STUDIES ON CERTAIN GENETIC AND NONGENETIC FACTORS AFFECTING BIRTH WEIGHT AND GROWTH RATE IN MALABARI AND CROSSBRED GOATS

BY

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THESIS

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DECLARATION

I hereby declare that this thesis entitled "STUDIES ON CERTAIN GENETIC AND NON GENETIC FACTORS AFFECTING BIRTH WEIGHT AND GROWTH RATE IN MALABARI CROSSBRED GOATS" 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 of Society.

Mannuthy,
30-1-1980.

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CERTIFICATE

Certified that this thesis entitled "STUDIES ON CERTAIN GENETIC AND NON GENETIC FACTORS AFFECTING BIRTH WEIGHT AND GROWTH RATE IN MALABARI AND CROSSBRED GOATS" is a record of research work done independently by Sri. K.C. Raghavan, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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K.C. Raghavan

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INTRODUCTION

INTRODUCTION

Goat (Capra hircus) is one of the earliest of the farm animals domesticated by man. Since then, it has maintained a strategic position in the field of livestock production. About 79 per cent of the total goat population is in the tropics and subtropics. Their small size, large surface area relative to body weight and limited subcutaneous fat adapt them poorly to cold climate and make them relatively more adapted to areas of high temperature. (Shelton, 1978). India possesses more than 68 million goats and is expected to increase by 74 million by 1980. This is about 19 per cent of the total goat population of the world (F.A.O., 1976).

Although India has the largest goat population in the world, our goats have the lowest productivity, when compared to their counterparts in some of the advanced countries of the world. With a view to improve the production performance of Indian goats, the All India Co-ordinated Research Project on Goat Breeding was commissioned with units in different parts of the country. In the units for milk, exotic bucks Saanen and Alpine are being used for cross breeding taking

into account their better genetic potential for milk production.

One of such project unit for milk production was instituted at the Kerala Agricultural University in 1972. This centre has focussed efforts on producing different crosses of the local Malabari breed of goats with exotic breeds viz. Saanen and Alpine and to test their performance in respect of growth, reproduction and production.

Growth is an important physiological phenomenon. This is of great importance in all classes of livestock, but of special significance in meat producing animals. A fast rate of gain is the key to success (Cole, 1966). Brody (1945) defined growth as "a relatively irreversible time change in measured dimensions". It is an important factor in determining the optimum period at which the maximum gain can be effectively obtained. Birth weight is the first measurable character in the life of an animal and it provides basic information on the future performance particularly for the rate of growth.

The age at which a female goat can be bred for the first time is related to its age at attainment of puberty and the age at attainment of puberty is likely to be prolonged by retarded growth rate. On the contrary, rapid growth rate may lead to attainment of puberty at an

earlier age resulting in more life time production.

From meat production point of view, also, faster growth is desirable. Goats contribute about 30 per cent of the total meat produced in the country (N.C.A. 1976). The meat production potential depends to a large extent on the birth weight and growth rate. Since the post natal growth is the function of the mass of living cells delivered at birth, the birth weight happens to be the base for determining the subsequent slaughter weight. Slaughter weight can be quickly and cheaply attained in fast growing animals.

There is a wide gap between the requirement and availability of goat meat in the country. This is primarly due to low productivity of our goats, especially lower birth weight and growth rate. Crossbred goats with Saanen and Alpine inheritance are likely to have higher birth weight and they may grow fast. In different species or animals a number of genetic and non genetic factors were found to influence the birth weight and growth rate. But in goats only very few reports are there on those aspects.

Knowledge on the birth weight, growth rate and the various genetic and non genetic factors influencing birth

weight and growth rate is essential to formulate a proper selection programme. The heritability estimate for birth weight at different stages is useful to the breeder in estimating the genetic progress by selection for a trait and that will also help to decide as to how much emphasis should be given for different breeding systems. Information with regard to correlation between body weight at different ages, if significant may enable early selection and culling.

Considering these points, a study was undertaken with the following objectives.

1. To assess the birth weight and effect of various genetic and non genetic factors influencing birth weight in Malabari, Alpine x Malabari and Saanen x Malabari goats.
2. To find out the growth rate and effect of different factors influencing growth rate in the three genetic groups.
3. To find out the heritability of body weight at different stages.
4. To estimate the genetic and phenotypic correlations between body weights at different ages.
5. To estimate the incidence of different types of birth and sex ratio.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Considerable amount of work has been done on birth weight and growth rate of cattle, sheep and pigs. Comparatively less work has been done on these aspects in goats, especially in the Indian breeds. Literature available on these aspects is briefly reviewed under the following heads.

1. Birth weight.
2. Growth rate.
3. Heritability of body weight at different stages.
4. Correlation between body weight at different stages.
5. Incidence of different types of birth and sex ratio.

1. Birth weight

1.1. Importance

The birth weight, which is the first measurable character of an animal, has an economic importance since it provides a basic back ground for the future performance. It can be measured with reasonable accuracy and it indicates the kid's ability to survive and grow. Wide variation in it may provide opportunity for early selection of kids for better performance at later stages.

Wright (1934) reported that birth weight is of great practical importance as the new born of less than average weight for its breed is, as a rule, physiologically

younger or premature. Philips and Dawson (1940) stated that the birth weight is an earlier expression of growth that influences the survival of lambs.

Brody (1945) reported that animals born younger, than normal, are often lacking in the normal development of the heat regulating system and so have less power of survival after birth in a new environment. Ali et al.(1975) reported that the birth weight of Black Bengal goats had a direct relationship with the average length of survival.

1.2. Birth weight in different breeds

Galcon (1951) reported the mean birth weight in male and female Philippine kids as 1.54±0.12 and 1.56±0.112 kg respectively.

Epistein and Herz (1964) found that the means of birth weight of Saanen goats in Isreal were 2.90 kg for males and 2.70 kg for females. But Shalash et al.(1970) reported the birth weight as 2.62 in Egyptian Saanens. Elicin et al. (1976) observed the means of birth weight of Saanen x Killis, F1 goats, as 2.94, 2.47, 2.52 and 2.37 kg for singles born males, single born females, twin born males and twin born females respectively.

Montemuro (1966) observed the means of birth weight of Maltese Crossbred goats as 3.35 kg for males and 3.11 kg for females.

Sacker and Trial (1966) reported that the mean birth weight of East African Mubende goats was 4.70±0.01 lbs for single male kids.

Guha et al.(1968) observed that the means of birth weight of Black Bengal goats averaged 2.90±0.63 lbs for males and 2.56±0.56 lbs for females. The averages of birth weight of singles, Twins, Triplets and quadruplets were 3.30±0.70, 3.04±0.57, 2.63±0.61 and 2.78±0.66 lbs respectively. Ali et al.(1973) reported the mean birth weight as 1.60 lbs (0.5.3). Ali et al.(1975) obtained a maximum survival in kids with an average birth weight of 3 lbs.

Lall (1968) found that the means of birth weight of crossbred Angora goats were 4.37, 4.79, 4.72, 4.47 and 4.57 lbs for 50 per cent Angora (A) x 50 per cent Gaddi (G), 75 per cent A x 25 per cent G, 87.5 per cent A x 12.5 per cent G, 93.75 per cent A x 6.25 per cent G and pure bred Angoras respectively. Pant (1968) found that the means of birth weight of pure bred Angora and Angora x Gaddi were 2.16 and 2.25 kg respectively. Nikitenko and

Zuparazhlsev (1972) observed the means of birth weight of white Angora x Don goats as 3.50 and 3.00 kg for males and females respectively.

Correra and De la Parra (1969) observed that the averages of birth weight of Anglo Nubian x Granada goats in Mexico were 2.42 kg for males and 2.13 kg for females. For Malaya, 50 per cent Malaya x 50 per cent Anglo Nubian and 75 per cent Anglo Nubian x 25 per cent Malaya the birth weight averaged 1.93, 3.06 and 3.20 for single male kids (Mahamud and Devendra, 1970). The averages of birth weight of Nubian and Saanen x Nubian were 1.83 and 1.95 kg respectively (Shalash et al., 1970). For Criollo single males, Criollo single females, Criollo twin males and Criollo twin females the birth weight averaged 3.3, 2.9, 2.3 and 2.0 kg respectively. In Nubian breed the corresponding values were 3.3, 2.9, 2.9 and 2.7 kg respectively. For Criollo x Nubian the values averaged 3.6, 3.1, 3.2 and 3.0 kg respectively (Castallo et al., 1972). The means of birth weight of Anglo Nubian goats were 3.07 and 2.77 kg for males and females respectively.

Misarev (1969) observed the mean birth weight of Bashkir x Don goats as 2.7 kg.

Bhatnagar et al.(1971) reported that the means of birth weight of Alpine, Beetal and Alpine x Beetal were

3.0, 2.8 and 3.5 kg respectively for males and 2.7, 2.9 and 3.0 kg respectively for females. The means of birth weight of French Alpine were found to be 3.67 kg for males and 3.30 kg for females (Gill and Dev, 1972). Mishra et al.(1976) reported that the means of birth weight of Beetal, Alpine and Alpine x Beetal were 2.82, 3.03 and 2.95 kg respectively. Iqbal Nath and Chawla (1978) obtained the overall means of birth weight of Alpine, Beetal, Alpine x Beetal and Saanen x Beetal as 3.30±0.045, 2.81±0.056, 3.12±0.057 and 3.18±0.55 kg respectively.

Johri and Talapatra (1971) reported that the means of birth weight of Jamnapari kids varied from 3.19 to 5.8 kg in the case of males and 3.00 to 3.85 kg in the case of females. Singh (1973) observed the means of birth weight as 4.92 for single males and 3.96 for single females. Mittal and Pandey (1974) reported the means of birth weight as 3.95 kg for males and 2.75 kg for females. Mittal (1976) found the mean birth weight as 3.50 kg whereas Khan (1979) found those as 3.18 kg for males and 2.70 kg for females.

Mittal and Pandey (1974) reported the averages of birth weight of Barbari kids as 2.20 and 1.70 kg for males and

females respectively. Mittal (1976) found the mean birth weight as 2.01 kg whereas Mittal and Pandey (1978) reported the means as 1.95±0.29, 1.98±0.18, 1.74±0.23 and 1.82±0.16 kg respectively for single males, single females, twin males and twin females of similar sex and 1.78±0.15 and 1.70±0.19 kg for twin males and females of dissimilar sex. Joshi (1979) reported the means of birth weight in Barbari breed as 1.90 kg for males and 1.66 kg for females.

Mukundan (1976) reported the means of birth weight of Malabari, Alpine x Malabari and Saanen x Malabari as 1.79, 1.95 and 2.39 kg for males and 1.76, 2.33 and 2.11 kg for females, respectively. According to Nair (1978) the birth weight of these breeds averaged 1.71, 2.46 and 2.02 kg respectively. Further, Nair (1979) reported the mean birth weight of Malabari goats as 1.73±0.02 kg.

Mazumdar (1978) reported the means of birth weight of Pashmina kids as 2.34 and 2.25 kg for males and females respectively.

Richetti et al.(1976) found that the means of birth weight of crossbred kids born out of Toggenburg males and Gargano females averaged 4.17, 3.51, 3.35 and 2.85 for single born males, single born females, twin born males

and twin born females respectively. In Gargano x Gargano these values averaged 2.94, 2.62, 2.21 and 2.01.

1.3. Effect of Breed

Pant (1968) found a highly significant difference between pure bred and cross bred Angoras in birth weight.

Gill and Dev (1972) reported that there was a significant difference in birth weight between Alpine and Anglo-Nubian breeds.

Singh et al.(1977) observed that Jamnapari x Saanen crossbreds registered higher mean birth weight than kids of Jamnapari and Saanen breeds.

Castillo et al.(1978) in their growth studies on four imported goat breeds viz. Nubian, Alpine, Toggenburg and Saanen observed that birth weight was significantly affected by breed. Richetti and Intrieri (1976) also observed a significant effect of breed on birth weight in Calabrian and Calabrian x Toggenburg kids.

Iqbal Nath and Chawla (1978) observed a significant effect of breed on birth weight. They found that Alpine x Beetal kids were heavier than the kids of native Beetal breed.

1.4. Sexual dimorphism

Wilson (1958) reported a higher birth weight in male than females in East African dwarf goats.

Seth et al.(1968) observed that the birth weight of males born as single was significantly higher than that of female born as singles among Barbari breeds. The birth weight of males born as partner to female was found to be significantly heavier. Birth weight of males born as twins were significantly more than birth weight of female born so. Prasad et al.(1971) and Mittal (1979) observed a significant effect of sex on birth weight of Barbari kids, whereas Mittal and Pandey (1978) found that sex was a non significant source of variation affecting birth weight of kids.

Wijeratne (1968) found a significant effect of sex on birth weight in South Indian meat breeds.

Correa and De la Para (1969) observed significantly higher birth weight in males than females in Anglo Nubian x Granada Crossbred goats. Gill and Dev (1972) found a significant effect of sex on birth weight of French Alpine and Anglo Nubian goats. Castillo et al. (1978), on the basis of growth studies of Nubian, Alpine, Togrenburg and Saanen kids, reported that sex had a significant effect on birth weight of kids.

Singh and Singh (1974) observed that sex of the kid was a significant source of variation affecting birth

weight of Jamnapari kids. Singh et al. (1977) found a significant effect of sex on birth weight of Jamnapari, Saanen, Barbari and their crossbreds. Khan (1979) observed a highly significant effect of sex on birth weight of Jamnapari kids. Richetti et al.(1976) found a significant effect of sex in Toggenburg x Gargano crossbred goats.

Iqbal Nath and Chawla (1978) reported that male kids of Beetal, Alpine and Beetal x Alpine registered higher birth weight than females. Male kids born as singles had higher birth weight than twins and triplets in all genetic groups except Saanen x (Alpine x Beetal). Similarly, single females had higher values than twins and triplets. The effect of sex on birth weight was found to be highly significant. Mishra et al.(1978) observed that males were slightly heavier at birth than females in Alpine, Beetal and Alpine x Beetal crosses.

1.5. Effect of litter size

Paramsothy (1957) found that singles were heavier at birth than twins and triplets in Indonesian, Malaya and Indonesian x Malaya breeds.

Guha et al.(1968) reported that litter size had a significant effect on birth weight of Barbari goats. But

Mittal (1977) observed that the difference in weights between singles and twins was not statistically significant.

Singh et al.(1977) on their studies on the performance of Saanen, Barbari and Jamnapari goats observed that although singles had a higher birth weight than twins, the difference in weight was not statistically significant. The same was reported by Mittal (1978) in Jamnapari kids. But Khan (1979) observed a significant effect of type of birth on birth weight of Jamnapari kids.

Iqbal Nath and Chawla (1978) observed that the variation due to type of birth on birth weight was not significant in Beetal, Alpine and Beetal x Alpine crossbreds.

Significant effect of type of birth on birth weight was reported by Castillo et al.(1978) in Nubian, Alpine, Toggenburg and Saanen kids.

1.6. Effect of season of birth

Singh (1973) did not find any seasonal influence on birth weight of Jamnapari kids. But Singh et al.(1977) and Khan (1979) obtained a significant effect of season of birth on birth weight of Jamnapari kids.

Mittal (1979) reported that the winter born kids were significantly superior in birth weight than summer born kids in the Jamnapari breed.

1.7. Effect of Gestation period undergone by the kids

Gill and Dev (1972) in Anglo Nubian goats observed that gestation period undergone by male kids was longer than in female kids and this might account for the higher birth weight in males.

1.8. Effect of post kidding weight of dam

Mittal (1979) observed a significant correlation between dam's weight and birth weight of kids in Jamnapari and Barbari goats. Khan (1979) observed a significant effect of dam's weight on weight of Jamnapari kids.

2. Growth rate.

2.1. Importance

Growth is an important physiological phenomenon. It has great practical applicability in livestock economics especially in goat farming. It is an important factor in determining the optimum period at which the maximum gain can be effectively achieved.

Brody (1945) defined growth as "a relatively irreversible time change in the measured dimensions". Growth is pliable, it can be accelerated or delayed with little influence on final mature body size (Crichton et al., 1959).

Hammond (1955) explained that the rate at which an animal grows is of greater importance for the livestock

owner than its mature weight, as only few animals live long enough to reach the mature weight.

2.2. Growth rate in different breeds

Paramsothy (1957) observed body weight gains of 2.00, 2.84 and 1.24 lbs per week respectively in Indonesian, local (Malaya) and Indonesian x local kids. At 15 weeks of age singles averaged 35.2, 37.75 and 36.00 lbs respectively in the above genetic groups.

Montemuro (1966) observed the mean weight at 40 days of age as 9.3 kg for males and 8.10 kg for females.

Sacker and Trial (1966) reported that the body weight for single in East African Rubende goats were 16.2±0.04 lbs at 2 months, 26.2±0.6 lbs at weaning and 41.7±0.9 lbs at one year of age.

Guha et al. (1968) found that the averages of weights at one year in Black Bengal goats were 25.66±6.05 lbs for males and 24.62±6.09 lbs for females. Ali et al. (1973) observed that the mean weaning weight in Black Bengal goats as 19.5 lbs at 35-180 days of age. Half yearly weight gain for the period from three months to one year, one to two years and two to three years were 10 lbs (7-14), 4 lbs (3-15) and 4 lbs (2-9) respectively.

Wijeratne (1968) observed the monthly growth rates in male and female south Indian goats as 3.44 and 2.49 kg respectively.

Correa and Dela Parra (1969) observed the means of body weight at 30 days as 4.29 kg for males and 4.20 kg for females.

Misarev (1969) reported that the means of body weight of Bashkir x Don goats were 27.0 kg at one year and 40.8 kg at 5½ years.

Nikitenko and Suparazhisev (1972) observed the means of body weight at 18 months of age as 32.5 and 27.1 kg respectively for male and female in white Angora x Don goats. The adult weights were 49.5 and 33.3 kg respectively.

Shalash et al. (1970) found that the averages of body weight at 48 weeks of age in Nubian, Saanen x Nubian and Saanen goats were 12.1, 21.81 and 25.98 kg for male and 10.5, 17.55 and 20.83 kg for females respectively.

Bhatnagar et al.(1971) obtained the weekly growth rates in Alpine, Beetal and Alpine x Beetal goats as 722, 847 and 1120 gms respectively in females.

Castillo and Graoia (1971) found that the means of body weights at 6 months of Nubian x Criolla, F1, were

19.9 and 16.8 kg for male and female singles and 17.8 and 16.3 kg for male and female twins. At one year of age the corresponding values were 33.7 and 30.0 for singles and 32.9 and 30.3 kg respectively for twins. According to Castillo et al.(1972) the means of weight at 6 months and weight at one year of Nubian x Criolla were 18.2 and 33.2 kg for single males 16.8 and 30.1 kg for single females, 16.8 and 31.2 kg for twin males and 14.9 and 28.7 kg for twin females respectively.

Johri and Talapatra (1971) reported that at the end of 15 weeks the averages of weight of males were 13.49 kg and that of females were 12.51 kg. It could be observed that the Jamnapari kids grew at an average rate of 0.63 kg per week. Mittal and Pandey (1974) observed that the means of weight at two months and four months were 9.6 and 10.2 kg for males and 7.67 and 8.0 kg for females.

Singh and Singh (1974) observed a better growth rate in kids during the first four months in Jamnapari kids. During the period from 4th to 8th month the growth rate was lowest and from 8th to 12th months the growth rate again increased appreciably. Khan (1978) reported that the means of weight at 2 months, 6 months, 9 months and at one year were 11.54, 16.68, 18.76 and 22.90 kg for males and 10.41, 12.17, 17.00 and 19.20 kg for females respectively.

Mittal and Pandey (1974) reported that the means of body weight at 2 months and 4 months in Barbari goats were 7.5 and 9.10 kg for males and 6.53 and 7.20 kg for females. Joshi (1979) reported the averages of body weights at 3 months, 9 months and 12 months as 6.10, 8.85 and 12.59 kg for males and 5.68, 7.63 and 10.23 for females respectively.

Mukundan (1976) reported that the monthly weight gains for Malabari, Alpine x Malabari and Saanen x Malabari were 1.15, 1.97 and 1.22 kg from birth to four months of age and 0.65, 0.50 and 0.95 kg from 8-12 months of age. Nair (1978) found that the means of weight at 4 months in these genetic groups as 6.05, 8.15 and 8.25 kg respectively. Nair (1979) observed that the mean weights at one month, four months and one year in Malabari goats were 2.93±0.05, 6.17±0.14 and 14.92±0.44 kg respectively. The average growth rate was found to be about 30 gms per day.

Wilson (1976) observed that the averages of rate of gain in body weight upto three months of age was 87 gms per day and that upto 6 months was 67 gms per day. The growth rates of twin and single kids were similar and faster than triplet kids.

Mazumdar (1978) found that the live weights of Pashmina goats averaged 19.40 and 18 kg at 12 months and

48.91 and 30.78 kg at three years of age, in males and females respectively.

Richetti and Intrieri (1978) found that for twin born calabrian kids the weights at 28 days averaged 6.31 kg for males and 5.89 kg for females. For Toggenburg x Calabrian goats the corresponding values were 6.92 and 6.26 kg respectively.

2.3. Effect of breed

Mishra et al.(1976) reported that the crossbred (Alpine x Beetal) kids had a better trend of growth rate than Alpine and Beetal breeds, considered seperately.

Castillo et al.(1978), in their growth studies on four imported goat breeds viz. Nubian, Alpine, Toggenburg and Saanen observed that the weaning weight, weight at six months and weight at one year were seen affected significantly by the breed.

2.4. Sexual dimorphism

Galoon (1951) reported that the male kids of Philippine breed gained weight until 15 months and that the females until 14 months of age.

Datta et al.(1963) observed that the males registered better gain in weight than females. On an average the males gained 33 gms more per day during the first and second month and 59 gms more during the third month than females.

Guha et al.(1968) reported that in Black Bengal goats the gain in body weight from birth to 52nd week was significantly influenced by sex of the kids. Males registered higher weight gain than females.

Correa and Dela Para (1969) observed that in Anglo Nubian x Granada Crossbred goats no significant difference between male and female was descernible at 30 days of age.

Singh and Singh (1974) found that sex was a significant source of variation in growth rate of Jamnapari breed. Growth rates in two sexes were significantly different except during 4th to 8th month of age. The growth rates of singles and twins were different only in 8th to 12 month of age for males and in birth to 4th month and 8th to 12 month age group for females. Khan (1979) found a highly significant effect of sex of the kid on body weights at all ages. In all cases males were superior to their female counterparts.

Castillo et al.(1978) on the basis of the growth studies of Nubian, Alpine, Toggenburg and Saanen kids reported that the weaning weight, weight at six months and that at one year were seen affected by sex of the kids.

Mishra et al.(1978) observed highest growth velocities during the age interval of 1-2 months in females and 4-8 months in males of Alpine, Beetal and Alpine x Beetal crosses.

Mittal and Pandey (1978) found that there was no significant effect of sex on live weight of single and twin born kids at any age interval in Barbari breed. Male kids were heavier than female kids at every interval from one month to nine months, although the differences were non significant.

2.5. Effect of Litter size

Guha et al.(1968) reported that in Barbari breed litter size had no influence on body weight gain from birth to 52nd week. Seth et al.(1968) found that there was no significant difference in the gain in weight of singles and twins of either sex, in barbari kids. In 30-60 days and 60-90 days intervals the gain in weight of the males born as singles were significantly more than those born as twins. Prasad (1971) reported that the live weight gain from birth to one year of age was not affected by type of birth.

Wilson (1970) observed that the growth rates of single and twin kids were similar, though triplets grew at a slower rate.

2.6. Effect of season of birth

Guha et al.(1968) reported that the gain in body weight from birth to 52nd week was significantly influenced by season of birth in Black Bengal goats.

Khan (1979) found a highly significant influence of season of birth on body weight at 12 months of age. Season of birth was a non significant source of variation for body weights at other ages.

3. Heritability of body weight at different stages

Guha et al. (1968) estimated the heritabilities of gain in weight, in Black Bengal goats, by paternal half sib correlation as 77.66 per cent for females and 19.7 per cent for males. Heritabilities estimated by the regression of body weight of the progenies on post kidding weight of dams were 6.7, 15.2, 21.1 and 32.2 per cent at birth, 16 weeks, 36 weeks, and 52nd weeks respectively.

Moulick and Systrad (1970) reported the heritability of birth weight in Black Bengal goats by paternal half sib analysis as 0.01, Full sib and maternal half sib analysis estimated the maternal environment common to litter mates and that accounted for 60 per cent of the variance of which 25 per cent was due to the permanent difference between dams. The remaining 39 per cent was attributed to individual environment including most of the non additive genetic

variance. The heritability of maternal environment was estimated as 0.2. Ali and Nasanath (1977) estimated the heritability of birth weight in Black Bengal goats using half sib correlations. The heritability estimates of birth weight for male kid and that of female kids were 0.76±0.82 and 0.55±0.64 respectively. The data were analysed irrespective of sex and pooled together which gave the heritability estimate as 0.75±0.48. Ricordeau et al.(1972) reported that the heritability estimates of weights at 1, 2, 3, 5 and 7 months were 0.63, 0.51, 0.40, 0.49 and 0.49 respectively in Saanen females.

Castillo et al.(1978) found that the heritability estimates of birth weight and body weights at 6 months and 12 months were 0.39, 0.21 and 0.11 respectively in Nubian, Toggenburg and Saanen kids.

c. Correlation between body weight at different stages

Wacker and Trial (1960) based on their studies of the East African Mubende goats reported the correlation between body weights at different ages. They observed that birth weight had little effect upon subsequent body weights. Two months body weight was found to be an useful guide to weaning weight and weaning weight was found to have some value in predicting the weight at one year.

Guha et al.(1964) on their growth studies in Black Bengal female goats observed a slight positive correlation between birth weight and 16th week weight in quadruplets. In males the correlations between birth weight and weight at other stages of growth were significant in the case of twins and triplets. Correlations between body weights at different stages of growth were found significant among the pooled data of males and females. Moulick and Patrad (1970) found the partial correlation between birth weight of kids and post kidding body weight of their dams as 1.175 independent of their litter size and age of the dam in Black Bengal goats.

Montemuro (1966) established the correlation between birth weight and one month weight as 0.83 in crossbred Maltese goats.

Wijeratne (1963) observed that the phenotypic correlations between weight at three months and weight at five and seven months in Saanen females were 0.91 and 0.89 respectively.

Singh and Singh (1974) found that in Barbari and Jamnapari kids, body weights at birth, 4 months, 8 months and one year were not associated with the age at first kidding.

5. Incidence of different types of birth and sex ratio

Shanmughasundaram (1957) in Malabari goats observed that among the total kidding 50 per cent were twins, and 42 per cent were singles. But only 8 per cent contributed triplets and quadruplets. Mukundan and Rajagopalan (1971) observed that the percentage of incidence of singles, twins and triplets in Malabari goats were 47, 42.4 and 10.6 respectively. Overall sex ratio was found to be 50:50. Sudarsanan and Raja (1973) reported that the incidence of singles, twins and triplets in Malabari goats were 47.06 per cent, 35.29 per cent and 17.65 per cent respectively. Nair and Mathai (1979) observed a sex ratio of 52:48 in Malabari, 49:51 in Saanen x Malabari and 58:42 in Alpine x Malabari.

Wilson (1958) reported the incidence of multiple birth in Black Bengal goats as 77.6 per cent which comprised of 54 per cent twins, 20.9 per cent triplets and 2.7 per cent quadruplets.

Muhamud and Devendra (1970) observed a twinning percentage of 58.06 in Malaya goats, 53.19 per cent in 75 per cent Anglonubian x 25 per cent Malaya and 49.02 per cent in 50 per cent Anglo Nubain x 50 per cent Malaya goats.

Singh and Singh (1974) observed in Jamnapari kids a sex ratio of 44.81:55.19 at birth. They found that of all

the births 54.81 per cent were singles and 45.18 per cent were twins. Khan (1979) observed a sex ratio of 53.01:46.98 in Jamnapari goats. The percentage of singles, twins and triplets were 62.71, 33.89 and 3.39 per cent respectively.

Mishra et al.(1976) observed a sex ratio of 97:100 in Alpine, Beetal and Alpine x Beetal breeds.

Yaker (1979) observed a sex ratio of 102:98 in British Saanens.

Generalising, the mean birth weight of Indian breeds of goats, ranged from 1.50-3.62 kg (Datta et al., 1963). Crossbred goats of Indian breeds with exotic breeds found to weigh higher at birth than the local breeds. The small breeds of goats were found to had given birth to kids with lower birth weight and vice versa. Effect of breed was reported to be a significant factor causing variation in birth weight. Most of the workers reported that sex, litter size and season of birth significantly influenced birth weight. Growth rate was reported to be higher in crossbred goats when compared with local goats. Breed, sex and litter size were observed to be important factor causing variation in growth rate. Heritability values reported by different authors in different breeds show that there exists a considerable variation in heritability values in

different breeds. Most of the workers reported a fairly higher correlation between body weight at different stages. Sex ratio was observed to be 50:50 in almost all breeds.

MATERIALS AND METHODS

MATERIALS AND METHODS

The data used for the study were collected from the records maintained at the All India Co-ordinated Research Project on goats for milk production, Kerala Agricultural University, Mannuthy. A total number of 1227 records were collected for the study pertaining to the following three genetic groups.

Malabari

Alpine x Malabari

Saanen x Malabari

The All India Co-ordinated Research Project on goats for milk production was commissioned at the Kerala Agricultural University on 7.9.1972. This centre has focussed attention on producing different crosses of the local Malabari breed of goats with exotic breeds Alpine and Saanen and to test their performance in respect of production, reproduction and growth.

Breeding programme: The breeding programme envisaged a flock of 350 breedable females of local breed in two groups of 150 does each to be crossed to Saanen and Alpine respectively, the third group of 50 being retained to produce purebred contemporaries. A constant flock strength of 350 local females were to be maintained by 10 per cent replacement

every year. Out of the half breds two third were to be bred inter-se and the remaining one third to the alternate breed to create three breed crosses.

Records relating to body weight, production and reproduction of each animal were maintained systematically.

Management: Standard feeding and management practices were followed in the farm. Animals below one year were grouped into the following categories.

1. Birth to 5 days along with the dam.
2. 6 days to 2 months.
3. 3 months to 4 months.
4. 5 months to 7 months.
5. 8 months to 12 months.

For the first five days the kids were kept along with their dam. After the colostrol stage, the kids were allowed to suckle the mothers three times daily upto 2 months. Concentrate mixture*(kid starter) was fed upto 100 gms and roughage upto 250 gms. During third and fourth month milk was hand fed at the rate of 1/10th and 1/15th of the body weight. At this stage, concentrate was fed at the rate of 150-250 gms and roughage, 500 gms per kid. At the end of 4th month the milk was gradually replaced by concentrate mixture and roughage. From 5 months onward,

*Composition given in the appe

males and females were housed separately. Their concentrate mixture was fed at the rate of 250-350 gms and roughage 1-1.5 kg. From 7-12 months, the goats were fed on 'Conom/ milk ration pellets (E.M.R. pellets, Godrej*) as the concentrates at the rate of 400-450 gms per goat. The different groups of animals were housed and managed separately.

Data: Data for the period of 5 years from April 1974 to March 1979 pertaining to the following parameters have been utilised in this study.

1. Birth weight
2. Weight at 1 month
3. Weight at four months and
4. Weight at one year.

The records collected included the particulars of those animals died at different stages of growth and also of the growing stock which had not attained one year of age. The data were grouped according to genetic group of kids, sex of kids, litter size at birth, season of birth, dam's weight at kidding, gestation period undergone by the kids and bucks which sired the kids.

To study the effect of season on body weight the calender year was divided into three seasons according to the classification given by Mathai and Raja (1976) and Nair (1979)

* composition given in the appen/

Summer - February to May

Rainy - June to October.

Winter - November to January.

The effect of gestation length undergone by the kids on body weight at different stages was studied by grouping the data according to class intervals of gestation periods as given below.

136 - 139 days

140 - 143 days

144 - 147 days

148 - 151 days and

152 - 155 days.

Similarly the effect of dam's weight at kidding on body weight was studied by grouping the data under dam's weights according to the following class intervals.

14-17 kg, 18-21 kg, 22-25 kg,

26-29 kg, 30-33 kg and 34-37 kg.

Analytical methods: The mean, standard error and coefficient of variations were estimated for all characters in the three genetic groups separately as per the methods given by Snedecor and Cochran (1967).

The effect of genetic group on body weight at different stages was studied by the following one way model

$$Y_{ik} = u + g_i + l_{ik}$$

where,

Y_{ik} = observation of the k^{th} individual in the i^{th} genetic group.

u = General mean

g_i = effect of i^{th} genetic group.

l_{ik} = Random error.

When genetic groups were found to be significant further analysis were carried out for the three genetic groups separately. The model assumed was

$$Y_{ijklmnp} = \mu + S_i + L_j + E_k + D_l + G_m + R_n + e_{ijklmnp}$$

where,

$Y_{ijklmnp}$ = Observation of p^{th} individual of the i^{th} sex, j^{th} litter size, born on k^{th} season, having l^{th} dam weight and m^{th} gestation length of dam and sired by n^{th} sire.

μ = general mean

S_i = effect of i^{th} sex

L_j = effect of j^{th} litter size

E_k = effect of k^{th} season

D_l = effect of l^{th} dams weight

G_m = effect of m^{th} gestation length

R_n = effect of n^{th} sire

$e_{ijklmnp}$ = random error.

The significance of various effects were tested by F test.

Growth rate: Weekly growth rate in the three genetic groups were calculated during the periods from

Birth to one month

One month to four months.

Four months to one year.

Effect of genetic group on weekly gain was tested by analysis of variance as per the method of Snedecor and Cochran (1967).

Estimation of heritability

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

The model used for the estimation of heritability was

$$Y_{ik} = \mu + L_i + e_{ik}$$

where

Y_{ik} = observation of the k^{th} progeny of the i^{th} sire.

μ = common mean

L_i = effect of i^{th} sire

e_{ik} = uncontrolled environmental and genetic deviations attributable to individuals within sire groups.

Analysis of variance table

Source	d.f.	S.S.	MSS	EMS
Between sire	S-1	SS_s	MS_s	$\sigma^2 wtk\ ^2_s$
Progeny within sire	N-S	SS_w	MS_w	$\sigma^2 w.$

$$k = \frac{1}{S-1} \left(N - \frac{\Sigma ni^2}{N} \right)$$

= The average number of progeny per sire

where,

S = number of sire

n_i = number of progeny with in i^{th} sire

N = total number of progenies.

$\sigma^2 w = M_w$ = Random effect mean squares (variance among progeny within sires)

$\sigma^2 s$ = sire component of variance = $\frac{M_{ss} - M_{sw}}{k}$

$$t = \frac{^2_s}{^2_{s+}\ ^2_w}$$

$$h^2 = 4^t$$

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

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

Estimation of Genetic and phenotypic correlations

Genetic correlations (r_G) between body weights at different stages were estimated using the model similar to that by the method of analysis of Covariance of data on half sib described under heritability.

k, $\sigma^2 s(x)$ and $\sigma^2 s(y)$ were estimated as in the case of heritability where x and y were the two characters considered.

The analysis of covariance between x and y is as given below.

Analysis of covariance table

Source	d.f.	MCP	EMCP
Sire	S-1	$M_C P_S$	$Cov_W + K\ Cov_S$
Progeny within sire	N-S	$M_C P_W$	Cov_W

$$Cov_W = MCP_W$$

$$Cov_S = \frac{MCP_S - MCP_W}{k}$$

$$r_G(xy) = \frac{Cov_S}{\sqrt{\sigma^2 s(x)\sigma^2 s(y)}}$$

The approximate standard error of genetic correlation was calculated by the method described by Robertson (1959).

$$SE\ r_G(xy) = (1-r^2 G) \sqrt{\frac{SE\ h^2(x)\ \ SE\ h^2(y)}{2h^2(x)\ \ h^2(y)}}$$

Phenotypic correlation

The phenotypic correlation between body weight at different stages were calculated by the formula described by Backer (1975).

$$rp_{(xy)} = \frac{Cov_w + Cov_s}{\sqrt{\left(\sigma^2 w(x) + \sigma^2 s(x)\right)\left(\sigma^2 wy + \sigma^2 s(y)\right)}}$$

Regression coefficient was calculated as per Snedecor and Cochran (1967).

RESULTS

RESULTS

1. Birth weight

1.1. Effect of genetic group

The means of birth weight of Malabari, Alpine x Malabari (A x M) and Saanen x Malabari (S x M), F1 generation, crossbreds along with the standard error (S.E) and coefficient of variation (C.V) are presented in Table 1. From the table, it may be seen that higher mean birth weight was registered by S x M crossbred goats (2.31±0.03 kg) than A x M (2.04±0.02 kg) and Malabari (1.71 ±0.02 kg). The analysis of variance presented in Table 12 revealed significant differences ($P < 0.01$) in birth weight of kids in the three genetic groups.

1.2. Sexual dimorphism

Sex wise particulars of means of birth weight in the three genetic groups are furnished in Table 3. In all the three genetic groups, males had a higher birth weight than females. On analysis of data (table 9) it could be observed that there was significant difference between male and female kids in birth weight in both S x M and A x M ($P < 0.01$), though the difference was non significant in the case of Malabari.

1.3. Effect of litter size

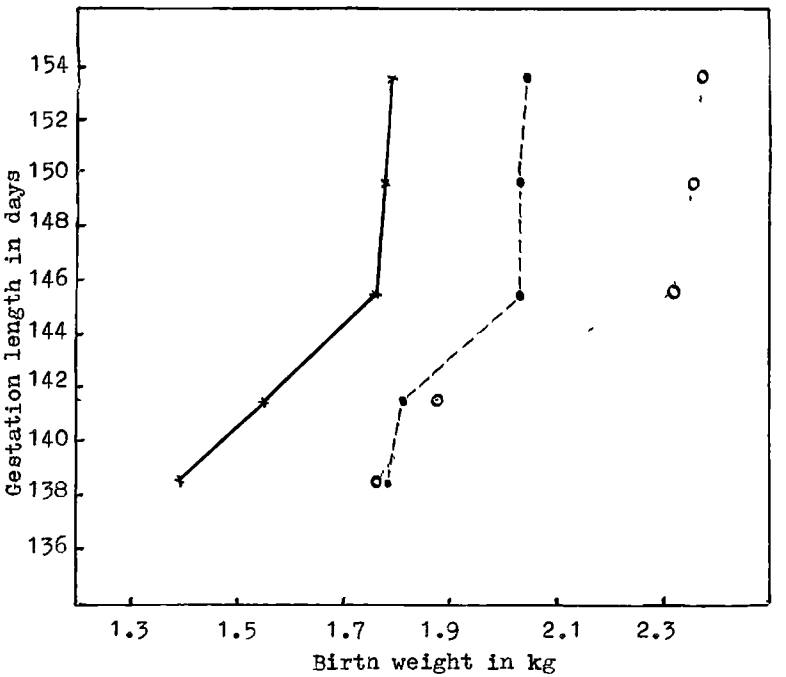
Presented in Table 4 are the means of birth weight according to the litter size in the three genetic groups. Kids born as singles had a higher birth weight in all the three genetic groups followed by twins and triplets. There were highly significant differences ($P < 0.01$) in birth weights according to litter size at birth in all the three genetic groups (Table 9).

1.4. Effect of season of birth

The means of birth weight of kids born during different seasons of the year are presented in Table 5. Analysis of variance presented in Table 9, could not reveal any significant difference in birth weight according to the season of birth. However, Malabari and Alpine x Malabari kids born in winter registered higher birth weight than the kids born in summer and rainy seasons.

1.5. Effect of gestation length undergone by the kids

The averages of birth weight of kids according to the gestation length are presented in Table 6. In all the three genetic groups the effect of length of gestation on birth weight was significant (< 0.01, Table 9). Fig.1 reveals the relationship between gestation lengt



Malabari

Alpine x Malabari

Saanen x Malabari

Fig.1. Relationship between gestation length of dam and birth weight of kids.

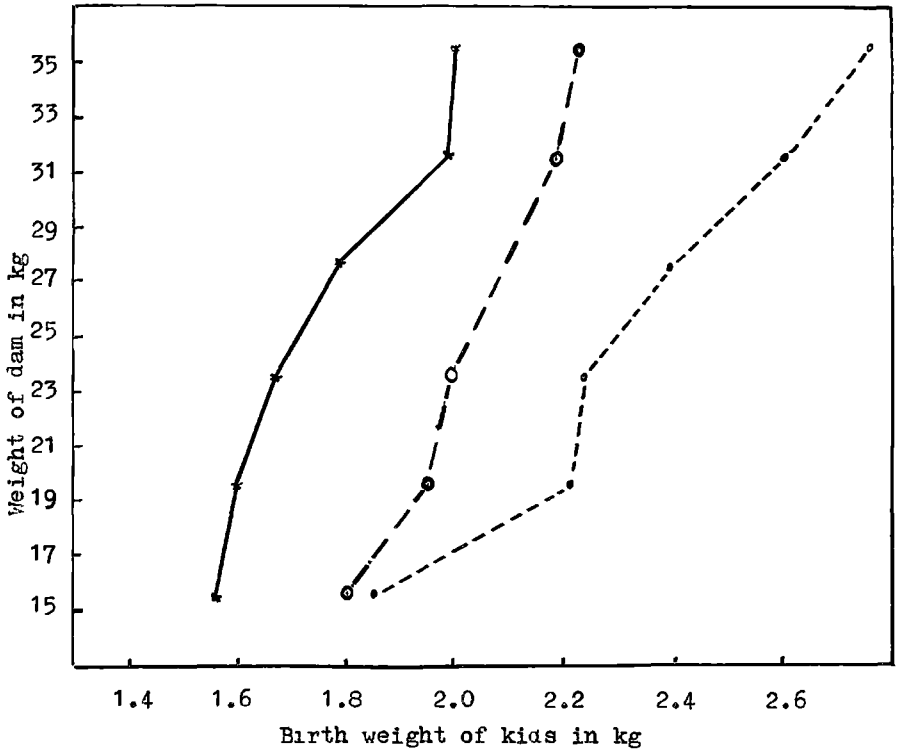


Fig.2. Relationship between weight of the dam and birth weight of kids.

undergone and birth weight of kids. As the gestation length increased the birth weight of kids were also seen increased upto 145 days and then onwards the birth weight remained almost steady.

1.6. Effect of dam's weight at kidding

Presented in Table 7 are the means of birth weight of kids according to dam's weight at kidding. Dam's weight at kidding had a significant influence ($P < 0.01$) on the birth weight of kids in all the three genetic groups as revealed from the analysis of variance presented in Table 9. Fig.2 reveals the direct proportionality between dam's weight at kidding and birth weight of kids. As dam's weight increased birth weight of kids were also seen increased. However, highest birth weight could be observed in kids born to dams with a body weight at kidding of 34 kg and above. From dams weighing 17 kg and less kids were born with the lowest birth weight. The above trend could be discerned in all the three genetic groups. Another interesting observation was that the largest number of kids were born to dams having a body weight at kidding ranging from 22-25 kg in all the three genetic groups. Correlations between birth weight and dam's weight at kidding and regression of birth weight on dam's weight

were presented in Table 8. The correlation coefficient is found to be significant in all the three genetic groups ($P < 0.01$). Regression coefficients were found to be 0.0167 in Malabari, 0.0080 in A x M and 0.0228 in C x M.

1.7. Effect of Sire

Though only a few bucks were in use for breeding purposes, in each breed a preliminary study was made to find out whether the sire had any significant effect on birth weight of kids. The analysis of variance revealed (Table 9) significant effect of sire on birth weight of kids in A x M ($P < 0.05$), even though the effect was non significant in the case of C x M and Malabari.

Table 1. Means of birth weight of kids in different Genetic Groups

Genetic Group	No.of obs.	Mean ± SE(Kg)	C.V.%
Malabari	309	1.71± 0.02	24.56
Alpine x Malabari	529	2.04± 0.02	28.92
Saanen x Malabari	389	2.31± 0.03	26.83

Table 2. Analysis of variance of birth weight according to the genetic group

Source	d.f.	M.S.S.
Genetic Groups	2	31.01**
Error	1224	0.33

** Significant at 1% level

Table 3. Means of birth weight according to the sex of the kids.

Sex	Malabari			Alpine x Malabari			Saanen x Malabari		
	No.of obs.	Mean ± SE ($\bar{kg}$)	C.V.%	No.of obs.	Mean±SE ($\bar{kg}$)	C.V%	No.of obs.	Mean± SE ($\bar{kg}$)	C.V.%
Male	160	1.75±0.03	25.14	278	2.12±0.04	27.83	193	2.44±0.05	27.46
Female	149	1.68±0.04	26.19	251	1.95±0.04	30.26	196	2.19±0.04	25.57

Table 4. Means of birth weight of kids according to Utter size at birth

Utter size	Malabari			Alpine x Malabari			Saanen x Malabari		
	No.of obs.	Mean± SE ($\bar{kg}$)	C.V.%	No.of obs.	Mean±SE ($\bar{kg}$)	C.V.%	No.of obs.	Mean±SE ($\bar{kg}$)	C.V.%
1	126	1.89±0.04	23.81	203	2.30±0.04	25.22	187	2.58±0.05	24.03
2	177	1.60±0.03	24.38	290	1.89±0.03	29.10	195	2.10±0.04	23.81
3	6	1.47±0.13	22.45	32	1.88±0.04	34.04	3	0.80±0.01	21.25
4	..	..	..	4	1.00	..	4	1.40±0.15	21.43

Table 5. Means of birth weight of kids according to the season of births

Season	Malabari			Alpine x Malabari			Saanen x Malabari		
	No.of obs	Mean ± SE(kg)	C.V.%	No.of obs.	Mean ± SE(kg)	C.V.%	No.of obs.	Mean ± SE(kg)	C.V.%
Summer	46	1.71±0.08	29.82	151	2.01±0.05	29.35	118	2.31±0.07	30.74
Winter	97	1.74±0.04	24.14	225	2.08±0.04	29.81	135	2.30±0.05	26.09
Rainy	166	1.70±0.03	24.12	153	2.01±0.05	28.86	136	2.34±0.05	24.36

Table 6. Means of birth weight according to the gestation length undergone by the kids

Gestation length range	Malabari			Alpine x Malabari			Saanen x Malabari		
	No.of obs.	Mean ± SE(kg)	C.V.%	No.of obs.	Mean ± SE(kg)	C.V.%	No.of obs.	Mean ± SE(kg)	C.V.%
136-139	12	1.39±0.20	20.20	16	1.76±0.14	31.25	8	1.78±0.27	24.26
140-143	71	1.60±0.04	22.50	95	1.81±0.54	28.88	53	1.87±0.07	28.73
144-147	127	1.76±0.04	22.60	217	2.08±0.04	27.75	178	2.32±0.04	23.71
148-151	72	1.77±0.06	26.70	109	2.08±0.06	29.67	112	2.36±0.06	24.12
152-155	27	1.79±0.08	23.46	92	2.09±0.07	31.25	38	2.38±0.11	27.31

Table 7. Means of birth weight of kids according to the weight of the dam at kidding

Weight of the dam range	Malabari			Alpine x Malabari			Saanen x Malabari		
	No.of obs.	Mean± SE($k\bar{g}$)	C.V.%	No.of obs.	Mean± SE($k\bar{g}$)	C.V.%	No.of obs.	Mean± SE($k\bar{g}$)	C.V.%
14-17	40	1.56±0.07	26.92	27	1.80±0.12	35.56	17	1.85±0.11	24.32
18-21	66	1.60±0.04	21.88	84	1.95±0.07	31.79	67	2.21±0.07	27.15
22-25	80	1.67±0.05	25.15	146	1.99±0.06	30.65	154	2.24±0.04	24.55
26-29	79	1.78±0.05	25.28	102	2.16±0.05	23.15	96	2.38±0.07	28.15
30-33	26	1.99±0.08	19.60	118	2.18±0.06	30.54	32	2.61±0.11	24.90
34-37	18	2.00±0.10	20.50	52	2.25±0.08	25.33	23	2.80±0.13	22.50

Table 8. Correlations between birth weight and dam's weight and regression of birth weight on dam's weight

Genetic group	Correlation coefficient	Regression
Malabari	0.16**	0.0167
Alpine x Malabari	0.19**	0.0088
Saanen x Malabari	0.30**	0.0228

** Significant at 1% level.

Table 9. Analysis of variance of birth weight

Source	Malabari		Alpine x Malabari		Saanen x Malabari	
	d.f.	M.S.S.	d.f.	M.S.S.	d.f.	M.S.S
Sex	1	$0.45^{N.S}$	1	3.54**	1	5.79**
Liter size	2	3.11**	3	7.34**	3	10.82**
Season	2	$0.05^{N.S}$	2	$0.34^{N.S}$	2	$0.08^{N.S}$
Weight of dam	5	1.11**	5	1.28**	5	2.78**
Gestation length	4	0.72**	4	1.27**	4	5.77**
Sire	9	$1.15^{N.S}$	6	0.80*	6	$0.33^{N.S}$
Error	284	0.15	507	0.29	367	0.20

** Significant at 1% level.

* Significant at 5% level.

N.S.Non significant.

2. Growth rate

2.1. Effect of genetic group

2.1.1. Weight at one month: Presented in Table 10 are the genetic group wise means of weight at one month of age. The highest weight at one month was in A x M (3.90 ± 0.05 kg) followed by S x M (3.78±0.05 kg) and the lowest in Malabari (2.83±0.05 kg). Analysis of variance presented in Table 11 showed significant difference between genetic groups for weight at one month of age ($P < 0.01$).

2.1.2. Weight at four months:

The means of body weight at four months in Malabari, A x M and S x M are presented in Table 12. Higher weight at four months was noticed in A x M crossbreds (9.92±0.19) followed by S x M (7.75±0.14) and Malabari (6.00±0.15). Analysis of variance presented in Table 13, revealed a highly significant difference between genetic groups ($P < 0.01$) in weight at four months.

2.1.3. Weight at one year

The means of weight at one year in Malabari, A x M and S x M are presented in Table 14. S x M registered highest weight at 12 months (18.49±0.29) followed by A x M (17.40±0.38) and Malabari (15.24±0.49). Analysis of variance presented in Table 15 showed that there were

significant differences (P $<$0.01) between the three genetic groups in weight at one year.

2.2. Sexual dimorphism

2.2.1. Weight at one month

From Table 16, it may be seen that in A x M and S x M genetic groups, the male kids were heavier. But in Malabari the female kids recorded higher mean weight than males. Analysis of variance presented in Table 31 revealed that sex had significant effect on body weight at one month of age only in S x M (P $<$0.01). On the contrary, in A x M and Malabari the same was non significant.

2.2.2. Weight at 4 months

Significant sexual dimorphism (P $<$0.01) could be observed only in S x M goats (Table 32). In all the genetic groups males had a higher weight at four months than females (Table 17).

2.2.3. Weight at one year

Sex wise means are presented in Table 18. In all the three genetic groups males registered higher weight at 12 months than females. Analysis of variance presented in Table 33 revealed that sex had a significant effect on one year weight in S x M (P $<$0.01), A x M (P $<$0.01) and Malabari (P $<$0.05).

2.3. Effect of litter size at birth

2.3.1. Weight at one month

Table 1) presents the means of weight at one month according to the litter size in the three genetic groups. From the table it can be discerned that in all the three genetic groups single had a higher weight at one month than twins, triplets and quadruplets. Highly significant ($P < 0.01$) effect of litter size on weight at one month could be observed in all the three genetic groups (Table 31)

2.3.2. Weight at four months

The means of body weight at four months according to the size of the litter are presented in Table 20. Singles were found to be heavier in all the three genetic groups followed by twins and triplets. But the effect of litter size was found to be non significant in all the three genetic groups (Table 32).

2.3.3. Weight at one year

Presented in Table 21 are the means of 12th month weight in different genetic groups according to the size of the litter at birth. Analysis of variance presented in Table 33 showed only non significant effect of type of birth on birth weight.

2.4. Effect of season of birth

2.4.1. Weight at one month.

Season wise averages of weight at one month in the three genetic groups are presented in Table 22. But season of birth had not exerted any significant influence on body weight at one month in any of the genetic groups (Table 31).

2.4.2. Weight at four months

Table 23 gives the means of weight at four months according to the season of birth. Season was found to be a significant source of variation ($P < 0.01$) 4th month weight in all the three genetic groups (Table 32).

2.4.3. Weight at one year

The means of one year body weight according to the season of birth are presented in Table 24. Analysis of variance presented in Table 33 revealed a significant effect of season of birth on one year weight in Malabari ($P < 0.05$), Alpine x Malabari ($P < 0.01$) and Saanen x Malabari ($P < 0.05$).

2.5. Effect of gestation length undergone by the kids

2.5.1. Weight at one month

Averages of body weight at one month in kids according to the period of gestation undergone are presented in Table 25. Though the effect of gestation length on body

weight at one month was significant in Malabari ($P < 0.01$) the same was non significant in S x M and A x M (Table 31). In all the three genetic groups body weight at one month was observed to be higher in kids born after a gestation period of 152 days and above.

2.5.2. Weight at four months

Presented in Table 26 are the means of weight at four months according to the gestation length undergone by the kids. That had no significant effect on weight at 4 months in any of the genetic groups (Table 32).

2.5.3. Weight at one year

Table 27 presents the means of weight at one year acoording to the gestation length undergone by the kids. On analysis of data (Table 33) non significant effect of gestation length on weight at one year could be observed.

2.6. Effect of weight of dam at kidding

2.6.1. Weight at one month

Presented in Table 28 are the means of body weight at one month according to the body weight of dams at kidding. Analysis of variance (Table 31) revealed that dam's weight at kidding had a significant effect on body weight at one month ($P < 0.05$) but in the case of A x M the effect was non significant. It could be observed that body weights at one month was higher in kids born to dams which had a body weight of 34 kg and above at kidding.

2.6.2. Weight at four months

Even though the dams weight at kidding was a non significant source of variation in S x M and A x M, in Malabari the four months weight was found to be significantly affected ($P < 0.01$) by the dams weight at kidding (Table 32). In all the three genetic groups there observed a general tendency that as dams weight increased, the weight of kids at four months was also seen increased (Table 29).

2.6.3. Weight at one year

The means of weight at one year according to dams weight at kidding are presented in Table 30. Analysis of variance presented in Table 33 revealed a non significant effect of weight of the dam at kidding on one year weight.

2.7. Effect of sire

2.7.1. Weight at one month

Analysis of variance presented in Table 31 revealed that the sire effect though was significant in the case of Malabari, that was non significant in A x M and S x M.

2.7.2. Weight at four months

Sire effect was found to be a significant source of variation ($P < 0.01$) only in Malabari, but not in A x M and S x M (Table 32).

2.7.3. Weight at one year

A significant effect of sire on weight at 12 months could be observed in Malabari ($P < 0.01$) and A x M ($P < 0.01$). But the effect was non significant in S x M (Table 33).

2.8. Gain in weight in different genetic groups

Weekly gain in weights in the three genetic groups are shown in Table 34. A x M registered highest weight gain during the first month (450 gms/week), followed by S x M (330 gms/week) and Malabari (230 gms/week). During the period from one month to four months, A x M gained 510 gms per week, S x M 320 gms per week and Malabari 250 gms per week. From four months to one year period weight gain was highest in S x M (337 gms/week) followed by Malabari (238 gms/week) and A x M(227 gms/week). Analysis of variance presented in Table 35 showed a significant difference between the three genetic groups in weight gains during the different periods. The growth rates of the three genetic groups are presented in Fig.3.

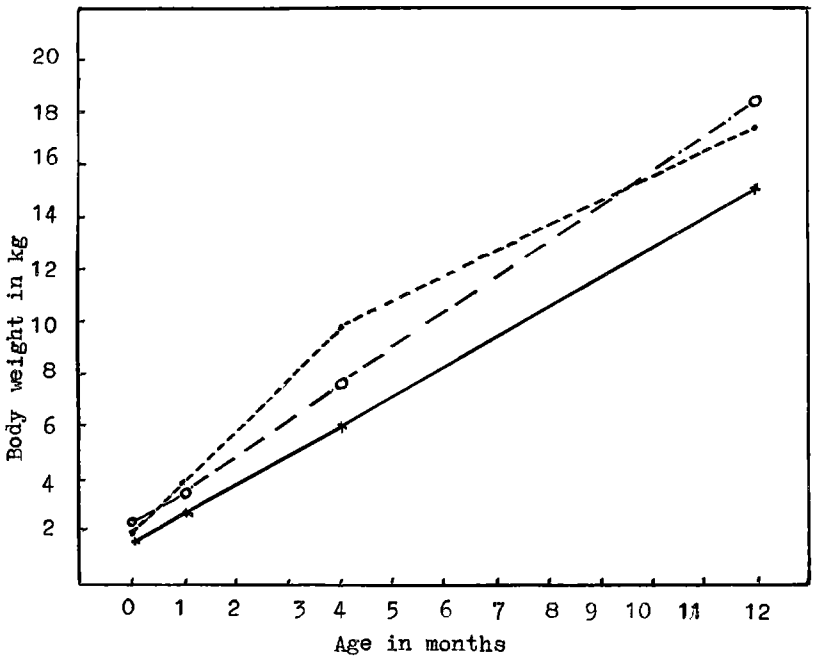


Fig.3. Growth rate in the three genetic groups.

Table 10. Means of body weight at one month in different genetic groups.

Genetic group	No.of obs.	Mean ± SE (kg)	C.V.%
Malabari	180	2.83±0.05	20.31
Alpine x Malabari	310	3.90±0.05	26.92
Saanen x Malabari	236	3.78±0.05	20.37

Table 11. Analysis of variance of body weight at one month according to the genetic group

S Source	d.f.	M.S
Genetic group	2	71.45**
Error	723	0.76

** Significant at 1% level.

Table 12. Means of body weight at four months according to different genetic groups

Genetic group	No.of obs.	Mean ± S.E.(kg)	C.V.%
Malabari	103	6.00 ± 0.15	25.33
Alpine x Malabari	137	9.92 ± 0.19	21.38
Saanen x Malabari	175	7.75 ± 0.14	25.30

Table 13. Analysis of variance of weight at four months according o genetic groups

Source	d.f.	M.S.
Genetic group	2	462.26**
Error	412	3.57

** Significant at 1% level.

Table 14. Means of body weight at one year according to different genetic groups

Genetic group	No. of obs.	Mean ± SE (kg)	C.V.
Malabari	55	15.24 ± 0.49	23.82
Alpine x Malabari	74	17.40 ± 0.38	18.79
Saanen x Malabari	148	18.49 ± 0.29	19.36

Table 15. Analysis of variance of weight at one year according to different genetic groups

Source	d.f.	M.S.S.
Genetic group	2	215.71**
Error	274	12.55

** Significant at 1% level.

Table 16. Means of body weight at one month according to the sex of the kids

Sex	Malabari			Alpine x Malabari			Saanen x Malabari		
	No. of obs.	Mean ± SE(kg)	C.V.%	No. of obs.	Mean ± SE(kg)	C.V.%	No.of obs.	Mean ± SE(kg)	C.V.%
Male	88	2.80±0.05	17.86	159	3.94±0.09	27.46	116	3.92±0.02	5.61
Female	92	2.86±0.07	24.13	151	3.86±0.09	27.46	120	3.65±0.02	7.12

Table 17. Means of body weight of four months according to the sex of the kids

Sex	Malabari			Alpine x Malabari			Saanen x Malabari		
	No.of obs.	Mean ± SE(kg)	C.V.%	No.of obs.	Mean± SE(kg)	C.V.%	No.of obs.	Mean ± SE(kg)	C.V.%
Male	41	6.11±0.17	18.17	65	10.14±0.32	25.54	87	8.10±0.20	23.70
Female	62	5.93±0.22	29.51	72	9.72±0.20	17.39	86	7.38±0.18	23.17

Table 18. Means of body weight at one year according to the sex of the kids

Sex	Malabari			Alpine x Malabari			Saanen x Malabari		
	No. of obs.	Mean± SE(kg)	C.V.%	No.of obs.	Mean± SE(kg)	C.V.%	No.of obs.	Mean± SE (kg)	C.V.%
Male	13	17.14±0.77	27.60	30	18.37±0.62	18.51	70	18.99±0.40	17.54
Female	42	14.65±0.57	25.12	44	16.74±0.46	18.16	78	18.05±0.44	21.39

Table 19. Means of body weight at one month according to the litter size

Litter size	Malabari			Alpine x Malabari			Saanen x Malabari		
	No.of obs.	Mean ± SE(kg)	C.V.%	No.of obs.	Mean± SE(kg)	C.V.%	No.of obs.	Mean ± SE(kg)	C.V.%
1	85	2.98±0.06	21.47	118	4.14±0.09	25.36	121	3.92±0.06	18.87
2	91	2.70±0.05	18.08	169	4.00±0.08	26.75	115	3.63±0.07	20.93
3	4	2.35±0.39	26.38	20	3.66±0.11	13.66	..	..	..
4	..	..	..	3	3.43±0.56	28.27	..	..	..

Table 20. Means of body weight at four months according to the litter size

Litter size	Malabari			Alpine x Malabari			Saanen x Malabari		
	No.of obs.	Mean ± SE(kg)	C.V.%	No.of obs.	Mean ± SE(kg)	C.V.%	No.of obs.	Mean ± SE(kg)	C.V.%
1	46	6.20±0.26	29.03	67	10.11±0.24	19.88	87	7.89±0.17	20.91
2	54	5.82±0.17	21.64	65	9.82±0.29	23.82	88	7.60±0.21	26.41
3	3	6.16±0.43	12.33	5	8.54±0.30	7.84			

Table 21. Means of body weight at one year according to the litter size

Litter size	Malabari			Alpine x Malabari			Saanen x Malabari		
	No.of obs.	Mean ± SE(kg)	C.V.%	No.of obs.	Mean ± SE(kg)	C.V.%	No.of obs.	Mean ± SE(kg)	C.V.%
1	23	15.94±0.69	20.89	40	18.00±0.51	19.05	73	18.85±0.43	20.43
2	32	14.74±0.67	25.71	33	15.83±0.50	17.11	75	18.11±0.40	19.60
3	..	..	..	1	12.00	..	..	..	..

Table 22. Means of body weight at one month according to the season of birth

Season	Malabari			Alpine x Malabari			Saanen x Malabari		
	No.of obs.	Mean ± SE(kg)	C.V.%	No.of obs.	Mean ± SE(kg)	C.V.%	No.of obs.	Mean ± SE(kg)	C.V.%
Summer	23	2.73±0.11	19.78	92	3.91±0.13	30.95	65	3.95±0.09	18.93
Winter	69	2.75±0.08	25.09	142	3.84±0.07	17.86	85	3.68±0.09	21.47
Rainy	53	2.92±0.06	13.84	76	3.93±0.14	30.53	85	3.76±0.08	20.48

Table 23. Means of body weight at four months according to the season of birth

Season	Malabari			Alpine x Malabari			Saanen x Malabari		
	No.of obs.	Mean ± SE(kg)	C.V.%	No.of obs.	Mean ± SE(kg)	C.V.%	No.of obs.	Mean ± SE(kg)	C.V.%
Summer	18	6.18±0.44	29.29	47	9.52±0.33	24.05	53	8.53±0.29	24.74
Winter	37	5.65±0.26	30.62	48	10.73±0.35	20.12	65	7.31±0.20	21.61
Rainy	42	6.21±0.07	7.57	42	9.48±0.23	15.72	57	7.52±0.22	21.94

Table 24. Means of body weight at one year according to the season of birth

Season	Malabari			Alpine x Malabari			Saanen x Malabari		
	No.of obs.	Mean ± SE(kg)	C.V.%	No.of obs.	Mean± SE(kg)	C.V.%	No.of obs.	Mean± SE(kg)	C.V.%
Summer	9	13.90±0.90	19.50	24	20.09±0.59	14.29	41	17.39±0.50	18.21
Winter	23	14.62±0.85	25.20	29	15.84±0.43	14.58	56	18.66±0.48	19.24
Rainy	23	14.80±0.92	21.00	21	16.49±0.65	18.31	51	19.20±0.54	20.26

Table 25. Means of body weight at one month according to the gestation period undergone by the kids

Gestation period range	Season	Malabari			Alpine x Malabari			Saanen x Malabari		
		No.of obs.	Mean ± SE(kg)	C.V.%	No.of obs.	Mean± SE(kg)	C.V.%	No.of obs.	Mean± SE(kg)	C.V.%
136-139		6	2.33±0.12	12.88	9	3.64±0.49	40.39	1	3.50	
140-143		34	2.64±0.09	20.45	42	3.95±0.20	33.42	16	3.49±0.18	20.34
144-147		82	2.87±0.07	23.00	135	3.86±0.09	25.91	111	3.72±0.07	20.16
148-151		41	2.84±0.09	20.07	62	4.11±0.12	22.87	85	3.86±0.08	19.43
152-155		17	3.12±0.12	16.03	62	3.75±0.13	26.40	23	3.98±0.20	23.87

Table 26. Means of body weight at four months according to the gestation period undergone by kids

Gestation period range	Malabari			Alpine x Malabari			Saanen x Malabari		
	No.of obs.	Mean ± SE(kg)	C.V.%	No.of obs.	Mean ± SE(kg)	C.V.%	No.of obs.	Mean ± SE(kg)	C.V.%
136-139	5	4.84±0.45	20.87	1	6.50		1	10.5	
140-143	22	5.75±0.29	24.00	17	9.17±0.31	13.96	11	7.08±0.61	28.81
144-147	47	6.15±0.25	28.13	63	10.03±0.24	19.34	86	7.70±0.19	22.34
148-151	17	6.28±0.34	22.13	31	9.95±0.27	15.38	59	7.72±0.24	24.35
152-155	12	5.97±0.32	18.43	25	10.23±0.69	33.72	18	8.31±0.50	25.27

Table 27. Means of body weight at one year according to the gestation period undergone by the kids

Gestation period range	Malabari			Alpine x Malabari			Saanen x Malabari		
	No.of obs.	Mean ± SE(kg)	C.V.%	No.of obs.	Mean ± SE(kg)	C.V.%	No.of obs.	Mean ± SE(kg)	C.V.%
136-139	3	14.33±2.03	24.49	..	..	..	1	20.00	..
140-143	8	15.14±0.74	13.87	9	18.39±1.13	21.03	8	17.94±0.84	13.21
144-147	28	14.80±0.67	24.12	35	18.21±0.48	15.65	72	18.33±0.38	17.40
148-151	11	10.30±1.19	21.94	21	16.43±0.73	20.53	52	18.19±0.60	23.64
152-155	5	12.34±1.00	18.07	9	19.53±1.16	18.83	15	20.57±0.89	16.82

Table 20. Means of body weight at one month according to the dam's weight at kidding

Dam's weight range	Malabari			Alpine x Malabari			Saanen x Malabari		
	No. of obs.	Mean ± SE(kg)	C.V.%	No.of obs.	Mean± SE(kg)	C.V.%	No.of obs.	Mean ± SE (kg)	C.V.%
14-17	19	2.97±0.13	20.29	16	3.83±0.23	18.18	8	3.63±0.23	18.18
18-21	39	2.85±0.08	19.29	39	3.54±0.13	23.72	41	3.54±0.13	23.72
22-25	54	2.65±0.06	19.24	87	3.74±0.07	18.44	88	3.74±0.07	18.44
26-29	43	2.83±0.09	21.20	55	3.88±0.09	20.36	54	3.88±0.09	20.36
30-33	16	3.01±0.22	29.90	81	3.84±0.16	19.79	21	3.84±0.16	19.79
34-37	9	3.05±0.14	14.42	32	4.25±0.22	19.52	14	4.25±0.22	19.52

Table 29. Means of body weight at four months according to the weight of the dam at kidding

Weight of dam's range	Malabari			Alpine x Malabari			Saanen x Malabari		
	No. of obs.	Mean ± SE(kg)	C.V.%	No. of obs.	Mean ± SE(kg)	C.V.%	No. of obs.	Mean ± SE(kg)	C.V.%
14-17	5	5.94±0.35	19.44	8	9.23±0.71	21.84	5	7.14±1.24	38.36
18-21	25	5.55±0.22	19.73	22	9.98±0.68	31.96	25	7.92±0.36	25.10
22-25	73	5.60±0.22	22.32	45	9.88±0.26	17.91	73	7.36±0.19	22.28
26-29	47	6.15±0.28	22.27	20	9.92±0.55	24.89	49	8.14±0.27	23.34
30-33	14	6.46±0.81	39.78	29	10.28±0.36	19.06	14	7.70±0.42	29.77
34-37	9	6.48±1.06	36.57	13	9.50±0.39	14.84	9	8.46±0.83	31.20

Table 30. Means of body weight at one year according to the weight of the dam at kidding

Weight of dam range	Malabari			Alpine x Malabari			Saanen x Malabari		
	No.of obs.	Mean± SE($\bar{kg}$)	C.V.%	No.of obs.	Mean± SE($\bar{kg}$)	C.V.%	No.of obs.	Mean± SE($\bar{kg}$)	C.V.%
14-17	8	14.85±1.09	15.68	6	18.00±1.05	14.33	5	15.80±0.84	11.90
18-21	12	14.35±0.92	22.23	13	18.14±1.03	20.56	21	17.19±0.90	23.97
22-25	18	14.08±0.66	19.82	21	17.72±0.76	19.64	60	18.90±0.44	18.15
26-29	11	14.81±0.95	21.20	10	16.17±0.91	17.69	45	18.93±0.48	16.59
30-33	3	17.20±3.92	39.43	17	17.16±0.19	18.82	11	19.85±1.40	23.38
34-37	3	16.50±3.55	37.21	7	16.90±1.20	18.98	8	18.69±1.40	22.42

Table 31. Analysis of variance for weight at one month

Source	Malabari		Alpine x Malabari		Saanen x Malabari	
	d.f.	M.S.S	d.f.	M.S.S.	d.f.	M.S.S
Sex	1	0.17 N.S.	1	0.47 N.S	1	4.35**
Litter size	2	2.20**	3	3.95**	1	5.13**
Season	2	0.69 N.S.	2	0.10 N.S	2	1.41 N.S
Weight of dam	5	0.65*	5	2.04 N.S	5	1.31*
Gestation length	4	1.06**	5	1.25 N.S	4	0.90 N.S
Sire	9	1.05**	6	0.83 N.S	4	0.80 N.S.
Error	156	0.27	288	1.08	218	0.53

** Significant at 1% level

* Significant at 5% level

N.S Non significant

Table 32. Analysis of variance for weight at four months

Source	Malabari		Alpine x Malabari		Saanen x Malabari	
	d.f.	M.S.	d.f.	M.S.	d.f.	M.S.
Sex	1	0.84 N.S	1	5.99 N.S	1	22.60**
Litter size	2	1.80 N.S	2	6.28 N.S	1	3.67 N.S
Season	2	55.4**	2	22.9**	2	23.23**
Weight of dam	5	4.31**	5	1.98 N.S	5	1.90 N.S
Gestation length	4	2.63 N.S	4	6.11 N.S	4	1.60 N.S
Sire	7	4.77**	5	8.63 N.S	4	1.63 N.S
Error	81	1.18	119	4.19	157	2.99

** Significant at 1% level

* Significant at 5% level

N.S. Non significant

Table 33. Analysis of variance for weight at one year

Source	Malabari		Alpine x Malabari		Saanen x Malabari	
	d.f.	M.S.S	d.f.	M.S.S	d.f.	M.S.S
Sex	1	61.48**	1	47.21**	1	47.21*
Litter size	1	18.66$^{N.S}$	3	10.70$^{N.S}$	1	20.97$^{N.S}$
Season	2	27.38*	2	130.58**	2	38.70*
Weight a of dam	5	13.48$^{N.S}$	5	5.85$^{N.S}$	5	24.26$^{N.S}$
Gestation length	4	14.80$^{N.S}$	4	9.75$^{N.S}$	4	19.04$^{N.S}$
Sire	7	25.65**	4	15.41**	4	18.76$^{N.S}$
Error	41	7.33	55	4.28	131	11.03

** Significant at 1% level

* Significant at 5% level.

N.S Non significant.

Table 34. Weekly weight gains (gms) in different genetic groups

Period	Malabari	Alpine x Malabari	Saanen x Malabari
Birth - 1 month	230	450	330
1 month - 4 months	250	510	320
4 months - 1 year	288	227	337

Table 35. Analysis of variance (weekly weight gains)

Period	Source	d.f.	M.S.S
Birth to 1 month	Genetic group	2	36.4**
	Error	723	0.57
1 month - 4 months	Genetic group	2	35.6**
	Error	412	0.27
4 months - 1 year	Genetic group	2	4.79**
	Error	274	0.16

** - Significant at 1% level.

3. Heritability estimates of body weight at different stages

Heritability estimates of body weight at birth for the three genetic groups are presented in Table 36. The heritability estimates were not different from zero. That was zero in Malabari, 0.0496±0.027 in A x M and -0.0276±0.018 in S x M. Heritability estimates of body weight at one month are presented in Table 37. The highest estimate of heritability for weight at one month could be obtained in Malabari (0.3292±0.2856), followed by that in A x M (0.1289±0.2288). For S x M the heritability was found to be zero.

Presented in Table 38, are the heritability estimates of weight at four months. For Malabari, it was found to be 0.2514±0.5368 and that in A x M the estimate was 0.2692±0.3816. In S x M the value was found to be nearly zero (0.1421±0.1302). For weight at one year, the estimates were found to be 0.521±0.48 in Malabari, 0.4026±0.56 in A x M and 0.5726±0.15 in S x M (Table 39).

4. Correlation between body weights at different stages

Table 40 shows the correlations between birth weight and one month weight in the three genetic groups. The phenotypic correlations were found to be 0.4860 in Malabari, 0.3161 in A x M and 0.7547 in S x M. All were found to be highly significant (P $<$ 0.01). Since the heritability

estimates of birth weight were found to be near to zero in all the three genetic groups, the genetic correlations between birth weight and weight at different stages are not worth considering.

Presented in Table 41 are the phenotypic correlations between birth weight and weight at four months. The correlations were 0.1618 in Malabari, 0.2454 in A x M and 0.3419 in S x M. That was found significant ($P < 0.01$) only in S x M. Table 42, shows the phenotypic correlations between birth weights and 12 months weights. The correlations were 0.2722 in Malabari, 0.1245 in A x M and 0.4044 in S x M. The correlations were significant in Malabari ($P < 0.05$) and S x M ($P < 0.01$).

Genetic and phenotypic correlations between weight at one month and four months are presented in Table 43. Genetic correlations were found to be 0.4055 ± 0.8039 in Malabari and 0.5097 ± 0.8192 in A x M. Genetic correlation in S x M was not considered since the heritability estimates for one month weight and 4 month weights were found to be approximately zero. The phenotypic correlations were 0.6881 in Malabari, 0.4075 in A x M and 0.4906 in S x M and they are all significant ($P < 0.01$).

Table 44 presents the genetic and phenotypic correlations between one month weights and 12 months weights.

The genetic correlations were 0.2295±0.5989 in Malabari and 0.4±0.9211 in A x M. The phenotypic correlations were 0.1603 in Malabari, 0.3553 in A x M and 0.4145 in S x M. The values were significant in A x M (P <0.05) and non significant in S x M.

The correlations between four months weights and 12 months weights were presented inTable 45. The genetic correlations were 0.6754±0.6392 in Malabari and 0.5781±0.4189 in A x M. The Phenotypic correlations were 0.4042 in Malabari, 0.3535 in A x M and 0.2764 in S x M. All were found to be significant (P <0.05).

5. Incidence of different types of birth and sex ratio

Presented, in Table 46, are the percentages birth of singles, twins, triplets and quadruplets during the period. Percentages of singles, were 40.78 in Malabari, 38.37 in A x M and 48.07 in S x M. Those of twins were 57.28, 54.83 and 50.13 per cent in the three genetic groups respectively. Triplets were 1.94 per cent in Malabari, 6.04 per cent in A x M and 0.77 per cent in S x M. Quadruplets were nil in Malabari 0.76 per cent in Alpine x Malabari, and 1.09 per cent in Saanen x Malabari.

Table 47 shows the secondary sex ratios in the three genetic groups. Those were 52:48 in Malabari, 50:50 in Alpine x Malabari and 52:48 in S x M.

Table 36. Heritability estimates of birth weight Analysis of variance

Source	Malabari			Alpine x Malabari			Saanen x Malabari		
	d.f.	M.S.	$h^2 \pm$ S.E.	d.f.	M.S.	$h^2 \pm$ S.E.	d.f.	M.S.	$h^2 \pm$ S.E.
Sire	6	0.20	..	5	0.46	0.0498 ± 0.027	4	0.29	-0.0276 ± 0.018
Error	112	0.20		191	0.32		182	0.39	

Table 37. Heritability estimates of body weight at one month
Analysis of variance

Source	Malabari			Alpine x Malabari			Saanen x Malabari		
	d.f.	M.S.	$h^2 \pm$ S.E.	d.f.	M.S.	$h^2 \pm$ S.E.	d.f.	M.S.	$h^2 \pm$ S.E.
Sire	6	0.63	0.3292 ± 0.2856	5	1.82	0.1289 ± 0.2228	4	0.56	..
Error	74	0.32		111	1.15		116	0.56	

Table 38. Heritability estimates of body weight at four months

Analysis of variance

Source	Malabari			Alpine x Malabari			Saanen x Malabari		
	d.f.	M.S.	$h^2 \pm$ S.E.	d.f.	M.S.	$h^2 \pm$ S.E.	d.f.	M.S.	$h^2 \pm$ SE
Sire	5	4.89	0.2514± 0.5368	5	6.82	0.2692± 0.3816	4	1.07	-0.1421± 0.1302
Error	38	3.31		61	3.99		82	2.83	

Table 39. Heritability estimates of body weights at one year

Analysis of variance

Source	Malabari			Alpine x Malabari			Saanen x Malabari		
	d.f.	M.S.	$h^2 \pm$ SE	d.f.	M.S.	$h^2 \pm$ S.E.	d.f.	M.S.	$h^2 \pm$ S.E.
Sire	4	25.00	0.521± 0.48	4	19.52	0.4026± 0.56	4	40.92	0.5726± 0.15
Error	16	15.48		35	10.90		68	12.15	

Table 40. Correlation between birth weight and one month body weight

Analysis of covariance

Genetic group	Source	d.f.	M.S.S.(x)	M.S.P.(xy)	M.S.S.(y)	Phenotypic correlation
Malabari	Sire	6	0.1678	0.1067	0.6400	0.4860**
	Error	74	0.1463	0.1234	0.4023	
Alpine x Malabari	Sire	5	0.2187	0.0543	1.6394	0.3161**
	Error	111	0.3099	0.1766	1.1010	
Saanen x Malabari	Sire	4	0.4000	-0.0072	0.5567	0.7541**
	Error	116	0.3594	0.3497	0.5680	

** Significant at 1% level.

Table 41. Correlation between birth weight and four month body weight

Analysis of covariance table

Genetic group	Source	d.f.	M.S.(x)	M.S.P.(xy)	M.S.S.(y)	Phenotypic correlation
Malabari	Sire	5	0.1101	0.2533	5.98	0.1618 N.S
	Error	32	0.1459	0.1464	3.29	
Alpine x Malabari	Sire	5	0.2006	0.2757	3.9276	0.2454 N.S
	Error	61	0.2584	0.2557	3.9276	
Saanen x Malabari	Sire	4	0.0525	0.1274	1.0705	0.3419**
	Error	82	0.3223	0.3042	2.0351	

** Significant at 1% level.

N.S. Non significant.

Table 42. Correlation between birth weight and body weight at 12 months

Analysis of covariance table

Genetic group	Source	d.f.	M.S.S(x)	M.S.P.(xy)	M.S.S(y)	Phenotypic correlation
Malabari	Sire	4	0.2242	1.6134	45.96	0.2722*
	Error	76	0.1983	0.0912	2.726	
Alpine x Malabari	Sire	4	0.3666	0.2810	19.5175	0.1245 N.S
	Error	35	0.2311	0.2006	10.8062	
Saanen x Malabari	Sire	4	0.0721	-1.4800	40.9212	0.4044**
	Error	68	0.31	0.8611	12.1521	

** Significant at 1% level.

* Significant at 5% level.

N.S. Non significant.

Table 43. Correlation between body weight at one month and four months

Analysis of covariance table

Genetic group	Source	d.f.	M.S.S(x)	M.S.P.(xy)	M.S.S(y)	Genetic correlation±SE	Phenotypic correlation
Malabari	Sire	5	0.8026	1.1125	3.9793	0.4055±0.8039	0.6881**
	Error	33	0.5441	0.9421	3.2966		
Alpine x Malabari	Sire	5	2.0780	1.6558	6.5960	0.5097±0.8192	0.4075**
	Error	61	0.9313	0.7641	3.9276		
Saanen x Malabari	Sire	4	0.2096	-0.2015	1.0709	-	0.4906**
	Error	82	0.5635	0.6485	2.8331		

** Significant at 1% level.

Table 44. Correlation between body weight at one month and 12 months

Analysis of covariance table

Genetic group	Source	d.f.	M.S(x)	M.S.P.(xy)	M.S.(y)	Genetic correlation ± S.E.	Phenotypic correlation
Malabari	Sire	4	0.6750	1.0750	48.9661	0.2295 ± 0.5989	0.1603 N.S
	Error	16	0.1438	0.0500	2.7263		
Alpine x Malabari	Sire	4	2.3211	2.5078	19.5185	0.4000 ± 0.9211	0.3553*
	Error	35	0.9799	1.1475	10.8961		
Taanen x Malabari	Sire	4	0.1754	1.7550	40.9200		0.4145*
	Error	68	0.5803	1.1140	12.1468		

* Significant at 5% level.

N.S. Non significant.

Table 45. Correlation between four month and 12 months weights

Analysis of covariance table

Genetic groups	Source	d.f.	M.P.S(x)	M.P.P.(xy)	M.P.S(y)	Genetic correlation±S.E.	Phenotypic correlation
Malabari	Sire	4	4.4742	2.2662	48.4660	0.5754± 0.6392	0.4342*
	Error	16	1.2638	0.0926	2.8513		
Ha Alpine x Malabari	Sire	4	4.8356	3.3505	19.5185	0.3781± 0.4109	0.3535*
	Error	35	2.5196	0.7070	10.8961		
Saanen x Malabari	Sire	4	0.4312	0.8368	40.92		0.2767*
	Error	68	2.7242	2.9719	12.1512		

* Significant at 5% level.

Table 46. Incidence of different types of birth in goats

Genetic group	Total no. of obs.	Singles	% singles	Twins	% twins	Triplets	% Triplets	Quadruplets	% quadruplets
Malabari	309	126	40.78	179	57.28	6	1.94	..	..
Alpine x Malabari	529	205	38.37	290	54.83	32	6.04	4	0.76
Saanen x Malabari	389	187	48.07	195	50.13	3	0.77	4	1.03

Table 47. Secondary sex ratios in goats

Genetic group	Total no.of obs.	Males	Females	Sex ratio (M.F.)
Malabari	309	160	149	52:48
Alpine x Malabari	529	278	251	50:50
Saanen x Malabari	389	193	196	52:48

DISCUSSION

DISCUSSION

1. Birth weight

1.1. Effect of breed:

From the results it was observed that the Saanen x Malabari goats registered the highest weight at birth followed by Alpine x Malabari goats and Malabari goats. In general crossbred goats weighed more at birth than the local goats belonging to Malabari breed. The higher birth weight in crossbred goats with exotic inheritance than the local breed were also reported by Pant (1968) in crossbred Angoras, Muhamad and Devendra (1970) in Malaya x Anglo Nubian goats, Bhatnagar and Tomar (1971) in Alpine x Beetal crossbreds, Castillo et al.(1972) in Criollo x Nubian crosses, Mishra et al.(1976) in Alpine x Beetal crossbred Mukundan (1976) in Alpine x Malabari and Saanen x Malabari crosses, Singh et al.(1977) in Saanen x Jamnapari crosses, Iqbal Nath and Chawla (1978) in Alpine x Beetal and Saanen x Beetal crosses and Nair (1979) in Alpine x Malabari and Saanen x Malabari crossbred goats.

On analysis of the data, it was found that genetic group of the kid had a highly significant effect on birth weight. This finding concurs with the reports by Pant (1968) in pure bred and crossbred Angoras; Gill and Dev (1972) in

Alpine and Anglo Nubian breeds; Castillo et al.(1978) in Nubian, Alpine, Toggenburg and Saanen goats; Riebetti and Intrieri (1978) in Calabrian and Calabrian x Toggenburg crosses and Iqbal Nath and Chawla (1978) in Alpine and Alpine x Beetal crossbreds. The coefficient of variation was found to be high (between 25-28%) in all the three genetic groups indicating that the trait is highly variable and hence afford selection for the trait for genetic improvement.

1.2. Effect of sex:

In all the three genetic groups studied males had a higher weight at birth than the females. Although the effect was significant in Alpine x Malabari and Saanen x Malabari, the same was non significant in Malabari. Hence distinct sexual dimorphism in body weight at birth could be discerned in crossbred goats unlike that in Malabari goats.

The higher birth weight noticed in males than in females may be due to the beneficial effects of sex hormones secreted by the gonades. The male sex hormones used to exert an anabolic effect which help to grow fast during prenatal development in males (Hafez, 1962). According to Perry and Pomeroy (1956) the androgenic hormones in males used to be released earlier than oestrogenic hormones and so the nitrogen loss from the male foetus is relatively lessened.

This stored nitrogen apparently is utilised in body building and for producing heavier males than females.

Significant effects of sex on birth weight of kids were also reported by Wilson (1954) in East African dwarf goats; Amble (1964), Seth et al.(1968), Prasad et al.(1971), and Mittal (1979) in Barbari goats; Wijeratne (1968) in South Indian meat breed of goats; Correa and Dela Parra (1969) in Anglo Nubian x Granada crossbred goats; Gill and Dev (1972) in French Alpine and Anglo Nubian breeds; Singh and Singh (1974) and Khan (1979) in Jamnapari goats; Richetti et al. (1976) in Toggenburg x Gargano crossbreds; Singh et al.(1977) in Jamnapari, Saanen, Barbari and their crossbreds; Castillo et al.(1978) in Nubian, Alpine, Toggenburg and Saanen kids; Iqbal Nath and Chawla (1978) in Beetal, Alpine and Alpine x Beetal and Mishra et al. (1978) in Alpine, Beetal and Alpine x Beetal crosses.

Non significant effect of sex of the kid on birth weight was also seen reported by Mittal and Pandey (1978) in Barbari goats.

1.3. Effect of litter size at birth:

Single born kids were found to be heavier than twins and triplets in all the three genetic groups. As the litter size increased the birth weight of kids was seen decreased.

The reason for this can be attributed to the limited blood supply to twins and triplets due to greater number of placentae, and hence less nutrient supply.

The birth weight of kids was significantly affected by litter size at birth in all the three genetic groups. Significant effect of litter size on birth weight were also reported by Paramsothy (1957) in Indonesian, Malaya and Indonesian x Malaya crossbreds; Gupta et al. (1966) in Barbari goats; Castillo et al. (1978) in Nubian, Alpine, Toggenburg and Saanen goats and Khan (1979) in Jamnapari goats. On the contrary, Singh et al. (1977) in Saanen, Barbari and Jamnapari breeds; Mittal (1977) in Barbari and Iqbal Nath and Chawla (1978) in Beetal, Alpine and Alpine x Beetal crossbreds, reported that the litter size at birth was a non significant source of variation for birth weight of kids.

1.4. Effect of season of birth:

Winter born kids were found to have higher birth weight in A x M and Malabari, presumably due to better availability of green fodder and grazing facilities to dams during advanced stage of pregnancy. Higher nutritional status of the dams during advanced stage of pregnancy might have improved the birth weight of kids. Similar reasoning was attributed by Mittal (1979) in Jamnapari goats. But the

effect of season was found to be a non significant source of variation for birth weight in all the three genetic groups, as reported by Singh (1973) in Jamnapari. But Singh et al.(1977) and Khan (1979) obtained a significant effect of season of birth on birth weight in Jamnapari kids.

1.5. Effect of gestation length undergone by the kids

Significant effect of gestation length undergone by the kids on birth weight could be observed.

Similar observations were also made by Bradue and Walker (1949) and Kasoir (1967) in dairy cattle and Poshir (1969) in Nali sheep. Another interesting observation was that as the gestation length of the dam increased, birth weight of kids was also seen increased. This increment was noticed only upto a gestation length of 147 days and thereafter there was not much increase. That is clear from Fig.1 which shows the relationship between birth weight of kids and gestation length of dams. So it could be inferred that the optimum size and weight of the kid during prenatal stage was attained with a gestation length of 144-147 days. The fact that largest number of kids were born after a gestation length between 144-147 days clearly supports this finding. Another observation is that kids born after a gestation length of 139 and below recorded the lowest birth weight presumably because complete development has not taken place in the womb during the gestation period.

1.6. Effect of dam's weight at kidding

Dam's weight at kidding significantly affected the birth weight of kids in all the three genetic groups. Similar reports were also made by Khan (1979) in Jamnapari goats; Bhasin and Desai (1967) and Copra and Acharya (1971) in Bikaneri sheep.

The birth weight of kids showed an increasing trend with the increase in body weight of dams at kidding. Fig.2 reveals the direct proportionality between dam's weight at kidding and birth weight of kids. As the body weight of dam increases the kids get more space in the womb to grow and receive enough blood supply required for growth. Highest birth weight was recorded in kids born to dams having body weight of 34 kg and above and lowest birth weight in kids born to dams having body weight of 17 kg and below. So body weight of dams at kidding was found to be an important factor causing variation in birth weight of kids.

The correlation between dam's weight at kidding and birth weight of kids was found to be significant in all the three genetic groups. Significant correlations between dam's weight at kidding and birth weight of kids were also reported by Mittal (1979) in Jamnapari goats and Gajdosik and Gyarmathy (1970) and Gonzalezjimenoz (1971) in sheep. The regression coefficient was found to be highest in Malabari (0.0228) followed by AxM (0.0167) and 3 x 1 (0.0088).

1.7. Effect of sire:

Significant effect of sire on birth weight of kids was found only in A x M crosses, but the effect was non significant in S x M and Malabari. As the number of sires were limited more studies are envisaged to arrive at valid conclusions.

2. Growth rate

2.1. Effect of breed:

Significant effect of genetic group was found for body weights at one month, weight at 4 months and weight at one year in all the three genetic groups. The weights at one month and four months were highest in A x M followed by S x M and Malabari. But at one year of age, S x M gained highest weight followed by A x M and Malabari. In all the stages crossbreds recorded highest body weight than the local Malabari goats.

Gains in body weight were also significantly affected by the breed during all the periods from birth to one month, one month to four months and from four months to one year. The gain in weight was highest in A x M during the period from birth to one month (45 gms/week), whereas in S x M that was 330 gms/week and that in Malabari 230 gms/week. From one month to four months also A x M

gained the highest followed by S x M and Malabari. During the period from four months to one year, S x M gained the highest weight followed by Malabari and Alpine x Malabari. Almost uniform gains in weight could be noticed in S x M and Malabari, but in A x M the gain in weight appeared maximum during the period from one month to four months. However, afterwards the weight gain was lower than Malabari and Saanen x Malabari. Higher weight gain in crossbred goats observed in this study is akin to the reports by Khatnagar and Tomar (1971) in Alpine x Beetal and Mukundan (1976) in Alpine x Malabari and Saanen x Malabari.

Significant effect of breed of the kid on growth rate was also reported by Mishra et al. (1976) in Alpine, Beetal and Alpine x Beetal goats and Castillo et al. (1978) in Nubian, Alpine, Toggenburg and Saanen.

2.3. Effect of sex:

Males recorded higher body weight than females at all stages of growth, in all the three genetic groups, except at the age of one month where Malabari females recorded slightly higher body weight than males. The reason for the higher growth rate in males than females may be due to the fact that the testicular hormones have exerted a stimulatory action upon the growth of males. In addition they may bring about pronounced changes in body metabolism by their

influence upon protein synthesis. This effect of androgens is of obvious importance and may explain the difference in weight between males and females (Cole, 1966).

Significant sexual dimorphism in body weight could be observed at all the stages of growth only in Saanen x Malabari crossbreds. In Malabari and Alpine x Malabari the effect of sex was a non significant factor causing variation in weight at one month and four months of age. But at the age of one year significant sexual dimorphism could be detected in all the three genetic groups.

Significant effect of sex on weight gain was reported by Galcon (1951) in Philippine breed, Guha et al. (1968) in Black Bengal kids, Correa and De la Para (1969) in Anglo Nubian x Criolla crossbreds kids; Singh and Singh (1974) and Khan (1979) in Jamnapari kids; Mishra et al. (1978) in Beetal, Alpine and Alpine x Beetal crossbred kids; Mittal and Pandey (1978) in Barbari kids and Castillo et al. (1978) in Nubian, Alpine, Toggenburg and Saanen kids.

2.2. Effect of litter size:

Single born kids registered higher weight than those born as twins, triplets and quadruplets in all the stages of growth upto one year in all the three genetic groups. The difference in body weight at birth continued upto the age of one year in all the three genetic groups. The litter

size at birth affected significantly only the body weight at one month. At four months and 12 months of age the effect of litter size on body weight were not significant. This may probably be due to the maternal influence at the early stages of growth. Single born kids received more milk in comparison to twins and triplets for their growth. This added with the higher birth weight of singles may be the reason for the higher body weight of singles than twins, triplets and quadruplets. This effect gets reduced as they grow and the difference in body weight between males and females becomes lesser. This may be the probable reason for the non significant effect of litter size on weight at four months and 12 months of age.

Similar reports were also made by Seth et al. (1968) in Barbari breed. According to them in 30-60 days and 60-90 days interval the gain in weight of the males born as singles were significantly more than those born as twins. But Guha et al. (1968) and Prasad (1971) reported that the gain in weight was not been affected by litter size in Barbari kids. Wilson (1970) observed a similar growth pattern in single and twin kids.

2.4. Effect of season of birth:

Body weights of kids were not affected by season of birth at one month of age. But season was seen significantly affected by body weight at four months and 12 months of age

in all the three genetic groups. Guha et al. (1968) reported that the gain in body weight from birth to 52nd week was significantly influenced by season of birth in Black Bengal goats. A highly significant effect of season of birth on weight at 12 months and 15 months of age were reported by Khan (1979). He found that the season of birth was a non significant source of variation in body weights at other ages.

2.5. Effect of gestation length undergone by the kids

Gestation length undergone by the kids had a significant effect only on weight at one month for Malabari kids only. Other stages of growth was not seen significantly affected by gestation length of the dam. The significant effect on gestation length of dam on birth weight was seen reduced as the kid grew.

2.6. Effect of dam's weight at kidding

Effect of dam's weight at kidding was significant on body weight in Malabari at the age of one month and four months. In S x M it was significant only at the age of one month. In A x M it was not significant at any stages of growth, studied. As in the case of gestation length the effect of dam's weight on body weight at birth seen decreased as the age advanced.

2.7. Effect of sire:

Significant effect of sire on body weights at one month, four months and one year was found in Malabari. But in A x M sire effect was significant at one year of age only. In S x M the effect of sire was non significant at all the stages of growth, studied. The results are contradictory in different genetic groups probably due to the limited number of sires used and hence further detailed studies are envisaged.

3. Heritability estimates of body weight at different stages.

The heritability estimate of birth weight was found to be nearly zero in all the three genetic groups. Very low heritability estimate for birth weight suggests that this trait was mostly influenced by non genetic factors, thus there is not much scope for improving the trait by selection.

The above observation is in agreement with Moulick and Bystrad (1970) who found that the heritability estimate of birth weight in Black Bengal goats was only 0.01. A higher estimate was obtained by Ali and Basanath (1977) in Black Bengal goats. They obtained a heritability estimate for birth weight as 0.76±0.82 in males and 0.55±0.64 in females. Guha et al.obtained 0.77 for male and 0.19 for females as the heritability of birth weight

in Black Bengal goats. A fairly high estimate of 0.39 was obtained by Castillo et al.(1978) in Nubian, Toggenburg and Saanen kids.

Heritability estimates of body weight showed an increasing trend as age advanced in A x M crossbred. This clearly indicates that the influence of genetic factors is higher at later stages of growth. As the age advances the inherent ability of the kids play an important role in gain in weight than the environmental effects. Almost similar trend was seen in the case of Malabari also. In S x M the heritability estimates of one month weights and four months weights were not different from zero. The negative values obtained may be due to the smaller number of sires used for analysis. The findings of this study are in agreement with the findings of Guha et al. (1965). They observed that as the age advanced heritability estimate of body weight also increased. A contradictory report of decrease in the heritability as the age advanced was obtained by Richordeau (1972) in Saanen female and Castillo et al. (1978) in Nubian, Toggenburg and Saanen kids.

Higher heritability estimates for body weights at the age of one year in all the three genetic groups indicates that sufficient genetic variability exists for this trait at this stage. So selection for body weight at early stages

is less indicated in these breeds. For improving body weight at early stages careful feeding and management practices are necessary. Standard errors obtained for heritability of body weight at different stages were fairly large, probably due to the limited number of sires as the number of progeny/sire plays an important role in determining the size of the error of heritability. Even though the number of sires was small this gives a trend of the heritability estimate.

4. Correlation between body weight at different stages

Since the heritability estimates of birth weight in the three genetic groups were found to be zero, genetic correlation between birth weight and weight at different stages are not worth considering. Correlation between birth weight and weight at one month age was significant in all the three genetic groups. But between birth weight and four months weights, that was significant only in S x M crosses and between birth weight and 12 month weight that was significant in S x M and Malabari. Higher phenotypic correlations obtained between early stages of growth may be due to the similar feeding and management conditions in the farm.

Significant phenotypic correlations were obtained between one month and four months body weights in all the three genetic groups, between one month and 12 months body

weights in A x M and G x M and between four months and 12 months body weights in all the three genetic groups.

Significant correlations between birth weight and weight at different stages were obtained by Guha et al. (1968) in Black Bengal goats. A higher phenotypic correlation of 0.57±0.16 between birth weight and one month and 0.82±0.11 between birth weight and one year weight were obtained by Wijeratne (1968) in South Indian meat breeds.

The genetic correlations obtained were moderate. But they had large standard errors, which may be due to the limited number of sires used for the analysis. Even though the number of sires was small this gives a trend of genetic correlations between body weights.

5. Incidence of different types of birth and sex ratio

Malabari breed of goats are known for their higher prolificacy. The present study confirmed the view that twinnings were higher in all the three genetic groups where the dams were Malabari goats. The result is in agreement with the observation made by Shanmugasundaram (1957), but contradictory to the reports of Mukundan and Rajagopalan (1971) and Sudarsanan and Raja (1973) who found a higher incidence of single births than twins.

A secondary sex ratio of 52:48 was observed in A x M, 50:50 in A x M and 52:48 in Malabari. These ratios were in accordance with the expected ratio of 50:50. Similar was the observation by Mukundan and Rajagopalan (1971) and Nair and Mathai (1979) in Malabari breed and Deaker (1979) and Khan (1979) in Jamnapari breed. A wider ratio was obtained by Gill and Dev (1972) in Alpine and Anglo Nubian breed, and Mishra et al. (1976) in Alpine, Beetal and Alpine x Beetal crosses.

SUMMARY

SUMMARY

The possible effects of various genetic and non genetic factors on body weights at birth and those at one month, four months and twelve months were studied based on data pertaining to 1227 kids belonging to Malabari, Saanen x Malabari and Alpine x Malabari genetic groups born and brought up at the goat farm of the All India Co-ordinated Research Project on Goats for milk Production, Kerala Agricultural University, Mannuthy during the period from April, 1974 to March, 1979. Genetic groups of kids, sex of the kids, litter size at birth, season of birth, gestation period undergone by the kids, dam's weight at kidding and the bucks which sired the kids are the effects of which were studied.

The means of birth weight were 1.71±0.02 kg, 2.04±0.02 kg and 2.31±0.05 kg respectively in Malabari, Saanen x Malabari and Alpine x Malabari kids. The effects of the genetic group of kids, litter size at birth, gestation length undergone by kids and dam's weight at kidding, on birth weight were found to be highly significant. Though the sex of the kids was found to have significant effect on birth weight in crossbred kids, the effect was non significant in the case of Malabari kids. Season of kidding did

not exert any significant influence on birth weight. Only in the case of Alpine x Malabari kids, significant sire effect on birth weight could be discerned.

Means of body weight at one month averaged 2.83±0.05, 3.90±0.05 and 3.78±0.05 kg in Malabari, Alpine x Malabari and Saanen x Malabari respectively. The corresponding mean were 6.00±0.15, 9.92±0.19 and 7.75±0.14 kg at four months and 15.24±0.49, 17.40±0.38 and 16.49±0.29 kg at one year in those respective genetic groups. Significant effects of genetic group of kids on body weights at all ages could be observed. Distinct sexual dimorphism in body weight at one month was observed, though the effect of sex on the body weights at 4 months and one year was found significant in Saanen x Malabari kids only. Litter size at birth had exerted significant influence on body weight at one month but non significant on body weights at four months and one year. Body weights at four months and one year were significantly affected by the season of birth. The gestation length undergone by kids was a non significant source of variation for body weight at all ages, except in the case of Malabari kids, in which the body weight at one month was seen affected by the gestation length. Dam's weight at kidding was a significant source of variation for body weights of kids at one month and four months in Malabari only. However, that

had no effect on body weight at one year in all the genetic groups studied. On the contrary, the sire effect was found significantly affecting the body weight at one year in all the genetic groups.

Weekly weight gains were significantly affected by genetic group, at all the periods. Gains in weights were found to be highest in Alpine x Malabari up to four months and then onwards Saanen x Malabari registered higher weight gain.

The heritability estimate for body weight at birth was not different from zero. The heritability estimate was seen increased with advancement of age. The genetic correlations were moderate between one month and four months weights, between one month and one year weights and four months and one year weights. But the phenotypic correlation between body weight at different ages were highly variable. Twinning rates were higher in all the genetic groups and the secondary sex ratio of kids was almost 50:50.

In general crossbred kids were found to have higher birth weight and body weights at different ages and hence crossbreeding is envisaged for improvement of weight gain in goats. The selection of kids for body weight at early stages may not be desirable in the light of the very low heritability estimate obtained for body weights at early ages.

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* Original not consulted.

APPENDIX

APPENDIX

1. Composition of kid starter ration

Groundnut cake	- 30 parts
Coconut cake	- 10 ,,
Yellow maize	- 32 ,,
Rice bran	- 10 ,,
Mineral mixture	- 2 ,,
Salt	- 1 part
Vitamin A, B_2, D_3	- 25 gm/100 kg feed (Vitablen-Glaxo, containing 40,000 iu of vitamin A, 25 mg of vitamin B_2 and 6,000 i.u of vitamin D_3 per gram).

2. Composition of EMR pellets

Moisture (maximum)	- 10%
*Crude protein NN x 6.25 (minimum)	- 20%
*Crude fibre (maximum)	- 13%
*Acid insoluble ash (maximum)	- 4.0%

* on dry matter basis

STUDIES ON CERTAIN GENETIC AND NONGENETIC FACTORS AFFECTING BIRTH WEIGHT AND GROWTH RATE IN MALABARI AND CROSSBRED GOATS

BY

K C RAGHAVAN

ABSTRACT OF A THESIS

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ABSTRACT

The data on 1227 kids belonging to Malabari (309) Saanen x Malabari (389) and Alpine x Malabari (309) genetic groups born and brought up at the All India Co-ordinated Research Project on Goats, Kerala Agricultural University, Mannuthy during the period from April 1974 to March 1979 were utilised to study the effects of various genetic and non genetic factors on body weight at different ages.

Crossbred goats, S x M and A x M, registered higher weights at birth, at one month, at four months and at one year than the local Malabari goats. Distinct sexual dimorphism in body weights at different ages could be observed in crossbred goats. Litter size significantly affected birth weight and weight at one month. Season of birth had only non significant influence on weights at birth and that at one month, though the effect was significant on 4 months' and one year weights. Even though the effect of gestation length undergone by kids was a significant source of variation for weights at birth alone in Saanen x Malabari and Alpine x Malabari kids, the same had significant effect on body weights at birth and at one month in Malabari. Significant effects of dam's weight at kidding on weights at birth, one month and four months in Malabari; at birth and a one month in Alpine x Malabari and at birth alone in Saanen x Malabari could be observed. Sire effect was