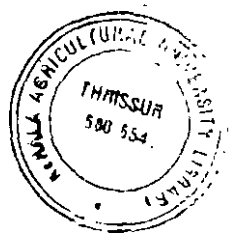
GENETICS OF BODY DIMENSIONS OF MALABARI GOATS AND ITS CROSS IN KERALA



By

RAJ MENON

THESIS

Submitted in partial fulfilment of the
requirement for the degree

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University

Department of Animal Breeding and Genetics
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
Mannuthy, Thrissur

1994

DECLARATION

I hereby declare that this thesis entitled **GENETICS OF BODY DIMENSIONS OF MALABARI GOATS AND ITS CROSS IN KERALA** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Mannuthy,
30.8.94.

RAJ MENON

CERTIFICATE

I hereby declare that this thesis entitled **GENETICS OF BODY DIMENSIONS OF MALABARI GOATS AND ITS CROSS IN KERALA** is a record of research work done independently by RAJ MENON under my guidance amd supervision and that it has not previously formed the basis for the award of any degree, fellowship, or associateship to him.

Mannuthy,
30.8.94.

30/8/94.

Dr.STEPHEN MATHEW
Chairman, Advisory Committee,
Assoicate Professor,
Centre for Advanced Studies in
Animal Genetics and Breeding,
College of Veterinary & Animal
Sciences, Mannuthy.

CERTIFICATE

We the undersigned members of the Advisory Committee of **RAJ MENON**, a candidate for the degree of Master of Veterinary Science in Animal Breeding and Genetics, agree that the thesis entitled **GENETICS OF BODY DIMENSIONS OF MALABARI GOATS AND ITS CROSS IN KERALA** may be submitted by **RAJ MENON** in partial fulfilment of the requirement for the degree.

Dr.STEPHEN MATHEW
Chairman, Advisory Committee,
Assoicate Professor,
Centre for Advanced Studies in
Animal Genetics and Breeding,
College of Veterinary & Animal
Sciences, Mannuthy.

Dr. G. MUKUNDAN,
Director,
Centre for Advanced Studies
in Animal Genetics and Breeding.
(Member)

Dr.V.SUDARSANAN,
Professor,
Department of Animal
Reproduction.
(Member)

Dr. K.C. GEORGE,
Professor & Head,
Department of Statistics.
(Member)

Dr. M. R. JAYASHANKAR
EXTERNAL EXAMINER
ASSOCIATE PROFESSOR
Dept. of Animal Breeding,
Genetics and Biostatistics,
Veterinary College, Hebbal,
U.A.S., BANGALORE-560 024

ACKNOWLEDGEMENTS

I am deeply indebted to **Dr. Stephen Mathew,** Associate Professor, Centre for Advanced Studies in Animal Genetics and Breeding and Chairman of the Advisory Committee for his timely suggestions, infinite patience and understanding shown to me.

I am grateful to **Dr. Mukundan,** Director, Centre for Advanced Studies in Animals Genetics and Breeding, and member of the Advisory Committee for his timely and valuable guidance during the many difficulties faced by me during my study period.

I hereby express my sincere gratitude to **Dr. K. C. George,** Head, Department of Statistics and member of the Advisory Committee for guidance and patience shown to me during my study.

I am grateful to **Dr. V. Sudarsanan,** Professor, Department of Animal Reproduction and member of the Advisory Committee for his help and suggestions.

I am thankful to **Dr. Sosamma Iype,** Professor, Centre for Advanced Studies in Animal Genetics and Breeding, for helping me always and lending a sympathetic ear to my problems.

I am also thankful to all the staff of the Centre for Advanced Studies in Animal Genetics and Breeding for all the help rendered to me.

I would like to express my sincere gratitude to Dr.Ravindran Nayar, Professor, Department of Surgery for his help during the course of my study.

I would be failing in my duty if I were not to thank Dr. J. Radhakrishnan and Dr. Mary John for the understanding they have shown to me.

Words are not enough to express my hearfelt thankfulness to Dr. K.A. Bindu and Dr. Anil kumar for every thing they have done for me.

I express my deep sense of gratitude to Dr.Fabiana Lobo, whose immeasurable understanding and encouragement helped me finish this thesis.

I also express my thanks to may friends, Dr. G.Krishnakumar, Dr. A.M. Vahida, Dr. A.V. Harikumar, Dr. Prabhakaran, Dr. R. Anil Kumar, Dr. Viju Geroge, Dr.B.Suresh, Dr. S. Manumohan, Dr.Krupesh Sharma, Dr.Shaji Antony and all my other friends for encouraging and supporting me all the time.

My heartfelt gratitude is hereby expressed to **Dr.G. Kishore, Dr. C. Gopakumar** and **Mr. Sunesh Raja** for their timely and valuable guidance and help.

I am also grateful to **Mrs.Leela, Mrs. Savithri** and **Mrs. Devaki** farm labourers for the help rendered during my study.

Finally, I cannot find enough words to express the loving encouragement I have received from my family.

RAJ MENON

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Introduction

INTRODUCTION

The goat (Capra hircus) is perhaps the most misunderstood but an important economic species of livestock, especially in the developing world. They form an important part of the rural economy in countries like India which is a member of the many economically backward nations of the world known collectively as the Third World Countries.

The fact that the goat has been an important co-factor in the life of human beings, can be adjudged by the revelation that the goat was one of the earliest discoveries of mankind in pre-historic times as a ready and easy source of meat. The human race however, took a little time to understand the value of its milk, meat, hair and skin. The beginning of domestication of Capra (hircus) took place in the Near East in 7500-7000 BC, the progenitor being a wild goat of the region Capra (hircus) aegagrus as reported by Mason (1951).

Of the developing countries, India occupies a premier position as regards the goat population, which according to the 1982 census was 95 million, the maximum of any country in the world. According to the FAO, the population in 1987 (FAO, 1988) was 105 million

with the current population being 104 million. This is in spite of an inbuilt bias and prejudice towards the goat, being added on to the neglect of the goat by development planners due to misconception of its role in ecological degradation and deforestation. The fact that the population of the goat has achieved an annual rate of growth of about 3.39 per cent in India and that their number has increased relatively more than other domestic species especially in Asia, adds substance to the goats role as an important contributor to the economy of many of the Third World Countries.

Relative to the increase in the population, there has been a larger increase in chevon, milk and skin production. Goats contribute 2.5 million metric tonnes of meat, 8.8 million metric tonnes milk and 0.087 million metric tonnes of skin to the world market, of which 64 per cent of the meat and 47 per cent of milk is produced in Asia (FAO, 1988). In India 35 per cent of the total meat consumed in the country comes from this species. One of the major reasons for this is that there are no religious taboos attached to chevon consumption as against that seen in the case of beef or pork.

The inseparable association of the goat with the rural economy of India is very well brought to light by their sobriquet-poor man's cow. In our country goats provide a dependable source of income to about 40 per cent of the rural population. In many villages it may be seen that even those who have little or no holding of land take to goat rearing. Due to its multiparity and ready market for sale near its home, it pays a very high dividend to its owner and thus it finds high popularity among the poor peasantry as a source of supplementing their income, a fact further proved by the large number of small and marginal farmers and landless labourers who maintain goats for sustenance. The goat also has an additional role to play in the rural economy of a country like ours, which is that of a contributor to the house hold nutrition.

Sporadic efforts have been made in the last five decades in India to identify the breeds, describe their morphology and record their performance. India now has about 20 recognised breeds of goats of which Kerala is represented by only one, the Malabari or Tellicherry, the prestigious goat breed of Kerala. This breed is well known for its high prolificacy, milk yield and adaptability to the hot humid conditions prevalent in

the state. In the recent past as a part of All India Co-ordinated Research Project on Goats for milk production, Kerala Agricultural University has undertaken an experiment with the support of ICAR for crossing this breed with the famous Alpine goat breed of France in keeping with the then ongoing policy of quick genetic improvement by using exotic breeds. Further research efforts have been made to determine the nutritional requirements, reproductive behaviour and production characteristics of these goats. But now there is a growing realization of the importance of indigenous genetic resources because of their adaptation to specific agro-ecological and socio-economic condition. It is not the absolute production but the efficiency of production in relation to physical environments, feed resources availability, management and disease factors which ought to be considered in deciding the future of the indigenous breeds and the breed improvement strategies.

Further, modern programmes of selecting goats for meat production are rare. Scanty are the reports on the growth characters of Malabari and its exotic cross and reports are non existing as regards to their body dimensions. Further, the studies on the growth and meat

production performance of the above genetic groups on Kerala conditions are rare.

The objective of the present study is to study and analyse the bodyweights and body dimensions of Malabari goats and it Alpine half breds and their relationships. Further a concurrent study on the other major factors affecting the above traits will be of a great help in formulating an efficient breeding and management plan.

This study also envisages the estimation of the genetic and phenotypic correlations between bodyweights and different body dimensions in the two genetic groups and suggesting a suitable formula for the prediction of bodyweights from different body dimensions.

By these observations the lacunae existing in the data on growth and meat production characteristics of the Malabari and its exotic Alpine cross will be filled up to the extent possible.

Review of Literature

REVIEW OF LITERATURE

Bodyweight

Ali (1980) reported that for 77 male 90 female kids, 13 week weight averaged 11.20 and 11.33 lb and correlations between birth weight and body weight at one, three and eight weeks of age were highly significant (0.40 - 0.71 in males and 0.26 - 0.57 females).

For six male single, seven male twin, four female single and female twin goats born in the dry season in Brazil bodyweight at 240 days averaged 15.2, 18.7, 13.3 and 15.2 kg respectively Vs 16.3, 15.2, 13.7 and 15 kg for nine, 18, six and eight goats respectively for the four types born in the rainy season (Figueiredo et al., 1980).

Mihra (1980) recorded the bodyweight and four body measurements of 343 Sirohi goats in four age groups from young kids to adults and tabulated the correlation of bodyweight with body length, heart girth and paunch girth. Overall, the equation for multiple regression of bodyweight on the three body measurements had a R^2 value of 0.83.

Rana (1980) reported that the factors significantly affecting weaning weight of Beetal and its crosses with

French Alpine and Anglo-Nubian were season of kidding and litter size.

Velez et al. (1980) reported that in Anglo Nubian (AN) and Peruvian Criollo kids the correlation of birth weight with 24 week weight was 0.03 and 0.19 respectively for AN single and twin males, whereas for single and twin females the correlations of birth weight with 36 week weight was 0.17 and 0.41.

For 12 and 87 kids sired by native and Anglo-Nubian bucks and for 82 and 17 kids from native and Anglo-Nubian x native dams, live weight at 90 days of age averaged 9.3 and 11.4 kg, 12.0 and 10.7 kg respectively (Wilson and Katsigianis, 1980).

According to Ayoade (1981) the average bodyweight of 46 Malawi goats grouped as females and castrated males aged less than one year and females and castrated males aged above one year respectively were 10.52±1.52, 13.05±0.98, 23.01±0.73 and 18.17±0.95 kg. Further he confirmed that bodyweight was significantly correlated with body length (0.70-0.98) ($p<0.01$) and heart girth (0.84-0.99) ($p<0.01$) in both sex and age groups.

Mohd-Yusuff et al. (1981) reported that in 16 Saanen x Katjang, 17 Anglo-Nubian x Katjang, 13 British Alpine x Katjang and 422 Katjang kids born over a two year period, adjusted 90 day weaning weights were 9.35, 7.24, 6.13 and

5.37 kg, and for single and twin born kids, adjusted 90 day weights were 7.93 and 5.68 kg respectively ($p<0.05$). Year and sex had significant effects on pre-weaning average daily gain and 90 day weight.

Mukherjee et al. (1981) tabulated the phenotypic correlations of bodyweight with length, wither height and chest circumferences in 43, 39, 41, 47 and 42 Gray Bengal females aged 0-3, 3-6, 6-12, 12-36 and above 36 months respectively and found that all correlations were significant, with the highest being with chest circumference (0.74±0.09 to 0.95±0.04) and equations for predicting bodyweight from the measurements in females aged one to three and > three year are estimated.

According to Prasad et al. (1981) the largest phenotypic correlation among body measurements to bodyweight were those involving chest circumference. This was revealed in a study involving bodyweight, length, withers height and chest circumference in 350 female Black Bengal goats, aged 0-3, 3-6, 6-12, 12-16 and > 36 months

In 136, Assam Hill kids born during May 1977 - December 1978, bodyweight at 90 days was 4.75 kg and at 180 days it was 8.06 kg. Type of birth had a significant effect on bodyweight at all ages and season had a significant effect on weaning weight, which averaged 5.45

kg for kids born during October-March Vs 3.77 kg for kids born during April-September. There was also a significant season x type of birth interaction for 180 day bodyweight. This was revealed by Sarma et al. (1981).

Siddiqui et al. (1981) revealed in their studies on some growth attributes of Osmanabadi goat kids that sex and type of birth had highly significant effect on birth weight and all subsequent monthly weights upto the tenth month while season significantly affected birth weight and bodyweights at one, two, three, six and nine months. Phenotypic correlations amongst birth weight and subsequent bodyweights were positive and highly significant and Osmanabadi goats could be improved by selection for three and six months bodyweight and twinning rate.

According to Wahid and Khusahry (1981) the live weights of 20 male and 20 female Australian feral goats at three, six, 12 and 18 months were 21.98 and 18.5 kg, 35.2 and 27.71 kg, 34.56 and 29.33 kg and 41 and 27.49 kg. respectively. They further mentioned that from three months of age the males were significantly heavier than the females.

Ayoade and Butterworth (1982) revealed that for 52 male and 55 female Boer, 32 male and 16 female Malawi and

26 male and 13 female Boer x Malawi goats, weaning weights averaged 20.2±5.39, 18.7±4.60, 16.30±2.99, 15.4±3.62, 16.0±4.16 and 15.2±3.74 kg and that in Malawi and crossbred goats weaning weight was significantly correlated with birth weight (0.48 and 0.47 respectively).

In 236 Anglo-Nubian (AN), Jamnapari, Damascus, 50 per cent AN x 50 per cent Damascus and 5 per cent Jamnapari x 25 per cent Damascus goats weaning weight averaged 18.2, 16.8, 12.2, 11.31, 11.9, 19.3 and 20.9 kg, the values of males generally being higher than those for females. This was revealed by El-Serafy and Al-Busaidy (1982) in a study on the performance of kids produced of local and exotic breeds of goats in Oman.

Khan and Sahni (1982) revealed that in 90 Jamnapari kids grown under semi arid conditions, type of birth (Single Vs Twin) and dam weight at kidding affected growth from 0-3 months of age while season of birth had a significant effect on growth from 3-6 months.

According to Mukundan et al. (1982), sex had a significant effect on daily weight gain in 212 Malabari and cross-bred kids born during 1974-77, at 3-6, 0-6 and 0-9 months and while breed type had a significant effect in all growth periods except 6-9, 9-12 and 6-12 months, type of birth (single Vs multiple) did not significantly

affect daily gain. Month and year of birth, however, had a significant effect at 0-3, 3-6, 6-9, 9-12, 0-6, 0-9, 3-9 and 6-12 month and the effect of breed type x month interaction was significant at 0-3, 3-6, 6-9, 0-6 and 6-12 months.

Least-squares analysis of bodyweight from birth to 24 months of age as revealed by Patro and Madelli (1982) in 345, female and castrated male Ganjam goats, have shown that sex had a significant effect on bodyweight at six and 24 months, females being higher than males.

Taneja (1982) revealed that in Sirohi Beetal and Sirohi kids average live weights at 12 months were 21.3 and 22.3 kg respectively for single born kids (males and females) the differences being significant. Kanaujia et al. (1986) confirmed that in Black Bengal (BB) and Jamnapari x BB kids bodyweight averaged 2.1 and 2.5 kg at one month of age respectively and 4.4 and 5.5 kg at 4 months, both differences being significant.

According to Garcia et al. (1983) for Nubian x Criollo, Alpine x Criollo, Toggenburg x Criollo, 75 per cent Nubian 25 per cent Criollo, 75 per cent Alpine 25 per cent Criollo, 25 per cent Criollo - 50 per cent Alpine - 25 per cent Nubian and 50 per cent Nubian - 25 per cent Criollo - 25 per cent Toggenburg goats, weaning weight at four months of age and bodyweight at six months

were 11.3 and 15.2, 11.8 and 17.0, 11.8 and 15.9, 12.1 and 15.3, 11.7 and 18.1, 11.8 and 14.6 and 11.5 and 14.0 kg respectively. They also observed that there were significant correlations of birth weight with weaning weight (0.29, 0.24, 0.28) and bodyweight at six months (0.3, 0.27 and 0.27) and of weaning weight with six months weight (0.8, 0.75 and 0.84) in Nubian x Criollo, Alpine x Criollo and Toggenburg x Criollo breed groups.

Khan and Sahni (1983) observed that in 11 Jamnapari kids born in March-April or September-November during 1976-78 bodyweights at one, two and three months of age were 6.25, 8.73 and 10.78 kg respectively and the factors affecting the traits were, year having a significant effect on bodyweight at 1-2 months, type of birth and weight of dam significantly affecting bodyweight at one, two and three months and season of birth which significantly affected bodyweights at two and three months. The regression of body weight on age in months was also found to be highly significant (R^2-0.603).

In eight Saanen, 14 Jamnapari, 20 Barbari, 135 crossbred (1/2 Black Bengal) and 149 Black Bengal goats live weight at six months averaged 13.64, 12.72, 9.81, 9.96 and 7.82 kg ($p<0.05$) as reported by Kumar and Singh (1983). Mishra et al. (1983) reported that, in 256 Ganjam goats studied over a nine year period, bodyweight was

significantly correlated genetically with elbow height at six months, 0.65±0.10, height at stifle at birth (-0.26±0.10), six months (0.63±0.08), 12 months (-0.35±0.06) and 24 months.

Mukherjee et al. (1983) in 212 Grey Bengal goats representing five age groups (0-3, 3-6 and 6-12 months and 1-3 and above 3 years) and reared in three zones (Plain, sub-plateau and plateau). They observed that phenotypic correlation of bodyweight to body measurements was maximum in the sub-plateau, with all correlations being significant, while in the other two zones fewer significant correlations were observed.

Mukundan et al. (1983) revealed that for, 140 Malabari and 177 Saanen x Malabari kids born during 1974-77, average bodyweights at one, two and three months were 2.83 and 3.91 kg, 3.97 and 5.16 kg and 4.96 and 6.48 kg respectively. Sex, genotype and year had significant effect on bodyweight at all ages, while bodyweight at one month was significantly affected by type of birth (single Vs multiple), at two months by month of birth and the genotype x month of birth interaction and at three months by age and sire (Malabari only).

Ozekin and Akcapinar (1983) in Angora goat kids revealed that for 153 kids weight at weaning (120 days of age) were 14.2 kg for males, 12.7 kg for females, 13.5 kg

for singles and 12.5 kg for twins. At six months bodyweights were 17.3, 19.2, 16.3 and 14.9 kg respectively and at 12 months 20.8, 16.3, 18.6 and 17.1 kg. Sex had a highly significant effect on bodyweight at all ages, birth type (single Vs twin) had a significant effect at 120 days only.

Singh et al. (1983b) observed that for Jamnapari and Barbari kids born during 1966-69 average weaning weight at three months was 7.32 kg. sex, season age and weight of dam did not significantly affect the weaning weight.

Singh et al. (1983a) in 89 male Black Bengal (BB) and 99 female and 90 male ½ Jamnapari-1/2 BB's and 59 female bodyweights at birth averaged 1.3, 1.2, 1.4 and 1.3 kg respectively and 11.4, 10.9, 14.1 and 12.6 kg at 48 weeks of age. They further observed that the factors significantly affecting bodyweights at almost all ages were genotype and birth type (single Vs twin) and that crossbreds expressed their maximum superiority over pure breds at 36 weeks of age (21.28 per cent).

Bhattacharaya et al. (1984) reported that in 135 female Black Bengal goats of different ages the average bodyweight was 13.4±0.52 kg.

In 125 male and 145 female Beetal goats aged approximately one year, bodyweight averaged 17.22 kg (Bose and Basu, 1984).

Chawla et al. (1984) analysed the bodyweight records from birth to 42 months of age in males and female of 294 Beetal, 216 Alpine and 42 Saanen where in the body weights were 26.8, 30.6 and 35.0 Vs 19.3, 22.8 and 32.8 kg at 12 months and 65.6, 64.1 and 76.4 Vs 39.2, 40.3 and 48.6 kg respectively.

Madeli and Patro (1984) analysed data on 342 Ganjam goats maintained at the Goat Breeding Project of Orissa University and revealed that genetic correlations of birth weight with 12, 18 and 24 months weight were negative, but from six months onwards, were positive and six and 12 month weight had high genetic correlation with bodyweight at 18 month so sequential selection can be made at six and 12 months.

Manik et al. (1984) reported that for 102 Beetal, 97 Alpine x Beetal and 47 Saanen x Beetal, bodyweights averaged 34.85, 33.45 and 37.78 respectively. They further confirmed that breed difference were highly significant for bodyweight and correlations among traits were highly significant.

Misra and Rawat (1984) analyzing the data on bodyweight and four body measurements for Sirohi kids at birth and weaning revealed that season and sex did not have significant effect on weaning weight but that

birthweight was significantly correlated with weaning weight (0.68).

In 135 male and 159 female Beetal and 111 male and 105 female Alpines born during 1972-82, the bodyweight was significantly affected by season which had an effect upto 12 months in Beetal 15 months in Alpine, sex which significantly affected bodyweight at all ages, except for Alpine at three months and both breeds at six months and one year which significantly affected bodyweight at all ages in both the breeds. This was reported by Nagpal and Chawla (1984).

Sarma et al. (1984) observed that, in Assam local x Beetal kids average live weight at 15, 30, 45, 60, 75 and 90 days of age averaged 2.21, 2.88, 3.64, 3.93, 4.2 and 4.53 kg respectively.

Singh et al. (1984) revealed, in their study of 66 Jamnapari and 115 Barbari kids, that average bodyweights were 7.45 and 7.19 six months was 9.40 and 8.21 kg respectively, the weights being significantly affected by breed, at birth and at six months with season and birth type exerting their influence at all ages on bodyweights.

Naik et al. (1985) in 418 Ganjam goats studied over an 11 year period, reported that bodyweight at birth and at six and 18 months of age was significantly affected by

season of birth while sex had a significant effect on birth weight only.

Data analysed by Lima et al. (1985) on 54 non descript goats in Brazil revealed that for goats born in the rainy season bodyweight at 153, 181, 209, 293 and 349 days of age averaged 12.3±0.4, 14.3±0.4, 14.8±0.5, 14.9±0.5, 14.9±0.4 and 12.9±0.4 kg respectively Vs 8.1±0.5, 8.6±0.6, 9.1±0.8, 10.3±0.9, 12.8±0.9 and 15.3±0.8 for goats born in the dry season ($p<0.05$). Sex and birth type (single or twin) had no significant effect on any weight except at 349 days ($p<0.05$).

The major factor affecting bodyweights at different ages in 663 Alpine-Beetal (F1, F2, F3 and 75 per cent Alpine) 378 Saanen-Beetal (F1 and 75 per cent Saanen), 344 Saanen x (Alpine x Beetal) and 256 Alpine x (Saanen x Beetal) goats, as revealed in a study by Nagpal and Chawla (1985) was, genetic group, which had a significant effect on weight at birth and at three, six, 12, 18 and 21 months. Sex also had a significant effect on bodyweight at most ages in all groups except Saanen x (Alpine x Beetal) where it was only significant from 15 months onwards.

Abdulwahid et al. (1985) reported that in Malaysia male Saanen goats were mated with 28 Anglo-Nubian (AN) x local and 68 Jamnapari x local females to study the

performance of their offspring with the parenteral types and the results showed that the weaning weights ranged from 10.19±2.32 kg in Jamnapari x local goats to 13.54±2.79 kg in Saanen x (AN x local) goats.

Analysis of data collected on 234 Criollo kids born at the Cardas Experiment Station, Chile by Garcia et al. (1986) showed that the important factors affecting bodyweights were, sex of kid and year of birth which affected weights at 2 months of age, type of birth season and year of birth (with births in November being lighter than those in July or September) affecting weights at four and six months. They further went on to reveal that at two, four and six months of age respectively, single born kids weighed 37, 22 and 25 per cent more than twin-born kids.

Kanaujia et al. (1986) in six Beetal, six Black Bengal (BB), seven Beetal x BB and seven BB x Beetal male kids and reported that the six month weights averaged 17.45, 13.2, 15.4 and 16.73 kg respectively.

Mukherjee et al. (1986) recorded the bodyweight and measurements (length, height and chest circumference) in Brown Bengal does in five age groups viz. 0-3, 3-6 and 6-12 months and 1-3 and less than three years, situated in three region (planes, sub-plateau and plateau) and found out that correlation of bodyweight with the three

measurements for each age group and region were significant.

Haricharan et al. (1987) reported that in 280 Anglo-Nubian (AN), Saanen, Toggenberg and Alpine goats bodyweights on an average at 12 weeks of age ranged from 107.0±0.2 for AN goats to 13.8±0.7 for Alpine goats, the effect of breed being significant. In males and females average bodyweight at 12 week of age were 12.9±0.2 kg and 10.2±0.2 kg respectively, the differences between sexes being significant. The bodyweight was not significantly affected by type of birth but was affected by year of birth and interactions of year of birth with sex and breed.

Data collected by Patro and Mishra (1987) on 723 village Ganjam goats in Orissa revealed that at three, six, nine, 12, 18 and 24 months of age averaged 7.11, 9.79, 12.41, 13.54, 16.14 and 18.19 kg respectively.

In a study on a group of Tellicherry goats, Prakasam et al. (1987) reported that weaning weights averaged 8.26±0.02 kg for males and 6.23±0.05 kg for females.

Singh et al. (1987) observed that in 144 male and 122 female Black Bengal goats slaughtered at one year of age, live weight averaged 14.93 and 14.35 kg respectively.

Gupta et al. (1989) reported that in the 60 Black Bengal kids studied by them, the males were heavier at 16 week of age than females (5.48 Vs 5.17 kg) and according to them bodyweight at 16 week of age was not influenced by sire's bodyweight or birth weight.

According to Oumara (1989), the average bodyweights at 30 days and 90 days of age in 130 Maradi goats reared at the Niger research station, were 3.94 kg and 9.05 kg respectively.

Salah et al. (1989) revealed that for 31 male and 19 female kids least squares means for bodyweights were 14.15±0.65 and 11.91±0.82 kg respectively at three months, 22.42±0.89 and 17.81±1.11 kg at six months, 27.84±1.28 and 21.17±1.61 kg at nine months and 32.41±2.84 and 24.23±2.24 kg at 12 months of age. Sex, litter size or season of kidding had no significant effects on bodyweights.

Bodyweight, body length, withers height, hearth girth and distance between hips were recorded for 50 Jamnapari and 115 Barbari goats at birth and at three and six months of age by Das et al. (1990) and they observed that maximum correlation obtained at birth was 50 per cent in Barbari kids and 76 per cent in Jamnapari kids.

Rodriguez et al. (1990) carried out a study of the morphology of 139 male and female young and adult goats

of Sprain, and revealed that bodyweights averaged 60.43±0.94 and 45.90±0.50 kg for adult males and females respectively.

Saxena et al. (1990) analysed the data on weights at birth and weaning of 135 Jamnapari kids born in September-December and revealed that the kids born in November and December had significantly higher values than kids born in September, while kids born as twins and males were heavier than females. The genetic and phenotypic correlations of weaning weight with total and daily pre-weaning gain were high and positive.

Growth studies in 284 male and female Beetal goats by Malik and Kanaujia (1991) revealed that males were heavier than females at 6 months of age their weights being 13.80 kg and 12.42 kg respectively.

Ruvuna et al. (1991) analysed bodyweights of female Somali (Galla) and East African goats using least square procedure and confirmed that while breed and sex of fetus had no significant effect on bodyweight of dam, breed of female, year, type of birth, season and pregnancy status significantly affected bodyweight. Bodyweight was 1.0-2.0 kg heavier in cooler, dry season than in the rainy warm season and Somali females were approximately 15 per cent heavier at all ages than East African goats, their mature weights averaging 35 and 31 kg approximately.

Das and Goswami (1992) investigated the growth performance of 293 Assam local (AL), ½ AL x Beetal (B) and ¼ AL x ¾ B and confirmed that their bodyweights at one year were 11.92 kg, 14.86 and 15.74 kg respectively. Further studies revealed that while sex and type of birth significantly affected bodyweight, genetic group and season of kidding did not affect it and the crossbreds had higher bodyweight at one year ($p<0.05$).

Birth Weight

Ali (1980) observed that for 77 male and 90 female Black Bengal kids, birth weight averaged 1.80 and 1.75 lb respectively and correlation between birth weight and bodyweight at one, four and eight weeks of age were highly significant (0.40-0.71 in males and 0.26-0.57 in female).

Figueiredo et al. (1980) confirmed that for six male single, seven females twins, four male single and five female twin goats born in the dry season in Brazil, birth weight average 2.3, 1.8, 2.2 and 1.8 kg respectively Vs. 2.1, 1.8, 2.0 and 1.9 kg for nine, 18, six and eight goats of the four types born in the rainy season.

Velez et al. (1980) reported that for 957 Anglo Nubian (AN) and 162 Criollo kids, birth weight averaged 2.93 and 2.59 kg respectively and that for AN single and twin males, the correlation of birth weight with 24 week

weight was 0.03 and 0.19 respectively and for single and twin female, the correlation of birth weight with 34 week weight was 0.17 and 0.41.

According to Mohd-Yusuff et al. (1981) the average birth weights of 16 Saanen x Katjang, 17 Anglo-Nubian x Katjang, 13 British Alpine x Katjang and 42 Katjang kinds born over a two year period were 2.11, 2.17, 1.98 and 1.44 kg respectively ($p<0.05$) and for single and twin-born kids birth weight averaged 1.98 and 1.64 kg ($p<0.05$) respectively.

Mukundan (1981) found out that for 208 Malabari and 265 Malabari x Saanen kids born during 1974-77 birth weights averaged 1.71 and 1.81 respectively the differences being non-significant. It averaged 1.89 kg in males Vs. 1.70 in females ($p<0.05$) and 2.37 kg in singles, 1.86 in twins and 0.63 in triplets ($p<0.01$) and there were significant interactions of genetic groups with sex, month of birth and birth type but month or year of birth did not significantly affect birth weight.

According to Sarma et al. (1981) the average birth weights in 136 Assam Hill kids born during May 1977-December 1978 was 1.17 kg and that type of birth (single Vs multiple) had a significant effect on bodyweight at all ages.

In an analysis of some growth attributes of Osmanabadi goat kids Siddiqui et al. (1981) mentioned that sex and type of birth had highly significant effect on birth weight and all subsequent weights upto tenth month in addition to the effect of season on birth weight and bodyweights at one, two, three, six and nine months. They also revealed that phenotypic correlations amongst birth weight and subsequent bodyweights were positive and highly significant and suggested that Osmanabadi goats could be improved by selection for three and six months bodyweight and twinning rate.

Wahid and Khusahry (1981) revealed that in 20 male and 20 female Australian Feral goats in Malaysia birth weights averaged 2.85 and 2.64 kg respectively.

In a study on the relationship between birth and weaning weights in kids of Malawian goats, Ayoade and Butterworth (1982) opined that for 52 male and 55 female Boar, 32 male and 16 female Malawi and 26 male and 13 female Boer x Malawi goats, birth weight averaged 3.8±0.85, 3.7x2410.66, 2.6±1.52. 2.3±0.53, 2.9±0.62 and 2.5±0.54 kg respectively.

El-Serafy and Al-Busaidy (1982) confirmed that for 236 Anglo-Nubian (AN), Jamnapari, Damascus, 50 per cent AN x 50 per cent Damascus and 75 per cent Jamnapari x 25 per cent Damascus goats, birth weight averaged 3.55,

3.55, 2.89, 3.42, 3.22, 3.80 and 3.80 kg respectively. They further mentioned that values for males were generally higher than those for females.

According to Montaldo and Juarez (1982) the average birth weights for 229 French Alpine, 59 Anglo-Nubian, 84 Granada, 81 Saanen and 85 Toggenberg goats born in Mexico were 3.58±0.05, 3.28±0.08, 2.71±0.07, 3.67±0.07 and 3.56±0.07 kg respectively ($p<0.01$) and sex of kid and type of birth had a significant effect on birth weight ($p<0.01$).

Taneja (1982) tabulated some data on Sirohi and Beetal x Sirohi goats and revealed that birth weight on an average was 2.8 and 3.1 kg respectively for single born kids (male and female). He also reported that for Black Bengal (BB) and Jamnapari x BB kids birth weights averaged 1.2 and 1.4 kg respectively both differences being significant.

Darokhan and Tomar (1983) studied the bodyweights and body measurements for 226 male and 248 female Changthiang Pashmina goat kids and observed that average bodyweight at birth was 2.03 and 1.82 kg respectively. Sex and year of birth had a significant effect on birth weight while genetic correlation between birth weight and body length were not significantly different from zero.

Garcia et al. (1983) in their study on the genetic improvement of the Criollo goat by crossing with imported breeds revealed that the average birth weights for Nubian x Criollo, Alpine x Criollo, Toggenberg x Criollo, 75 per cent Nubian and 25 per cent Criollo, 75 per cent Alpine - 25 per cent Criollo, 25 per cent Criollo - 50 per cent Alpine and 25 per cent Nubian, 50 per cent Nubian - 25 per cent Criollo and 25 per cent Toggenberg goats were 3.2, 3.4, 2.9, 3.1, 3.4, 3.2 and 2.9 kg respectively.

Khan and Sahni (1983) analysed the data collected on 111 Jamnapari kids born in March-April or September-November during 1976-78 and observed that while the average weight at birth was 3.01, factors such as sex, type of birth (single Vs multiple) had a significant effect on birth weight.

Kumar and Singh (1983) observed that in eight Saanen, 14 Jamnapari, 20 Barbari, 135 crossbred (1/2 Jamnapari- ½ Black Bengal) and 149 Black Bengal goats birth weights averaged 3.29, 2.38, 1.80, 1.32 and 1.21 kg respectively ($p<0.01$).

Ozekin and Akcapinar (1983) found out that for 153 Angora kids birth weights averaged 2.3 kg for males, 2.4 kg for females, 2.5 kg for singles and 2.4 kg for twins and observed that sex had a highly significant effect on bodyweight at all ages.

Singh et al. (1983a) confirmed that the average birth weight of Jamnapari and Barbari kids born during 1966-69 was 2.80 and it was significantly affect by breed, sex and season but not by age or weight of dam.

Singh et al. (1983b) observed that in 89 male Black Bengal (BB) and 99 female and 90 male ½ Jamnapari - ½ BBs and 59 females birth weights averaged 1.3, 1.2, 1.4 and 1.3 kg respectively.

Sinha and Sahni (1983) studied the birth weights of 232 kids of Jamnapari, Beetal, Barbari, Black Bengal (BB), Jamnapari x Barbari, Jamnapari x BB, Beetal x Barbari and Barbari x BB and mentioned that their birth weights on an average were 2.97±0.13, 2.76±0.51, 1.84±0.22, 0.98±0.10, 2.35±0.43, 2.10±0.18, 2.48±0.23 and 1.56±0.17 kg respectively all of which were significantly affected by effects of breed, season of birth, type of birth (single Vs twin) and sex.

Chawla et al. (1984) carried out work on bodyweight gains of Beetal, Alpine and Saanen goats and mentioned that in 294 Beetals, 216 Alpines and 42 Saanens birth weights averaged 3.3, 3.4 and 3.7 kg respectively for males Vs 3.0, 3.0 and 3.1 kg for females.

Sarma et al. (1984) found that the average birth weight was 1.40 kg.

Singh et al. (1984) observed that bodyweight at birth averaged 3.55 and 2.05 kg respectively the birth weight being significantly affected by breed, sex (2.92 kg for males Vs. 2.68 for females), season and birth type (single Vs twin) in Jamnapari and Barbari kids.

Naik et al. (1985) observed that in 418 goats of Ganjam breeds season of birth and sex of kid had significant effect on the birth weight.

Data collected and analysed by Singh and Prakash (1985) on 606 Changthiang males and 795 females confirmed that at birth bodyweight averaged 2.22 and 2.04 kg respectively and it was significantly affected by year of birth and sex and kid.

Singh (1985) reported the average kid birth weights for singles, twins and triplets were 3.49, 3.28 and 2.85 kg while that for males were 3.49 kg and 3.12 kg for females indicating that effect of sex and litter size on birth weight were significant in kids of Saanen breed.

Wahid and Khusahry (1985) reported that, the average birth weights ranged from 2.41±0.54 kg in Anglo-Nubian x local goats as compared to 2.75±0.61 in Saanen x (Anglo-Nubian x local).

Garcia et al. (1986) observed that the birth weights averaged 3.8 and 3.9 kg for males and 3.4 and 3.3 kg for females. The birth weights were found to be

significantly affected by type of birth (twin Vs single), but were not affected by season of birth.

Jagtap and Patil (1986a) carried out a study in 252 local, 995 Angora x local and 199 Angora kids born during 1972-82, and observed that birth weights averaged 2.03, 2.30 and 2.24 kg respectively in singles, and 1.66, 1.93 and 2.10 kg in twins and for triplets (last 2 groups only) the corresponding figures were 1.44 and 1.80 kg, confirming that in all genetic groups, effect of birth type (single Vs multiple) on birth weight was significant.

Jagtap and Patil (1986b) analysed the data obtained from 252 local kids, 995, 1296 and 322 crossbreds with ½, ¾ and 7/8 Angora inheritance respectively and 199 Angora kids and confirmed that their birth weights were in males 1.90, 2.18, 2.41, 2.28 and 2.28 kg on an average Vs 1.76, 2.01, 2.22, 2.08 and 2.07 in females revealing that sex difference was significant for all but 7/8 Angoras.

Kanaujia et al. (1986) observed that in six Beetal, six Black Bengal (BB) seven Beetal x BB and seven BB x Beetal male kids birth weight averaged 2.80, 1.12, 1.56 and 2.54 kg respectively ($p<0.05$).

Haricharan et al. (1987) observed that birth weight of Alpine goats an average was 3.68±0.13 kg, which was significantly higher than the average birth weights of AN

and Saanen goats which were 3.25±0.05 and 2.88±0.07 kg respectively while the average birth weights among Toggenburg goats were 3.36±0.09 kg. The birth weight of single, twin and triplet kids averaged 3.51±0.08, 3.14±0.05 and 2.90±0.09 kg respectively ($p<0.001$) while that of males and females averaged 3.37±0.05 and 3.07±0.03 respectively ($p<0.0001$). They further confirmed that there was a significant effect of the year of birth on birth weights.

Koul and Biswas (1987) reported that in 1286 Chegu kids studied from 1973 or 1984, birth weights averaged 2.0±0.20 kg and that in males and females it averaged 2.05±0.02 kg and 1.92±0.02 kg respectively ($p<0.01$). The differences in birth weights between years were found to be significant.

Patro and Mishra (1987) studied the performance of 723 Ganjan goats of Orissa and observed that their average birth weight was 2.45 kg.

Prakasam et al. (1987) observed that average birth weights in males and females were 2.22±0.01 and 1.81±0.01 kg respectively in Tellicherry goats.

Gupta et al. (1989) analysed the birth weight and bodyweight gain in 60 Black Bengal kids and revealed that males were heavier than females at birth (1.13 Vs 1.04 kg) and that birth weights did not differ among sires.

Average weight at birth of 130 Maradi goats at the Niger research Station was 2.05 kg as revealed byOumara (1989).

Salah et al. (1989) reported that in 31 male and 19 female Avadi goat kids the least square means for bodyweights were 3.39±0.11 and 2.94±0.15 kg respectively at birth.

For 252 local goats, 977, 1261 and 332 local x Angora crossbred with ½, ¾ and 7/8 Angora inheritance respectively and 193 Angoras, the least square means for birth weights were 2.0, 2.0, 2.2, 2.1 and 1.2 kg respectively and year and month of birth had significant effects on birth weights. This was revealed by Jagtap et al. (1990) in their studies on genetic and non-genetic factors affecting birth weight in local Angora and their crossbred goats.

Mishra and Ghei (1990) analysed 20-50 records of bodyweight at various ages and observed that birth weight averaged 1.60±0.05 kg.

Malik and Kanaujia (1991) studied the birth weights of 284 male and female Beetal goats and revealed that males were heavier at birth than females, the weights corresponding being 2.73 Vs 2.48 kg the singles were heavier than the twins or triplets, their respective

weights being 3.13±0.05 kg, 2.66±0.03 kg and 2.003±0.09 kg.

Type of birth

The average birth weight of six male single, seven male twins, four males single and five male twin goats born in the dry season in Brazil were 2.3, 1.8, 2.2 and 1.8 respectively and their weight at 240 days averaged 15.2, 18.7, 13.3 and 15.2 kg while for nine, 18, six and eight goats of the four types born in the rainy season average birth weights were 2.1, 1.8, 2 and 1.9 kg respectively and at 240 days the weights were 16.3, 15.2, 73.7 and 15 kg (Figueiredo et al., 1980).

Velez et al. (1980) revealed that in Anglo-Nubian (AN) and Peruvian Criollo kids, the birth weights averaged 2.93 and 2.59 kg respectively, males being significantly heavier than females and singles heavier than twins in both breeds and for AN single and twin males the correlation of birth weight with 24 week weight was 0.03 and 0.19 respectively and for single and twin female, the correlation of birth weight with 36 week weight was 0.17 and 0.41.

In 16 Saanen x Katjang, 17 Anglo-Nubian x Katjang, 13 British Alpine x Katjang and 42 Katjang kids born over a two year period, single and twin born kids respectively

had an average birth weight of 1.989 and 1.64 (Mohd-Yusuff et al., 1981).

Accordingly to Mukundan et al. (1981), in an analysis of birth weight of Malabari and Saanen x Malabari kids, genetic group had significant interaction with birth type and the average birth weight of males were 1.89 kg vs. 1.70 for female ($p<0.05$) and 2.37 kg in singles, 1.86 intwins and 0.63 in triplets ($p<0.01$).

Sarma et al. (1981) reported that in the Assam Hill goat kids type of birth had a significant effect on bodyweight at all ages with a significant interaction between season and type of birth for 180 day weight.

Siddiqui et al. (1981) observed that type of birth had highly significant effect on birth weight and all subsequent monthly weights upto tenth month.

According to Wahid and Khusahry (1981) in the Australia feral goat the twinning rate was 46.15 per cent.

Montaldo and Juarez (1982) reported that in 229 French Alpine, 59 Anglo-Nubian, 84 Granada, 81 Saanen and 85 Toggenburg goats, sex of kid and type of birth (single or twin) had a significant effect on birth weight ($p<0.01$).

Khan and Sahni (1983) found out that type of birth (single Vs. multiple) had a significant effect on birth

weight, bodyweight at one, two and three months and on almost all bodyweight measurements at all ages.

Ozekin and Akcapinar (1983) reporting on their work on Angora kids observed that although sex had a significant effect on bodyweight at all ages, birth type (single Vs. twin) had a significant effect at 120 days only and they revealed that the bodyweight at birth on an average were 2.3 kg males, 2.4 kg for females, 2.5 kg for single and 2.4 kg for twins. The corresponding figures for 120 days of age were 14.2, 12.7, 13.5 and 12.5 kg respectively for six months, 17.3, 19.2, 16.3 and 14.9 kg respectively and at 12 months 20.8, 16.3, 18.6 and 17.1 kg respectively.

Singh et al. (1985) observed that in Black Bengals and Jamnapari x Black Bengal kids birth type (Single Vs. twin) had a significant effect on bodyweight at almost all ages and sex had a significant effect to 24 weeks of age.

Type of birth (single Vs. twin) had a highly significant effect on birth weight along with sex of kids as revealed by Sinha and Sahni (1983) in their study on the birth weights of Jamnapari, Beetal, Barbari, Black Bengal (BB), Jamnapari x Barbari, Jamnapari x BB, Beetal x Barbari x BB kids.

Sarma et al. (1984) studied the bodyweight and body measurements of 61 Assam local x Beetal kids of preweaning age and observed that type of birth had a significant effect on body length at birth and 45 days and on body measurements at 45 and 90 days of age.

Singh et al. (1984) observed that for 66 Jamnapari and 115 Barbari kids, bodyweights at all ages were significantly affected by birth type (single Vs. twin).

Lima et al. (1985) reported that in a study on 54 nondescript goats of Brazil at different ages, sex and type (single Vs. twin) had no significant effects on any weight except that at 349 days ($p<0.05$).

In a study of 1019 Malabari, 373 Alpine x Malabar and 174 Saanen x Malabari kiddings during 1975-84, Prakash and Singh (1985) recorded that of multiple births was 44.75, 33.75 and 40.23 per cent respectively, the difference being significant and that in all three genetic groups, year, parity and age and weight of females had significant effects on the incidence of multiple births.

In 77 Saanen kids born at 61 parturitions during 1971-76, percentage of singles, twins and triplet kiddings, were 54.9, 39.2 and 5.90 respectively with average kid birth weight of 3.49, 3.28 and 2.85 kg and that of males were 3.49 kg and 3.12 kg for females

revealing that sex and litter size had significant effects on birth weight. This fact was confirmed by Singh (1985) in his work on frequently of kidding, type of birth and birth weight of Saanen kids.

Garcia et al. (1986) revealed that in Criollo kids born in Chile during 1980 and 82, birth weight was significantly affected by type of birth (single Vs. twin) with kids born as single being 23 per cent heavier than twin borns. Type of birth also significantly affected bodyweights at four and six months.

Jagtap and Patil (1986) revealed that for 252 local, 995 Angora x local and 199 Angora kids born during 1972-82 birth weights for singles averaged 2.03, 2.30 and 2.24 respectively for twins, 1.66, 1.93 and 2.01 kg and for triplets (last 2 groups only) 1.44 and 1.80, confirming that the effect of birth type (single Vs. multiple) on birth weight was significant. They further mentioned that in the 3 groups twinning rates were 34.22, 12.58 and 12.50 per cent respectively.

Malik et al. (1986) conducted an experiment on 1174 kids belonging to different breed as Beetal, Black Bengal, Beetal x Black Bengal, Black Bengal x Beetal and concluded that while kids born single averaged 2.10 kg in their birth weight, those born as twins and triplets

weighed 1.76 and 1.35 respectively at birth (all differences $p<0.05$).

The average birth weight recorded by Haricharan et al. (1987) for singles, twin and triplets of 280 Anglo-Nubian (AN), Saanen, Toggenburg and Alpine goats were 3.51±0.08, 3.14±0.05 and 2.90±0.09 kg respectively ($p<0.001$) and they further confirmed that type of birth did not significantly affect bodyweight.

Prakasam et al. (1987) observed that in Tellicherry goats, during 1981 to 1984, there were 535 kiddings, of which 320 were singles, 180 were twin and 5 were triplet births and average litter size was 1.38.

Jagtap et al. (1988) carried out genetic analysis of pre and post weaning bodyweight of 626 half bred Angora goats and observed that the least square means of preweaning and post weaning weights of single born goats were similar to those of twins.

Salah et al. (1989) observed that in 31 males and 19 female kids litter size did not have a significant effect on weights at all ages.

Jagtap et al. (1990) carried out a study on the genetic and non-genetic factors affecting birth weights in 252 local, 977, 1261 and 332 local x Angora crossbreds with ½, ¾ and 7/8 Angora and 193 Angoras and observed

that type of birth (single Vs. multiple) had a significant effect on birth weight.

In a study on the growth of 284 male and female Beetal goats by Malik and Kanaujia (1991) the birth weights of single, twin and triple born kids were found to be 3.13±0.05 kg, 2.66±0.03 kg and 2.03±0.09 kg.

Ruvuna et al. (1991) analysed 617, 1009, 1180, 1644 and 2865 records of bodyweights at two, three, four, five and above five years of age respectively in East African and Gella goats by least square procedures and revealed that type of birth had a significant effect on the bodyweights of dam.

In 293 Assam local and their crossbreds with Beetal investigated by Das and Goswami (1992) sex and type of birth significantly affected bodyweight with males being superior to females and singlets to multiple birth kids.

Body Measurement

Mishra (1980) recorded the bodyweight and four body measurements of 343 Sirohi goats in four age groups and tabulated the correlations of bodyweight with body length, hearth girth and paunch girth. Overall the equation for the multiple regression of bodyweight on the 3 body measurements had an R^2 value of 0.83 while for goats with 4 permanent incisor teeth the value was 0.85.

In 46 Malabari local goats, consisting of female and castrated males aged below 1 year and female and castrated males aged above one year respectively, body length averaged 46.55±2.70, 51.00±2.16, 63.5±0.89 and 59.22±1.66 cm respectively, and heart girth was 50.38±2.97, 56.76±1.69, 69.37±0.86 and 62.92±0.96 cm. Body weight was significantly correlated with body length (0.79 - 0.98, $p<0.01$) and heart girth (0.84 - 0.99 $p<0.01$) in both sexes and age groups. This observation was confirmed by Ayoade (1981).

Mukherjee et al. (1981) worked out the phenotypic correlation of bodyweight with length, withers height and chest circumference of Grey Bengal females of different ages and revealed that although all correlations were significant, the correlation with chest circumference was the highest (0.74±0.09 to 0.95±0.04).

Prasad et al. (1981) revealed that, of the tabulated phenotypic correlations of bodyweight with length, withers height and chest circumference in Black Bengal goats, the largest correlations were those involving chest circumference.

Singh et al. (1981) mentioned that, from the body measurements of 391 Brown and 350 Black Bengal female of five age groups (0-3, 3-6 and 6-12 month 1-3 and > 3

year) body length was significantly greater in brown than in black females.

Valdez et al. (1982) tabulated various body dimensions such as bodyweight, body length, height at withers, chest circumference, flank girth and midriff girth according to age and breed group in 304 pure breds (Anglo-Nubian, Toggenburg, Saanen and Alpine, 163 grade or crossbred Anglo Nubians and 136 local or other goats of both sexes and aged between one month and five years. They confirmed that there were highly significant correlations (0.81-0090) between bodyweight and the other five measurements. They further mentioned that the best single predictor of bodyweight was chest circumference.

Valdez et al. (1982) analysed the data on bodyweight, chest circumference and bodyweight, midriff, circumference, flank circumference and body length of 603 goats of several breeds and crosses and revealed that the squared correlation between chest circumference and bodyweight was 0.90, while the squared multiple correlation of chest circumference and withers height with body weight was 0.90.

Darokhan and Tomar (1983) observed that in 226 male and 248 female Changthiang Pashmina kids, body length averaged 21.18 and 20.53 cm respectively, chest circumference was 29.53 and 28.45 cm and withers height

was 26.64 and 25.72 cm. They also revealed that the sex and year of birth significantly affected the traits but genetic correlations between birth weight and body length was not significantly different from zero.

In a study on the pre-weaning bodyweights and linear body measurements in Jamnapari goats Khan and Sahni (1983) reported that type of birth and weight of dam had a significant effect on almost all body measurements at all ages. They further observed that season of birth had a significant effect on most body measurements at 2 and 3 months.

Mukherjee et al. (1983) observed that in 212 Grey Bengal goats representing five age groups reared in three climatic zones phenotypic correlations of bodyweight with three body measurements (length, height and chest circumference) was maximum in the sub plateau region, with all correlations being significant while, there were fewer significant correlations in the other two zones.

In Malabari and its Saanen crossbreds, type of birth (single Vs. multiple) affected significantly the bodyweight at one month. This was revealed by Mukundan et al. (1983) in their study on pre-weaning bodyweights and factors affecting them.

Bhattacharya et al. (1984) observed that in 135 female Black Bengal goats of different ages, the average

chest circumference was 55.24±0.72 cm, withers height 46.53±0.57 cm body length 46.15±0.68 cm and neck circumference 30.06±0.51 cm.

Average body length of 56.74 and 61.58 cm, withers height of 60.15 and 64.19 cm chest circumference of 60.03 and 66.80 cm paunch circumference of 60.98 and 66.06 cm and loin width of 10.90 and 11.66 cm was observed by Bose and Basu (1984) in 125 males and 145 female Black Bengal goats and they found out that there were significant phenotypic correlations of body length, height, chest circumference and paunch circumference with slaughter weight (0.80-0.89).

Manik et al. (1984) reported that in 102 Beetal, 97 Alpine x Beetal and 47 Saanen x Beetal goats chest circumference averaged 74.18, 72.11 and 74.73 am. body length 75.05, 70.53 and 73.70 cm and withers 74.11, 67.68 and 68.17 cm. They further observed that differences were highly significant for all traits except chest circumference and correlations among traits were highly significant.

In 61 Assam local x Beetal goats birth type had a significant effect on body length at birth and 45 days and on body measurements at 45 and 90 days. Sex had a highly significant effect on body measurements at birth as revealed by Sarma et al. (1984).

Singh and Prakash (1985) analysed the data collected during 1976-81 on 606 Changthang males and 795 females and reported that body length averaged 22.62 and 22.44 cm respectively, withers height 25.52 and 24.48 cm and chest circumference 29.47 and 25.58 cm and that withers height and chest circumference were significantly affected by year and sex and body length by year only.

Abdul wahid et al. (1985) carried out a study on the performance of crossbred goats compared to their parental types by crossing male Saanen goats with 28 Anglo-Nubian (AN) x local goats and 68 Jamnapari x local female, and revealed that differences between breed types in body height, length and girth at weaning and at one year of age were not significant.

Mukherjee et al. (1986) reported that correlation of bodyweight with body length, girth and height were significant in Brown Bengal does of five age group (-3, 3-6 and 6-12 and 1-3 and > 3 years) measured at three different regions ie. plains, sub-plateau and plateau.

Singh et al. (1987) observed that for 144 and 112 female Black Bengal goats slaughtered at one year of age body length was 40.60 and 40.04 cm, chest circumference 56.92 and 56.66 and withers height 49.69 and 48.58 cm, ($p<0.01$) respectively, and all body measurements were significantly ($p<0.01$) correlated with live weight.

Eighty male Beetal, Bengal, reciprocal Beetal x Bengal (F1) and F2 kids were studied for growth performance by Pander et al. (1989) who revealed that Beetal and F2 goats had greater body measurements than the other breed types at all ages.

Das et al. (1990) studied the bodyweights and body measurements in 115 Barbari and 50 Jamnapari kids and found out that linear body measurements were poor predictor for bodyweight at birth in both breeds, while the combination of heart girth and height was a better predictor for bodyweight at three and six months in kids of both breeds and the correlations of the combinations between girth, length and height were around 87-88 per cent in both breeds at three months and around 84-85 per cent in both the breeds at six months.

Worman et al. (1990) tabulated and analysed the measurements of 86 Tswana kids of above three months of age and 147 goats below three months by regression procedures and revealed that for animals above three months, the R^2 values for the regression of bodyweight on heart girth for animals with heart girth of 25-29, 30-43 and 44-51 cm were 0.71, 0.63 and 0.69 respectively, while the R^2 values for males, females and castrates were 0.87, 0.85 and 0.95 respectively. They further observed that

for adults, linear and quadratic terms of heart girth were used to predict bodyweight.

Season

Figueiredo et al. (1980) observed that the average birth weights and weight at 240 days in six male single, seven female twins, four male single and five female twins born in the dry season in Brazil were 2.3, 1.8, 2.2 and 1.8 kg respectively and 15.2, 18.7, 13.3 and 15.2 kg and for nine, 18, six and eight goats of the four types born in the rainy season, the corresponding figures were 2.1, 1.8, 2 and 1.9 kg and 16.3, 15.2, 13.7 and 15 kg.

According to Mukundan et al. (1981) month or year of birth did not have any significant effect on birth weight but genetic group had significant interaction with month of birth.

Sarma et al. (1981) revealed that in 136 Assam Hill kids born during May 1977-December 1978 season had a significant effect on weaning weight, which averaged, 5.45 kg for kids born during October-March Vs. 3.77 for kids born during April-September and that there also was a significant season x type of birth interaction on 180 day weight although season did not seem to affect average daily gain in weight.

Season had a highly significant effect on birth weight and body weight at one, two, three, six and nine

months as observed by Siddiqui et al. (1981) in their studies on Osmanabadi goat kids.

According to Khan and Sahni (1982) season had a significant effect on growth from 3-6 months in 90 Jamnapari kids grown under semi-arid conditions.

Mukundan et al. (1982) reported that in 212 Malabari and crossbred kids born during 1974-77, month and year of birth had a significant effect on weight gain at 0-3, 3-6, 6-9, 9-12, 0-6, 0-9, 3-9 and 6-12 months.

In 226 male and 248 female Changthang Pashmina kids in Ladakh, sex and year of birth had a significant effect on bodyweight, body length, chest circumference and withers height (Darokhan and Tomar, 1983).

Khan and Sahni (1983) observed that season of birth had a significant effect on bodyweight and most body measurements at two and three months.

Mukundan et al. (1983) reported that in Malabar and Saanen x Malabar kids born during 1974-77 year of birth had a significant effect on bodyweight at all ages, while two months weight was significantly affected by month of birth and the genotype x month interaction.

Singh et al. (1983) studied the factors affecting bodyweight at birth and weaning in Jamnapari kids and observed that, although birth weight was significantly affected by season, weaning weight was not.

Singh and Sahni (1983) reported that season had a significant effect on the birth weights of Jamnapari, Beetal, Barbari, Black Bengal kids and their crosses as summer born kids were heavier than winter born kids.

Nagpal and Chawla (1984) reported, from the data analysis on 135 male and 150 female Beetal and 111 male and 105 female Alpine born during 1972-82, that season had a significant effect on some bodyweights upto 12 months in Beetals and to 15 months in Alpine and on the birth weight in both breeds.

Singh et. al. (1984) revealed that season of birth had a significant effect on all ages on bodyweights in 66 Jamnapari and 115 Barbari kids.

Lima et al. (1985) analysed the data on 54 non-descript goats in Brazil and observed that for goats born in the rainy season bodyweight at 153, 181, 209, 237, 293 and 349 days of age averaged 12.3±0.4, 14.3±0.4, 14.8±0.5, 14.9±0.5, 14.9±0.4 and 12.9±0.4 kg respectively Vs. 8.1±0.5, 8.6±0.6, 9.1±0.8, 10.3±0.9, 12.8±0.9 and 15.3±0.8 for goats born in the dry season ($p<0.005$).

In Alpine x Beetal, Saanen x Beetal, Saanen x (Alpine x Beetal) and Alpine x (Saanen x Beetal) goats, season had a significant affect on bodyweight at birth and at three months in all genetic groups, but there after had only an occasional significant effect. Sex

also had a significant effect on bodyweight at most ages in all groups except Saanen x (Alpine x Beetal) where it was only significant from 15 months onwards (Nagpal and Chawla, 1985).

Naik et al. (1985) confirmed that season of birth had a significant effect on bodyweight at birth and at six and 18 months of age and sex had a significant effect on birth weight only, in a study on 418 goats of Ganjam breed.

Garcia et al. (1986) on their study in 234 Criollo kids born in Chile during 1980 and 82, found that birth weights were not significantly affected by season of birth, while those at four and six months were affected both by year and season of birth, with kids born in November being lighter than those born in July or September. Garcia et al. (1986) in the course of their study on non-genetic factors as sources of variation on the growth of Criollo kids in Chile.

Malik et al. (1986) reported that in 1174 Beetal, Black Bengal, Beetal x Black Bengal, Black Bengal x Beetal kids studied, the birth weights were affected significantly by season the kids born during February to April averaging 1.85 kg at birth Vs. 1.63 kg for those born in September-November. Males averaged 1.82 kg at birth and females 1.66 kg on an average ($p<0.05$).

Jagtap et al. (1988) reported that in half bred Angora kids the means of pre-weaning weight was lower in goats born between July and October and that of post-weaning weight was greater in goats born in November and December than in goats born in the other months.

Oumara (1989) reported that growth rate of 130 Muradi goats at Niger research station was affected by month and year of birth and sex of kids.

Salah et al. (1989) observed that in Aradi goats of Saudi Arabia, season of kidding had no significant effects on bodyweights.

Sex year and month of birth had significant effects on the birth weights of 252 local, 977, 1261 and 332 local x Angora crossbreds with ½, ¾ and 7/8 Angora inheritance and 793 Angora goats studied by Jagtap et al. (1990).

Das and Goswami (1992) reported that in the Assam Hill goat and its crossbreds with Beetal, season and kidding did not significantly affect bodyweights at one year.

Materials and Methods

MATERIALS AND METHODS

The study was conducted in 92 goat kids reared at the All India Co-ordinated Research Project on goats farm at Mannuthy, Trichur. There were 36 Malabari kids and 56 Alpine x Malabari kids available for the study. A comparative study was made on the native Malabari with its third generation cross with the exotic Alpine breed.

The main item of observations were:

1. Birth weight and body dimensions at 3, 6, 9 and 12 months of age.
2. Standard body dimensions such as body length from point of shoulder to pin bone, height at withers and heart girth were observed at birth and various age intervals upto 12 months of age.
3. Types of birth as single and multiple were recorded.

3.1 *Experiment*

The bodyweights in kilograms (kg) were recorded using a platform balance and the body dimensions in centimeters were measured using a measuring tape. All measurements were taken in the afternoon before feeding with the animal standing still on a level surface.

The atmospheric temperatures were recorded daily. The maximum temperature of the previous day was recorded at 07.25 a.m. the next day while the minimum was recorded at 02.25 p.m. An ordinary maximum-minimum thermometer was used for this purpose.

Types of birth as single, and multiple were recorded at birth, in addition to the sex of the new born and dam number. The sire numbers were recorded during artificial insemination.

3.2 Feeding and management

All the experimental animals were reared separately under close supervision. The stalls used for rearing were wooden floored and raised from the ground level to avoid dampness.

The kids were raised along with their dams during the first month after birth. They were housed under infra-red lamps during the night time. Fodder grass was introduced by the third week.

The kids were fed as per the schedule given below:

Age (days)	Quantity of milk given (g)	Quantity of kid starter (g)	Quantity of green fodder (g)
Birth to 4 days	Colostrum	-	-
5-30 days	300-500	Small quantity	Small quantity
30-60 days	400-500	5-100	Small quantity
60-90 days	350-400	100-150	250-500
90-120 days	-	200-250	500-750
5th & 6th month	-	250-300	750-100
6-12 months	-	300-400 (concentrate)	1-2 kg

The kids were reared together upto an age of five months with infra-red lamp facilities provided in the stalls during the night. Thereafter, they were separated according to sex and housed separately.

The kids were dewormed at one month of age with Albendazole (Analgon) @ 5 mg/kg. Monthly deworming was practiced upto one year of age. Deworming with Niclosamide (Niclex) @ 100 mg/kg was also practiced at intervals of 2 months upto one year of age. A good

quality mineral and vitamin supplement was added to the concentrate ration.

3.3 Statistical analysis

The data on bodyweight was subjected to least-squares analysis of variance as described by Harvey (1966) for adjusting the effect of significant non-genetic factors on bodyweight in both the genetic groups separately. For this the following model was used

$$Y_{ijkl} = \mu + S_i + K_j + C_k + e_{ijkl}$$

Where,

Y_{ijkl} = Body weight of l^{th} kid born in the k^{th} season, of j^{th} kid type of the i^{th} sex

μ = Population mean

S_i = Effect of i^{th} sex (i=1,2)

1 = Male
2 = Female

K_j = Effect of j^{th} kid type (j=1,2)

1 = Single birth
2 = Multiple birth

C_k = Effect of season (k=1,2)

1 = Monsoon (June-October)
2 = Non-monsoon (November-May)

e_{ijkl} = Random error associated with Y_{ijkl} and assumed to be normally and independently distributed with mean zero and constant variance

$$\sigma^2_e \quad \text{i.e., NID } (0, \sigma^2_e)$$

Level of significance = $P<0.05$

In order to determine any difference in the body weights of kids in the two genetic groups, a separate least squares analysis (Harvey, 1966) was done on pooled data which was adjusted for significant non-genetic effect, if any.

The following model was used:

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

Where,

Y_{ij} = Adjusted bodyweights of j^{th} kid of i^{th} breed

U = Population mean

B_i = Effect of i^{th} breed (i=1,2)

1 = Malabari
2 = Alpine x Malabari

e_{ij} = Random error associated with Y_{ij} and assumed to be normally and independently distributed with mean zero and constant variance

$$\sigma^2_e \quad \text{i.e., NID } (0, \sigma^2_e)$$

Level of significance = $P<0.05$

3.4 Estimation of heritability

The data adjusted for the effect of non-genetic factors which were found to be significant ($P<0.05$) was used for the estimation of heritability with the following model (Becker, 1964).

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

Where,

Y_{ij} = Adjusted bodyweights of j^{th} progeny of the i^{th} sire

μ = Population mean

S_i = Effect of i^{th} sire (i=1 .....11)

e_{ij} = Random error associated with Y_{ij} and assumed to be normally and independently distributed with mean zero and constant variance

$$\sigma^2_e \quad \text{i.e., NID } (0, \sigma^2_e)$$

The method of paternal half-sib correlation through least squares analysis was used to estimate the

heritability (h^2) of body dimensions. The above model was used to estimate the sire component of variance ($\sigma^2 s$). The analysis of variance (ANOVA) table was:

Source of variation	d.f.	Mean sum of squares	Expected sum of squares
Among sires	S-1	MSs	$\sigma^2_W + K\sigma^2_s$
Within sires	n.-s	Mse	σ^2_w

Where,

$$K = \frac{1}{S-1}\left(n. - \frac{\Sigma\, ni^2}{n.}\right)$$

S = Total number of sires

n. = Total number of daughter of all sires

n_i = Total number of daughter of i^{th} sire

The heritability was then calculated as:

$$h^2 = \frac{4\,\sigma^2_S}{\sigma^2_s + \sigma^2_e}$$

Where,

σ^2_s = Sire variance

$$= \frac{MSs - MSw}{K}$$

σ^2_w = Error variance or mean sum of squares due to error

The standard error of heritability was calculated by using the formula suggested by Swiger et al. (1964) as:

$$S.E.\ (h^2) = 4\sqrt{\frac{2(n.-1)\ (1-t)^2\ [1+\ (k-1)t]^2}{K^2\ (n.-s)\ (s-1)}}$$

Where,

t = Intra-class correlation among paternal half-sibs.

S = Total number of sires
n and k as described above

3.5 Correlation

For estimating genotypic correlations and phenotypic correlations the One-way layout with a single parent design (Becker, 1964) was used. The correlations

were worked out between the weights (raw data) and other body dimensions in both genetic groups. For estimating the genotypic correlations between birth weights and the body weights at different ages data corrected for the effect of sex, season and litter size was used. The procedures and models for the analysis of variance were the same as that used for the estimation of heritability. The analysis of covariance (ANCOVA) table was:

Source of	d.f.	Mean cross products	Expected mean cross products
Sires	S-1	MCP_s	$Cov_w + K\ Cov_s$
Progeny	n.-S	MCP_w	Cov_w

Where,

S = Total number of sires

n. = Total number of progeny

For estimating Cov_s:

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

where K is the same as that used in the estimation of heritability.

The genetic correlation was then calculated as.

$$r_G = \frac{4\ Cov_s}{\sqrt{4\ \sigma^2_{s(x)}\ \ 4\ \sigma^2_{s(y)}}}$$

Where,

$\sigma^2_{s(x)}$ = Variance between sires for the trait x.

$\sigma^2_{s(y)}$ = Variance between sires for that trait y.

The phenotypic correlation was calculated as:

$$r_{p(xy)} = \frac{Cov_w + Cov_s}{\sqrt{(\sigma^2_{w(x)} + \sigma^2_{s(x)})\ (\sigma^2_{w(y)} + \sigma^2_{s(y)})}}$$

Where,

$\sigma^2_{w(x)}$ = Variance within sires for the trait x.

$\sigma^2_{w(y)}$ = Variance within sires for the trait y.

Significance of phenotypic correlations were tested as per Snedecor and Cochran (1967).

3.6 Prediction equation

Prediction equations were calculated using multiple regression formulae (Snedecor and Cochran, 1967), which gave the best results on a preliminary analysis.

The models used were:

1. $Y = A + a_1x_1 + a_2x_2 + a_3x_3$

Where,

A = Regression constant
a_1 = Co-efficient of regression for trait x_1
a_2 = Co-efficient of regression for trait x_2
a_3 = Co-efficient for trait x_3
Y = Dependent variable (bodyweight)

2. The second model used was:

$$Y = A + b_1x + b_2x^2$$

Where,

A = Regression constant

B_1 = Co-efficient of regression for trait x

B_2 = Co-efficient of regression for trait x^2

Results

RESULTS

4.1 Body dimensions

The raw mean body lengths (cm), girth (cm) and height (cm) ± standard errors of the Malabari male kids are 25.68 ± 0.53, 23.37 ± 0.46 and 29.66 ± 0.60 at birth, 41.12 ± 0.90, 41.12 ± 0.90 and 43.03 ± 0.70 at three months, 46.97 ± 0.01, 46.19 ± 0.14 and 48.59 ± 0.80 at six months, 53.09 ± 0.90, 51.93 ± 0.90 and 52.46 ± 0.84 at nine months and 61.42 ± 0.90, 61.12 ± 0.9 and 59.04 ± 1.01 at 12 months respectively.

The raw mean body lengths (cm), girth (cm) and height (cm) ± standard errors of the Malabari female kids respectively are 25.63 ± 0.73, 27.56 ± 0.68 and 29.53 ± 0.48 at birth 40.88 ± 0.51, 41.46 ± 0.71 and 42.96 ± 0.59 at three months, 46.29 ± 0.81, 47.50 ± 0.51 and 48.17 ± 0.71 at six months, 51.09 ± 0.75, 51.55 ± 0.61 and 51.18 ± 0.56 at nine months and 58.36 ± 0.72, 59.07 ± 0.90 and 58.36 ± 0.72 at 12 months.

The raw mean body lengths (cm), girth (cm) and height (cm) ± standard errors of the Alpine x Malabari male kids respectively are 26.01 ± 0.06, 28.23 ± 0.08 and 30.24 ± 0.10 at birth, 42.35 ± 0.06, 42.18 ± 0.46,

Table 1. Body dimensions of Malabari goats (male) (Mean ± S.E.)

Age (months)	No. of observation	Weight (kg)	Length (cm)	Girth (cm)	Height (cm)
Birth	20	1.87± 0.09	25.68± 0.53	27.37± 0.46	29.66± 0.60
3	18	6.50± 0.35	41.12± 0.90	41.12± 0.90	43.03± 0.70
6	17	10.12± 0.53	46.97± 1.01	46.19± 0.14	48.59± 0.80
9	15	13.61± 0.44	53.09± 0.90	51.93± 0.90	52.46± 0.84
12	14	20.70± 1.04	61.42± 0.90	61.12± 0.90	59.04± 1.01

Table 2. Body dimensions of Malabari goats (Female) (Mean ± S.E.)

Age (months)	No. of observation	Weight (kg)	Length (cm)	Girth (cm)	Height (cm)
Birth	16	1.88± 0.06	25.63± 0.73	27.56± 0.68	29.53± 0.48
3	13	6.50± 0.03	40.88± 0.51	41.46± 0.71	42.96± 0.59
6	12	10.27± 0.01	46.29± 0.81	47.50± 0.51	48.17± 0.71
9	11	13.47± 0.02	51.09± 0.75	51.55± 0.61	51.18± 0.56
12	11	17.61± 1.01	58.36± 0.72	59.07± 0.90	58.36± 0.72

43.28 ± 0.90 at three months, 50.60 ± 0.48, 49.78 ± 0.09 and 50.60 ± 0.28 at six months, 56.50 ± 0.49, 55.52 ± 0.09 and 54.67 ± 0.56 and 64.19 ± 0.72, 64.60 ± 0.10 and 61.98 ± 0.59 at 12 months.

The raw mean body lengths (cm), girth (cm) and height (cm) ± standard errors of the female Alpine x Malabari kids respectively are 25.23 ± 0.17, 27.60 ± 0.32 and 29.14 ± 0.35 at birth, 40.83 ± 0.15, 40.20 ± 0.41 and 41.30 ± 0.24 at three months, 47.95 ± 0.21, 47.15 ± 0.56 and 48.35 ± 0.36 at six months, 53.66 ± 0.75, 52.11 ± 0.33 and 52.21 ± 0.85 at nine months and 60.39 ± 0.81, 59.66 ± 0.82 and 58.18 ± 0.91 at 12 months.

4.2 Bodyweights

The raw mean body weights and dimensions of Malabari male and female kids are presented in Tables 1 and 2 respectively. The mean body weights (kg) ± standard error of the Malabari male kids were 1.87 ± 0.09 at birth, 6.50 ± 0.35 at three months, 10.12 ± 0.53 at six months, 13.61 ± 0.44 at nine months and 20.70 ± 1.04 at 12 months. The corresponding figures of the female Malabari kids are 1.88 ± 0.06, 6.50 ±

Table 3. Body dimensions of Alpine x Malabari cross (male) goats (Mean ± S.E.)

Age (months)	No. of observation	Weight (kg)	Length (cm)	Girth (cm)	Height (cm)
Birth	34	1.98± 0.09	26.01± 0.06	28.23± 0.08	30.24± 0.10
3	33	7.30± 0.30	42.35± 0.06	42.18± 0.46	42.28± 0.90
6	28	11.94± 0.57	50.60± 0.48	49.78± 0.09	50.60± 0.28
9	25	16.08± 0.64	56.50± 0.49	55.52± 0.09	54.67± 0.56
12	23	23.61± 1.00	64.19± 0.72	64.60± 0.10	61.98± 0.59

Table 4. Body dimensions of Alpine x Malabari goats (Female) (Mean ± S.E.)

Age (months)	No. of observation	Weight (kg)	Length (cm)	Girth (cm)	Height (cm)
Birth	22	1.78± 0.10	25.23±0 .17	27.60± 0.32	29.14± 0.35
3	20	6.50± 0.07	40.83± 0.15	40.20± 0.41	41.30± 0.24
6	20	10.44± 0.21	47.95± 0.21	47.15± 0.56	48.35± 0.36
9	19	14.10± 0.06	53.66± 0.75	51.11± 0.33	51.21± 0.85
12	19	18.33± 0.07	60.39± 0.81	59.66± 0.82	58.18± 0.91

0.03, 10.27 ± 0.01, 13.47 ± 0.02 and 17.61 ± 1.01 in the same order.

The raw mean body weights and dimensions of the Alpine x Malabari male and female kids are presented in Tables 3 and 4 respectively. The mean body weights (kg) ± standard error of the Alpine x Malabari male kids are 1.98 ± 0.09, at birth, 7.30 ± 0.30 at three months, 11.94 ± 0.57 at six months, 16.18 ± 0.64 at nine months and 23.61 ± 1.00 at 12 months. The corresponding figures of the female Alpine x Malabari kids are 1.78 ± 0.10, 6.50 ± 0.07, 10.44 ± 0.21, 14.10 ± 0.06 and 18.33 ± 0.07 in the same order.

The mean atmospheric temperatures are presented in Table 16 and Fig.3.

The least squares anova to study the effect of sex, type of birth and season of birth on bodyweights of Malabari kids are given in Table 5. The analysis revealed that the non-genetic factors had no significant effect on the body weights at all the ages studied. The least squares mean and standard error of body weights at various ages in Malabari kids for different factors are given in Table 7. The overall least squares mean and standard error of the body

weight of kids at different ages wee 1.91 ± 0.08, 6.46 ± 0.29, 10.99 ± 0.51, 13.75 ± 0.48 and 20.04 ± 0.94 kg at birth, third month, sixth month, ninth month and 12th month respectively.

The least squares anova to study the effect of non-genetic factors on body weights of the Alpine x Malabari kids are given in Table 6.

The overall least squares mean and standard error of body weights at various ages in Alpine x Malabari kids for different factors are given in the Table 8. The overall least squares mean and standard error of the body weights of kids at birth, third month, sixth month, ninth month and 12th month were 1.88 ± 0.05, 6.76 ± 0.23, 11.50 ± 0.36, 15.27 ± 0.43 and 21.15 ± 0.63 kg respectively.

Sex had a significant effect on the body weights at all ages in the Alpine x Malabari kids. The least squares mean and standard error of the body weights (kg) of male and female kids were respectively 2.01 ± 0.073 and 175 ± 0.09, 7.20 ± 0.28 and 6.30 ± 0.35, 12.29 ± 0.47 and 10.69 ± 0.54, 16.32 ± 0.56 and 14.22 ± 0.64 and 23.72 ± 0.84 and 18.58 ± 0.92 at birth third

Table 5. Least square analysis of variance for the effect non genetic factors on the body weight of Malabari kids at different ages (ANOVA)

Source	At birth		At 3 month		At 6 month		At 9 month		At 12 month	
	df	MS	df	MS	df	MS	df	MS	df	MS
Sex	1	0.000	1	0.318	1	0.161	1	1.000	1	8.127
Season of birth	1	0.071	1	0.724	1	2.736	1	0.333	1	14.793
Type of birth	1	0.484	1	0.247	1	3.048	1	0.369	1	5.070
Error	32	0.149	27	1.755	25	4.600	22	3.909	21	15.289

$P<0.05$

Table 6. Least square analysis of variance for the effect non genetic factors on the body weight of Alpine x Malabari kids at different ages (ANOVA)

Source	At birth		At 3 month		At 6 month		At 9 month		At 12 month	
	df	MS	df	MS	df	MS	df	MS	df	MS
Sex	1	0.903*	1	9.973*	1	29.504*	1	47.395*	1	274.692*
Season of birth	1	0.331	1	8.224	1	111.551*	1	46.469*	1	134.450*
Type of birth	1	2.894	1	31.223	1	21.900	1	3.798	1	3.948
Error	52	0.176	49	2.454	44	5.774	40	7.592	38	15.577

* $P<0.05$

Table 7. Least squares mean ± standard error of body weight (kg) at various ages in Malabari kids

	Birth weight	3rd month	6th month	9th month	12th month
	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Overall mean	1.91± 0.08 (36)	6.46± 0.29 (31)	10991± 0.51 (29)	13.75± 0.48 (26)	20.04± 0.94 (25)
Sex					
Male	1.91± 0.94 (20)	6.57± 0.35 (18)	10.91± 0.009 (17)	13.96± 0.590 (15)	21.93± 1.18 (14)
Female	1.91± 0.11 (16)	6.36± 0.42 (13)	11.07± 0.701 (12)	13.55± 0.670 (11)	18.14± 1.32 (11)
Season of birth					
Monsoon	1.96± 0.131 (9)	6.28± 0.511 (7)	12.20± 0.893 (6)	13.89± 0.823 (6)	20.94± 1.63 (6)
Non-monsoon	1.86± 0.08 (27)	6.65± 0.277 (24)	9.79± 0.457 (23)	13.62± 0.450 (20)	19.13± 0.11 (19)
Type of birth					
Single	1.94± 0.09 (22)	6.37± 0.36 (19)	11.33± 0.597 (18)	13.63± 0.572 (16)	19.56± 1.14 (15)
Multiple	1.90± 0.11 (14)	6.55± 0.408 (12)	10.65± 0.720 (11)	13.88± 0.690 (10)	20.31± 1.36 (10)

Note: Figures in parenthesis indicate number of observations

Table 8. Least squares mean ± standard error of body weight (kg) at various ages in Alpine x Malabari kids

	Birth weight	3rd month	6th month	9th month	12th month
	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Overall mean	1.88± 0.05 (56)	7.76± 0.23 (53)	11.50± 0.36 (48)	15.27± 0.43 (44)	21.15± 0.63 (42)
Sex					
Male	2.01^{a}± 0.073 (34)	7.20^{a}± 0.280 (33)	12.29^{a}± 0.470 (28)	16.32^{a}± 0.561 (25)	23.72^{a}± 0.841 (23)
Female	1.75^{b}± 0.090 (22)	6.30^{b}± 0.354 (20)	10.69^{b}± 0.544 (20)	14.22^{b}± 0.640 (19)	18.58^{b}± 0.920 (19)
Season of birth					
Monsoon	1.96^{a}± 0.090 (23)	6.34^{a}± 0.360 (20)	13.11^{a}± 0.580 (18)	16.33^{a}± 0.670 (18)	23.02^{a}± 0.992 (17)
Non-monsoon	1.80^{a}± 0.076 (33)	7.18^{a}± 0.282 (33)	9.87^{b}± 0.450 (30)	14.21^{b}± 0.544 (36)	19.28^{b}± 0.793 (25)
Type of birth					
Single	2.11± 0.080 (28)	7.55± 0.309 (26)	12.19± 0.482 (25)	15.57± 0.553 (25)	21.46± 0.810 (24)
Multiple	1.64± 0.086 (28)	5.96± 0.330 (27)	10.80± 0.540 (23)	14.97± 0.654 (19)	20.83± 0.974 (18)

Note: Figures in parenthesis indicate number of observations
Means having different superscripts within a factor are significantly different

month, sixth month, ninth month and 12th month in the same order respectively.

Alpine x Malabari crossbreds season of birth had a significant effect at six, nine and 12 months of age but was not significant at birth and three months. Those born in monsoon had a significantly higher body weight than those born in the non-monsoon period. In the Malabari breed non-genetic factors had no significant effect at the ages studied. The least squares mean and standard error of the body weights (kg) of monsoon and non monsoon kids respectively were 1.96 ± 0.09 and 1.80 ± 0.076 at birth, 6.34 ± 0.36 and 7.18 ± 0.282 at three months, 13.11 ± 0.580 and 9.87 ± 0.450 at six months, 16.33 ± 0.670 and 14.21 ± 0.544 at nine months and 23.02 ± 0.992 and 19.28 ± 0.793 at 12 months of age.

In the Alpine x Malabari breed season of birth had a significant effect at 6th, 9th and 12th month with kids born in monsoon having a significantly higher body weight than those born in the non-monsoon period. The least square means and S.E. of the body weight of monsoon and non-monsoon kids were 13.11 ± 0.58 and 9.87

Table 9. Least squares analysis of variance for the effect of breed on body weights at various ages

Source	At birth		At 3 month		At 6 month		At 9 month		At 12 month	
	df	MS	df	MS	df	MS	df	MS	df	MS
Breed	1	0.013	1	1.799	1	3.841	1	43.103	1	46.534
Error	90	0.160	82	2.164	75	5.269	68	5.811	65	14.404

* $P<0.05$

Table 10. Least squares mean ± standard error of the pooled data (kg) at various ages of the body weights of Alpine x Malabari and Malabari kids

	Birth weight	3rd month	6th month	9th month	12th month
	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Overall mean	1.88± 0.04 (92)	6.71± 0.17 (84)	11.29± 0.27 (77)	14.50± 0.30 (70)	20.33± 0.48 (67)
Breed					
Malabari	1.89± 0.07 (36)	6.56± 0.26 (31)	11.06± 0.43 (29)	13.68± 0.47 (26)	19.47± 0.76 (25)
Alpine x Malabari	1.87± 0.05 (56)	6.86± 0.20 (53)	11.52± 0.33 (48)	15.31± 0.36 (44)	21.19± 0.59 (42)

Note: Figures in parenthesis indicate number of observations

± 0.45, 16.33 ± 0.67 and 14.21 ± 0.54 and 23.02 ± 0.99 and 19.28 ± 0.79 kg respectively.

The least squares analysis of variance on adjusted pooled data (Table 9) has revealed that there is no significant difference in the body weights of kids between Malabari and Alpine x Malabari at all the ages studied.

The overall least squares mean body weights (kg) and standard errors in the analysis for the Malabari and Alpine x Malabari breed were 1.88 ± 0.04, 6.71 ± 0.17, 11.29 ± 0.27, 14.50 ± 0.30 and 20.33 ± 0.48 at birth, third month, sixth month, ninth month and 12th month respectively. The results are presented in Table 10.

4.3 Heritability

The heritabilities (h^2) of bodyweights at different ages in both the genetic groups are presented in Table 11. The heritabilities and standard errors of the Malabari breed in respect to body weights were 0.63 ± 0.07 at birth, 0.46 ± 0.08 at three months, 0.22 ± 0.06 at six months, 0.72 ± 0.05 at nine months and 0.60 ± 0.07 at 12 months. In the Alpine x Malabari

Table 11. Heritability of body weights at various ages for Malabari and Alpine x Malabari kids ($h^2 \pm S.E$)

Age (months)	No. of observation	Malabari	Alpine x Malabari
At birth	92	0.63 ± 0.07	0.06 ± 0.06
3	84	0.46 ± 0.08	0.19 ± 0.07
6	77	0.22 ± 0.06	0.22 ± 0.08
9	70	0.72 ± 0.05	0.03 ± 0.07
12	67	0.60 ± 0.07	0.14 ± 0.09

Table 12. Phenotypic correlations (rp) of body weights at various ages to corresponding body dimensions

Body weights	No. of observation	Body length	Heart girth	Height at withers
At birth	92	0.767 ± 0.073	0.813 ± 0.062	0.816 ± 0.034
3 month	84	0.913 ± 0.082	0.902 ± 0.049	0.702 ± 0.021
6 month	77	0.658 ± 0.079	0.831 ± 0.062	0.930 ± 0.039
9 month	70	0.872 ± 0.076	0.906 ± 0.039	0.809 ± 0.084
12 month	67	0.835 ± 0.070	0.944 ± 0.048	0.865 ± 0.074

Table 13. Genotypic correlations (rg) of body weights at various ages to corresponding body dimensions

Body weights	No. of observation	Body length	Heart girth	Height at withers
At birth	92	0.431 ± 0.084	0.558 ± 0.045	0.343 ± 0.073
3 month	84	0.543 ± 0.088	0.535 ± 0.034	0.373 ± 0.081
6 month	77	0.231 ± 0.089	0.717 ± 0.032	0.573 ± 0.073
9 month	70	0.077 ± 0.043	0.357 ± 0.034	0.413 ± 0.048
12 month	67	0.621 ± 0.047	0.845 ± 0.042	0.472 ± 0.052

crossbreds the heritabilities in the above order were 0.06 ± 0.06, 0.19 ± 0.07, 0.22 ± 0.08, 0.03 ± 0.07 and 0.14 ± 0.09.

4.4 Correlations

Since the two genetic groups did not significantly differ the data were pooled to work out the genotypic and phenotypic correlations of body weights with various body dimensions. These are tabulated in Tables 12 and 13. The phenotypic correlations of body length, girth and height with body weights were generally very high at all ages studied. But on the whole heart girth showed better genetic correlation with body weights at all ages compared to body length and height.

Genotypic correlations were worked out between birth weights, one month weights, three month weights, six month weights, nine month weights to the 12 month weights in both the genetic groups. The data used for calculation were corrected for the effect of sex, season and litter size.

In the Malabari breed genotypic correlations were unobtainable.

Table 14. Partial regression co-efficients of body weights on body dimensions

Equation 1. $Y = A + b_1x_1 + b_2x_2 + b_3x_3$

Age in months	A	b_1	b_2	b_3	R^2
Birth weight	-3.0169	0.0453	0.0666	0.0637	0.7773
3 month weight	-11.804	0.2595	0.2144	-0.0241	0.8841
6 month weight	-17.329	0.1003	0.3459	0.1377	0.9351
9 month weight	-14.804	0.1967	0.3730	-0.0196	0.8393
12 month weight	-35.904	0.6621	0.5167	0.3481	0.8482

Y = body weight

A = Regression constant (intercept)

b_1, b_2, b_3 = Partial regression coefficient of body weight on body length, heart girth and height at withers respectively

x_1, x_2, x_3 = Body length, heart girth and height at withers respectively

Table 15. Partial regression co-efficients of body weights on heart girth

Equation 1. $Y = A + B_1x + B_2x$

Age in months	A	B_1	B_2	R^2
Birth weight	-3.4031	0.2340	-0.0016	0.6609
3 month weight	3.9837	-0.3040	0.0089	0.8247
6 month weight	6.6977	-0.3735	0.0095	0.9234
9 month weight	12.8256	-0.4633	0.0092	0.8240
12 month weight	32.2644	-1.1948	0.0161	0.8239

Y = body weight

A = Regression constant (intercept)

B_1, b_2 = Partial regression constants on heart girth

x = Heart girth in cms

Table 16. Atmospheric temperature °C (Mean±S.E.) from October 1999 to April 1992

Month		1990	1991	1992
January	Max	-	34.65±0.02	32.82±0.02
	Min	-	19.94±0.02	21.37±0.13
February	Max	-	36.84±0.02	35.88±0.08
	Min	-	19.80±0.07	22.46±0.06
March	Max	-	37.24±0.06	37.68±0.07
	Min	-	22.60±0.03	23.38±0.11
April	Max	-	36.70±0.10	37.28±0.04
	Min	-	22.60±0.03	24.48±0.03
May	Max	-	36.50±0.13	
	Min	-	23.00±0.09	
June	Max	-	31.04±0.06	
	Min	-	20.30±0.01	
July	Max	-	31.10±0.09	
	Min	-	18.90±0.07	
August	Max	-	30.90±0.05	
	Min	-	22.90±0.13	
September	Max	-	33.80±0.03	
	Min	-	24.60±0.08	
October	Max	34.05±0.06	32.73±0.11	
	Min	22.07±0.03	24.25±0.04	
November	Max	33.00±0.04	33.93±0.09	
	Min	20.90±0.05	22.93±0.09	
December	Max	33.40±0.02	33.18±0.14	
	Min	20.67±0.12	21.46±0.12	

In the Alpine x Malabari breed genotypic correlations were worked out only in the comparison between six month to 12 month and nine month to 12 months weights which were 0.2155 and 0.4430 respectively.

4.5 Prediction equations

Prediction equations with multiple regression coefficients of respective variables and coefficient of determination (R^2) are presented in Tables 14 and 15. The highest coefficients of determination were observed at the age of six months for both the prediction equations. The R^2 value was higher in the equation incorporating body length, height at withers and heart girth than in the equation with heart girth and it square only as the variables.

Discussion

DISCUSSION

5.1 Body dimensions

The mean body length, heart girth and height at withers were 25.68 ± 0.53, 27.37 ± 0.46 and 29.66 ± 0.60 cm respectively in male kids of the Malabari breed at birth while that of the male Alpine x Malabari crossbreds at birth in the same order were 26.01 ± 0.16, 28.23 ± 0.23 and 30.24 ± 0.45 cm respectively at birth. It was also observed that in the female Malabari kids at birth the body length, heart girth and height at withers were 25.63 ± 0.73, 27.56 ± 0.68 and 29.53 ± 0.48 cm respectively and that in the Alpine x Malabari female kids at birth were 25.3 ± 0.17, 27.60 ± 0.32 and 29.14 ± 0.35 cm in the same order. Similar findings were recorded by Singh and Prakash (1985) in 606 male and 795 female Changthang goats and Mukherjee et al. (1980) in 421 Brown Bengal does, while Darokhan and Tomar (1983) observed lower values than that observed in the present study.

The mean body length, heart girth and height at withers of male Malabari and Alpine x Malabari goats at 12 months were 61.42 ± 0.90, 61.12 ± 0.90 and 59.04 ±

1.01 cm and 64.19 ± 0.81, 64.60 ± 0.73 and 61.68 ± 0.9 cm respectively. The corresponding figures for females were 58.36 ± 0.81, 59.0 ± 0.7 and 58.36 ± 0.72 and 60.39 ± 0.81, 59.66 ± 0.82 and 58.18 ± 0.91 respectively. Similar findings were reported by Bhattacharya et al. (1984) in Black Bengal goats and Bose and Basu (1984) in male and female Beetal goats.

5.2 Body weights

Least-squares analysis showed that type of birth, season and sex had no significant effects on bodyweight in Malabari kids. In the Alpine x Malabari crossbreds the effect of sex on bodyweight was significant at birth, three, six, nine and 12 months of age. Season of birth had significant effect on body weights at six, nine and 12 months of age in Alpine x Malabari cross-breds. But type of birth did not have any influence on the body weights.

Non genetic factors affecting body weights

Sex

The mean birth weights of male Malabari and Alpine x Malabari crossbreds were 1.87 ± 0.09 and 1.98 ± 0.09 kg and that of female kids was 1.88 ± 0.06 and 1.78 ±

0.05 in Malabari and Alpine x Malabari respectively. There was no significant difference between male and female Malabari and Alpine x Malabari crossbred kids (Fig.1 and 2). Similar observations were made by Wahid and Khusahry (1981) in Australian feral goats, Ayoade and Butterworth (1982) in male and female Boer, male and female Malawi and male and female Boer x Malawi goats, El-Serafy and Al-Busaidy (1982) in Anglo-Nubian (AN) Jamnapari, Damascus, Anglo-Nubian x Damascus cross and Jamnapari x Damascus cross, Montaldo and Juarez (1982) in French Alpine, Anglo-Nubian, Granada, Saanen and Toggenburg goats. These observations were also in agreement with the findings of Singh et al. (1983) in Black Bengal goats, Sarma et al. (1984) in Assam local x Beetal kids, Singh et al. (1984) in Jamnapari and Barbari kids, Singh and Prakash (1985) in Changthang goats, Abdul Wahid et al. (1985) in Anglo-Nubian x local goats and Jamnapari x local goats, Jagtap and Patel (1986, a&b) in local Angora and their half breds Kanaujia et al. (1986) in six Beetal and six Black Bengal goats and their crosses, Hamcharan et al. (1987) in Anglo-Nubian, Saanen, Toggenburg and Alpine goats, Koul and Biswas (1987) in Chegu breed of Indian Pashmina goats, Prakasam et al. (1987) in Tellicherry

Fig.1 Mean Body Weights of Malabari Kids

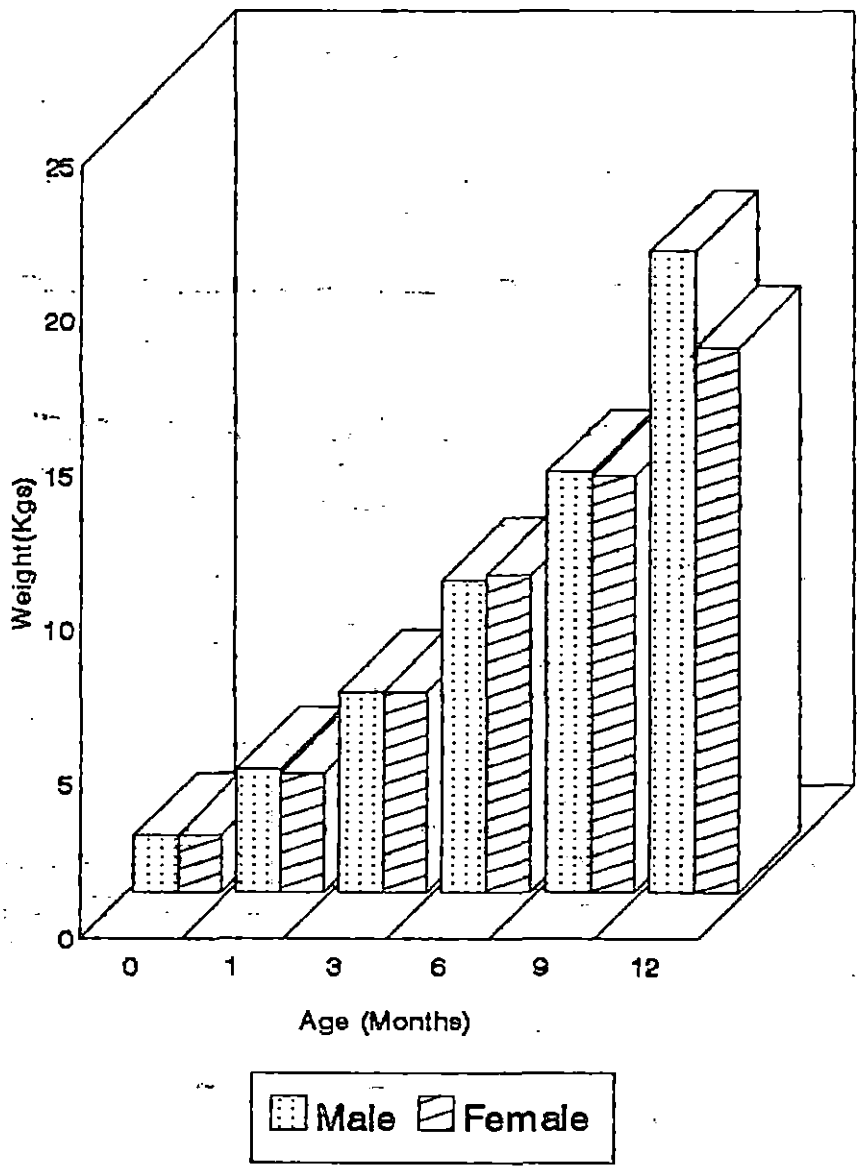


Fig.2 Mean Body Weights of Alpine X Malabari Kids

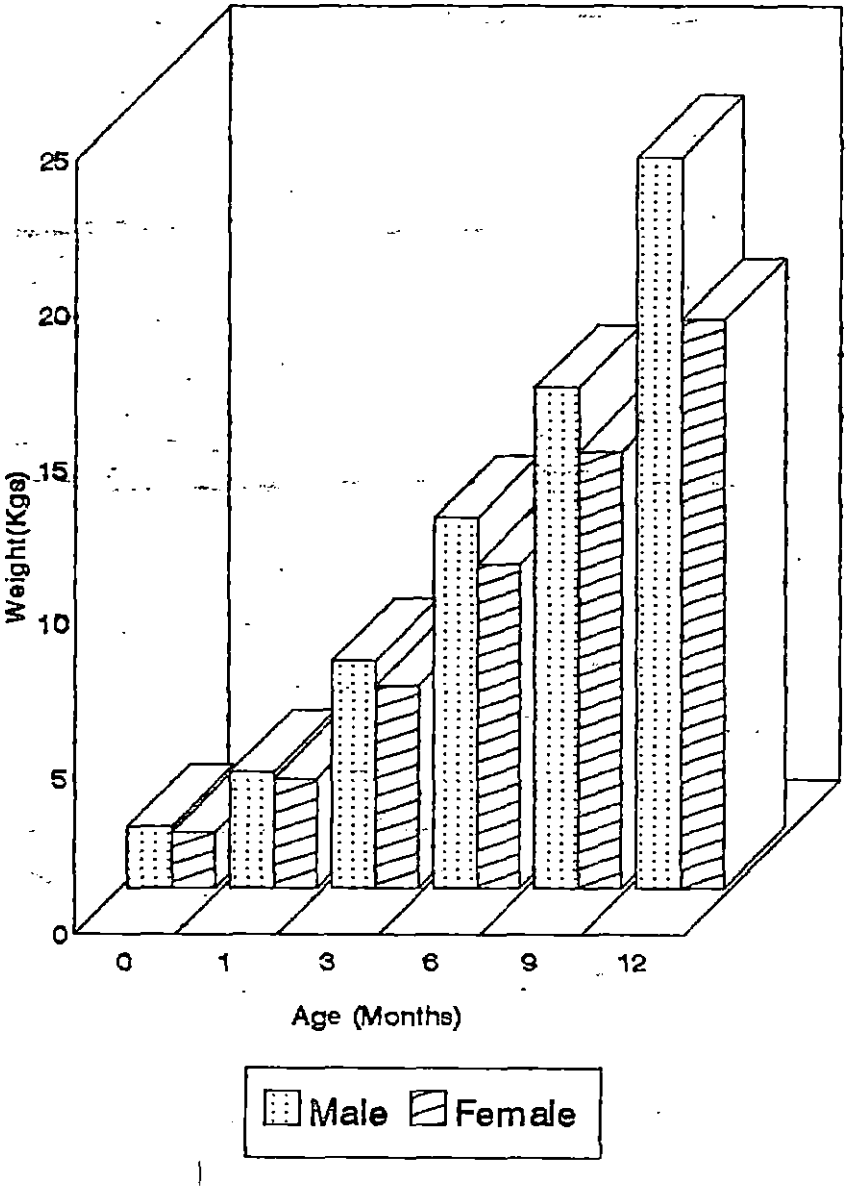
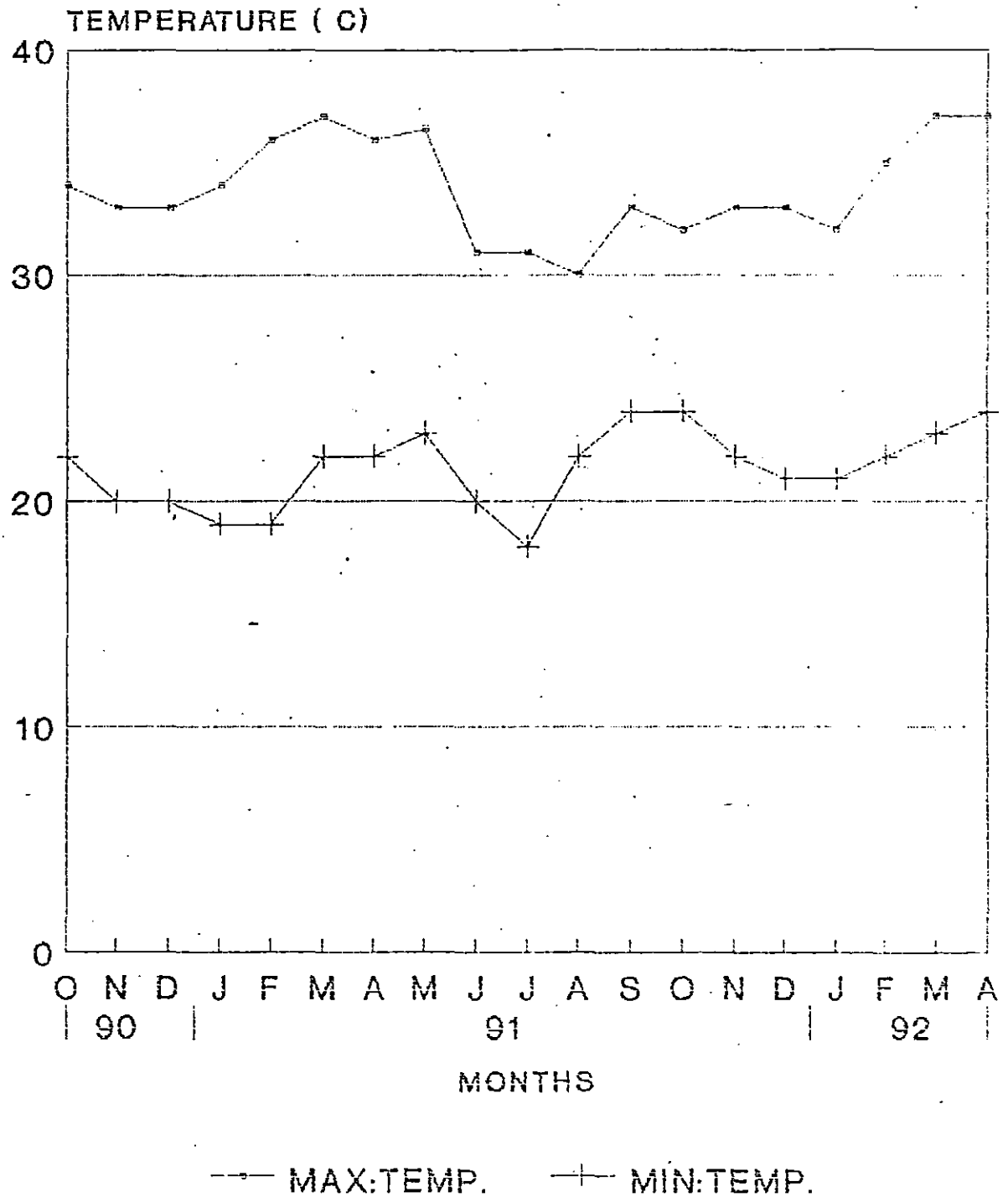


Fig. 3. Atmospheric temperature ^{o}C from October 1990 to April 1992



breed of goat, Oumara (1989) in Maradi goats and Mishra and Ghai (1990) in Sikkim local goats.

The mean 12 month body weight of male Malabari and Alpine x Malabari crossbreds were 20.71 ± 1.04 and 23.61 ± 1.00 kg and that of the females were 17.61 ± 1.01 and 18.31 ± 1.06 in Malabari and Alpine x Malabari respectively. There was significant difference ($P<0.05$) in the body weight at 12 months of age between male and female Malabari kids and male and female Alpine x Malabari kids. Similar observations were made by Taneja (1982) in Sirohi goats, Chawla et al. (1984) in Beetal goats. Wahid and Khusahry (1981) observed a higher body weight at 12 months of age of 34.56 and 29.33 kg in 20 male and female Australian feral goats and Nagpal and Chawla (1985) observed a body weight of 27.61 kg in Alpine x Beetal and 25.50 kg in Saanen x Beetal bucks at 12 months of age which Das and Goswami (1992) observed lower bodyweights of 11.92, 14.86 and 15.74 kg in 1/2 Assam local (AL) x Beetal cross and 1/4 AL and 3/4 Beetal.

Season

During the experimental period the mean maximum and minimum temperature were 34.55 ± 1.2°C and 22.03 ± 1.4°C respectively (Fig.3).

Season had a significant effect on the body weight ($P<0.05$) at six, nine and 12 months of age in Alpine x Malabari Crossbreds with kids born during monsoon showing a higher body weight than hose born during non-monsoon. Similar observation were made by Nagpal and Chawla (1985) in Alpine, Beetal, Saanen and their crosses, Jagtap et al. (1986) in Angora half breds and Salah et al. (1989) in Aradi Goats. The probable cause may be the fact that usually crossbreds are more sensitive the seasonal changes than local breeds.

Type of birth

The mean birth weights of Malabari singles and twins were 1.96 ± 0.90 and 1.86 ± 0.43 kg respectively and in the Alpine x Malabari crossbreds it was 2.13 ± 0.50 and 1.68 ± 0.43 respectively.

Type of birth did not have any significant effect on body weights of the Malabari and Alpine x Malabari at all the ages studied (Table 5 and 6). No significant

effect of type of birth on birth weight was observed by Lima et al. (1983) in 54 non-descript goats in Brazil. Significant effect of type of birth on birth weight was observed in Malabari's and their half breds by Mukundan et al. (1981), Montaldo and Juarez (1982) in French Alpine, Anglo-Nubian, Granada, Saanen and Toggenburg goats, Khan and Sahni (1983) in Jamnapari goats, Mukundan et al. (1983) in Malabari goats and its half breds, Sinha and Sahni (1983) in Jamnapari, Beetal, Barbari, Black Bengal goats and their crosses, Singh and Prakash (1985) in Changthang goats, Prakash and Singh (1985) in Malabari goats with its Alpine and Saanen crosses, Jagtap and Patel (1986) in local Angora and its half breds, Mukherjee et al. (1986) in Brown Bengal goats and Jagtap et al. (1991) in East African and Galla goats.

The mean 12 months bodyweights of Malabari singles and Malabari twins was 19.77 ± 1.19 and 19.61 ± 1.82 kg respectively and in the Alpine x Malabari crossbreds it was 21.92 ± 1.73 and 21.19 ± 1.90 kg respectively. Non-significant ($P<0.05$) differences were observed between the weights of singles and twins of both the genetic groups. These observations were supported by Lima et al. (1983) in his work on 54 non descript goats

of Brazil. Significant effect of type of birth on body weight was observed by Mukundan et al. (1983) in Malabari and its Saanen half breds, Singh et al. (1983) in Black Bengal goats, Sinha and Sahni (1983) in Jamnapari, Beetal, Barbari, Black Bengal goats and their crosses and Prakash and Singh (1985) in Malabari goats and Prakash and Singh (1985) in Malabari goats and their crosses with Saanen and Alpine.

Pooled analysis

Least squares analysis using adjusted data for nongenetic effects revealed that there was no difference between Malabari and Alpine x Malabari with regards to their body weights at birth three, six, nine and 12 months of age. As in the present study absence of superiority of crossbreds for body weights were observed by Nagpal and Chawla (1985) in their work on Alpine, Saanen, Beetal and their cross-breds. On the contrary, Malik et al. (1986) reported that breed had a significant ($P<0.05$) effect on bodyweight on Black Bengal goats. Further, it can be seen from the least-squares analysis that while non-genetic factors such as sex and season had significant role to play in the bodyweight of the Alpine x Malabari crossbreds, the

breed or genotype has very little say in the matter. So genotypic selection in the study population may be performed successfully only with the concurrent improvement of the environmental conditions so that the genotype may be expressed more efficiently.

5.3 Heritabilities

The heritabilities (h^2) of body weights at various ages for Malabari and Alpine x Malabari kids were 0.633 ± 0.07, 0.464 ± 0.08, 0.224 ± 0.06, 0.717 ± 0.05, 0.60 ± 0.07, and 0.058 ± 0.06, 0.194 ± 0.07, 0.22 ± 0.08, 0.03 ± 07 and 0.14 ± 0.09 at birth, three, six nine and 12 months of age respectively. Similar results were obtained by Siddique et al. (1981) in Osmanabadi goat kids, Montaldo and Juarez (1982) in French Alpine, Anglo-Nubian, Granada, Saanen and Toggenburg goats, Darokhan and Tomar (1983) in Changthang Pashmina goats, Garcia et al. (1983) in Criollo and crosses with Nubian, Alpine and Toggenburg and Mishra et al. (1983) in Ganjam goats.

5.4. Correlations

The phenotypic correlation between the birth weights and final weights showed a very low value in

both genetic groups. The highest phenotypic correlations was observed between bodyweights and heart girths in both the genetic groups. The genotypic correlations between different traits were found to be non-significant. Largest phenotypic correlations involving bodyweights and heart girths were reported by Mukherjee et al. (1981) in Grey Bengal goats, Prasad et al. (1981) in Black Bengal goats, Siddiqui et al. (1981) reported in their work on Osmanabadi goats, that phenotypic correlations between birth weights and subsequent body weights were positive and highly significant. Mukerjee et al. (1983) observed that phenotypic correlations of body weights with three body dimensions were significant in sub-plateau zone, while there were fewer significant correlations in plains and plateau. Darokhan and Tomar (1983) reported in their work on Changthang Pashmina goats that the genetic correlations between weight and body length were not significantly different from zero.

Genotypic correlations were obtainable only in the six month to 12 month and nine month to 12 month group in the Alpine x Malabari cossbreed. The correlations were 0.2155 and 0.4430 which indicated a very low estimate. The fact that a very low population size was

used in the estimation may have contributed to the low genotypic correlations in the Alpine x Malabari group and the inability to obtain the correlations in the Malabari group. The fact that each sire had a very low number of replications of progenies might also form a contributing factor.

Mishra et al. (1983) in their work on Ganjam goats opined that body weight was significantly correlated genetically with body measurements namely elbow height at 6 months. Height at stifle at birth, six months, 12 months and 24 months. Saxena et al. (1983) referring to their work on Jamnapari goats opined that genetic correlations of weaning weight with total and daily preweaning weight gain were high and positive.

5.5 Prediction Equations

The highest coefficient of determination (R^2) were observed at six months of age in the predication equations for bodyweight from body dimensions. R^2 value was highest in the equation incorporating body length, height at withers and heart girth as the independent variables (R^2 = 0.9351)for six month weights, than in the equation with heart girth and its square only as independent variables (R^2=0.9234). Misra (1980) found

the R^2 value for the regression of bodyweight on three body measurements was 0.83 in Sirohi goats. Valdez et al. (1982) in various exotic pure breds found that the best single predictor of body weight was the chest circumference with an R^2 value of 90.25 per cent. Pander et al. (1989) in Beetal and Black Bengal kids found that the R^2 value for the regression of body weight on heart girth, body length and length of metatarsal bone was 0.93 and Worman et al. (1990) observed an value of 0.71, 0.63 and 0.69 at <3 months, three months and >3 months respectively.

From the results of the present study, it may be concluded that the exotic cross Alpine x Malabari does not vary significantly from the native Malabari with respect to body weights at different ages. The low genotypic and high phenotypic correlations may point to the fact that in the study population, environment played a major role in shaping the growth of the kids while genotype has been reduced to a secondary role. The variations seen in the heritabilities may be due to the above factors or may be due to increase of inbreeding or due to low population size used for the experiment.

Summary

SUMMARY

The study was conducted in 92 goat kids reared at the All India Co-ordinated Research Project on goats farm at Mannuthy, Trichur. A comparative study was made on the native Malabari with its third generation cross with exotic Alpine breed.

The mean body length, heart girth and height at withers at birth were 25.68 ± 0.53, 27.37 ± 0.46 and 29.66 ± 0.60 cm and 26.01 ± 0.16, 28.23 ± 0.23 and 30.24 ± 0.45 in male kids of Malabari and Alpine x Malabari crossbreds respectively. In the females the corresponding values were 25.63 ± 0.073, 27.56 ± 0.68 and 25.53 ± 0.48 and 25.3 ± 0.17, 27.60 ± 0.32 and 29.14 ± 0.35 cm.

The mean body length, heart girth and height at withers of male Malabari and Alpine x Malabari goats at 12 months were 61.42 ± 0.90, 61.12 ± 0.90 and 59.04 ± 1.01 cm 64.19 ± 0.81, 64.60 ± 0.73 and 61.98 ± 0.9 cm respectively. The corresponding values for females were 58.36 ± 0.72 and 60.39 ± 0.81, 59.66 ± 0.82 and 58.18 ± 0.91 respectively.

There was no significant difference between the birth weights of male and female Malabari kids and between the birth weights of male and female Alpine x Malabari crossbreds and between the birth weights of the two genetic groups. The corresponding values were 1.87 ± 0.09 and 1.88 ± 0.06 in the males and 1.98 ± 1.78 in the females.

There was no significant difference in the bodyweight at 12 months of age between male and female Malabari but the difference was significant in the Alpine x Malabari crossbred kids. No significant difference was observed in the bodyweight at 12 months between the two genetic groups.

During the experiment period mean maximum and minimum temperature were 34.55 ± 1.2 and 22.03 ± 1.4°C respectively.

Season of birth had a significant effect on the body weight at six, nine and 12 months of age in Alpine x Malabari crossbreds but similar effects were not seen in Malabari.

No significant difference was observed between the birth weights of single and twin Alpine x Malabari and Malabari kids.

Least square analysis showed that season, sex and type of birth had no significant effects on the body weight in Malabari kids while in the Alpine x Malabari crossbreds the effect of sex on body weight was significant at all the ages studied. Season at six, wine and 12 months of age in Alpine x Malabari crossbreds had significant effect on body weight.

Genetic group had no significant effect on body weights. The highest phenotypic correlations were observed between the body weight and heart girth in both genetic groups. Genotypic correlations between different traits were.

The heritabilities of bodyweights at various ages were higher in Malabari when compared to Malabari x Alpine crossbreds. The values at birth, three, six, nine and 12 months of age were 0.63 ± 0.07, 0.46 ± 0.08, 0.22 ± 0.06, 0.72 ± 0.05 and 0.60 ± 0.07 respectively for the Malabri breed. In the Alpine x Malabari crossbreed the corresponding values were 0.06 ± 0.06, 0.19 ± 0.07, 0.22 ± 0.08, 0.03 ± 0.07 and 0.14 ± 0.09.

The highest phenotypic correlations were observed between the bodyweight and heart girth in both genetic groups. Genotypic correlations between different traits were found to be low.

The coefficients of determination were more with the equation using multiple variables than with the equation using heart girth and its square only as the variables. The highest coefficients of determination were observed at the age of six months for both the prediction equations.

From the results of the present study it may be concluded that Alpine x Malabari cross does not vary significantly with respect to different bodyweights from the Malabari. The low genotypic and high phenotypic correlation may be a result of environment playing a major role in shaping the growth of kids. The variation in heritabilities may be due to the above factors or increased level of in breeding and a low population size used in the experiment. Genotypic selection in the study population may be performed along with a concurrent improvement of the environmental conditions so that the genotype may be expressed more efficiently.

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GENETICS OF BODY DIMENSIONS OF MALABARI GOATS AND ITS CROSS IN KERALA

By

RAJ MENON

ABSTRACT OF A THESIS

Submitted in partial fulfilment of the
requirement for the degree

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University

Department of Animal Breeding and Genetics
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
Mannuthy, Thrissur

1994

ABSTRACT

The main objectives of this study were: (1) to study the bodyweight and body dimensions of Malabari goats and its Alpine half breds, (2) to estimate the genetic and phenotypic correlations between bodyweight and different body dimensions in various genetic groups and (3) to study any other major factors affecting bodyweights and body dimensions.

The study was conducted in 92 goat kids reared at the All India Co-ordinated Research Project on goats farm at Mannuthy, Thrissur. A comparative study was made on the native Malabari with its third generation cross with the exotic Alpine breed.

The mean body length, heart girth and height at withers at birth were 25.68 ± 0.53, 27.37 ± 0.46 and 29.66 ± 0.60 cm and 26.01 ± 0.16, 28.23 ± 0.23 and 30.24 ± 0.45 in male kids of Malabari and Alpine x Malabari crossbreds respectively. In the females the corresponding values were 25.63 ± 0.073, 27.56 ± 0.68 and 25.53 ± 0.48 and 25.3 ± 0.17, 27.60 ± 0.32 and 29.14 ± 0.35 cm.

The mean body length, heart girth and height at withers of male Malabari and Alpine x Malabari goats at

12 months were 61.42 ± 0.90, 61.12 ± 0.90 and 59.04 ± 1.01 cm and 64.19 ± 0.81, 64.60 ± 0.73 and 61.98 ± 0.9 cm respectively. The corresponding values for females were 58.36 ± 0.81, 59.0 ± 0.7 and 58.36 ± 0.72 and 60.39 ± 0.81, 59.66 ± 0.82 and 58.18 ± 0.91 respectively.

There was no significant difference between the birth weights of male and female Malabari kids and between the birth weights of the two genetic groups. But the difference was significant in the Alpine x Malabari crossbreds.

There was significant difference in the bodyweight at 12 months of age between male and female Alpine x Malabari crossbred kids. No significant difference was observed in the bodyweight at 12 months between the two genetic groups.

During the experiment period mean maximum and minimum temperature were 34.55 ± 1.2 and 22.03 ± 1.4°C respectively.

Season had a significant effect on the body weight at six, none and 12 months of age in Alpine x Malabari crossbreds.

The effect of type of birth was not significant on the birth weights in Alpine x Malabari crossbreds and Malabari kids. Type of birth had no significant effect on the 12 months body weight in both the genetic groups.

Least squares analysis showed non-significant effects of season and sex on the body weights in Malabari kids while in the Alpine x Malabari the effect of sex on body weights was significant at all the ages studied. Season at six, nine and 12 months of age had significant effects on bodyweight in Alpine x Malabari crossbreds

Breed had no significant effect on body weights.

The heritabilities of bodyweights at various ages were higher in Malabari when compared to Malabari x Alpine crossbreds.

The highest phenotypic correlations were observed between the bodyweight and heart girth in both genetic groups. Genotypic correlations between different traits were found to be low at different ages in both the genetic groups.

The highest coefficients of determination were observed at the age of six months for both the prediction equations.