NS---Non-significant

Table 4.9 Least Squares Mean Partitioning for the effect of the Breed, sires within breed, month of birth and sex on Body weight at 4th, 5th & 6th months

Source	No. of observations	Bodyweight at fourth month	Bodyweight at fifth month	Bodyweight at sixth month
Breed	100	P≤0.0000**	P≤0.0000**	P≤0.0000**
Alpine Malabari	50	5.76±1.03	5.84±1.40	6.81±1.611
Boer x Alpine Malabari	50	13.62±0.62	15.74±0.83	17.79±0.96
Sires within Breed	100	P≤0.0000**	P≤0.0000**	P≤0.0000**
SireNo:4	9	5.87±1.45	7.21±2.13	8.46±2.46
SireNo.8	17	5.04±1.27	6.38±1.87	7.03±2.16
Sireno.9	17	3.00±1.23	3.81±1.81	4.59±2.09
SireNo.10	7	5.17±1.30	3.91±1.89	4.78±2.18
Sireno.103	1	26.40±3.35	27.57±4.93	31.81±5.70
SireNo.104	12	13.67±0.95	15.26±1.40	17.40±1.62
SireNo.106	19	13.30 ±0.84	14.70 ±1.24	16.62±1.43
SireNo.107	7	8.99±1.43	12.03±2.10	13.52±2.43
SireNo.109	11	14.20±1.08	16.37±1.60	18.31±1.85
Month of birth	100	P≤0.0000**	P≤0.0096**	P≤0.0046**
January	17	11.82±0.89	12.25±1.20	13.93±1.38
February	3	5.61±1.97	5.45±2.66	6.23±3.07
April	12	12.11±1.15	12.27±1.55	13.40 ±1.78
May	21	9.10 ±0.84	10.76±1.13	12.32±1.30
July	18	7.98±1.02	9.12±1.38	11.01±1.59
December	29	11.52±0.90	14.87±1.22	16.89±1.41
Sex	100	P≤0.8712NS*	P≤0.7877NS	P≤0.6080NS
Male	59	9.72±0.50	10.92±0.67	12.57±0.77
Female	41	9.67±0.66	10.66±0.89	12.02±1.02

Table 4.10 Analysis of variance for the effect of breed, sires within breed, month of Birth and sex on average daily gain (0-3 month), average daily gain (3-6 month), average daily gain (0-6 month)

Source	Degrees of Freedom	TRAITS		
		Average daily gain (0-3) (MSS)	Average daily gain (0-6) (MSS)	Average daily gain (3-6) (MSS)
Breed	1	23253.15 **	1885.42 NS	13500.19**
Sire within breed	8	2338.53 **	607.26 NS	4262.58**
Month of birth	5	4333.97**	5858.09**	2337.61 **
Sex	1	2.26 NS	313.78 NS	516.93 NS
Error	84	483.65	548.98	418.48

** $P \leq 0.01$
* $P \leq 0.05$
NS---Non-significant

Table 4.11Least squares mean partitioning for the effect of the Breed, Sires within breed, month of birth and sex on Average daily gain (0-3), Average daily gain (3-6) and Average daily gain (0-6)

Source	No. of observations	Average daily gain(0-3)	Average daily gain(3-6)	Average daily gain(0-6)
Breed	100	P≤0.0000**	P≤0.0759NS	P≤0.0000**
Alpine Malabari	50	35.19 ± 7.35	48.57 ± 8.08	33.85 ± 6.83
Boer x Alpine Malabari	50	104.39 ± 4.39	58.27 ± 4.83	86.58 ± 4.08
Sires wthin breed	100	P≤0.0000**	P≤0.4310NS	P≤0.0000**
Sire No.4	9	32.52 ± 10.49	56.56 ± 12.90	37.47 ± 10.44
Sire No.8	17	25.29 ± 9.20	47.70 ± 11.30	28.93 ± 9.15
Sire No.9	17	12.61 ± 8.90	41.98 ± 10.94	20.27 ± 8.85
Sire No.10	7	34.73 ± 9.29	44.29 ± 11.42	30.65 ± 9.24
Sire No.103	1	200.22 ± 24.29	98.08 ± 29.85	150.54 ± 24.16
Sire No.104	12	96.44 ± 6.88	70.83 ± 8.16	85.06 ± 6.84
Sire No.106	19	104.89 ± 6.09	65.38 ± 7.49	82.57± 6.06
Sire No.107	7	82.05 ± 10.34	51.73 ± 12.71	69.39 ± 10.29
Sire No.109	11	108.22 ± 7.87	71.08 ± 9.68	90.54 ± 7.83
Month of birth	100	P≤0.0000**	P≤0.0000**	P≤0.0004**
January	17	74.35 ±6.29	73.30 ±4.83	68.52 ±5.85
February	3	64.23 ±13.10	11.29 ± 15.39	32.25 ± 13.02
April	12	85.18 ± 8.13	77.51 ± 8.94	66.49 ± 7.56
May	18	73.61 ±5.94	38.40 ±6.53	58.64 ±5.53
July	29	36.92 ± 7.23	75.50 ± 7.96	51.87 ± 6.73
December	21	84.48 ± 6.42	74.52 ± 7.06	83.50 ± 5.97
Sex	100	P≤0.9455NS	P≤0.4658NS	P≤0.2693NS
Male	59	69.63 ± 4.65	60.28 ± 3.88	62.60 ± 3.28
Female	41	69.95 ± 4.66	56.56 ± 5.12	57.83 ± 4.33

Table 4.12 Heritability estimates of litter traits, growth and pre-weaning mortality among crossbred goats

Traits	Heritability	Standard Error
Litter size at birth	0.32	0.15
Litter size at weaning	0.73	0.42
Litter weight at birth(kg)	0.14	0.11
Birth weight(kg)	0.28	0.15
Body weight at first month (kg)	0.59	0.17
Bodyweight at second month (kg)	0.71	0.17
Bodyweight at third month (kg)	0.66	0.17
Bodyweight at fourth month (kg)	0.67	0.16
Bodyweight at fifth month (kg)	0.47	0.17
Bodyweight at sixth month (kg)	0.45	0.16
Enteritis	0	
Respiratory infections	0.17	0.13
Pre-weaning mortality	0.34	0.34
Average daily gain1 (0-3) (g)	0.48	0.29
Average daily gain2 (3-0) (g)	0.08	0.23
Average daily gain3 (0-6) (g)	0.34	0.15

Table 4.13 Phenotypic correlation

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Litter size at birth (1)	1															
Litter size at weaning (2)	0.796**	1														
Litter weight at birth (3)	0.585**	0.409**	1													
Birth weight (4)	-0.458**	-0.362**	0.178	1												
Body weight at first month (5)	-0.364**	-0.218*	0.173	0.809**	1											
Body weight at second month (6)	-0.219*	0.071	0.147	0.626**	0.810**	1										
Body weight at third month (7)	-0.112	0.206*	0.170	0.510**	0.708**	0.937**	1									
Body weight at fourth month (8)	-0.157	0.176	0.092	0.492**	0.692**	0.915**	0.949**	1								
Body weight at fifth month (9)	-0.116	0.170	0.077	0.382**	0.608**	0.766**	0.825**	0.830**	1							
Body weight at sixth month (10)	-0.123	0.169	0.064	0.385**	0.605**	0.763**	0.821**	0.823**	0.986**	1						
Enteritis (11)	-0.166	0.032	-0.165	-0.057	-0.502	0.002	-0.018	-0.037	0.007	0.010	1					
Respiratory infections (12)	-0.106	-0.179	-0.167	-0.084	-0.206*	-0.235*	-0.326**	-0.312**	-0.347**	-0.329**	0.038	1				
Pre-weaning mortality (13)	-0.101	-0.547**	-0.003	0.11	-0.206	-0.452**	-0.588**	-0.594**	-0.540**	-0.548**	-0.135	0.263**	1			
Average daily gain (0-3) (14)	-0.108	0.101	0.189	0.531**	0.765**	0.916**	0.963**	0.898**	0.779**	0.769**	-0.067	-0.301**	-0.371**	1		
Average daily gain (3-6) (15)	-0.072	0.170	0.004	0.22*	0.326**	0.472**	0.498**	0.618**	0.499**	0.562**	-0.073	-0.190	-0.190**	0.399**	1	
Average daily gain (0-6) (16)	-0.774**	0.109	0.054	0.417**	0.665**	0.801**	0.847**	0.850**	0.949**	0.966**	-0.035	-0.330**	-0.330**	0.830**	0.591**	1

** Significant at 1% level * Significant at 5% level

Plate 1 A & B Alpine Malabari X Boer crosses six months of age

Fig.2 BODY WEIGHTS OF CROSSBRED GOATS

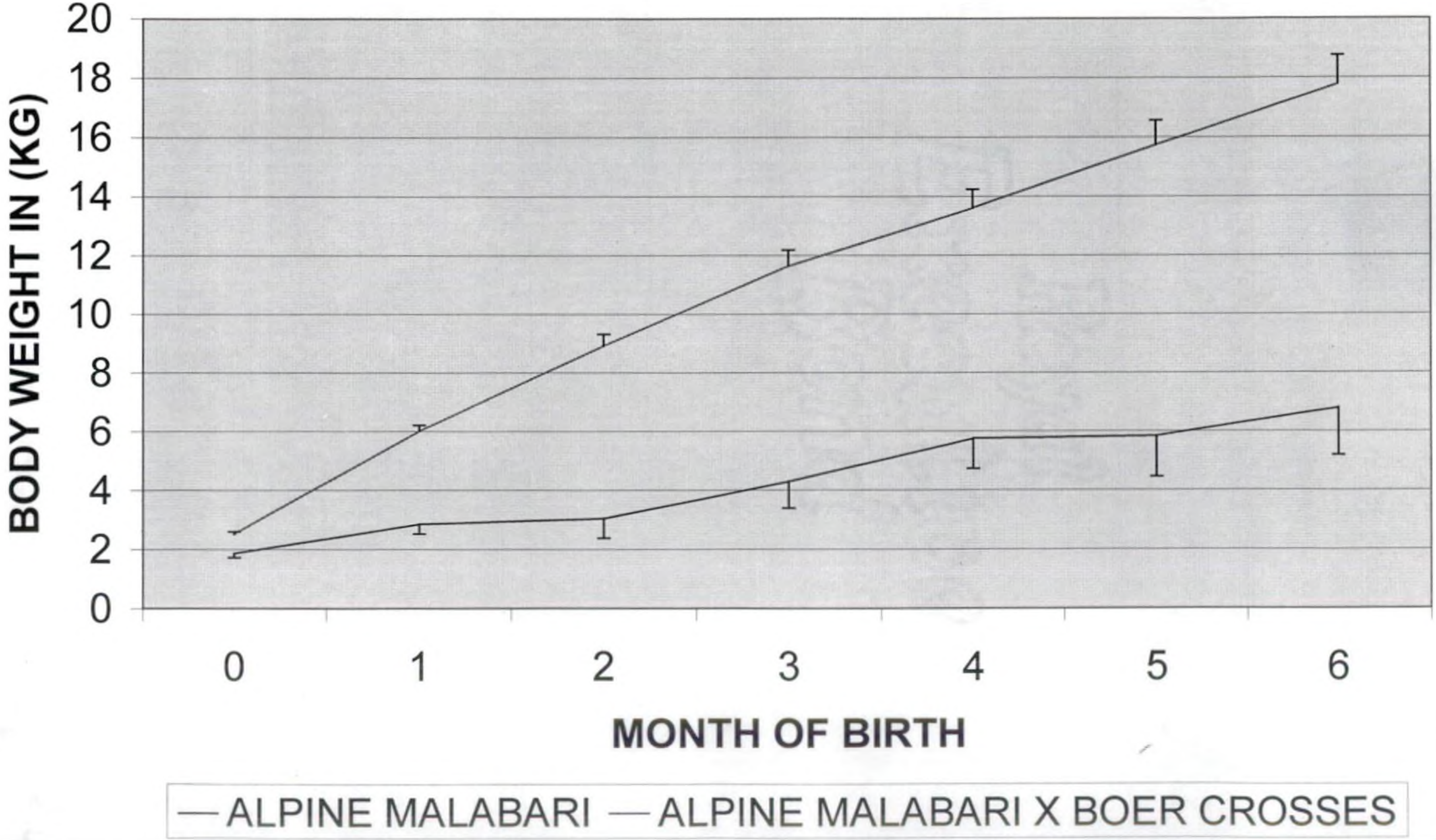
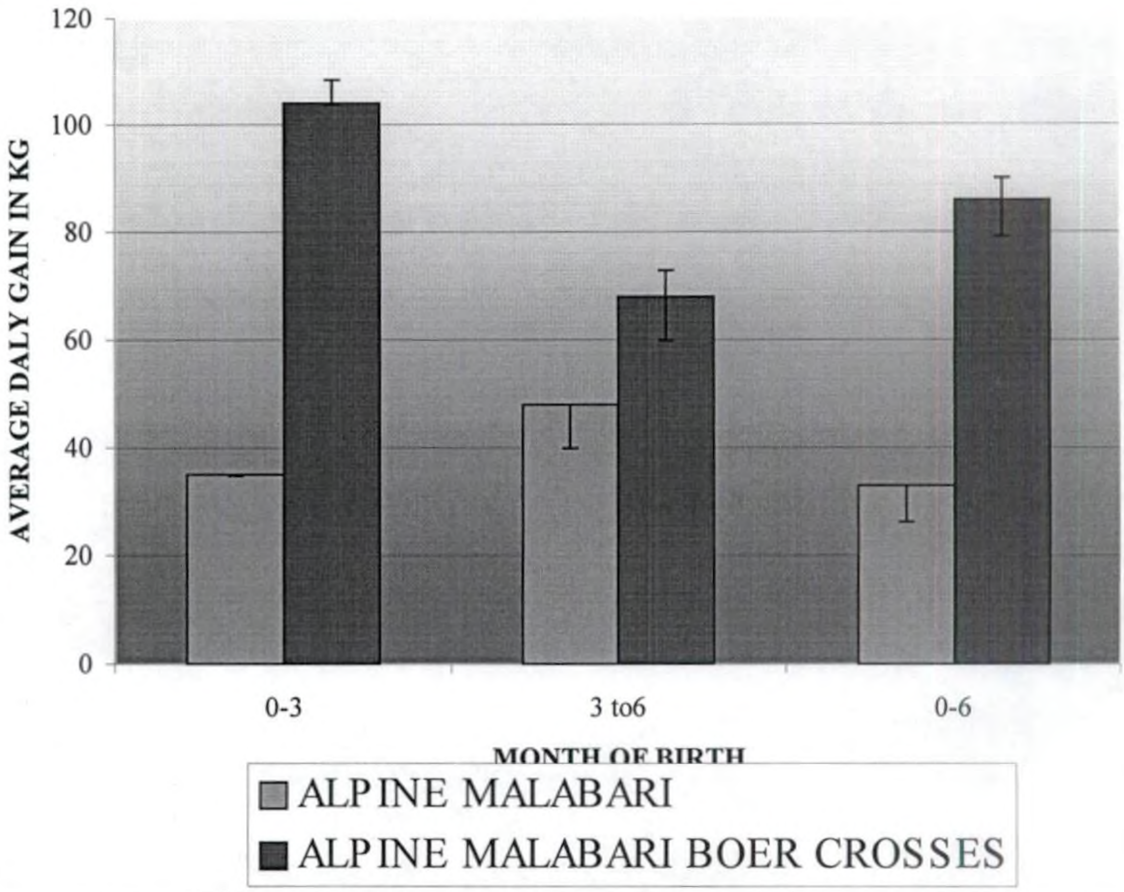


Fig .3 AVERAGE DAILY GAIN OF CROSSBRED GOATS



Discussion

DISCUSSION

5.1 LITTER SIZE AND LITTER WEIGHT AT BIRTH

5.1.1 Litter Size at Birth

The overall mean for litter size at birth in Alpine Malabari x Boer cross (AMB) and Alpine Malabari (AM) was 1.79. The high prolificacy rate in Malabari goats with 58.5% incidence of twins and triplets and 42%single births out of 103 kiddings was reported by Shanmughasundaram (1957). Stephen and Rai (1995) recorded the average litter size at birth was 1.4 in Malabari goats and its crosses with Alpine and Saanen breeds .The average litter size at birth in Malabari was 1.98 ±0.081 (Raghavan *et al.*, 1999) and 1.5 ±0.01 (Nandakumar *et al.*, 2003). The mean litter size at birth observed in the present study is in agreement with the litter size of Malabari crosses in Kerala obtained in previous studies and is suggestive of feasibility in utilizing Malabari for improvement in litter size.

Factors Influencing Litter Size at Birth

5.1.1 1 Genetic Group

The mean for litter size at birth in Alpine Malabari x Boer cross (AMB) was 1.68, which was significantly lower compared to 2.12 in Alpine Malabari. The incidence of multiple births increased when the goats of Jamunapari and Barbari was mated to exotic bucks like Alpine and Saanen. The average number of kids born for Barbari was found to be 3.6 ±0.31 and was significantly higher than Jamunapari (Tomar, 1996). The significant effect of genetic group on litter size at birth is in agreement with the reports of Tomar (1996). The higher litter size in Alpine Malabari might be a contribution of adaptability of that genotype which has been acclimatized over longer periods of time in the state. Oestrus synchronization and frozen semen technology in the development of Alpine Malabari x Boer cross might also have influence on litter size which was significantly different from Alpine Malabari kids inspite of the same genetic groups of dams.

5.1.1.2 Sire

The highly significant effect (P≤0.01) of sire, with highest litter size at birth for Sire No.4 in this study emphasizes the genetic factors influencing this trait. The heritability estimate for litter size at birth was 0.318 ± 0.154. Sire had highly significant effect of on litter size of Black Bengal goats (Moulick *et al.*, 1966). Sire had significant influence on litter size on analyzing the records of local and Alpine goats (Mourad, 1996). Nandakumar *et al.* (2003) observed that the sire effects were not significant on litter size at birth. The highly significant influence of sire on litter size at birth in goats is in agreement with the reports of Moulick *et al.* (1966) and Mourad (1996).

5.1.1.3 Month of Birth

Association between month of birth and litter size at birth was highly significant (P≤0.01) with highest litter size at birth was observed during July (2.22) followed by April (2.05) and lowest litter size during December (1.19 ± 0.1697) followed by January (1.78). Litter size of 1.4 in November and April and a litter size of 1.5 in least kidding period were reported by Tomar *et al.* (1995). Arunkumar *et al.* (2001) observed that the month of birth had significant effect on twinning percentage and was found to be 10.4% in most kidding seasons (October –March) and was 29.3% in the least kidding seasons. The highly significant effect of month of birth on litter size at birth is endorsed by the reports of Tomar *et al.* (1995) and Arunkumar *et al.* (2001). The modulation of litter size at birth is indicative of environmental factors like ambient temperature, humidity and sunshine, which might influence the ovulation rate, conception rate and embryonic survival (Nandakumar *et al.*, 2003) and would find potential application in intensive goat production programmes.

5.1.1.4 Sex

Effect of sex on litter size at birth was not significant. Lawer *et al.* (1991) observed that the twins born as female and male combination was more than the combinations of male to male and female to female. According to Tomer (1996) the number of female kids produced by Barbari goats were 1.5and did not differ significantly from the female kid productions of Jamunapari but male kids born were 55.4% higher in Barbari goats than in Jamunapari. The present finding that the sex of the kid had no significant effect on litter size at birth is endorsed by the reports of Lawar *et al.* (1991) and Tomar (1996).

5.1.2 Litter Weight at Birth

The mean for litter weight at birth was 3.774kg. Litter weight at birth obtained in present study is in agreement with the findings of Raghavan *et al.* (1999a) and Nandakumar *et al.* (2003).

Factors Influencing Litter Weight at Birth

5.1.2.1 Genetic Group

The effect of genetic group on litter weight at birth was not significant. Raghavan *et al.* (1999a) observed that the highest litter weight at birth was seen in triplets with a mean of 3.82 kg. The litter weight for singlets was 1.84 ± 0.11 kg and for twins was 3.183 ± 0.107 kg. The non-significant effect of breed on litter weight at birth might be possibly due to the fact that this trait is a property of the dam.

5.1.2.2 Sire

Associations of sire on litter weight at birth were highly significant. Highest litter weight at birth was observed for Sire No. 109 (4.59 kg) followed by Sire No.4 (4.11 kg). Sire No. 104 (3.02 kg) had the lowest litter weight at birth followed by Sire No. 10 (3.42 kg). Heritability estimate for litter weight at birth was 0.14. Nandakumar *et al.* (2003) documented that the effect of sire was not significant on litter weight. Highly significant associations between litter weight at birth and sire in the present study is contradictory to the reports of Nandakumar e*t al.* (2003).

5.1.2.3 Month of Birth

Month of birth exerted a highly significant ($P \leq 0.01$) effect on litter weight at birth. Litter weight at birth was higher in kids born during April (4.82 kg) followed by July (4.72 kg). Lowest litter weight at birth was for kids born in December (2.57 kg) followed by February (3.38 kg). Raghavan *et al.* (1999b) observed that the month of kidding had no significant effect on litter weight at birth. The highly significant effect of month of birth on litter weight at birth is contradictory to the reports of Raghavan *et al.* (1999a). The non- significant effect of season of birth on litter weight is possibly due to the variations in the classifications of seasons.

5.1.2.4 Sex

Sex of the kid was not found to be associated with litter weight at birth. The contribution of sex on litter weight at birth appears to be non- significant.

5.2 PRE-WEANING TRAITS

5.2.1 Birth Weight

Mean birth weight of kids was found to be 2.16 Kg. Haas (1978) compared the growth rate of Boer crosses to indigenous Small East African goats in Kenya and found that the birth weight in Boer goat crosses and Small East African goats were 2.6 kg and 2.3 kg respectively. Mukundan (1980) documented that the birth weight of Malabari kids (1.71 ± 0.06 kg) was lower than that of Saanen halfbreds (1.88 ± 0.1 kg). But the difference in birth weight was not statistically significant. Raghavan (1980) observed that the average birth weight of Malabari was 1.71 ± 0.03 kg and birth weight of Alpine Malabari was 2.04 ±

0.02 kg. Seabo *et al.* (1999) observed that the birth weight of Boer does in South Eastern Bostwana reared under semi-intensive system was 3.2 ± 0.87kg.Though higher birth weight of Alpine Malabari kids in the present study is in agreement with the findings of Raghavan(1980). The higher birth weight might be due to the fact that it is the pooled mean of Alpine Malabari and Boer crosses.

Factors Influencing Birth Weight

5.2.1.1 Genetic Group

Influence of genetic group on birth weight of kids were highly significant ($P \leq 0.01$) The least squares mean for AMB was 2.53kg while that of in Alpine Malabari was 1.87 kg. Haas (1978) found that the birth weight in Boer goat crosses and Small East African goats were 2.6 kg and 2.3 kg respectively in Kenya. Mukundan (1980) documented that the birth weight of Malabari kids (1.71 ± 0.06 kg) was lower than that of Saanen halfbreds (1.88 ± 0.1 kg). Raghavan (1980) observed that the average birth weight of Malabari was 1.71 ± 0.03 kg and birth weight of Alpine Malabari was 2.04 ± 0.02 kg. Birth weight of Alpine Malabari kids in the present study concurs with the reports of Raghavan (1980) and birth weight of Boer crosses is in agreement with the reports of Haas (1978). A Boer superiority in birth weight is evident in this study and introgression of Boer genes into Alpine Malabari increased the birth weight.

5.2.1.2 Sire

Sire differences were highly significant ($P \leq 0.01$) on birth weight and was higher in kids sired by Sire No. 103 (3.05 Kg) followed by Sire No. 104 (2.63Kg). Lowest least square mean for birth weight was in Sire No. 4 (1.59 kg). The heritability estimate for birth weight was 0.28. The pooled value of heritability for two herds of Beetal goats – A and B was 0.19 ± 0.07 in herd A based on 1,195 degrees of freedom and was negative for herd B (Amble *et al.*, 1964). Mukundan (1980) observed that the sire had no significant influence on the birth weights of Malabari and Saanen Malabari. Raghavan (1980) documented that the effect of sire was significant in Alpine Malabari kids but not in Malabari and Saanen Malabari. According to Goonewardene *et al.* (1997) Alpine sired kids were observed to grow 15 per cent faster than Boer sired kids. They documented a 9 per cent increase in birth weight in using Boer sire. Highly significant effect of sire on birth weight is in agreement with the reports of Goonewardene *et al.* (1997).

5.2.1.3 Month of Birth

The influence of month of birth on birth weight was not significant. Highest birth weight was for kids born during April (2.3 3 kg) followed by May (2.30 kg). Lowest birth weight was for kids born during January (1.97 kg) followed by February (2.04 kg). Raghavan (1980) reported that the season of birth had no significant influence on birth weight in Malabari, Alpine Malabari and Saanen Malabari. Mukundan (1980) documented that the month of birth had no significant influence on the birth weights. According to Sanjeevkumar *et al.* (1992) observed that the month of birth had significant influence on birth weight of Jamunapari goats. Mostly kids born in February-April were heavier than those born in other months. According to Singh and Singh (1998) the kids born in monsoon were heavier than kids in winter and summer. Jithendrakumar (2003) documented that the month of birth had no significant effect on birth weight of Malabari kids. However, kids born in July weighed heavier (2.05 ± 0.15 kg) and lowest birth weight was noticed in September (1.58 ± 0.17 kg). The present observation on non-significant effect of month of birth and birth weight agrees with the findings of Raghavan (1980), Mukundan (1980) and Jithendrakumar (2003). This is possibly due to thermal stress, humidity and non-availability of better pasture during the gestation period.

5.2.1.4 Sex

Sex of the kid had no significant influence on birth weight. Birth weight in males and females were 2.18 kg and 2.17 kg respectively. Raghavan (1980) observed that the sex differences were highly significant in Alpine Malabari and Saanen Malabari but not significant in Malabari. According to Sanjeevkumar *et al.* (1992) the sex differences were significant on the birth weight of Jamunapari kids and the males were significantly heavier than females. Gokhale *et al.* (1996) documented that the significant influence of sex on birth weight of nondescript and graded Sirohi kids. Nagpal and Chawla (1984) observed that the male kids of Sirohi goats maintained at Western Regional Research Centre, Avikanagar was significantly heavier than females. According to Jithendrakumar (2003) the analysis of variance revealed that the sex differences were significant on birth weight in Malabari goats. Absence of significant association between sex on birth weight is supported by Raghavan (1980) in Malabari goats. However, Gokhale *et al.* (1996) and Sanjeevkumar *et al.* (1992) found significant contribution of sex on birth weight.

5.2.2 Pre-weaning Body Weight

The overall mean of body weight at first, second and third month for Alpine Malabari x Boer cross and Alpine Malabari was 4.36, 6.31 and 8.27 kg respectively. According to Mukundan (1980) the pre-weaning body weights in Malabari and Saanen Malabari was 4.99 ± 0.19kg and 6.57 ± 0.184 kg respectively. The body weight of Malabari and its Saanen half bred at first month was 2.98 ± 0.09 kg, 3.89 ± 0.09 kg and in second month was 3.96 ± 0.136 kg and 5.19 ± 0.13 kg respectively. According to Raghavan (1980) the mean body weight at one month in Malabari and its halfbreds with Alpine and Saanen was 2.83 ± 0.05 kg, 3.9 ± 0.05 kg and 3.78 ± 0.05 kg respectively. Nagpal and Chawla (1984) recorded the body weight of Alpine and Beetal at 3 months was 9.62 ± 0.36 kg and 8.03 ± 0.20 kg respectively. Mathew *et al.* (1994) reported that the weaning weight of Malabari, Alpine Malabari (AM), Saanen x Malabari (SM), Alpine x AM, Saanen x SM, Alpine x SM and Saanen x AM goats were 5.4 kg, 6.7 kg, 6.6 kg, 6.6 kg, 6.5 kg, 7.2 kg and 6.9 kg respectively. According to Goonewardene *et al.* (1997) the weaning weight of Alpine x Alpine, Alpine x Saanen, Alpine x Spanish, Boer x Alpine, Boer x Saanen and Boer x Spanish were 18.78 kg, 17.86 kg, 15.82 kg, 17.65 kg, 16.1 kg and 14.81 kg respectively. Nimbkar *et al.* (2000) recorded the three month weights of 282 Boer x local kids maintained in the village conditions of Rajasthan and weaning weight in Boer x local kids was 13.1 ± 0.7 kg. The present observation that the body weight at first, second and third month for Alpine Malabari x Boer cross and Alpine Malabari is in agreement with the observations of Mukundan (1980), Raghavan (1980), Mathew *et al.* (1994) and Nimbkar *et al.* (2000) among Boer x local kids. The smaller bodyweights in this study and by Nimbkar *et al.* (2000) in Boer crosses compared to Goonewardene *et al.* (1997) is due to the smaller size of Indian breeds.

Factors Influencing Pre-weaning Body weight

5.2.2.1 Genetic Group

. . The least square mean for body weights at first, second and third month in Alpine Malabari x Boer cross was 6.01 kg, 8.92 kg, and 11.65 kg respectively. Least square mean for body weights at first second and third month in Alpine Malabari was 2.87, 3.05 and 4.30 kg respectively. The breed differences were highly significant. According to Mukundan (1980) the genetic group had significant influence on pre-weaning body weights on analyzing the body weight records on 275 kids of two genetic groups, Malabari and Saanen half breds. It was observed that the Saanen halfbreds were heavier than Malabari at first, second and third month. Raghavan (1980) documented the highly significant effect of breed on body weight at first month. Alpine Malabari had the highest body weight at one month (3.90 ± 0.05 kg) followed by Saanen Malabari (3.78 ± 0.05 kg) and the lowest in Malabari (2.83 ± 0.05 kg). Singh and Singh (1998) analysed the variance for the effect of breed on pre-weaning body weight and was found to be significant for first month and second month. The effect of breed was not significant on the body weight at third month. Beetal x Black Bengal kids were significantly heavier compared to purebred Black Bengal. Highly significant and superior bodyweights of Alpine Malabari x Boer cross over

Alpine Malabari crosses during first, second and third month of study is indicator of feasibility of Boer inheritance to be utilized in improving bodyweight gains in the development of meat strain of goats.This finding is in total agreement with Goonewardene *et al.* (1997) and Nimbkar *et al.* (2000). It might be pertinent to note that bodyweight gains among Alpine Malabari goats in this study was superior to Raghavan (1980) and introgression of Boer genes was found to substantially increase the bodyweights in Alpine Malabari x Boer cross.

5.2.2.2 Sire

Sire influences on first month body weights were highly significant. Body weight at first month was highest for Sire No. 103 (8.94 kg) and lowest in Sire No. 10 (2.39 kg). Sire 103 with a mean of 17.95 kg and was heavier at second month and lowest body weight at second month was found in Sire No.9 (1.43 kg) followed by Sire No. 4 (2.25 kg). The body weight at third month was highest in Sire No. 103 (23.04 kg) and lowest body weight at third month was in Sire No. 9 (1.50 kg). Heritability estimates for body weight at first, second and third month was 0.59, 0.77 and 0.66 respectively. Raghavan (1980) after analyzing the body weights of three genetic groups of goats, Malabari, Alpine Malabari and Saanen Malabari documented that sire had highly significant effect on the body weight of Malabari goats at one month of age. Sire differences were not recorded in the body weights of Alpine Malabari and Saanen Malabari at one month of age. The highest estimate of heritability for bodyweight at first month could be obtained in Malabari (0.329 ± 0.285) followed by that in Alpine Malabari (0.13 ± 0.23). For Saanen Malabari the heritability was found to be zero. According to Mehta *et al.* (1997) the heritability estimate for the body weight at third month in Sirohi goats was 0.26 ± 0.13. Nimbkar *et al.* (2000) observed that the effect of sire was significant on pre-weaning weight the body weight of Boer x local kids from birth up to sixth months of age. The significant effect of sire on bodyweight gain obtained in this study is endorsed by the reports of Raghavan (1980), Mehta *et al.* (1997) and Nimbkar *et al.* (2000).

5.2.2.3 Month of Birth

The influence of month of birth on pre-weaning bodyweights was highly significant with kids born during April (5.57 kg) with the highest body weight at first month followed by May (4.72 kg) and lowest was in July (3.15 kg).

The kids born during December with a least square mean of 8.04 kg was heavier at second month and lowest body weight at second month was for kids born during February (3.83 kg). The body weight at third month was more in kids born during April (9.80 kg) and was lowest during July (5.17). Mukundan (1980) concluded that the effect of month of birth was significant on body weight at second and third month only. Kids born in March to September had the maximum weights at second and third month.

Raghavan (1980) concluded that the effect of month of birth was not significant on body weight at first month on analyzing the body weight of 1227 kids from birth to 12 months of age in Malabari kids and its halfbreds with Saanen and Alpine. Malik *et al.* (1986) observed that the month was significant on body weight at third month. Mostly kids born in February-April were heavier than those born in other months. Tyagi *et al.* (1992) recorded that the influence of month of kidding had significant effect on pre-weaning body weights. Kids born during October – December were significantly heavier than those born during March – May. Malik *et al.* (1993) observed that the effect of month of birth was highly ($P<0.01$) significant on first month body weight. Month of birth was significant ($P<0.05$) on body weight at second and third month. Sharma *et al.* (1995) concluded that the month of birth had no significant influence in pre-weaning bodyweights in Jamunapari kids. Das *et al.* (1995) reported that the season of birth had significant influence on body weight at pre-weaning stages. Kids born in October-February weighed higher than those born during March – September. Singh and Singh (1998) observed that the month of birth of the kids had no significant influence on the body weight at first, second and third month on analyzing the body weights of 160 Black Bengal kids and 146 Beetal x Black

Bengal kids in the plateau region of Bihar. Taparia *et al.* (1999) analysed the body weight and growth rate from birth to 360 days of age of goats of Araveli region in Rajasthan and documented that the influence of season of birth was highly significant on pre-weaning body weight. The significant contribution of sire on body weight is supported by the study of Malik *et al.* (1986), Tyagi *et al.* (1992), Malik *et al.* (1993), Das *et al.* (1995)and Taparia *et al.* (1999) .The significant influence of the season might indirectly be a contribution of ambient temperature, its role in thermal stress and availability of natural vegetation and biomass to the does during the pre-weaning period.

5.2.2.4 Sex

Variance components for the influence of sex on pre-weaning bodyweights were not significant on analysis. The mean for males at first, second and third month were 4.43 kg, 5.79 kg and 7.84 kg respectively. The mean for females at first, second and third month were 4.65 kg, 6.18 kg and 8.11kg respectively. Mukundan (1980) documented that the effect of sex was significant on body weights at first, second and third month of age. Males were found to be heavier than females at all ages.

Raghavan (1980) analysed the data pertaining to 1227 kids belonging to Malabari, Saanen x Malabari and Alpine x Malabari during the period from April 1974 to March 1979 maintained in Kerala Agricultural University Goat and Sheep Farm, Mannuthy for the effects of genetic and non-genetic factors on body weight from birth up to 12 months of age. According to Taneja *et al.* (1992) the influence of sex was not significant on body weight at third month and recorded an average body weight of 9.91 kg in Marwari type goats. Sheikh *et al.* (1996) concluded that the sex of the kid had no significant influence on weaning weight and average weaning weight was 8.34 ± 0.01 kg in Changthangi kids. Significant influence of sex of the kids on body weight at first and second month was documented by Singh and Singh (1998). Male kids weighed heavier than females at all ages but the differences were not significant for weights at birth. Sex of the kid was not found to influence the bodyweights during the pre-weaning period and is in agreement with Taneja *et al.* (1992) in Marwari and Sheikh *et al.* (1996) in Changthangi kids

5.3 INCIDENCE OF NEONATAL DISEASES, PRE-WEANING MORTALITY AND LITTER SIZE AT WEANING

The mean of enteritis was 0.39 and the mean respiratory infections were 0.08. The mean of pre-weaning mortality was 0.07. The overall mean for litter size at weaning in Alpine Malabari x Boer cross (AMB) and Alpine Malabari (AM) was 1.67. Pneumonia, debility and Enteritis were higher in Sirohi goats than in Beetal x Sirohi kids. Kid mortality is comparatively high during pre-weaning period (Gupta and Sangar, 1985).

Sanyal *et al.* (1987) analysed the data on 216 Malabari kids maintained at Southern Regional Research Centre, Mannavarur and highest mortality (17.3%) was recorded during the first month of age. The mortality percentage decreased with the advancement of age and recorded 3.24% at three months of age. Pre-weaning mortality rate in the present study was significantly lower than that reported by Sanyal *et al.* (1987) in Malabari kids maintained at Mannavarur.This might be due to the climatic and manage mental variations.

Factors Influencing Incidence of Neonatal Diseases, Pre-weaning Mortality and Litter Size at Weaning

5.3.1 Genetic Group

Breed differences were significant ($P \leq 0.05$) on respiratory infections and not significant on enteritis. The incidence of respiratory infections for Alpine Malabari x Boer cross (AMB) cross was 0.02. The incidence of respiratory infections in Alpine Malabari was 0.24.The incidence of enteritis for Alpine Malabari x Boer cross (AMB) cross was 0.55. The incidence of enteritis in Alpine Malabari was 0.38. Breed differences were not significant on pre-weaning mortality. Pre-weaning mortality for Alpine Malabari x Boer cross (AMB) cross was observed to be 0.06 and Alpine Malabari was 0.15. The influence of breed on litter size at weaning of kids was highly significant ($P \leq 0.01$). The litter size at weaning in Alpine Malabari was 1.80 compared to Alpine Malabari x Boer cross, 1.58. Mittal, (1976) observed that the mortality rates in kids were highest in age group below 1 month. Major disease encountered were mainly Pneumonia, Enteritis and these two accounts for about two-thirds of the death in Barbari and three-fourth of deaths in Jamunapari According to Malik *et al.* (1990) mortality rate decreased in crossbred kids than in purebreds. The major diseases observed was Pneumonia and Gastroenteritis in Beetal, Black Bengal and their reciprocal crosses Obidu *et al.* (1995) observed that the mortality rate were highest in the Red Sokoto goats (92.3%) intermediate in the West Africa Dwarf Goats (89.8%) and least among its crosses (32%). Pneumonia (35.6%), Helminthosis (9.7%) and Starvation (9.9%) were the most common causes of disease. Tomar *et al.* (1999) documented that mortality rate in purebred Beetal female kids were higher than crossbred female kids of Beetal x Alpine and Beetal x Saanen kids. Nimbkar *et al.* (2000) concluded 5% mortality in Boer crosses maintained in the village conditions of Maharastra. The incidence of pre-weaning mortality and incidence of disease was not found to modulated by breed in this study. However litter size at weaning among Alpine Malabari was significantly higher over Alpine Malabari x Boer crosses.The results of this study are in conformity with Tomar *et al.* (1999) and Nimbkar *et al.* (2000). Alpine Malabari superiority at litter size at weaning reflects the higher litter size at birth of genetic group inspite of higher pre-weaning mortality in Alpine Malabari crosses.

5.3.2 Sire

Sire differences were significant on respiratory infections ($P \leq 0.05$) and was not significant on enteritis. The respiratory infections were more in Sire No. 9 (0.36). Respiratory infections were lower in Sire No. 103.The enteritis was more in Sire No. 107 (0.63). Enteritis was lower in Sire No. 10 (0.25) even though there exists no significant differences. Roy *et al.* (1995) observed that the differences among sire progeny groups were significant at all ages. Tomar *et al.* (1999) observed that the effect of buck was significant on mortality. Sire differences were not significant on pre-weaning mortality. The pre-weaning mortality was more in Sire No. 103 (0.42). Pre-weaning mortality was lower in Sire No. 109 (0.08) even though there exists no significant differences. The effect of sire on litter size at weaning was highly significant ($P \leq 0.01$). Sire No.103 with mean of 2.68 had the largest litter weaned. Lowest litter size at weaning was for sire No. 104 (1.22). The heritability estimate for litter size at weaning was 0.73.Significant effect of the buck on litter size at weaning in the present study is endorsed by the reports of Roy *et al.*(1995) and Tomar *et al.* (1999).This has wider ramification for buck selection for the improvement of litter size at weaning.

5.3.3 Month of Birth

Month of birth had no significant influence on respiratory infections and enteritis. Even though there exists no significant differences respiratory infections and enteritis was more in kids born during February (0.17 and 0.87respectively). Respiratory infections were lesser during May (0.01). The enteritis was lower during December (0.18).

Month of birth had no significant influence on pre-weaning mortality. Even though there exists no significant differences pre-weaning mortality was more in m kids born during February (0.35) and was lowest during December (0.02). The influence of month of birth on litter size at weaning was significant ($P \leq 0.05$). Highest litter size at weaning was for kids born during July (2.12). Lowest litter size at weaning was for kids born during December (1.30). Khan *et al.* (1978) and Mazumdar *et al.* (1980) observed that month of birth had significant influence on pre-weaning mortality. Malik *et al.* (1990) observed highest mortality in September to November months in Black Bengal goats on analyzing the mortality pattern in Beetal and Black Bengal goats and their reciprocal crosses. According to Singh *et al.* (1994) month of birth had significant effect on pre-weaning mortality of Jamunapari and Black Bengal kids. The influence of month of birth on litter size at weaning is in agreement with Malik *et al.* (1990) and Singh *et al.* (1994). Adverse climatic conditions might predispose the neonatal kids to enteritis and respiratory infections interfering with litter size at weaning. This pattern necessitates appropriate modification of management practices over pre-weaning mortality.

5.3.4 Sex

Association between sex ,enteritis and respiratory infections was not significant. The mean for enteritis in males and females were 0.52 and 0.42 respectively. The mean for respiratory infections in males and females were 0.06 and 0.15 respectively.

Association between sex and pre-weaning mortality was not significant .The mean in males and females were 0.13 and 0.15 respectively. Sex of the kid was not found to be associated with litter size at weaning. The litter sizes at weaning in males were 1.70 and in females were 1.69. Analysis of variance components for the influence of sex on pre-weaning mortality were not found to be significant by Mittal (1976). But Sanyal *et al.* (1987) observed that sex had significant influence on pre-weaning mortality. Malik *et al.* (1990) analysed the data on 1205 kids of Black Bengal and Beetal and their reciprocal crosses and documented that sex had no significant effect on mortality. The non-significant effect of sex with enteric and respiratory infections ,pre-weaning mortality and litter size at weaning obtained in this study is in agreement with Mittal (1976), Sanyal *et al.* (1987)and Malik *et al.* (1990).

5.4 POST-WEANING BODY WEIGHT

The overall mean of body weight at fourth, fifth and sixth month for Alpine Malabari x Boer cross and Alpine Malabari was 10.34kg, 11.96 kg and 13.68 kg respectively. Haas (1978) had compared the growth rate of Boer goat crosses to that of indigenous Small East African goats in Kenya. He documented that the body weight of Boer goat crosses and Small East African goats at 150 days were 19.7 kg and 14.9 kg respectively. The body weight at 180 days in Boer goat crosses and Small East African goats were 21.8 kg and 16.2 kg respectively. Sharma and Das (1995) documented that the body weight of Jamunapari at sixth month of age in intensive system was 15.54 ± 0.41 kg. Stephen and Rai (1995) documented that the body weight at six months in Purebred Malabari, Alpine x Malabari (AM), Saanen x Malabari (SM), Alpine x AM, Saanen x SM and Saanen x AM were 9.3 ± 0.16 kg, 10.9 ± 0.11 kg, 11.3 ± 0.14 kg, 10.8 ± 0.39 kg, 6.9 ± 0.34 kg, 11.4 ± 0.34 kg and 11.2 ± 0.38 kg respectively. Nimbkar *et al.* (2000) documented that the live weight at 6 months in Boer x local kids were 20.8 ± 1.9 and it was only 14.7 ± 0.9 kg in local 4.07 ± 0.05 kg in Osmanabadi and 10.06 ± 0.39 kg in Sangamneri. The result of the study on the body weight at fourth, fifth and sixth month among crossbred kids is in agreement with Haas (1978) and Nimbkar *et al.* (2000) on the increase in bodyweight by utilizing Boer bucks.

Factors Influencing Post-weaning Body Weight

5.4.1 Genetic Group

Breed differences were highly significant ($P \leq 0.01$) on post-weaning body weights. Body weight at fourth, fifth and sixth month for Alpine Malabari x Boer cross was observed to be 13.62kg, 15.73 kg, and 17.79 kg respectively. The body weight at fourth, fifth and sixth month in Alpine Malabari was 5.76kg, 5.84 kg and 6.81kg respectively. Mukundan (1980) analysed the data on the body weights of Malabari and observed that the effect of genetic group was highly significant at fourth, fifth and sixth month. Raghavan (1980) found that the body weight at 4th month in Malabari, Alpine Malabari and Saanen Malabari was 6.00 ± 0.15 kg, 9.92 ± 0.19 kg and 7.75 ± 0.14 kg respectively. The crossbreds of Malabari weighed significantly higher at 6 months of age than the Purebred Malabari. Body weights of crossbreds varied but the differences existed between crossbreds was not significant (Stephen and Rai, 1995). Singh (2002) documented that the effect of genetic group was significant on body weight at sixth months. Bodyweights of Alpine Malabari kids obtained in this present study is in agreement with Raghavan (1980) and Stephen and Rai (1995). The increase in bodyweights subsequent to introduction of Boer inheritance obtained in this study are in agreement with Haas (1978) and Nimbkar *et al.* (2000), who could find that there was a substantial increase in bodyweights of indigenous Small East African goats in Kenya and local goats of Maharastra upon crossing with Boer inheritance.

5.4.2 Sire

Analysis of variance components for the influence of sire were significant ($P \leq 0.01$) on post-weaning body weights. Body weight at fourth month was highest for Sire No. 103 (26.40 kg) followed by Sire No. 109((14.20 kg). Least square means was lowest in Sire No. 9 (3.00kg) followed by Sire No. 8 (5.04 kg).

Sire 103 with a least square mean of 27.57 kg was heavier at fifth month and is followed by Sire No. 10 (16.37 kg). Least body weight at fifth month was found in Sire No.9 (3.81 kg) followed by Sire No. 10 (3.91kg) .The body weight at sixth month was more in Sire No. 103 (31.81 kg) followed by Sire No. 109 (18.31 kg). Lowest body weight at sixth month was in Sire No. 9 (14.59 kg) followed by Sire No. 10 (4.78 kg).

Heritability estimates for body weight at fourth, fifth and sixth month was 0.66 ± 0.17, 0.48 ± 0.17 and 0.451± 0.17 respectively. Raghavan (1980) observed that the sire difference were highly significant for Malabari at fourth month of age. Mukundan (1980) recorded that the sire differences were significant in Malabari for bodyweights at fourth, fifth and sixth month. According to Mehta *et al.* (1997) the heritability estimate of body weight at sixth month in Sirohi goats were 0.30 ± 0.19. Roy *et al.* (1997) concluded that the heritability for body weight at six month was determined by paternal – half-sib method and was estimated as 0.51 ± 0.12. Singh (1997) estimated the heritability of body weight at sixth month by paternal half-sib method. It was observed that the heritability estimate of body weight at sixth month was 0.58 ± 0.09 and was medium to moderate. Nimbkar *et al.* (2000) recorded that the sire differences were not significant on body weight. Significant effect of sire on bodyweights at body weight at fourth, fifth and sixth month in present study are in agreement with Mukundan (1980), Mehta *et al.* (1997)and Singh (1997) . This points into the importance of buck selection in improving the bodyweights.

5.4.3 Month of Birth

Month of birth had highly significant influence on body weight at fourth, fifth and sixth month ($P \leq 0.01$). The kids born during April (12.11 kg) had the highest body weight at fourth month and lowest was in February (5.61 kg)

The kids born during December 14.87kg were heavier at fifth month and lowest body weight at fifth month was for kids born during February (12.27 kg). The body weight at sixth month was more in kids born during December (16.89 kg). Body weight at sixth month was lowest during February (6.23 kg). Raghavan (1980) observed that the season of birth was highly significant in all the three genetic groups. Mukundan (1980) reported the season of birth was significant on body weight at sixth month only.

Sharma and Das (1995) recorded that the kids born during October – February were heavier than those born during March – September at all post-weaning ages, the differences being significant at sixth month of age. Stephen and Rai (1995) studied the impact of crossbreeding of Malabari goats with Alpine and Saanen breeds on bodyweights at 6 months of age. Kids of Malabari and its crosses with Alpine and Saanen born during 1974-1988 at the All India Co-ordinated Research Project on Goats. . He observed that the winter born kids had a significantly higher body weight at sixth month (11.3 ± 0.14 kg) than those born in summer (10.7 ± 0.14 kg) and rainy season (10.6 ± 0.16 kg).

Gokhale *et al.* (1996) observed that the effect of month of birth was highly significant in post-weaning period up to six months of age kids born during February to June showed lower body weights compared to those born between September and January. Mehta *et al.* (1997) documented that the effect of season of kidding was highly significant in all post-weaning ages. Taparia *et al.* (1999) found that the month of birth were significant on body weight at sixth month. The kids born in summer were significantly heavier than those born during rainy and winter season. Modulation of body weight at fourth, fifth and sixth month by the month of birth obtained in this study is supported by Sharma and Das (1995), Stephen and Rai (1995) and Taparia *et al.* (1999). Environmental factors like thermal stress, availability of biomass might have modified the growth rate and would be used in semi- intensive goat production.

5.4.4 Sex

Association between sex and post-weaning body weights was not significant. The mean for males at fourth, fifth and sixth month were 9.72 kg, 10.92 kg and 12.57 kg respectively while in females it was 9.67 kg, 10.66 kg and 12.02 kg during fourth, fifth and sixth month respectively. Raghavan (1980) analysed the data on the bodyweights of Saanen halfbreds and Malabari kids and Alpine halfbreds for the effect of sex on bodyweight at fourth month. He documented that the sex was significant in Saanen halfbreds only. Mukundan (1980) observed that the sex was significant at fourth month only. Males weighed heavier than females in both genetic groups.

According to Nagpal and Chawla (1984) the influence of sex on bodyweight at six month was not significant in Alpine and Beetal goats. Taneja *et al.* (1992) observed that the sex had no significant influence on the body weight at six months. According to Stephen and Rai (1995) the sex differences were not significant on the body weight at sixth month of Malabari and its crosses with Alpine and Saanen. Singh and Singh (1998) observed that the influence of sex was significant ($P<0.01$) on body weights at fourth, fifth and sixth month. Male kids weighed heavier than females during post-weaning period. Roy *et al.* (2001) documented that the sex had significant influence on the body weight at sixth month. Males (15.95 ± 0.22 kg) were significantly heavier than females (13.7 ± 0.31 kg). Sex of the kid was not found to influence the post-weaning body weights. This in concordance with the findings of Taneja *et al.* (1992), Stephen and Rai (1995) and not in agreement with Roy *et al.* (2001).

5.5 AVERAGE DAILY GAIN IN BODY WEIGHT

The average daily gain from birth to third month was 71.36 g. The mean and standard error of average daily gain from third to six month was 65.70 g. The average daily gain from birth to sixth month was 66.89 g. Haas (1978) found that the average daily gain was significantly better in the Boer goat crosses than in the indigenous Small East African goats. The average daily gain from birth to weaning in Boer goat crosses and in Small East African goats were 114g and 84g respectively. The average daily gains from weaning to 360 days in Boer goat crosses and Small East African goats were 65g and 32g respectively. Barry and Godke (1991) observed that the average daily gain after 100 days in singles, twins and triplets in Namibia were 230 g, 237 g and 218 g respectively and is in agreement with present study.

Factors Influencing Average Daily Gain in Body Weight

5.5.1 Genetic Group

Effect of genetic group on average daily gain from birth to third month and from birth to sixth month was highly significant ($P \leq 0.01$) while the influence of breed on average daily gain from third to sixth month was not significant. Average daily gain from birth to third month and from birth to sixth month in Alpine Malabari x Boer cross was 104.39g and 86.58 g respectively while average daily gain from birth to third month and from birth to sixth month in Alpine Malabari was 35.19g and 33.85 g respectively. According to Nimbkar *et al.* (2000) the crossbreeding of local goats in Maharashtra with the Boer goats observed to have a growth rate from birth to 3 months was 130.4 ± 8.3 g/day and from birth to 6 months was 126.6 ± 11.2 g. The growth rate from birth to three months in Osmanabadi and Sangamneri were 55 g and 60 g respectively. The growth rate from birth to six months in Osmanabadi and Sangamneri were 48 g and 46 g respectively. Prieto *et al.* (2000) compared the nutrient requirement for meat production of Boer with Spanish goats and found that dietary requirement of two genetic groups were comparable. Cameron *et al.* (2001) evaluated the comparative efficiency of Boer × Spanish, Boer × Angora and Spanish and concluded that Boer crosses were excellent in average daily weight gain (ADG), dry matter intake (DMI) and ADG: DMI ratio and dressing percentage nearly indicated the superior performance of Boer crossbreds.

The growth rate in goats was dependant on mature size of a particular breed. The male kids from larger breeds like Boer and Saanen grew faster than kids born to smaller breeds like feral goats and Angora. The growth rate varies from around 50g per day for the small tropical breeds to over 200g per day for large European breeds and the South African Boer breed (Dhanda *et al.,* 2003). The significant contribution of Boer inheritance in average daily gain in the present study is in agreement with Nimbkar *et al.* (2000) and Dhanda *et al.* (2003). This advantage of Boer inheritance can potentially be used in the development of meat strains of goats.

5.5.2 Sire

The influence of sire on average daily gain from birth to third month and from birth to sixth month was highly significant and the influence of sire on average daily gain from third month to sixth month was not significant. Sire 103 had the highest average daily from birth to third month (200.22 g) and from birth to sixth month (150.54 g). The post –weaning average daily gain was also higher in Sire No.103 even though there existed no significant differences. Least average daily from birth to third month (12.61g) and from birth to sixth month (20.27 g) was found in Sire No.9. Heritability estimate for average daily from birth to third month was 0.48. Heritability estimate for average daily from third to sixth month was 0.008.Heritability estimate for average daily from birth to sixth month was 0.34. Mukundan (1980) observed that the sires within Saanen group were not significant on average daily gain from 0-3 and 3-6 and 0-6 months of age. He documented that the sires within Malabari group were significant on average daily gain from 0-3 months of age and highly significant ($P<0.01$) on average daily gain from 3-6 months of age and 0-6 months of age. Mehta *et al.* (1997) observed that the heritability estimate for pre-weaning daily gain was 0.26 ± 0.13.

Goonewardene *et al.* (1997) observed that that pre-weaning gains are not affected by including the Boer as the buck, bred to Alpine, Saanen or Spanish does. Primarily the breed of the doe determined the pre-weaning growth rate of kids. The significant sire effects on average daily gain among Malabari crosses is in agreement with Mukundan (1980), Goonewardene *et al.* (1997) and Mehta *et al.* (1997). Highly significant influence of sire on average daily gain is suggestive of improvement that can be brought in by utilizing superior sire

5.5.3 Month of Birth

Month of birth had highly significant influence on average daily gain from birth to sixth month and on pre-weaning and post-weaning daily gain in body weights The kids born during April had the highest average daily gain from birth to third month (85.19g) and from birth to sixth month (77.51g) than kids born during December. Highest post weaning daily gain was higher in kids born during April and was lower for kids born during February (11.29 g). Mukundan (1980) analysed the records of 212 kids of Malabari and its half bred with Saanen and observed that the month of birth had significant effect on pre-weaning daily gain and was highly significant on average daily gain from 3-6 months of age and0-6 months of age. Tyagi *et al.* (1992) the season of birth had significant effect on pre weaning and post weaning average daily gain. Kids born in March-May (80 ± 49) were significantly heavier than kids born in October-December (66 ± 39) during0-3 months of age. Malik *et al.* (1993) found that month of birth had highly significant effect on post weaning daily gain. Sharma and Das (1995) reported that the average daily gains in the month of October to February (4.87 ± 0.35 g) were significantly higher than that in the month of March to September (2.15 ± 0.53 g). Mehta *et al.* (1997) analyzed the data on the body weights from birth to 12 months of age and documented that the month of birth had significant effect on post weaning period only. Highly significant influence of month of birth on average daily gain is endorsed by the findings of Mukundan (1980), Tyagi *et al.* (1992), Sharma and Das (1995) and Mehta *et al.* (1997). The higher growth rate of kids born in January and the lowest growth rate of kids born in February indicate the influence of ambient temperature and thermal stress on the growth rate of kids. Maximum thermal stress is from February onwards, which might have an adverse effect on growth rate.

5.5.4 Sex

Sex influences were not significant on average daily gain. Males in general possessed higher average daily gain than females during post weaning and pre weaning period. Tyagi *et al.* (1992) documented that the sex differences were not significant on average daily gain of Jakhrana goats during pre weaning and post weaning period from 3-6 months of age. Average daily gain in males and females from 0-3 months were 69.63 g and 69.95g respectively. Malik *et al.* (1993) found out that the sex had significant effect on pre weaning and post weaning daily gain. Males were significantly heavier than females in all the growth period. Singh (2002) observed that the sex difference were not significant on growth rate during pre- weaning period. The non-significant effect of sex on average daily gain is in concurrence with the findings of Tyagi *et al.* (1992), Malik *et al.* (1993) and Singh (2002). However, in general male superiority in average daily gain was observed throughout the study.

5.6 PHENOTYPIC CORRELATION

Birth weight exerted a highly significant positive correlation ($P \leq 0.01$) on the bodyweights up to sixth month, average daily gain from 0-3 month and. average daily gain from 0-6 months. The correlation between pre-weaning mortality and respiratory infections was highly ($P \leq 0.01$) significant (0.263). The incidence of respiratory disease was found to be negatively correlated average daily gain from 0-3 month (-0.301) and average daily gain from 0-6 month (-0.330). The correlation between pre-weaning mortality and average daily gain from 0-3 month were highly significant. Mukundan (1980) documented that the birth weight was positively correlated with other bodyweights. Singh (1997) documented that the phenotypic association between bodyweight at third and sixth month were positive and significant for Black Bengal and its cross with Jamunapari and Beetal goats. The phenotypic association between bodyweight at third and sixth month in Black Bengal and its cross with Jamunapari and Beetal goats was 0.77±0.066,0.66±0.12 and 0.68±0.06 respectively. Singh (1998) documented that the phenotypic association between bodyweights were positive and highly significant ($P \leq 0.01$).

Result of the present study are in close conformity with Mukundan (1980), Singh (1997) and Singh (1998) and is suggestive of the benefits of early selection based on birth weight for enhanced daughter weights in meat strain of goat. Negative association between average daily gain upto three months, incidence of pneumonia and pre-weaning mortality might be exploited in commercial goat production. This association might have a base in lowered immune status of the kid, making it susceptible to infection, leading to poor growth and high pre-weaning mortality.

Summary

SUMMARY

Meat goat production programmes of Kerala state are seriously hampered by the non availability of meat goat strains suited to the state. In an attempt to develop meet goat strains suited to the state, performance of Alpine Malabari goats were compared and evaluated with Alpine Malabari x Boer developed at University Goat and Sheep Farm, Mannuthy. Litter traits, growth, adaptability and viability of Alpine Malabari and Alpine Malabari x Boer crosses were evaluated.

Average litter size at birth (LSB) among Alpine Malabari (AM) and Alpine Malabari x Boer (AMB) kids was 1.79 ± 0.48. Alpine Malabari kid had a significantly ($P \leq 0.05$) higher litter size at birth of 2.12 ± 0.16. Month of birth had a highly significant ($P \leq 0.01$) effect on litter size at birth with highest litter in July (2.2 ± 0.17). Sire influences were highly significant on litter size at birth while sex had no significant influence on litter size at birth. Mean litter weight at birth was 3.77 kg and it was not found to be significantly affected by genetic group and sex. Month of birth and sire had highly significant association with litter weight at birth

Alpine Malabari x Boer kids had a highly significant ($P \leq 0.01$) and higher body weight from birth to sixth month of age. Body weight in AMB kids was 2.38 kg, 6.01 kg, 8.92 kg and 11.65 kg while AM kids had only 1.8 kg, 2.87 kg, 3.05 kg and 4.30 kg respectively at birth, one, two and three months respectively. Buck had a highly significant influence on birth weight of kid and body weight at first, second and third month. Month of birth had a significant influence on birth weight and body weights at first, second and third month.

Incidence of enteritis was 0.31, respiratory infection 0.08 and pre-weaning mortality was 0.07. Effects of genetic group and sire were significant on respiratory infections and not on incidence of enteritis and pre-weaning mortality. Month of birth did not exert significant influence on respiratory infections, enteritis or pre-weaning mortality.

The mean body weights at fourth, fifth and sixth month in AM and AMB crosses were 10.34 kg, 11.96 kg and 13.68 kg respectively. The effect of genetic group on body weights at fourth, fifth and sixth month was highly significant and superior in AMB crosses was 13.62 kg, 15.73 kg and 17.79 kg respectively while it was only 5.76 kg, 5.84 kg and 6.81 kg respectively in AM crosses. Sire effects were highly significant on the body weights at fourth, fifth and sixth month. Month of birth contribute to the body weights to a highly significant level and kids born in April and December were found to have higher body weights from fourth to fifth month. Sex of the kids was not found to influence the body weights from fourth to sixth month. The mean average daily gain in body weight (ADG) from birth to third month was 71.36 g, from third to sixth month was 65.7 g and zero to sixth month was 66.7 g. AMB crosses had a highly significant ADG of 104.89 g and 86.58 g compared to 35.19 g and 39.1 g during zero to third month and zero to sixth month respectively. Sire influences were highly significant on ADG from birth to third month and birth to sixth month. Month of birth had a highly significant effect on ADG and highest ADG was for kids born during April. Birth weight had a highly significant positive correlation with ADG from zero to third month and ADG zero to sixth month and body weights from one to sixth month. Correlation between respiratory infections and pre-weaning mortality were highly significant ADG from zero to third month and had a highly significant negative correlation with respiratory infection and pre-weaning mortality.

(1) Genetic group of the kid was found to increase the litter size at birth and AM superiority for this trait would find application in future meat production programmes.

(2) Boer inheritance increased the birth weight, body weights at first, second, third, fourth, fifth and sixth month suggesting the potential of this breed in improving the body weight of AM goats in the development of a meat strain.

(3) Incidence of respiratory infections was significantly higher in AM crosses, pre-weaning mortality rates was more in AM crosses compared to AMB crosses indicating the better adaptability and viability of AMB crosses compared to AM crosses.

(4) Significantly higher ADG from 0-3 months and 0-6 months in AMB crosses establish the superiority of Boer inheritance for enhanced growth rate among goat kids which can be utilized for the development of meat goat strain.

(5) Month of birth of the kids modulated the litter size at birth, litter weight at birth, pre-weaning and post weaning body weights and ADG. Body weights and ADG was generally higher in kids born in December and January. Though further studies are required, this result can be exploited for intensive goat production programmes.

(6) Association between sire on body weights and ADG are strongly indicative of underlying genetic component which can be improved upon by selection based on sire.

(7) Highly significant association between ADG, (0-3) & (0-6) and body weights with birth weight offers potential scope for selection based on birth weight for improvement of growth rate. Negative correlations between birth weight and ADG 0-3 between respiratory infections and Pre-weaning mortality are suggestive of role of this traits on adaptability and fitness.

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EVALUATION OF BOER HALFBREDS FOR DEVELOPMENT OF MEAT GOAT STRAINS SUITED FOR KERALA

By

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ABSTRACT

The tremendous potential of goat production in Kerala State is constrained due to the non-availability of meat type of goats suited to our climatic conditions. Malabari goats native to Kerala and improved Alpine Malabari (AM) grows to around only 8.5 and 11 kg respectively, imposing severe restrictions on commercial exploitation of these breeds. Introgression of Boer inheritance into Australian feral goats has led to the development of Australian goat meat industry and utilization of Boer goats to improve local goats in Maharashtra has paid rich dividend. With this background, the present investigation undertaken in Alpine Malabari crosses (AM) by infusing Boer inheritance was undertaken at University Goat and Sheep Farm was to evaluate the suitability of Alpine Malabari x Boer (AMB) crosses as a meat strain suited to Kerala State.

Data on one hundred goat kids, 50 each belonging to 2 genetic groups, AM and AMB were subjected to least squares analysis to resolve the effect of genetic group, sire, month of birth and sex on type of birth, litter weight at birth, birth weight, body weight at first, second, third, fourth, fifth and sixth month, pre-weaning mortality, incidence of neonatal diseases, litter size at weaning, average daily gain in body weight, phenotypic correlation, viability and adaptability.

Average litter size at birth (LSB) among Alpine Malabari (AM) and Alpine Malabari x Boer (AMB) kids was 1.79±0.48. Alpine Malabari kid had a significantly ($P \leq 0.05$) higher litter size at birth of 2.12±0.16. Month of birth had a highly significant ($P \leq 0.01$) effect on litter size at birth with highest litter in July (2.2±0.17). Sire influences were highly significant on litter size at birth while sex had no significant influence on litter size at birth. Mean litter weight at birth was 3.77 kg and it was not found to be significantly affected by genetic group and sex. Month of birth and sire had highly significant associations with litter weight at birth.

Alpine Malabari x Boer kids had a highly significant ($P \leq 0.01$) and higher body weight from birth to sixth month of age. Body weight in AMB kids was 2.38, 6.01, 8.92 and 11.65 kg while AM kids had only 1.8, 2.87, 3.05 and 4.30 kg respectively at birth, one, two and three months respectively. Buck had a highly significant influence on birth weight of kid and body weight at first, second and third month. Month of birth had a significant influence on birth weight and body weights at first, second and third month.

Incidence of enteritis was 0.31, respiratory infection 0.08 and pre-weaning mortality was 0.07. Effects of genetic group and sire were significant on respiratory infections and not on incidence of enteritis and pre-weaning mortality. Month of birth did not exert significant influence on respiratory infections, enteritis or pre-weaning mortality.

The mean body weights at fourth, fifth and sixth month in AM and AMB crosses were 10.34 kg, 11.96 kg and 13.68 kg respectively. The effect of genetic group on body weights at fourth, fifth and sixth month was highly significant and superior in AMB crosses with 13.62 kg, 15.73 kg and 17.79 kg respectively while it was only 5.76 kg, 5.84 kg and 6.81 kg respectively in AM crosses. Sire effects were highly significant on the body weights at fourth, fifth and sixth month. Month of birth contribute to the body weights to a highly significant level and kids born in April and December were found to have higher body weights from fourth to fifth month. Sex of the kids was not found to influence the body weights from fourth to sixth month. The mean average daily gain in body weight (ADG) from birth to third month was 71.36 g, from third to sixth month was 65.7 g and birth to sixth month was 66.7 g. AMB crosses had a highly significant ADG of 104.89 and 86.58 compared to 35.19 and 39.1 g during 0-3 and 0-6 month respectively. Sire influences were highly significant on ADG from 0-3 and 0-6 month. Month of birth had a highly significant effect on ADG and highest ADG was for kids born during April. Birth weight had a highly significant positive correlation with average daily gain in body weight from birth to third month and average daily gain in body weight from birth to sixth month and body weights from first to sixth month. Correlation between respiratory infections and pre-weaning mortality were highly significant. Average daily gain in body weight from birth to third month had a highly significant negative correlation with respiratory infection and pre-weaning mortality.

Significantly higher litter size at birth in AM crosses over AMB crosses direct to the feasibility of AM genotype of enhancing litter size at birth which might partially be also contributed by use of oestrus synchronization on frozen semen technology in production of AMB crosses. Modulation of litter size at birth by month of birth reflect on the environmental factors influencing the ovulation rate, conception rate and embryonic survival. Monthly body weights from birth to six months was found to be highly superior in AMB crosses indicating the Boer superiority in enhancing body weights of AMB crosses. Significant effect of sire on these trait suggest of the additive genetic effect which might improve body weight in Boer crossbred goats. Contribution of month of birth on bodyweight probably influenced by ambient temperature, availability of biomass, offers potential for improvement of these traits by appropriate managemental strategies. Increased incidence of diseases in AM genetic group with higher pre-weaning mortality is worth for further investigation. ADG 0-3, ADG 0-6 were significantly higher in AMB crosses highlighting the importance of Boer development in improvement of growth rate of goats. The role of month of birth in variations in ADG partially reflect on the environmental conditions can adversely affect the growth rate. Phenotypic correlations, which were positive and highly significant between birth weight, ADG and body weight are suggestive benefits of early selection on birth weights for enhanced, slaughter weights. The negative correlation of ADG and incidence of pneumonia, pre-weaning mortality and enteritis could be used for the development of goats adapted to local climatic conditions.