GENETIC AND ENVIRONMENTAL FACTORS INFLUENCING GROWTH RATE AND BODY WEIGHTS UP TO SIX MONTHS IN MALABARI GOAT

By

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THESIS

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DECLARATION

I here by declare that this thesis entitled ***"Genetic and environmental factors influencing growth rate and body weights up to six months in Malabari goat"*** *is a bonafide record of research work done by me during the course of research and that this thesis has not previously formed the basis for the award to me of any degree, diploma, associate ship, fellowship or other similar title of any other University or Society.*

Place : Mannuthy

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DR.*K.B. JITHENDRAKUMAR*

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INTRODUCTION

Goat was one of the earliest discoveries of mankind in pre-historic times as a ready and easy source of meat. They are believed to be the first domesticated farm animal by the ancient man. The domestication of goat took place in the near east during 7500-7000 BC, the ancestor being the wild goat *Capra aegagrus* (Mason, 1951). Majority of the goat population of the world is concentrated in the tropics and sub-tropics. Their small size, large surface area relative to body weight and limited subcutaneous fat make them well adapted to the hot humid tropics (Shelton, 1978). Ninety percent of the world's goat population is concentrated in the developing countries of which 61% is in Asia. Ninety five percent of goats are raised for meat whereas five percent are meant for milk production (Anonymous, 1996).

India has an estimated goat population of 118 million ranking first in world and that account 19.86 % of the world total (FAO Report 1993). The increasing trend can be visualized from 1951 onwards when the population was only 47.1 million. In spite of the indiscriminate slaughter of 35% of total population in every year, this increase has occurred. Goat and Sheep contribute approximately 57% of the total meat produced in the country and more than 90% of the goats are maintained in rural sector of the country (Acharya, 1990).

Goats being small sized ruminant are capable of integrating itself into the dissimilar socio-economic conditions of the country. The importance of goat in the rural economy is evident by the unique features of goat like small body size,

inquisitive feeding habits, ability to get acclimatized to the diversified agro-climatic conditions, high digestive capacity, high dry matter consumption, high fertility, higher prolificacy and short generation interval.

Economically goat is ideally suited for poor rural population especially for marginal and landless labourers by its low cost of maintenance, short-term return on capital with low risk on capital investment and no involvement of extraneous labour. The entire rural family members including the women and children can be profitably associated with goat management. Goats thrive well in areas where it is difficult to raise cows and buffaloes (Gopalakrishnan and Lal, 1996). This makes the goat to be called as poor man's cow. More over goat meat is relished by all classes of the society, and there is no religious prejudice for goat and its products.

India has twenty recognized breeds of goats. Ninety percent of goats in India are nondescript (Acharya, 1992). Most of the breeds of goat in India are evolved naturally through adaptation to geographical and ecological conditions prevailing in different parts of country. Until fourth five-year plan, there were no organized efforts for genetic improvement of Indian goats. In 1971 the Indian Council of Agricultural Research (ICAR) launched All India Co-ordinated Research Projects (AICRP) on sheep and goats in different parts of the country to evolve ideal breeds suitable under specific agro climatic conditions and to generate information on reproductive, growth and production performance and estimates of genetic parameters of important economic traits.

The preliminary results of trial involving crossing of Beetal with Alpine and Anglo-Nubian indicated little improvement in body weight, efficiency of feed conversion for meat and dressing percentage (NCA, 1976). Study of combining ability of four breeds viz. Jamunapari, Beetal, Barbari and Black Bengal showed Jamunapari X Black Bengal had best performance with respect to meat production (RBS College Agra, 1990)

Kerala has 1.85 million goat (Census data, 1992). Malabari also called as Tellicherry is the prestigious breed of Kerala. According to the 1987 census the population of Malabari is 1.21 lakh. This breed is well known for its high prolificacy and adaptability to the hot humid conditions prevailing in the state (Devendra, 1990). These goats were used for cross breeding with Swiss breeds Alpine and Saanen under AICRP on goats for milk production at Mannuthy. Saanen x Malabari goats found to have higher milk yield (146.1 kg) compared to Malabari (98.0 kg) and Alpine x Malabari (107.5 kg), Stephen *et al.* (1996).

In view of the contribution of goats to the meat production sector and the preference of goat meat in the country it is imperative that meat type goats should be evolved and propagated. Unfortunately research attempts in similar lines are scanty from the state of Kerala, which is a humid tropic in spite of the promising prospects for goat meat industry. The potential of Malabari goat with its high adaptability, crude fibre conversion rate and prolificacy necessitates scientific breeding programs to evolve meat types. Economic value of goats depends on its growth rate, production and prolificacy (Mia and Bhuiyan, 1997).

The present study was undertaken in Malabari kids up to six months of age maintained at the University Sheep and Goat farm, College of Veterinary and Animal Sciences, Kerala Agricultural University, Mannuthy with the following objectives.

1. To study the genetic and non-genetic effects with particular emphasis to maternal effects on growth rate and body weights up to six months.

2. To ascertain the feasibility of evolving selection criteria for development of meat type goat.

Review of Literature

REVIEW OF LITERATURE

Goats contribute a major share of the meat produced in India. Majority of the goats of the country are maintained by rural poor including marginal farmers and landless labourers (Acharya, 1990). In view of the contribution of goats to the meat production sector, it is imperative that meat type goats be evolved and propagated. It is established that economic value of goat depends up on its growth, production and prolificacy (Mia and Buiyan, 1997). Growth is measured in terms of body weights. Even though much work has been made on growth and body weights of cattle, sheep and pigs, comparatively a less work has been done on these aspects in goats especially in Indian goats. Literatures available on these aspects are reviewed briefly.

2.1. BODY WEIGHTS

2.1.1 BIRTH WEIGHT

Nair (1979) analysed the data of 379 Malabari kids maintained under the All India Coordinated Research Project (AICRP) on goats for milk production under Kerala Agricultural University (KAU) and observed that the average birth weight of Malabari kids as 1.73 ± 0.02 kg. Mukundan (1980) reported the average birth weight of 112 Malabari kids as 1.71 ± 0.06 kg and Raghavan (1980) observed the birth weight as 1.71 ± 0.02 kg in 309 kids in the same project.

Mathew *et al.* (1994) analysed the data of 446 kids of Malabari goats kept at KAU farm, Mannuthy and found the average birth weight as 1.70 ± 0.03 kg. Raghavan *et al.* (1999) on analysis of data of 188 Malabari kids maintained at

Regional Research Station of KAU, Pilikode found that birth weight averaged to 1.59 ± 0.08 kg.

The average birth weights of other Indian breeds of goats are given in Table 2.1. It can be seen that the birth weights ranged from 2.88 to 3.55 kg in Jamnapari, 2.20 to 3.15 kg in Beetal, 2.83 to 2.94 kg in Sirohi, 1.76 to 2.05 kg in Barbari, and 1.13 to 1.24 kg in Black Bengal.

2.1.1.1 Factors affecting Birth weight

a. Sex

In Malabari breed of goat, Mukundan (1980) found males to be significantly heavier than females at birth. Similar observations were also made by Mathew *et al.* (1994). According to Raghavan (1980) the sex difference was not significant in purebred Malabari kids.

Prakasam *et al.* (1987) reported that the birth weight of Tellicherry (Malabari) goats in Tamil Nadu averaged as 2.22 ± 0.01 kg in males and 1.81 ± 0.01 kg in females. Sivakumar and Thiagarajan (1999) at Livestock Research Station, Kattupakkam reported the birth weight of Tellicherry (Malabari) kids born during 1991 to 1994 as 2.06 ± 0.03 kg for male and 1.78 ± 0.04 kg for female.

A significant effect of sex on birth weight was also reported by Malik *et al.* (1986), Malik *et al.* (1993) and Singh and Singh (1998) in Black Bengal kids; Misra and Rawat (1984), Gokhale *et al.* (1996) and Mehta *et al.* (1997) in Sirohi

Table 2.1 Birth weights of Indian goats

Male (kg)	Female (kg)	Pooled (kg)	Reference
Jamnapari			
3.13	2.99	3.01 (111)	Khan and Sahni (1983)
		3.55 ± 1.06 (66)	Singh *et al.* (1984)
3.65 ± 0.09 (71)	3.37 ± 0.10 (64)	3.51 ± 0.08 (135)	Saxena *et al.* (1990)
3.29 ± 0.08 (258)	2.96 ± 0.07 (266)	3.13 ± 0.06 (524)	Kumar *et al.* (1992)
3.32 ± 0.10 (48)	3.06 ± 0.10 (49)	3.19 ± 0.07 (97)	Sharma and Das (1995)
2.99 ± 0.64 (390)	2.77 ± 0.63 (477)	2.88 ± 0.06 (867)	Roy *et al.* (1997)
Beetal			
3.31 ± 0.08 (135)	2.99 ± 0.08 (159)	3.15 ± 0.06 (296)	Nagpal and Chawla (1984)
		2.20 ± 0.04	Malik *et al.* (1986)
		2.77 ± 0.06 (534)	Kanaujia *et al.* (1989)
Sirohi			
2.95 ± 0.04 (124)	2.69 ± 0.03 (116)	2.83 ± 0.03 (242)	Misra and Rawat (1984)
3.04 ± 0.14 (395)	2.84 ± 0.14 (375)	2.94 ± 0.32 (770)	Gokhale *et al.* (1996)
3.04 ± 0.03 (284)	2.71 ± 0.03 (292)	2.88 ± 0.03 (576)	Mehta *et al.* (1997)
Jakhrana			
		2.15 ± 0.06 (134)	Tyagi *et al.* (1992)
Marwari			
		2.38 ± 0.15 (30)	Patel *et al.* (1999)

(Cond.....)

Table 2.1 continued

Male (kg)	Female (kg)	Pooled (kg)	Reference
Parbatsar			
		3.00 ± 0.25 (20)	Patel et. al. (1999)
Barbari			
		2.05 ± 1.06 (115)	Singh et. al. (1984)
1.79 ± 0.05 (74)	1.73 ± 0.04 (86)	1.76 ± 0.03 (160)	Das et. al. (1995)
		2.03 ± 0.09	Khan et. al. (1998)
Changathangi			
2.03 ± 0.03 (226)	1.82 ± 0.02 (248)		Darokan and Tomar (1983)
1.88 ± 0.01 (333)	1.74 ± 0.01 (345)	1.82 ± 0.01 (678)	Sheik et. al. (1996)
Black Bengal			
1.3 (89)	1.2 (99)		Singh et. al. (1983)
		1.31 ± 0.04	Malik et. al. (1986)
		1.13 ± 0.02 (806)	Kanaujia et. al. (1989)
		1.24 ± 0.02 (339)	Singh et. al. (1991)
1.36±0.09 (276)	1.13 ± 0.09 (301)	1.24 ± 0.08 (577)	Malik et. al. (1993)
1.16 (35)	1.06 (44)		Ghosh et. al. (1999)

Note: Figures in parenthesis wherever given are number of observations involved.

kids; Naik *et al.* (1985) in Ganjam kids; Das *et al.* (1989), Saxena *et al.* (1990), Kumar *et al.* (1992) and Roy *et al.* (1997) in Jamunapari kids; Sheikh *et al.* (1996) in Changthangi kids; Tyagi et. al (1992) in Jakhrana kids; Nagpal and Chawla (1984) in Beetal kids. However no significant effect was observed by Roy *et al.* (1989), Sharma and Das (1995) in Jamunapari kids; Patnaik and Nayak (1988) in Ganjam kids and Das *et al.* (1995) in Barbari kids.

b. Type of birth

There are several reports that revealed the significant effect of type of birth on birth weight in goats. In Malabari and its Alpine and Saanen cross-breds Raghavan (1980) reported that kids born as singles had significantly higher birth weight followed by twins and triplets. A significant effect was also noted by Mukundan (1980) and Mukundan *et al.* (1981) in Malabari and its Saanen cross-breds, Mathew *et al.* (1994) in Malabari and its crosses with Alpine and Saanen, Raghavan *et al.* (1999) in Malabari kids.

Similar findings were also observed by Khan and Sahni (1983), Roy *et al.* (1989) Saxena *et al.* (1990), Kumar *et al.* (1992) and Roy *et al.* (1997) in Jamunapari kids; Sinha and Sahni (1983) in Jamunapari, Black Bengal (BB), Beetal and their crosses; Malik *et al.* (1993) in BB; Singh *et al.* (1983) in BB and its crosses; Singh *et al.* (1991) in BB and its crosses with Beetal and Jamunapari; Singh *et al.* (2000) in Beetal half breds; Tyagi *et al.* (1992) in Jakhrana; Das *et al.* (1995) in Barbari and Mehta *et al.* (1997) in Sirohi goats.

However non-significant effect of type of birth have been observed by Das *et al.* (1989) in Barbari, Sharma and Das (1995) in Jamunapari and Singh and Singh (1998) in BB and its crosses with Beetal goats.

c. Month of birth

Mukundan (1981) analysed the birth weights of 208 Malabari and 265 Malabari x Saanen kids and found that the effect of month of birth was non significant. Similar reports have also made by Gokhale *et al.* (1996) in Nondescript and graded up Sirohi goats, Premasundepa *et al.* (1998) in Boer goats and Reynolds (1979) in indigenous Malawi goat.

Significant effect of month of birth was observed by Kumar *et al.* (1992) and Saxena *et al.* (1990) in Jamunapari goats, Jagtap *et al.* (1988) in Angora and its cross-breds and Sanchez *et al.* (1994) in graded up tropical goats.

d. Sire effects and Heritability

Most of the available literatures showed that the effect of sire was not significant on birth weight. (Raghavan (1980) in Malabari and Malabari x Saanen cross-breds; Saxena *et al.* (1990), Kumar *et al.* (1992) and Roy *et al.* (1997) in Jamunapari kids). How ever a significant effect of sire was reported by Raghavan (1980) in Malabari x Alpine cross-breds.

Mathew (1991) reported the heritability of birth weight of Malabari kids as 0.06 ± 0.08. Heritability estimates of birth weights of Indian goats are presented in Table 2.2. Even though wide range in heritability estimate had been

Table 2.2 Heritability estimates of birth weights of Indian goats

Breed	Heritability	Reference
Beetal and half-breds	0.71 ± 0.04	Singh et. al. (2000)
Sirohi	0.40 ± 0.15	Mehta et. al. (1997)
Jamunapari	0.75 ± 0.39	Endang (1998)
Jamunapari	0.26	Kumar et. al. (1993)
Jamunapari	0.46 ± 0.15	Roy et. al. (1989)
Assam local and cross-breds	0.20 ± 0.10	Das et. al. (1998)
Sirohi and Kutchi	0.17 ± 0.06	Tomar et. al. (1997)
Angora	0.25	Hermiz et. al. (1997)
Ganjam	0.19 ± 0.14	Madeli and Patro (1984)
Changthang	0.05 ± 0.08	Darokhan and Tomar (1983)
Black Bengal	0.40 ± 0.24	Ali (1983)
Osmanabadi	0.10 ± 0.28	Siddiqui et. al. (1981)
Malabari x Saanen	0.33 ± 0.14	Mathew (1991)
Malabari x Alpine	0.18 ± 0.09	Mathew (1991)
Malabari x Alpine	0.05 ± 0.03	Raghavan (1980)

reported (0.75 to 0.03), most of reports revealed that heritability of birth weight was medium to low.

e. Dam's body weight at kidding

Singh and Singh (1998) in Jamunapari half breds, Roy *et al.* (1997) and Kumar *et al.* (1992) in Jamunapari goats reported that effect of dam's body weight at kidding influenced the birth weight significantly.

2.1.2 BODY WEIGHTS UP TO WEANING (90 DAYS)

Raghavan (1980) reported average first month body weights of Malabari kids as 2.83 ± 0.05 kg. According to Mukundan (1983) body weights of Malabari kids averaged 2.83 kg at first month and 3.97 kg at second month. Singh and Singh (1998) described the pre-weaning body weights of Black Bengal (BB) kids as 2.81 ± 0.01 kg at first month and 3.54 ± 0.02 kg at second month. Malik *et al.* (1993) described the first month body weight of BB as 2.64 ± 0.21 kg.

Mukundan (1980) reported mean body weight of Malabari at weaning as 4.997 ± 1.90 kg and Mathew (1991) found it as 5.4 ± 0.09 kg. The weaning weight of Malabari kids in Tamil Nadu was 8.26 ± 0.02 in males and 6.32 ± 0.184 kg in females (Prakasam *et al.*, 1987). The weaning weights of different Indian breeds of goats are presented in Table 2.3. The weaning weight ranged from 7.45 to 12.25 kg in Jamunapari, 7.03 to 9.70 kg in Beetal, 9.54 to 12.58 kg in Sirohi, 7.19 to 8.10 in Barbari and 5.41 to 5.85 kg in Black Bengal.

Table 2.3 Weaning weights of Indian goats

Male (kg)	Female (kg)	Pooled (kg)	Reference
Jamnapari			
11.22	10.33	10.78 (111)	Khan and Sahni (1983)
		7.45 ± 1.24 (66)	Singh *et al.* (1984)
9.56 ± 0.63 (8)	9.21 ± 0.95 (8)	9.38 ± 0.55 (16)	Patnaik and Nayak (1988)
13.5 ± 0.09	11.3 ± 0.90		Das *et al.* (1989)
8.78 ± 0.23 (71)	8.39 ± 0.24 (64)	8.59 ± 0.21 (135)	Saxena *et al.* (1990)
8.69 ± 0.39 (186)	8.69 ± 0.37 (204)	8.35 ± 0.35 (390)	Kumar *et al.* (1992)
13.18 ± 0.56 (29)	11.37 ± 0.53 (36)	12.27 ± 0.41 (65)	Sharma and Das (1995)
9.32 ± 0.19 (390)	8.84 ± 0.19 (477)	9.08 ± 0.18 (867)	Roy *et al.* (1997)
Beetal			
8.41 ± 0.26 (93)	7.64 ± 0.24 (127)	8.03 ± 0.20 (220)	Nagpal and Chawla (1984)
		9.70 ± 0.20 (376)	Kanaujia and Pander (1988)
		9.70 ± 0.20 (376)	Kanaujia *et al.* (1989)
Sirohi			
9.81 ± 0.21 (105)	9.26 ± 0.18 (112)	9.54 ± 0.14 (217)	Misra and Rawat (1984)
10.85±0.54(336)	10.03±0.54(338)	10.44±1.19(674)	Gokhale *et al.* (1996)
13.39±0.21(268)	11.77±0.21(271)	12.58±0.17(539)	Mehta *et al.* (1997)
Jakhrana			
8.88 ± 0.29 (57)	8.40 ± 0.27 (62)	8.64 ± 0.25 (119)	Tyagi *et al.* (1992)

(Cond.....)

Table 2.3 continued

Male (kg)	Female (kg)	Pooled (kg)	Reference
Marwari			
10.5 ± 0.82	9.55 ± 0.17		Mittal (1988)
		9.99 ± 1.45	Patel *et al.* (1999)
Parbatsar			
10.0 ± 0.01	8.8 ± 0.30		Mittal (1984)
		14.36 ± 0.95	Patel *et al.* (1999)
Barbari			
		7.19 ± 1.23 (115)	Singh *et al.* (1984)
9.20 ± 0.40 (40)	8.60 ± 0.40 (44)		Das *et al.* (1989)
8.26 ± 0.25 (59)	7.18 ± 0.24 (66)	7.72 ± 0.17 (125)	Das *et al.* (1995)
		8.10 ± 0.31 (137)	Khan *et al.* (1998)
Changathangi			
8.39 ± 0.02 (201)	8.28 ± 0.09 (201)	8.34 ± 0.01 (402)	Sheik *et al.* (1996)
Black Bengal			
6.08 ± 1.04 (6)	5.71 ± 0.31 (9)	5.85 ± 0.43 (15)	Patnaik and Nayak (1988)
		5.41 ± 0.06 (477)	Kanaujia *et al.* (1989)
5.75 ± 0.15 (157)	5.08 ± 0.16 (159)	5.41 ± 0.14 (316)	Malik *et al.* (1993)
		5.65 ± 0.10 (189)	Singh (1997)
		5.67 ± 0.48 (137)	Singh and Singh (1998)

Note: Figures in parenthesis wherever given are number of observations involved.

2.1.2.1 Factors affecting body weights up to weaning

a. Sex

Mukundan (1983) analysed the factors affecting pre-weaning body weights and weaning weight of Malabari and its cross-breds with Saanen and found that effect of sex significantly influenced the growth on all stages. According to Mathew *et al.* (1994) weaning weight of Malabari and its cross-breds with Alpine and Saanen is significantly affected by sex. Raghavan (1980) found that sex is non-significant on weight at one month of age.

A significant effect of sex on pre-weaning weights was also reported by Malik *et al.* (1993) and Husain *et al.* (1996 and 1997) in Black Bengal (BB), Gokhale *et al.* (1996) in non-descript and graded up Sirohi goats of Rajasthan and Singh and Singh (1998) in BB and its crosses with Beetal.

A significant effect of sex on weaning body weight was reported by Singh (1997) in Black Bengal and its halfbreds, Mehta *et al.* (1997) in Sirohi goats, Roy *et al.* (1997), Sharma and Das (1995), Saxena *et al.* (1990) and Das *et al.* (1989) in Jamunapari goats, Gokhale *et al.* (1996) in Non descript and graded up Sirohi goats, Das *et al.* (1995) in Barbari goats, Malik *et al.* (1993) in Black Bengal goats, Tyagi *et al.* (1992) in Jakhrana goats, Nagpal and Chawla (1984) in Beetal goats.

How ever the findings of Singh *et al.* (2000) in Beetal half-breds, Singh and Singh (1998) in Black Bengal and its crosses with Beetal, Sheikh *et al.* (1996) in Changthangi goats, Kumar (1992) in Jamunapari and Nagpal and Chawla

(1985) in cross-bred goats indicated that the influence of sex on weaning body weight was not significant.

b. Type of birth

Raghavan reported a significant effect of litter size on weight at one month of age in Malabari kids. According to Mukundan (1983) body weight of Malabari and Saanen x Malabari cross-breds at first month was significantly affected by type of birth. However Mukundan (1983) reported a non-significant effect of type of birth on body weights at two and three months of age in Malabari and its cross-breds. Mathew (1994) found a non-significant effect of type of birth on weaning weight.

Significant effects of type of birth on pre-weaning body weights were also reported by Singh and Singh (1998) in Black Bengal goats and its crosses with Beetal; Hussain *et al.* (1997), Hussain *et al.* (1996) and, Malik *et al.* (1993) in Black Bengal; Gokhale *et al.* (1996) in nondescript and graded up Sirohi goats.

Effect of type of birth was found insignificant on weaning (3 months) weight by Sharma and Das (1995) in Jamunapari, Das *et al.* (1995) in Barbari and Tyagi *et al.* (1992) in Jakhrana. However, Singh *et al.* (2000) in Beetal half breds, Singh and Singh (1998) in Black Bengal (BB) and its crosses with Beetal, Singh (1997) in BB and its half breds, Mehta *et al.* (1997) in Sirohi goats and Roy *et al.* (1997) in Jamunapari goats found a significant effect of type of birth on weaning weight.

c. Month of birth

Mukundan (1983) reported that weight at two months of age was significantly influenced by month of birth in Malabari and Saanen x Malabari kids. Significant effect of month of birth on pre-weaning body weights also reported by Ruvuna *et al.* (1998) in Small East African and Somali goats and Gokhale *et al.* (1996) in non descript and graded up Sirohi goats. A non-significant effect of month of birth on first month body weight in Malabari and its crosses with Saanen was also reported by Mukundan (1983).

Month of birth influenced the weaning weights, according to the studies of Gokhale *et al.* (1996) in non descript and graded up Sirohi goats and Kumar *et al.* (1992) and Saxena *et al.* (1990) in Jamunapari goats. Contradictory findings were made by Mukundan (1983) in Malabari and Saanen x Malabari kids, Reynolds (1979) in Malawi goats.

d. Sire effects and Heritability

Raghavan (1980) reported a significant effect of sire on first month body weight in Malabari kids and that was non-significant in Alpine x Malabari, Saanen x Malabari kids. A non-significant effect of sire on pre-weaning body weights (at one and two months) was also reported by Mukundan (1983) in Malabari and its crosses with Saanen. According to Roy *et al.* (1997) and Kumar *et al.* (1992) reported a significant influence of sire on the weaning weight of Jamunapari kids. Mukundan (1983) also noted a significant effect of sire on weaning weight. However non significant effect of sire on weaning weight was reported by Saxena *et al.* (1990) in Jamunapari kids.

Mathew (1991) reported the heritability of weaning weight of Malabari goats as 0.73 ± 0.28. According to Mukundan (1980) the heritability of Malabari and Saanen x Malabari was 1.08 ± 0.75 at weaning. Heritability estimates of weaning weights of Indian goats are listed in Table 2.4. It can be seen that the values ranges from 0.22 to 0.75. However majority of the values indicate that heritability of weaning weight was medium to low.

e. Dam's body weight at kidding

Kumar *et al.* (1992), Khan and Sahni (1982) reported that in Jamunapari goats, dam's weight at kidding significantly influenced body weight of kids up to three months of age.

2.1.3 POST-WEANING WEIGHTS UP TO 180 DAYS

Raghavan (1980) described the fourth month body weight of Malabari kids as 6.00 ± 0.15. Singh and Singh (1998) observed the post-weaning body weights of Black Bengal kids at four and five month of age as 5.57 ± 0.12 and 6.22 ± 0.23 kg respectively. According to Khan and Garg (1983) the post-weaning body weights of Jamunapari goats at four and five months of age are 11.69 and 12.93 kg respectively. Mathew (1991) reported the body weight of Malabari goats at six months as 9.30 ± 0.16 kg. Body weights of Indian goats at six months of age are presented in Table 2.5. The weights ranged from 9.40 to 13.96 kg in Jamunapari, 13.16 to 14.05 kg in Beetal, 15.35 to 18.29 in Sirohi, 10.78 to 11.97 kg in Barbari and 7.14 to 8.97 kg in Black Bengal.

Table 2.4 Heritability estimates of Weaning weights of Indian goats

Breed	Heritability	Reference
Beetal and half-breds	0.22 ± 0.02	Singh *et al.* (2000)
Sirohi	0.26 ± 0.13	Mehta *et al.* (1997)
Jamunapari	0.78 ± 0.04	Endang (1998)
Jamunapari	0.26 ± 0.13	Mehta *et al.* (1997)
Jamunapari	0.30 ± 0.10	Roy *et al.* (1997)
Jamunapari	0.23	Kumar *et al.* (1993)
Jamunapari	0.43 ± 0.15	Roy *et al.* (1989)
Jamunapari x Black Bengal	0.42 ± 0.18	Singh (1997)
Black Bengal	0.02 ± 0.08	Malik *et al.* (1986)
Black Bengal	0.47 ± 0.08	Singh (1997)
Beetal x Black Bengal	0.59 ± 0.15	Singh (1997)
Osmanabadi	0.75 ± 0.03	Siddiqui *et al.* (1981)
Malabari x Alpine	-0.32 ± 0.08	Mathew (1991)
Malabari x Saanen	0.08 ± 0.08	Mathew (1991)

Table 2.5 Weight at six months in Indian goats

Male (kg)	Female (kg)	Pooled (kg)	Reference
Jamnapari			
		13.96 (89)	Khan and Garg (1983)
		9.40 ± 1.21	Singh *et al.* (1984)
13.28 ± 0.61 (149)	11.83 ± 0.56 (164)	12.56 ± 0.54 (313)	Kumar *et al.* (1992)
16.82 ± 0.57 (29)	14.26 ± 0.54 (36)	15.54 ± 0.41 (65)	Sharma and Das (1995)
13.51 ± 0.23 (390)	12.43 ± 0.22 (477)	12.97 ± 0.21 (867)	Roy *et al.* (1997)
13.04 ± 0.34 (277)	11.85 ± 0.43 (305)	12.44 ± 0.28 (584)	Roy *et al.* (1989)
Beetal			
14.08 ± 0.82 (31)	14.02 ± 0.70 (93)	14.05 ± 0.59 (124)	Nagpal and Chawla (1984)
		13.16 ± 0.30 (264)	Kanaujia and Pander (1988)
		13.16 ± 0.30 (264)	Kanaujia *et al.* (1989)
Sirohi			
		15.35 ± 0.53 (32)	Misra *et al.* (1980)
16.19 ± 1.08 (81)	14.47 ± 1.05 (155)	15.33 ± 3.08 (236)	Gokhale *et al.* (1996)
19.70 ± 0.26 (253)	18.88 ± 0.26 (258)	18.29 ± 0.22 (511)	Mehta *et al.* (1997)
Jakhrana			
14.60 ± 0.49 (30)	13.36 ± 0.44 (48)	13.98 ± 0.37 (78)	Tyagi *et al.* (1992)
Marwari			
12.73 ± 0.42	10.40 ± 0.36		Mittal (1988)
		15.69 ± 1.12	Patel *et al.* (1999)

(Cond.....)

Table 2.5 continued

Male (kg)	Female (kg)	Pooled (kg)	Reference
Parbatsar			
12.70 ± 0.40	9.40 ± 0.40		Mittal (1984)
		18.26 ± 0.77	Patel *et al.* (1999)
Barbari			
11.21 ± 0.28 (59)	10.39 ± 0.27 (66)	10.78 ± 0.20 (125)	Das *et al.* (1995)
		11.95 ± 0.47 (137)	Khan *et al.* (1998)
Black Bengal			
		7.96 ± 0.14 (359)	Kanaujia *et al.* (1989)
		7.96 ± 0.14 (859)	Kanaujia and Pander (1988)
9.38 ± 0.46 (106)	7.77 ± 0.46 (131)	8.58 ± 0.41 (237)	Malik *et al.* (1993)
		8.97 ± 0.14 (128)	Singh (1997)
		7.14 ± 0.26 (130)	Singh and Singh (1998)

Note: Figures in parenthesis wherever given are number of observations involved.

2.1.3.1 Factors affecting post-weaning body weights up to 180 days

a. Sex

Raghavan (1980) analysed the body weights of Malabari, Alpine x Malabari and Saanen x Malabari (SM) and found that effect of sex was significant at fourth month's body weight for SM only. Significant effect of sex on post-weaning body weights was also reported by Singh and Singh (1998) in Black Bengal and its crosses with Beetal, Gokhale *et al.* (1996) in non descript and graded up Sirohi goats, Malik *et al.* (1993) in Black Bengal goats and Khan and Garg (1983) in Jamnapari kids. There were contradictory reports by Mukundan (1980) in Malabari and its crosses at fifth month weight and Raghavan (1980) in Malabari and its Alpine cross breds at fourth month weight.

At six months of age, the influence of sex on body weight was significant in Sirohi goats (Mehta *et al.*, 1997), Jamunapari (Roy *et al.*, 1997; Sharma and Das, 1995; Kumar *et al.*, 1992; Khan and Garg, 1983), Barbari (Das *et al.*,1995), Black Bengal (Malik *et al.*, 1993) and Jakhrana (Tyagi *et al.*, 1992). Non-significant effect of sex was reported in Malabari and its crosses with Saanen (Mukundan, 1980), Jamunapari and Barbari (Singh *et al.*, 1983), Malabari and its crosses with Alpineand Saanen (Mathew, 1991), Ganjam goats (Naik *et al.*, 1985), Beetal (Nagpal and Chawla, 1984) and Beetal and its crosses with Alpine and Saanen (Nagpal and Chawla, 1985).

b. Type of birth

Singh and Singh (1998) reported a significant effect of type of birth on post weaning body weights in Black Bengal and its crosses with Beetal. Similar observations were made by Gokhale *et al.* (1996) in non descript and graded up Sirohi goats. Raghavan (1980) found type of birth was not significant on weight at four months in Malabari and its crossbreds. How ever Khan and Garg (1983) reported a significant effect at four months and non-significant effect at five months in Jamunapari goat.

The significant effect of type of birth on body weight at six months of age have been observed by Singh and Singh (1998) in Black Bengal and its crosses with Beetal, , Singh (1997) in Black Bengal and its half-breds, Mehta *et al.* (1997) in Sirohi goats, Gokhale *et al.* (1996) in non descript and graded up Sirohi kids and Kumar *et al.* (1992) in Jamunapari goats. Type of birth had no significant effect on body weights at six months in Jamunapari (Sharma and Das, 1995; Khan and Garg, 1983), Barbari (Das *et al.*,1995), Black Bengal (Malik *et al.*, 1993), Jakhrana (Tyagi *et al.*, 1992), Malabari and its cross-breds (Mathew, 1991) and Malabari and its Saanen half breds (Mukundan, 1980).

c. Month of birth

According to Gokhale *et al.* (1998) month of birth significantly affected body weights at four, five and six months of age in non descript and graded up Sirohi goats. Significant effects also reported by Kumar *et al.* (1992) in sixth month body weight of Jamunapari goats and de Groot *et al.* (1992) in post-weaning weights of Sirohi goats. But Mukundan (1980) reported that month of birth had no

significant effect on body weights at four and five months of age but had significant effect on six months body weight in Malabari as well as their Saanen halfbreds. But Reynolds (1979) reported that in Malawi goats that month of birth had no significant effect on body weight at 24 weeks.

d. Sire effect and heritability

Raghavan (1980) found a significant sire effect on body weight at four months in Malabari goat and the effect was not significant in Alpine x Malabari, Saanen x Malabari crossbreds. According to Mukundan (1980) effect of sire was significant on body weights at four, five and six months in Malabari goat. A significant effect of sire on six month weights was also reported by Roy *et al.* (1997) and Kumar *et al.* (1992) in Jamunapari goats.

According to Mathew (1991) heritability of body weight at six months in Malabari goat was 0.05 ± 0.11. Heritability estimates bodyweight at six months in Indian goats are listed in Table 2.6. It can be seen that the values ranged from 0.05 to 0.66. However majority of the values indicated that body weight at six months is moderately heritable.

e. Dam's body weight at kidding

The studies of Raghavan (1980) in Malabari goats revealed that body weight at four months is significantly influenced by dam's weight at kidding. Similar findings also reported by Singh and Singh (1998) in Jamunapari half breds on body weight at six months.

Table 2.6- Heritability estimates of sixth month body weights of Indian goats

Breed	Heritability	Reference
Sirohi	0.30 ± 0.19	Mehta *et al.* (1997)
Jamunapari	0.17	Kumar *et al.* (1993)
Jamunapari	0.51 ± 0.12	Roy *et al.* (1997)
Jamunapari	0.25 ± 0.13	Roy *et al.* (1989)
Jamunapari x Black Bengal	0.48 ± 0.12	Singh (1997)
Assam local and cross-breds	0.26 ± 0.12	Nahardeka *et al.* (2001)
Ganjam	0.34 ± 0.23	Madeli and Patro (1984)
Black Bengal	0.58 ± 0.09	Singh (1997)
Beetal x Black Bengal	0.52 ± 0.11	Singh (1997)
Osmanabadi	0.66 ± 0.06	Siddiqui *et al.* (1981)
Malabari	0.05 ± 0.11	Mathew (1991)
Malabari x Alpine cross	0.16 ± 0.09	Mathew (1991)
Malabari x Saanen cross	0.05 ± 0.08	Mathew (1991)

2.2 CORRELATIONS

According to Sharma and Das (1995) in Jamunapari goats, correlation coefficients among body weights at different ages were positive and significant (ranged from 0.23 to 0.87). The correlation of birth weight with weaning weight was significant ($p \leq 0.05$). Weaning weight had highly significant correlation with subsequent weights. Correlations between body weights at two consecutive periods were higher than those between body weights at two distant periods. Koratkar *et al.* (1998) noticed a positive correlation between birth weight and body weights at three months of age in Osmanabadi goats. According to Al-Shaikh and Mogawer (2001) correlation coefficient between birth weight and weaning weight in Aradi goats of South Arabia was 0.41.

Sangare and Pande (2000) reported that in Sahel goats, kid's growth was affected by milk yield of dams ($p \leq 0.01$). According to Misra *et al.* (1985) pre-weaning body weights of Sirohi kids significantly affected by dam's milk yield. Ehoche and Buvanrndran (1983) reported that in case of Red Sokoto goats, correlation between milk yield and weight gain of kid remained at about 0.50 throughout pre-weaning period for singles, but increased from 0.09 at the beginning of lactation to 0.57 at the end of pre-weaning period for twins.

Pieniak *et al.* (1999) found that milk yield was significantly influenced by body weight in Podlasie goats. According to Misra *et al.* (1985) milk yield of Sirohi and its cross breds was significantly affected by post-partom body weight. Ehoche and Buvanendran (1983) reported that milk yield was significantly affected by body weight of the lactating female in Red Sukoto goats. Betancourt (1982)

also reported that milk yield was positively correlated with post-kidding body weight in cross-bred goats of Venezuela. Garci *et al.* (1996) reported that litter size was affected by dam body weight after parturition ($p \leq 0.01$) in tropical goats. Betancourt (1982) found that in tropical goats litter weight at birth had a significant positive correlation with post-kidding body weight of the dam.

Materials and Methods

MATERIALS AND METHODS

One hundred and thirteen kids of Malabari goat belonging to 8 sires and 80 dams maintained at the University Sheep and Goat farm of College of Veterinary and Animal Sciences, Kerala Agricultural University, Mannuthy, formed the experimental animals. Data was collected for a period from 18/05/2000 to 30/07/2001. The data was collected in litter of first parity. The Experimental animals were reared under identical farm conditions of management. The goats were reared under semi intensive system of management. Adult goats were fed with concentrate mixture and sent for grazing in morning and evening.

Kids were let free with dams for the first three months. Milk yield of the dams were recorded weekly twice. The kids were separated from the dams in the after noon of the day previous to recording. Milking was carried out in the morning, after recording the milk was fed to the respective kid/ kids uniformly. The kids were weaned at three months and housed in separate stalls. Compounded feed was introduced to kids from third month onwards. The kids were dewormed at one month of age and subsequently at monthly intervals with Albendazole suspension @ 15 mg/kg body weight.

The body weights of dams in kilograms (kg) were recorded immediately after shedding of the placenta. Birth weights of kids were recorded and body weights of kids were recorded at weekly intervals in kilograms (kg). Type of birth was recorded as single, twin, and triplet at birth. Month of birth, sex, sire number,

dam number were also recorded. Litter weight was calculated from the birth weights of kids born to each dam. Weights of dams after kidding were grouped according to the following class intervals.

Class 1. 18 – 20 kg

Class 2. 21 – 23 kg

Class 3. 24 – 26 kg

Class 4. 27 – 29 kg

Class 5. 30 – 32 kg

Statistical Analysis

The data on body weight was subjected to least-squares analysis (Harvey, 1987) for adjusting the effect of the genetic and environmental factors on body weights in the eight different genetic groups. For this the following model was used.

$$Y_{ijklmn} = \mu + X_i + T_j + S_k + M_l + D_m + e_{ijklmn}$$

Where,

Y_{ijklmn} = Body weight of n^{th} kid born to dam of m^{th} class body weight in l^{th}month, of the k^{th} sire, of j^{th} kid type, of the i^{th} sex.

μ = Population mean

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

T_j = Effect of j^{th} kid type (j=1,2,3)

S_k = Effect of k^{th} sire (k=1 to 8)

M_l = Effect of l^{th} month of kidding (l=1 to 12)

D_m = Effect of dam of m^{th} class body weight (m=1 to 5)

e_{ijklmn} = Random error associated with Y_{ijklm}

Calculation of Heritability

Paternal half-sib method by Becker (1984) was used to estimate the heritability of different characters. For this the following model was used.

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

Where,

Y_{ij} = Observation of j^{th} projeny of i^{th} sire

μ = Population mean

S_i = Effect of i^{th} sire (I = 1 to 8)

e_{ij} = Random error associated with Y_{ij}

Anova Table

Source	DF	MSS	EMS
Between sires	S-1	MSs	$\sigma_e^2 + K\sigma_s^2$
Progeny within sire	N-S	Mse	σ_e^2

Where,

K = average number of progenies per sire

S = number of sires

n_i = number of progenies in i^{th} sire

N = total number of progenies

σ_s^2 = sire component of variance

σ_e^2 = error component of variance

$$K = 1/S\text{-}1\ (N\text{-}\Sigma\ n_i^2/N)$$

$$\sigma_s^2 = \frac{MSs - MSe}{K}$$

Heritability (h^2) = 4t

$$t = \frac{\sigma_s^2}{\sigma_s^2 + \sigma_e^2}$$

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

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

Correlations

Multiple correlations between body weights of kids at different ages, body weights of kids with dam's milk yield, dam's body weight at kidding with litter size, litter weight and milk yield were worked out. Significance of correlations were tested as per Snedecor and Cochran (1967).

Results

RESULTS

4.1 BODY WEIGHTS

Results of analysis on body weights were categorized as birth weight, fortnightly pre and post weaning body weights (14 days to 168 days), weaning weight (90 days) and weight at 180 days. Means of body weights of Malabari kids from birth to 180 days were presented in Table 4.1. Malabari kids have a mean body weight of 1.79 ± 0.046 kg at birth to 11.04 ± 0.322 kg at 180 days. Growth curve of Malabari kids from birth to 180 days is represented in Figure 4.1.

4.1.1 BIRTH WEIGHT

The results of Least Squares analysis of variance for different factors affecting birth weight were presented in the Table 4.2. Least squares means of birth weight for effect of sex, type of birth, month of birth, sire and dam's body weight at kidding are presented in Table 4.3. The over all mean for birth weight was 1.79 ± 0.046 kg.

4.1.1.1 Factors affecting birth weight

a. Sex

Effect of sex was found to be significant on birth weight ($p \leq 0.05$). The means for males and females were 1.87 ± 0.059 kg and 1.73 ± 0.046 kg respectively. Sex wise means of birth weights are presented in Figure 4.2. Males were found to be heavier than females at birth. .

Table 4.1 Overall mean body weights of (kg) Malabari kids from birth to 180 days (Mean ± SE)

Age	Body weight
At birth	1.79 ± 0.046
14 Days	2.96 ± 0.077
28 Days	3.50 ± 0.095
42 Days	4.17 ± 0.120
56 Days	4.86 ± 0.148
70 Days	5.54 ± 0.174
84 Days	6.14 ± 0.196
98 Days	6.89 ± 0.214
112 Days	7.61 ± 0.244
126 Days	8.19 ± 0.255
140 Days	8.74 ± 0.299
154 Days	9.39 ± 0.289
168 Days	10.14 ± 0.310
180 Days	11.04 ± 0.322

Figure 4.1 Growth curve of Malabari kids from birth to 180 days

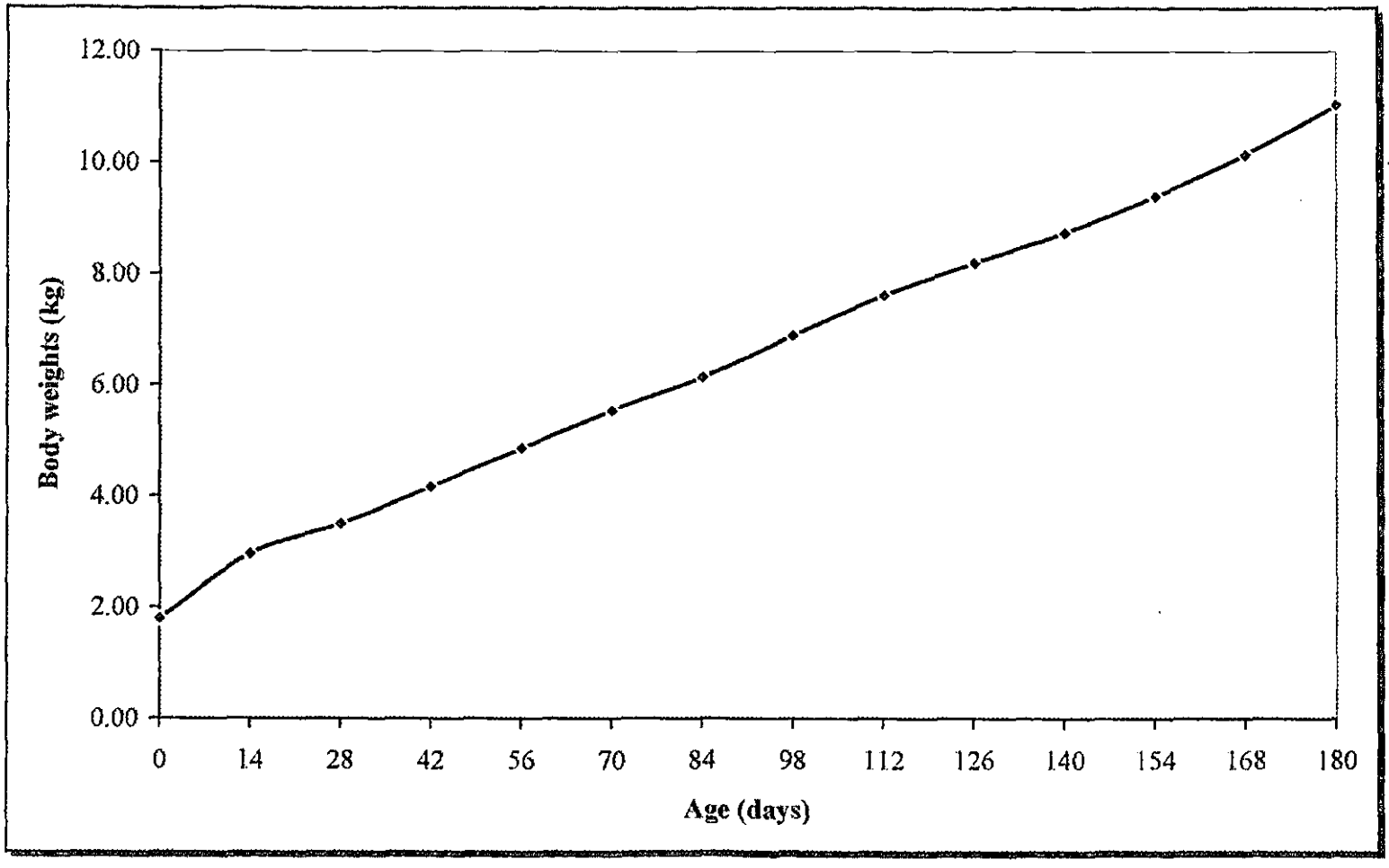


Table 4.2 Least squares analysis of variance for factors affecting birth weight of Malabari kids

Source of variation	df	MS
Sex	1	0.42711*
Type of birth	2	0.86773**
Month of birth	7	0.10078
Sire	7	0.08705
Dam's weight at kidding	4	0.20643
Error	91	0.10028

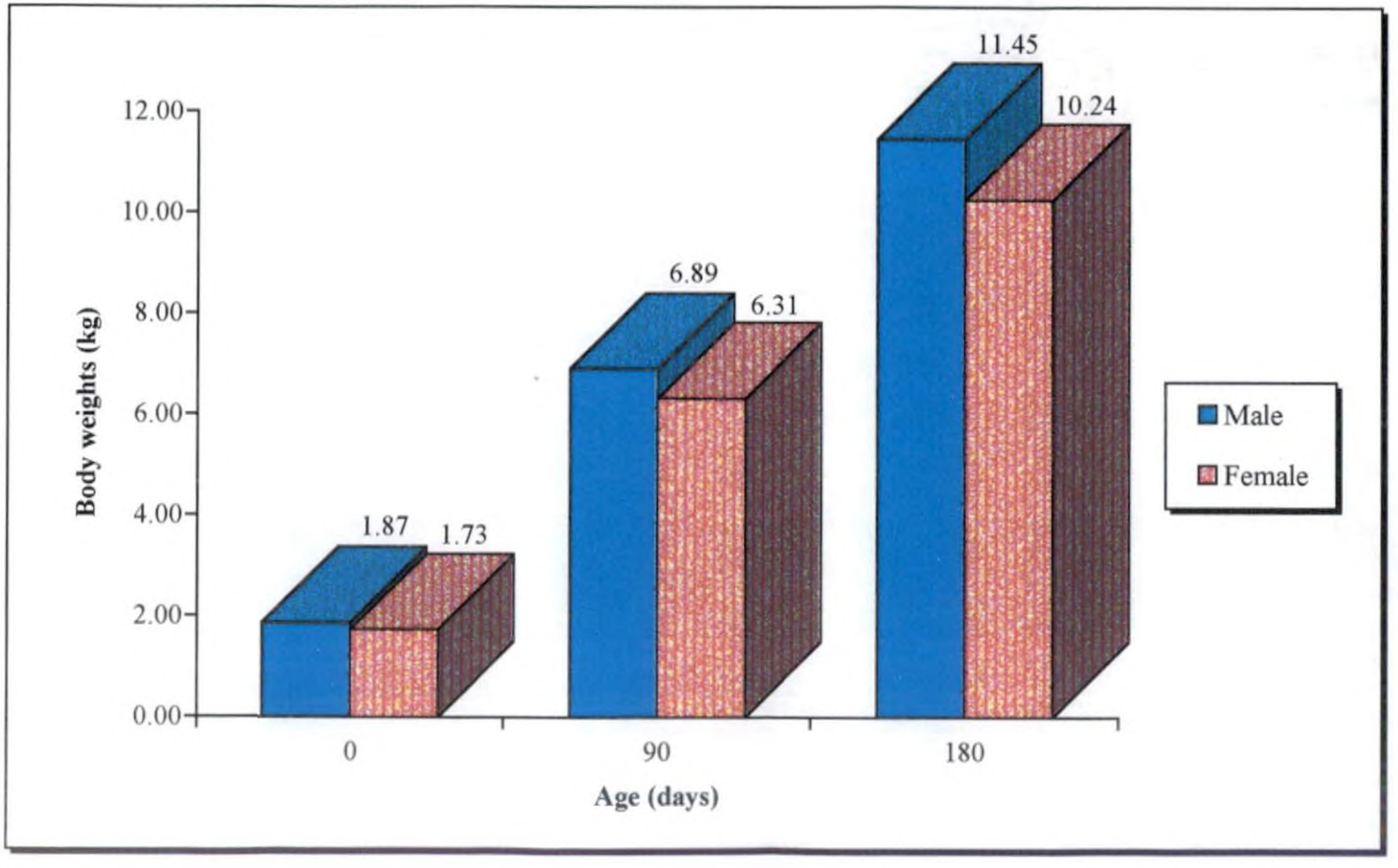
** $p < 0.01$ * $p < 0.05$

Table 4.3 Least Squares means for factors affecting Birth weight (kg) of Malabari kids (Mean ± SE)

Source	n	Mean ± SE
Overall	113	1.79 ± 0.046
Sex		
Male	52	1.87 ± 0.059
Female	61	1.73 ± 0.055
Type of birth		
Single	29	2.03 ± 0.070
Twin	70	1.83 ± 0.049
Triplet	14	1.54 ± 0.096
Month of birth		
January	17	1.67 ± 0.148
May	23	1.91 ± 0.131
June	27	1.96 ± 0.126
July	6	2.05 ± 0.149
August	4	1.81 ± 0.174
September	4	1.58 ± 0.171
October	14	1.76 ± 0.144
November	18	1.65 ± 0.127

Source	n	Mean ± SE
Overall	113	1.79 ± 0.046
Sire		
Sire 1	15	1.71 ± 0.136
Sire 2	14	1.70 ± 0.140
Sire 3	14	1.83 ± 0.154
Sire 4	14	1.84 ± 0.152
Sire 5	14	1.81 ± 0.106
Sire 6	12	1.87 ± 0.142
Sire 7	16	1.67 ± 0.140
Sire 8	14	1.96 ± 0.160
Dam's weight at kidding		
Class 1	13	1.69 ± 0.077
Class 2	22	1.83 ± 0.096
Class 3	26	1.76 ± 0.072
Class 4	32	1.82 ± 0.061
Class 5	20	1.77 ± 0.053

Figure 4.2 Sex wise body weights of Malabari kids



b. Type of birth

Type of birth had a significant ($p \leq 0.01$) effect on birth weight. The Least squares means for single, twins, triplets were found to be 2.03 ± 0.070, 1.83 ± 0.049 and 1.54 ± 0.096 kg respectively. Means of weights at birth according to type of birth are presented in Figure 4.3. Single born kids were found to be the heaviest at birth followed by twins and triplets.

c. Month of birth

The effect of month of birth had no significant effect on birth weight. How ever the kids born in May, June, July and August were found to be heavier than those born in September, October, November and January. Kids born in July have highest Least square mean (2.05 ± 0.149 kg) and those born in September have lowest birth weight (1.58 ± 0.171 kg).

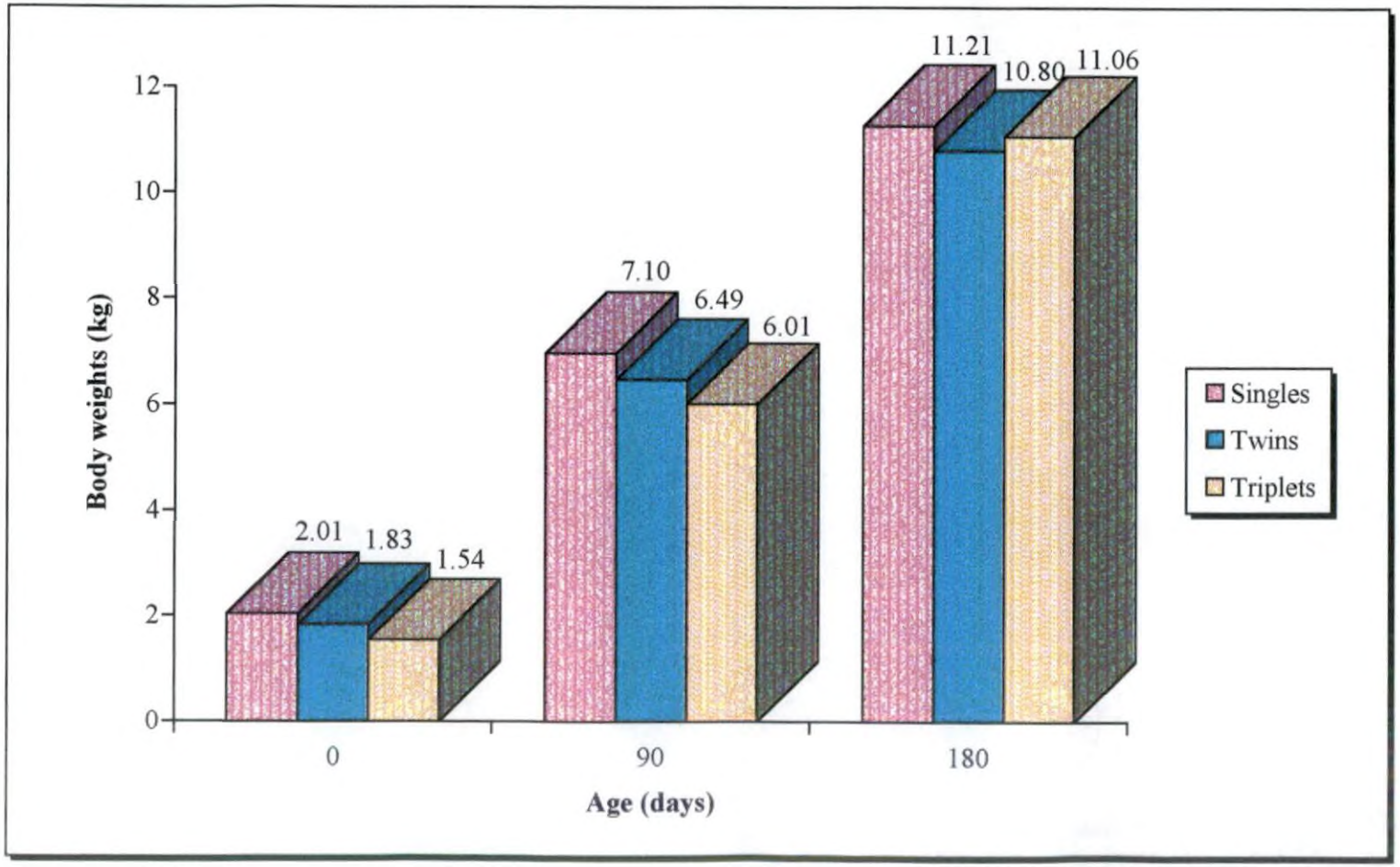
d. Sire effects and Heritability

Sire effect was not significant for birth weight. Kids born to sire No. 8 had highest Least square mean (1.96 ± 0.160 kg) and those born to sire No. 7 had the lowest mean (1.67 ± 0.140 kg). Birth weight was found to be medium heritable (0.30 ± 0.267 kg).

e. Dam's body weight at kidding

Effect of dam's weight at kidding on birth weight was non significant. Kids born to dams belong to 21-23 kg class registered maximum birth weight (1.83 ± 0.096) and those belong to 18-20 kg class had minimum birth weight (1.69 ± 0.077).

Figure 4.3 Body weights of Malabari kids according to birth type



4.1.2 PRE-WEANING BODYWEIGHTS

The results of Least squares analysis of variance for different factors affecting pre-weaning body weights were presented in the Table 4.4. Least squares means of pre-weaning body weights for effect of sex, type of birth, month of birth, sire and dam's body weight at kidding are presented in Table 4.5. The over all mean for body weight varied from 2.96 ± 0.077 kg at 14 days to 6.14 ± 0.196 kg at 84 days.

4.1.2.1 Factors affecting pre-weaning body weights

a. Sex

Sex had a significant effect on all pre-weaning weights ($p \leq 0.05$) except weight at 56 days. Mean weights of males vary from 3.09 ± 0.097 kg at 14 days to 6.46 ± 0.248 kg at 84 days and that of females vary from 2.83 ± 0.091 kg to 5.82 ± 0.233 kg. The sex wise growth of kids is represented in Figure 4.4. Males had higher pre-weaning body weights than females.

b. Type of birth

The effect of type of birth was found to be significant ($p \leq 0.01$) on all pre-weaning body weights except weight at 84 days. Single born kids had a mean body weight of 3.53 ± 0.116 kg at 14 days to 6.58 ± 0.296 kg at 84 days; twins had a mean body weight of 2.95 ± 0.082 kg at 14 days to 6.13 ± 0.209 kg at 84 days and triplets have a mean body weight of 1.54 ± 0.096 kg at 14 days to 5.71 ± 0.404 kg at 84 days. The growth of kids according to birth type is presented in Figure 4.5. Singles had a higher pre-weaning weights followed by twins and triplets.

Table 4.4 Least squares analysis of variance for factors affecting pre-weaning body weights of Malabari kids

Source of variation	14 Days		28 Days		42 Days		56 Days		70 Days		84 Days	
	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS
Sex	1	1.5212*	1	1.7118*	1	3.3666*	1	3.7054	1	5.3742*	1	9.5017*
Type of birth	2	5.2089**	2	4.9775**	2	5.7171**	2	5.6270**	2	6.4653**	2	3.0675
Sire	7	0.3557	7	0.9513*	7	1.3217	7	1.4527	7	1.4195	7	1.4169
Month of birth	7	0.6002*	7	1.8086**	7	2.4726**	7	3.3851**	7	3.3595*	7	4.2776*
Dam's weight at kidding	4	0.4321	4	0.3011	4	0.2278	4	0.5443	4	1.3674	4	2.5034
Error	91	0.2732	91	0.4193	91	0.6742	91	1.0265	91	1.4123	91	1.7940

** $p < 0.01$ * $p < 0.05$

Table 4.5 Least Squares means for factors affecting pre-weaning body weights (kg) of Malabari kids (Mean ± SE)

Source	No.	14 Days	28 Days	42 Days	56 Days	70 Days	84 Days
Mean	113	2.96 ± 0.077	3.50 ± 0.095	4.17 ± 0.120	4.86 ± 0.148	5.54 ± 0.174	6.14 ± 0.196
Sex							
Male	52	3.09 ± 0.097	3.65 ± 0.120	4.36 ± 0.152	5.06 ± 0.187	5.78 ± 0.220	6.46 ± 0.248
Female	61	2.83 ± 0.091	3.37 ± 0.113	3.97 ± 0.143	4.66 ± 0.177	5.29 ± 0.208	5.82 ± 0.233
Type of birth							
Single	29	3.53 ± 0.116	4.07 ± 0.143	4.77 ± 0.182	5.46 ± 0.224	6.18 ± 0.263	6.58 ± 0.296
Twin	70	2.95 ± 0.082	3.48 ± 0.101	4.09 ± 0.128	4.76 ± 0.158	5.51 ± 0.186	6.13 ± 0.209
Triplet	14	2.40 ± 0.158	2.98 ± 0.195	3.63 ± 0.248	4.37 ± 0.306	4.93 ± 0.359	5.71 ± 0.404
Month of birth							
January	17	2.77 ± 0.244	3.25 ± 0.302	3.97 ± 0.384	4.84 ± 0.473	5.66 ± 0.555	6.16 ± 0.626
May	23	3.51 ± 0.217	4.71 ± 0.269	5.48 ± 0.340	6.26 ± 0.421	6.54 ± 0.493	7.18 ± 0.556
June	27	3.27 ± 0.208	4.00 ± 0.258	4.75 ± 0.327	5.31 ± 0.404	5.76 ± 0.473	6.68 ± 0.534
July	6	3.27 ± 0.246	3.95 ± 0.305	4.63 ± 0.386	5.38 ± 0.477	6.18 ± 0.559	6.38 ± 0.630
August	4	3.00 ± 0.288	3.38 ± 0.357	4.28 ± 0.452	5.10 ± 0.558	6.32 ± 0.655	7.57 ± 0.738
September	4	2.79 ± 0.282	3.04 ± 0.349	3.49 ± 0.443	4.38 ± 0.547	4.72 ± 0.642	5.34 ± 0.723
October	14	2.75 ± 0.238	3.07 ± 0.294	3.52 ± 0.373	3.92 ± 0.461	4.65 ± 0.540	4.86 ± 0.609
November	18	2.34 ± 0.210	2.67 ± 0.260	3.18 ± 0.329	3.70 ± 0.407	4.48 ± 0.477	4.95 ± 0.538

Table 4.5 Continued

Source	No.	14 Days	28 Days	42 Days	56 Days	70 Days	84 Days
Mean	113	2.96 ± 0.077	3.50 ± 0.095	4.17 ± 0.120	4.86 ± 0.148	5.54 ± 0.174	6.14 ± 0.196
Sire							
Sire 1	15	2.97 ± 0.224	3.50 ± 0.278	4.22 ± 0.352	4.81 ± 0.434	5.46 ± 0.509	5.76 ± 0.574
Sire 2	14	2.80 ± 0.224	3.34 ± 0.278	4.04 ± 0.353	4.77 ± 0.435	5.58 ± 0.510	6.18 ± 0.575
Sire 3	14	2.72 ± 0.253	2.78 ± 0.314	3.12 ± 0.398	4.01 ± 0.491	5.05 ± 0.576	5.44 ± 0.649
Sire 4	14	3.15 ± 0.250	3.50 ± 0.310	4.23 ± 0.393	5.07 ± 0.485	6.11 ± 0.569	6.51 ± 0.641
Sire 5	14	2.92 ± 0.175	3.63 ± 0.217	4.19 ± 0.275	4.92 ± 0.340	5.40 ± 0.399	6.20 ± 0.449
Sire 6	12	2.88 ± 0.234	3.51 ± 0.290	4.18 ± 0.367	4.74 ± 0.453	5.18 ± 0.531	5.91 ± 0.599
Sire 7	16	2.90 ± 0.232	3.62 ± 0.287	4.26 ± 0.364	5.02 ± 0.449	5.49 ± 0.527	6.43 ± 0.594
Sire 8	14	3.34 ± 0.264	4.19 ± 0.328	4.89 ± 0.415	5.55 ± 0.513	6.05 ± 0.601	6.70 ± 0.678
Dam's weight at kidding							
Class 1	13	2.76 ± 0.192	3.26 ± 0.273	3.65 ± 0.320	4.57 ± 0.355	5.22 ± 0.384	5.89 ± 0.422
Class 2	22	3.08 ± 0.177	3.60 ± 0.215	4.22 ± 0.258	4.89 ± 0.297	5.52 ± 0.316	6.12 ± 0.345
Class 3	26	2.96 ± 0.164	3.52 ± 0.223	4.14 ± 0.277	4.75 ± 0.304	5.27 ± 0.314	5.84 ± 0.328
Class 4	32	3.05 ± 0.122	3.53 ± 0.139	4.17 ± 0.171	4.99 ± 0.217	5.79 ± 0.240	6.40 ± 0.267
Class 5	20	2.80 ± 0.111	3.42 ± 0.147	4.26 ± 0.199	4.95 ± 0.233	5.73 ± 0.295	6.29 ± 0.314

Figure 4.4 Sex wise growth of Malabari kids from birth to 180 days

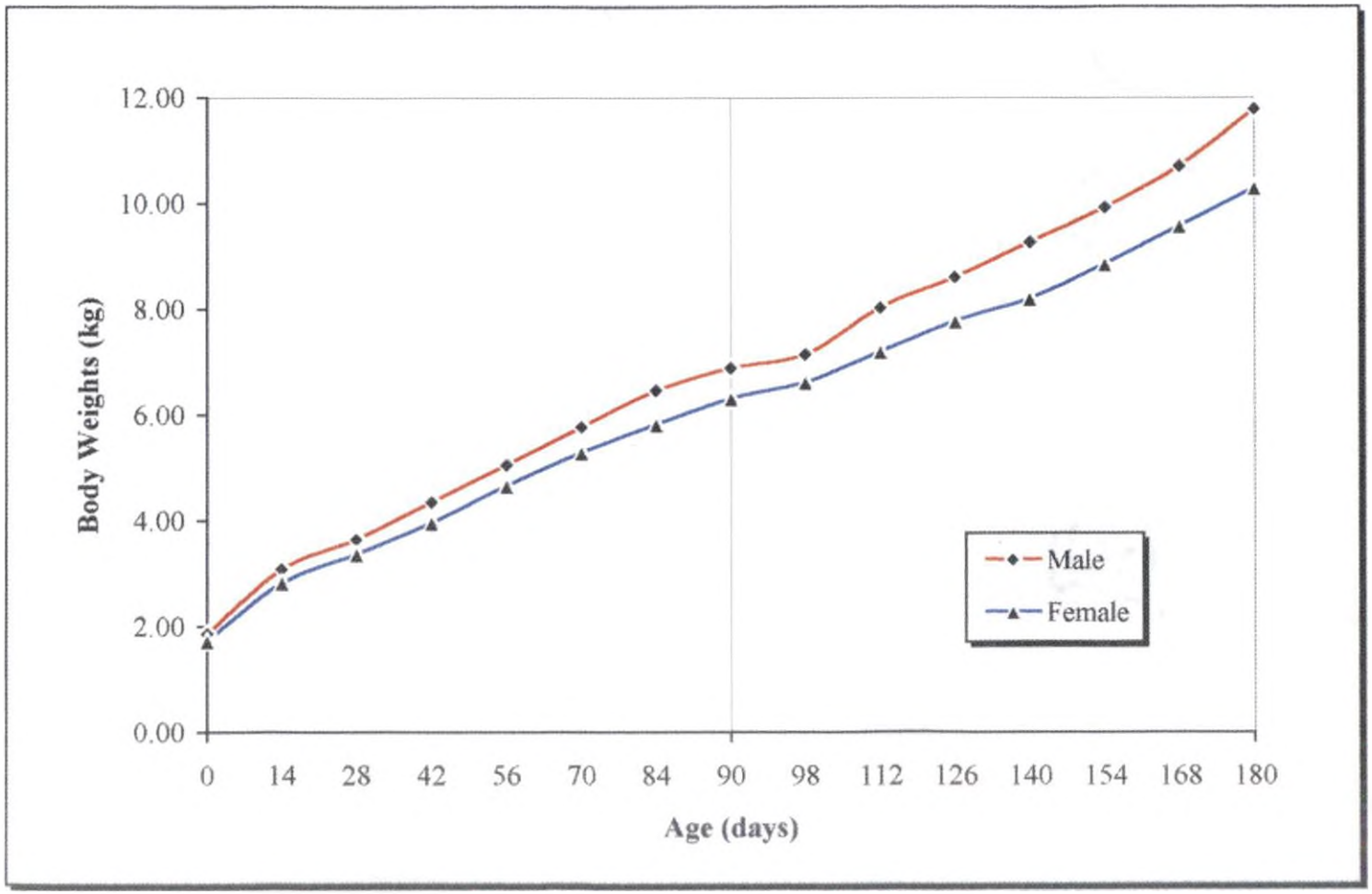
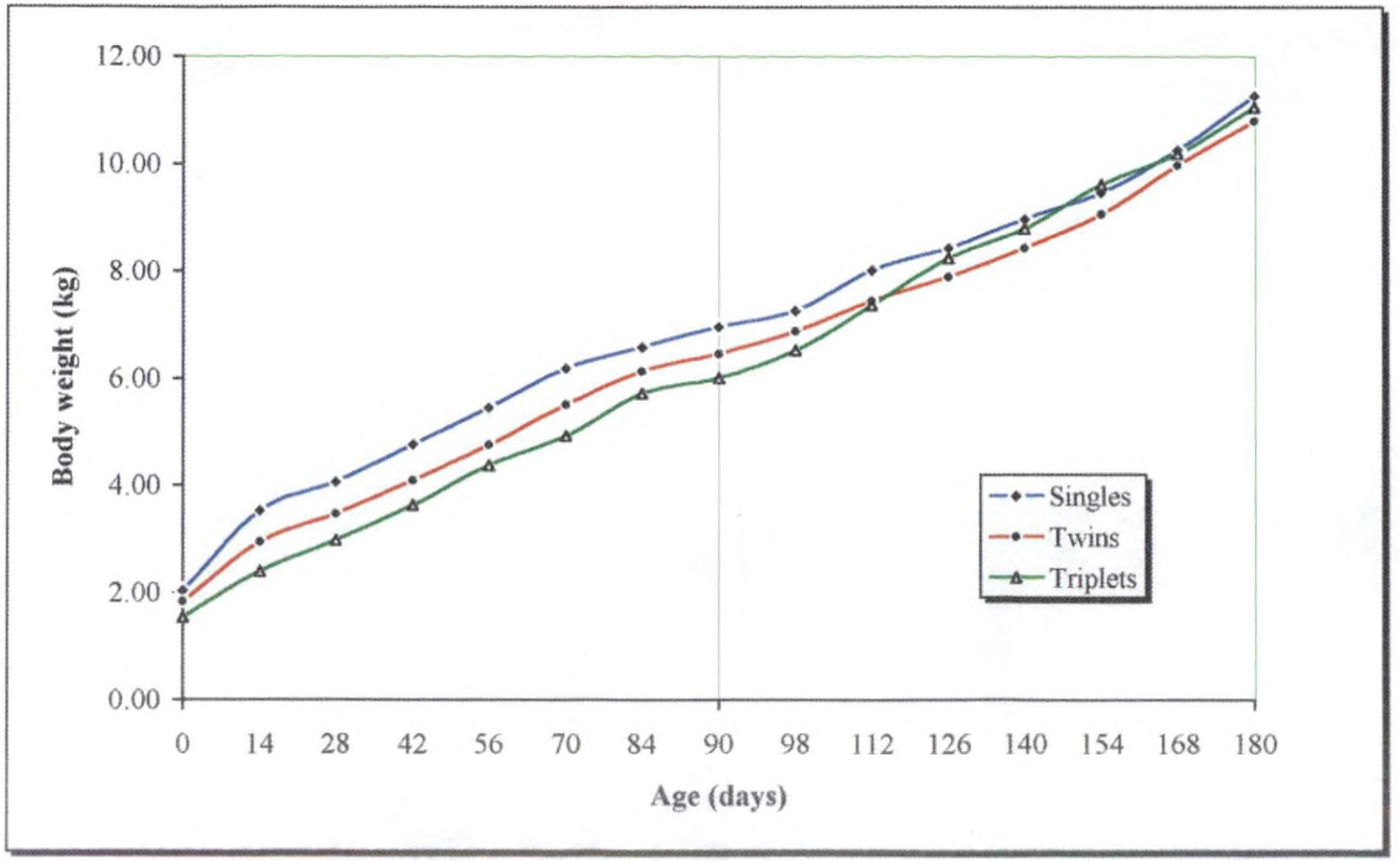


Figure 4.5 Growth of Malabari kids from birth to 180 days according to birth type



c. Month of birth

Month of birth had a significant effect ($p \leq 0.05$) on weights at 14days, 70 days and 84 days and highly significant effect ($p \leq 0.01$) on weights at 28 days, 42 days and 56 days. Kids born in May, June, July and August had higher pre-weaning weights than those born in September, October, November and January.

d. Sire

Sires did not have a significant effect on pre-weaning body weights except weight at 28 days ($p \leq 0.05$). Kids of sire 8 registered highest weights at pre-weaning growth and that of sire 3 had lowest weights.

e. Dam's body weight at kidding

Dam's weight at kidding was found to have no significant effect on pre-weaning weights.

4.1.3 WEANING WEIGHT

The results of Least squares analysis of variance for different factors affecting weaning weight were presented in the Table 4.6. Least squares means of weaning weight for effect of sex, type of birth, month of birth, sire and dam's body weight at kidding are presented in Table 4.7 The over all mean for weaning weight was 6.48 ± 0.211 kg.

Table 4.6 Least squares analysis of variance for factors affecting body weight of Malabari kids at 90 days

Source of variation	df	MS
Sex	1	7.75736*
Type of birth	2	3.64148
Month of birth	7	3.74385
Sire	7	1.04992
Dam's weight at kidding	4	4.20052
Error	91	2.08786

* $p < 0.05$

Table 4.7 Least Squares means for factors affecting Body weight (kg) of Malabari kids (Mean ± SE) at 90 days of age

Source	n	Mean ± SE
Overall	113	6.48 ± 0.211
Sex		
Male	52	6.77 ± 0.267
Female	61	6.19 ± 0.252
Type of birth		
Single	29	6.96 ± 0.319
Twin	70	6.46 ± 0.226
Triplet	14	6.01 ± 0.435
Month of birth		
January	17	6.35 ± 0.674
May	23	7.70 ± 0.599
June	27	7.07 ± 0.575
July	6	6.64 ± 0.679
August	4	7.65 ± 0.795
September	4	5.69 ± 0.779
October	14	5.38 ± 0.656
November	18	5.33 ± 0.579

Source	n	Mean ± SE
Overall	113	6.48 ± 0.211
Sire		
Sire 1	15	5.99 ± 0.619
Sire 2	14	6.40 ± 0.619
Sire 3	14	5.76 ± 0.699
Sire 4	14	6.61 ± 0.690
Sire 5	14	6.52 ± 0.484
Sire 6	12	6.57 ± 0.645
Sire 7	16	6.74 ± 0.639
Sire 8	14	7.24 ± 0.730
Dam's weight at kidding		
Class 1	13	6.29 ± 0.440
Class 2	22	6.45 ± 0.348
Class 3	26	6.09 ± 0.321
Class 4	32	6.83 ± 0.292
Class 5	20	6.58 ± 0.291

4.1.3.1 Factors affecting weaning weight

a. Sex

Effect of sex was found to be significant on weaning weight ($p \leq 0.05$). The means for males and females were 6.77 ± 0.267 and 6.19 ± 0.252 kg respectively. Sex wise means of weaning weights are presented in Figure 4.2. Males were found to be heavier than females at weaning.

b. Type of birth

Type of birth had no significant effect on weaning weight. The Least Square mean for single, twins, triplets were found to be 6.96 ± 0.319, 6.46 ± 0.226 and 6.01 ± 0.435 kg respectively. Means of weaning weights according to birth type is presented in Figure 4.3. Singles were found to be the heaviest at weaning, followed by twins and triplets.

c. Month of birth

The effect of month of birth was non-significant on weaning weight. How ever the kids born in May, June, July and August were found to be heavier than those born in September, October, November and January. Kids born in May have highest Least square mean (7.70 ± 0.599 kg) and those born in November have lowest (5.33 ± 0.579 kg).

d. Sire effects and Heritability

Sire effect was not significant on weaning weight. Kids born to sire No. 8 had highest Least square mean (7.24 ± 0.730 kg) and those born to sire No. 3 had

the lowest mean (5.76 ± 0.699 kg). Weaning weight was found to be moderately heritable (0.35 ± 0.277 kg).

e. Dam's body weight after kidding

Effect of dam's weight at kidding on weaning weight was non significant. Kids born to dams belong to 27-29 kg class registered maximum weaning weight (6.83 ± 0.292) and those belong to 18-20 kg class had minimum weaning weight (6.29 ± 0.440)

4.1.4 POST-WEANING BODYWEIGHTS

The results of Least squares analysis of variance for different factors affecting pre-weaning body weights were presented in the Table 4.8. Least squares means of post-weaning body weights for effect of sex, type of birth, month of birth, sire and dam's body weight at kidding are presented in Table 4.9. The over all mean for body weight varied from 6.89 ± 0.214 kg at 98 days to 10.14 ± 0.310 kg at 168 days.

4.1.4.1 Factors affecting post-weaning body weights

a. Sex

Sex of the kid had a significant effect on post-weaning body weights ($p \leq 0.05$) for weights at 112days, 126 days; highly significant effect ($p \leq 0.01$) for weights at 140 days, 154 days, 168 days) except weight at 98 days. Mean weights of males varied from 7.15 ± 0.270 kg at 98 days to 10.71 ± 0.391 kg at 168 days and that of females varied from 6.62 ± 0.255 kg to 9.57 ± 0.370 kg. Post-weaning

Table 4.8 Least squares analysis of variance for factors affecting post-weaning body weights of Malabari kids

Source of variation	98 Days		112 Days		126 Days		140 Days		154 Days		168 Days	
	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS
Sex	1	6.4281	1	15.8679*	1	16.0338*	1	26.1259**	1	26.0308**	1	29.8318**
Type of birth	2	2.3085	2	2.9864	2	2.5507	2	2.6052	2	2.3752	2	0.7950
Sire	7	1.4472	7	1.4029	7	2.1867	7	2.5330	7	1.8686	7	2.0239
Month of birth	7	3.0807	7	3.4733	7	3.5269	7	3.1004	7	2.6184	7	3.8642
Dam's weight at kidding	4	6.5724	4	5.3372	4	7.3788	4	8.7842	4	11.7933	4	20.5669*
Error	91	2.1371	91	2.7795	91	3.0388	91	4.1506	91	3.8896	91	4.4784

** p< 0.01 * p< 0.05

Table 4.9 Least Squares means for factors affecting post-weaning body weights (kg) of Malabari Kids (Mean ± SE)

Source	No.	98 Days	112 Days	126 Days	140 Days	154 Days	168 Days
Mean	113	6.89 ± 0.214	7.61 ± 0.244	8.19 ± 0.255	8.74 ± 0.299	9.39 ± 0.289	10.14 ± 0.310
Sex							
Male	52	7.15 ± 0.270	8.03 ± 0.308	8.61 ± 0.322	9.27 ± 0.377	9.92 ± 0.365	10.71 ± 0.391
Female	61	6.62 ± 0.255	7.20 ± 0.291	7.77 ± 0.304	8.20 ± 0.356	8.85 ± 0.344	9.57 ± 0.370
Type of birth							
Single	29	7.27 ± 0.324	8.02 ± 0.369	8.43 ± 0.386	8.98 ± 0.451	9.47 ± 0.437	10.26 ± 0.468
Twin	70	6.88 ± 0.228	7.45 ± 0.261	7.89 ± 0.272	8.44 ± 0.318	9.07 ± 0.308	9.98 ± 0.331
Triplet	14	6.52 ± 0.441	7.37 ± 0.503	8.24 ± 0.526	8.80 ± 0.615	9.62 ± 0.595	10.19 ± 0.639
Month of birth							
January	17	4.84 ± 0.473	5.66 ± 0.555	6.16 ± 0.626	9.13 ± 0.952	9.89 ± 0.921	10.41 ± 0.989
May	23	6.26 ± 0.421	6.54 ± 0.493	7.18 ± 0.556	9.78 ± 0.846	10.15 ± 0.819	10.79 ± 0.878
June	27	5.31 ± 0.404	5.76 ± 0.473	6.68 ± 0.534	9.03 ± 0.812	9.31 ± 0.786	9.39 ± 0.843
July	6	5.38 ± 0.477	6.18 ± 0.559	6.38 ± 0.630	7.81 ± 0.959	8.30 ± 0.928	9.34 ± 0.996
August	4	5.10 ± 0.558	6.32 ± 0.655	7.57 ± 0.738	9.47 ± 1.123	9.91 ± 1.087	10.90 ± 1.166
September	4	4.38 ± 0.547	4.72 ± 0.642	5.34 ± 0.723	8.56 ± 1.100	9.41 ± 1.065	10.83 ± 1.142
October	14	3.92 ± 0.461	4.65 ± 0.540	4.86 ± 0.609	7.86 ± 0.926	8.84 ± 0.897	9.53 ± 0.962
November	18	3.70 ± 0.407	4.48 ± 0.477	4.95 ± 0.538	8.30 ± 0.818	9.26 ± 0.792	9.95 ± 0.850

Table 4.9 Continued

Source	No.	98 Days	112 Days	126 Days	140 Days	154 Days	168 Days
Mean	113	6.89 ± 0.214	7.61 ± 0.244	8.19 ± 0.255	8.74 ± 0.299	9.39 ± 0.289	10.14 ± 0.310
Sire							
Sire 1	15	6.49 ± 0.627	7.12 ± 0.715	7.34 ± 0.746	8.21 ± 0.874	9.00 ± 0.846	9.60 ± 0.908
Sire 2	14	6.98 ± 0.628	7.52 ± 0.716	7.94 ± 0.748	6.98 ± 0.628	7.52 ± 0.716	9.29 ± 0.909
Sire 3	14	6.16 ± 0.709	6.68 ± 0.808	6.96 ± 0.845	7.43 ± 0.988	8.31 ± 0.956	9.19 ± 1.026
Sire 4	14	7.27 ± 0.699	7.67 ± 0.798	8.17 ± 0.834	8.33 ± 0.975	8.90 ± 0.944	9.92 ± 1.013
Sire 5	14	6.66 ± 0.490	7.60 ± 0.559	8.26 ± 0.585	9.01 ± 0.683	9.70 ± 0.662	10.40 ± 0.710
Sire 6	12	6.98 ± 0.654	7.75 ± 0.745	8.76 ± 0.779	9.47 ± 0.911	10.10 ± 0.882	10.92 ± 0.946
Sire 7	16	7.07 ± 0.648	8.24 ± 0.739	9.26 ± 0.773	10.24 ± 0.903	10.67 ± 0.874	11.42 ± 0.938
Sire 8	14	7.51 ± 0.740	8.33 ± 0.844	8.81 ± 0.882	9.11 ± 1.031	9.59 ± 0.998	10.42 ± 1.071
Dam's weight at kidding							
Class 1	13	6.66 ± 0.451	7.31 ± 0.445	7.95 ± 0.446	8.09 ± 0.542	8.70 ± 0.546	9.54 ± 0.576
Class 2	22	6.84 ± 0.341	7.50 ± 0.367	8.07 ± 0.361	8.62 ± 0.357	9.22 ± 0.357	9.79 ± 0.420
Class 3	26	6.58 ± 0.306	7.39 ± 0.328	7.80 ± 0.104	8.46 ± 0.426	9.13 ± 0.356	9.87 ± 0.404
Class 4	32	7.16 ± 0.264	7.85 ± 0.315	8.49 ± 0.359	9.00 ± 0.407	9.45 ± 0.409	10.26 ± 0.448
Class 5	20	7.06 ± 0.357	7.81 ± 0.395	8.51 ± 0.410	9.24 ± 0.424	10.25 ± 0.460	11.05 ± 0.449

growth of kids according to sex is represented in Figure 4.4. Males had higher post-weaning weights than females.

b. Type of birth

The effect of type of birth was non significant on all post-weaning body weights. Single born kids have a mean body weight of 7.27 ± 0.324 kg at 98 days to 10.26 ± 0.468 kg at 168 days; twins have a mean body weight of 6.88 ± 0.228 kg at 98 days to 9.98 ± 0.331 kg at 168 days and triplets have a mean body weight of 6.52 ± 0.441 kg at 98 days to 10.19 ± 0.639 kg at 168 days. Singles had higher weights in all stages post-weaning growth compared to twins or triplets. Post-weaning growth of kids according to birth type is presented in Figure 4.5. Triplets showed a higher growth rate followed by singles and twins.

c. Month of birth

Month of birth does not have a significant effect on post-weaning weights. Kids born in September had higher post-weaning weights and those born in June had the lower weights.

d. Sire

Sire had not influenced the post-weaning body weights. However kids of sire 7 registered higher weights in post-weaning growth and that of sire 2 had lower weights.

e. Dam's body weight at kidding

Dam's weight at kidding was found to have no significant effect ($p \leq 0.05$) on post weaning weights except weight at 168 days. Kids born to dams belong to

30-32 kg class registered maximum weight at 168 days (11.05 ± 0.449) and those belong to 18-20 kg class had minimum weight at 168 days (9.54 ± 0.576).

4.1.5 WEIGHT AT 180 DAYS

The results of Least Squares analysis of variance for different factors affecting weight at 180 days are presented in the Table 4.10 Least squares means for weight at 180 days for effect of sex, type of birth, month of birth, sire and dam's body weight at kidding are presented in Table 4.11. The over all mean for weight at 180 days was 11.04 ± 0.322 kg.

4.1.5.1 Factors affecting weight at 180 days

a. Sex

Sex of kid was found to have significant effect on weight at 180 days ($p \leq 0.05$). The means for males and females were 11.79 ± 0.407 kg and 10.29 ± 0.384 kg respectively. Sex wise means for weight at 180 days are presented in Figure 4.2. Males were found to be heavier than females at 180 days.

b. Type of birth

Type of birth had no significant effect on body weight at 180 days. The Least Square means for single, twins, triplets were found to be 11.27 ± 0.48, 10.80 ± 0.344 and 11.06 ± 0.664 kg respectively. Means for weight at 180 days according to birth type are presented in Figure 4.3. Singles were found to have higher weight at 180 days, followed by triplets and twins.

Table 4.10 Least squares analysis of variance for factors affecting body weight of Malabari kids at 180 days of age

Source of variation	df	MS
Sex	1	51.64399*
Type of birth	2	1.90079
Month of birth	7	2.46254
Sire	7	2.87178
Dam's weight at kidding	4	21.69421*
Error	91	4.84045

* $p < 0.05$

Table 4.11 Least Squares means for factors affecting Body weight (kg) of Malabari kids (Mean ± SE) at 180 days of age

Source	n	Mean ± SE
Overall	113	11.04 ± 0.322
Sex		
Male	52	11.79 ± 0.407
Female	61	10.29 ± 0.384
Type of birth		
Single	29	11.27 ± 0.487
Twin	70	10.80 ± 0.344
Triplet	14	11.06 ± 0.664
Month of birth		
January	17	11.52 ± 1.028
May	23	11.39 ± 0.913
June	27	10.38 ± 0.877
July	6	10.76 ± 1.036
August	4	11.54 ± 1.212
September	4	11.59 ± 1.188
October	14	10.28 ± 1.000
November	18	10.86 ± 0.884

Source	n	Mean ± SE
Overall	113	11.04 ± 0.322
Sire		
Sire 1	15	10.41 ± 0.943
Sire 2	14	10.23 ± 0.945
Sire 3	14	9.81 ± 1.066
Sire 4	14	10.50 ± 1.053
Sire 5	14	11.46 ± 0.738
Sire 6	12	12.09 ± 0.984
Sire 7	16	12.61 ± 0.975
Sire 8	14	11.24 ± 1.113
Dam's weight at kidding		
Class 1	13	10.51 ± 0.471
Class 2	22	10.87 ± 0.436
Class 3	26	10.54 ± 0.455
Class 4	32	11.05 ± 0.471
Class 5	20	12.19 ± 0.534

c. Month of birth

The effect of month of birth was observed as non-significant on weight at 180 days. How ever the kids born in January, May, August and September were found to be heavier than those born in June, July, October, and November. Kids born in September have highest Least square mean (11.59 ± 1.188 kg) and those born in October have lowest (10.28 ± 1.000 kg).

d. Sire effects and Heritability

Sire does not have a significant effect on weight at 180 days. Kids born to sire No. 7 had highest Least square mean (12.61 ± 0.975 kg) and those born to sire No. 3 had the lowest mean (9.81 ± 1.066 kg). Weight at 180 days was moderately heritable (0.35 ± 0.276 kg).

e. Dam's body weight at kidding

Dam's weight at kidding was found to have a significant effect ($p \leq 0.05$) on weight at 180 days. Kids born to dams belong to 30-32 kg class registered maximum weight at 180 days (12.19 ± 0.534) and those born to 18-20 kg class had minimum weight at 180 days (10.51 ± 0.471).

4.2 CORRELATIONS

Correlations were estimated between body weights of kids at different ages, body weights of kids with milk yield of dam up to 90 days, dam's body weight at kidding with milk yield, litter size and litter weight of Malabari goats.

Correlation between body weights at different ages of Malabari kids are presented in Table 4.12. Birth weight had significant correlation ($p \leq 0.01$) with

Table 4.12 Correlation between body weights at different ages in Malabari kids

	Birth weight	Weight at 90days	Weight at 180 days
Birth weight	1.000		
Weight at 90days	0.534**	1.000	
Weight at 180 days	0.172	0.265*	1.000

** p< 0.01 * p< 0.05

Table 4.13 Correlation between dam's milk yield and pre-weaning body weights of Malabari kids

Body weight of kids at	Milk yield up to					
	14 days	28 days	42 days	56 days	70 days	84 days
14 days	0.413**	0.409**	0.416**	0.404**	0.401**	0.396**
28 days	0.420**	0.417**	0.444**	0.443**	0.449**	0.455**
42 days	0.458**	0.446**	0.457**	0.455**	0.459**	0.467**
56 days	0.429**	0.415**	0.422**	0.418**	0.421**	0.432**
70 days	0.453**	0.433**	0.429**	0.421**	0.414**	0.414**
84 days	0.393**	0.367**	0.357**	0.345**	0.339**	0.338**

** p< 0.01

Table 4.14 Correlation between bodyweight, litter size, litter weight and milk yield of Malabari Goat.

	Dam's weight	Litter size	Litter weight	Milk yield
Dam's weight	1.000			
Litter size	0.477**	1.000		
Litter weight	0.558**	0.861**	1.000	
Milk yield	0.379**	0.111	0.203*	1.000

** p< 0.01 * p< 0.05

weaning weight (0.534) and the correlation between birth weight and weight at 180 days was not significant. Weaning weight had a significant correlation ($p \leq 0.05$) with weight at 180 days (0.265).

Correlation between dam's milk yield and pre-weaning body weights of kids is presented in Table 4.13. There was a significant correlation ($p \leq 0.01$) observed between dam's milk yield and the pre-weaning body weights (0.338 to 0.458).

Correlation of dam's body weight with litter size (0.477) and litter weight (0.558) and milk yield (0.379) is presented in Table 4.14. The correlations were found to be highly significant ($p \leq 0.01$).

Discussion

DISCUSSION

5.1 BODY WEIGHTS

5.1.1 BIRTH WEIGHT

Over all Least square mean for birth weight of Malabari kids was 1.79 ± 0.046 kg. The mean birth weight obtained in the present study was comparable to weights reported by Nair (1979), Mukundan (1980), Raghavan (1980) and Mathew *et al.* (1994). However a lower birth weight (1.59 ± 0.08 kg) was also reported by Reghavan *et al.* (1999) at Pilikkode. This can be attributed to the regional variation.

5.1.1.1 Factors affecting Birth weight

a. Sex

Effect of sex was found to be significant on birth weight. This result agreed with the findings of Mukundan (1980) and Mathew *et al.* (1994) in Malabari goats. Means were lower than that reported by Prakasam *et al.* (1987) and Sivakumar and Thiagarajan (1999). Males were found to be heavier than females. Higher weights in males could be attributed to the anabolic effect of androgens, which were released earlier than oestrogens (Hafez, 1974).

Significantly higher weight of males at birth were also reported by Singh and Singh (1998), Mehta *et al.* (1997), Roy *et al.* (1997), Gokhale *et al.* (1996), Sheikh *et al.* (1996), Malik *et al.* (1993), Kumar *et al.* (1992), Tyagi *et al.* (1992), Saxena *et al.* (1990), Das *et al.* (1989), Malik *et al.* (1986), Naik *et al.* (1985), Misra and Rawat (1984), Nagpal and Chawla (1984). However Raghavan (1980) in

Malabari goats and Das *et al.* (1995), Sharma and Das (1995), Roy *et al.* (1989). Patnaik and Nayak (1988) could not find a significant sex effect in other breeds.

b. Type of birth

Type of birth was found to have significant influence on birth weight. This is in agreement with the reports of Raghavan *et al.* (1999) in Malabari kids; Mukundan *et al.* (1981), Mukundan (1980) and Raghavan (1980) in Malabari and its crosses. Single born kids were found to be the heaviest, followed by twins and triplets. This might be partly due to the quantum of nourishment the singles get and the division of the same to twins and triplets during the pre and post natal period.

Singles had higher birth weight followed by twins and triplets according to the reports of Singh *et al.* (2000), Mehta *et al.* (1997), Roy *et al.* (1997), Das *et al.* (1995), Malik *et al.* (1993), Kumar *et al.* (1992), Tyagi *et al.* (1992), Singh *et al.* (1991), Saxena *et al.* (1990), Roy *et al.* (1989) and Khan and Sahni (1983), Singh *et al.* (1983), Sinha and Sahni (1983) in other Indian breeds of goats. But the effect of type of birth was non significant in reports of Das *et al.* (1995), Sharma and Das (1995), Roy *et al.* (1989), Patnaik and Nayak (1988) in Indian breeds of goats.

c. Month of birth

The effect of month of birth was observed as non-significant on birth weight, showing that environmental effect is less on prenatal growth and it is influenced by maternal uterine environment. Similar conclusions also made by Mukundan (1981) in Malabari and its crossbreds, Premasundepa *et al.* (1998),

Gokhale *et al.* (1996) and Reynolds (1979) in other breeds of goats. However a significant effect of month of birth on birth weight was reported by Sanchez *et al.* (1994), Kumar *et al.* (1992), Saxena *et al.* (1990) and Jagtap *et al.* (1988) in various breeds of goats.

d. Sire effects and Heritability

Effect of sire was non significant on birth weight. This may be due to the fact that birth weight depends on type of birth, which is correlated to dam's weight and other maternal factors. Non-significant effect of sire was reported by Raghavan (1980) in Malabari and cross-breds and Saxena *et al.* (1990), Kumar *et al.* (1992), Roy *et al.* (1997) in Jamunapari kids. How ever a significant effect of sire was reported by Raghavan (1980) in Malabari x Alpine cross-breds. Birth weight was found to be moderately heritable (0.30 ± 0.267 kg). Even though the literatures (Table 2.2) show a wide range of heritability values in birth weight, the value obtained in the study was in accordance with the value obtained by Mathew (1991) in Malabari x Saanen crosses.

e. Dam's body weight at kidding

Effect of dam's weight at kidding on birth weight was non significant. The reports of Singh and Singh (1998) in Jamunapari half breds, Roy *et al.* (1997) and Kumar *et al.* (1992) in Jamunapari goats showed effect of dam's weight at kidding on birth weight was significant. The result in the present study may be due to the fact that body weight of dam had a highly significant positive correlation with litter size, where as litter size had a negative association with birth weight. So

dam with more body weight produced twins and triplets and the birth weight did not showed a significant difference in different body weight classes.

5.1.2 PRE-WEANING BODYWEIGHTS

5.1.2.1 Factors affecting pre-weaning body weights

a. Sex

Sex had a significant effect on all pre-weaning weights except weight at 56 days. Male kids had higher weight than the females at all the stages of pre-weaning growth. This was in conformity with the findings of Mukundan (1980) in Malabari and it's cross breds. A significant effect of sex on pre-weaning weights was also reported by Singh and Singh (1998), Husain *et al.* (1996 and 1997), Gokhale *et al.* (1996) and Malik *et al.* (1993) in other Indian breeds of goats. The difference of body weight of male and female in the present study may be due to the endocrine variation in sexes resulting in variation in feed intake. But studies by Raghavan (1980) showed that sex has no significant on weight at one-month age in Malabari goat.

b. Type of birth

The effect of type of birth was found to be significant on all pre-weaning body weights except weight at 84 days. Singles had a higher weights in pre-weaning growth followed by twins and triplets. Raghavan (1980) reported a significant effect of litter size on weight at one month in Malabari kids. Similar observation was also made by Mukundan (1983) in Malabari and its cross-breds. However he also observed a non-significant effect of birth type on body weights at two and three months of age.

In the present study birth type was significant only on body weights up to 84 days. This is because though the kids are weaned in 90 days they will start consuming concentrate and grass from second month onwards. Single born kids received more milk in comparison to twins and triplets for their growth in earlier periods when the kids were solely depended on the dam's milk. But on the later part of the weaning period the disappearance of significant effect of type of birth on body weight may be due to the compensatory growth they had when they start consuming concentrate and grass. Higher birth weights of singles followed by twins and can also be an added effect in the early postnatal growth. Significant effects of type of birth on pre-weaning body weights were also reported by Singh and Singh (1998), Hussain *et al.* (1997), Hussain *et al.* (1996), Gokhale *et al.* (1996) and, Malik *et al.* (1993) in other Indian breeds of goats.

c. Month of birth

Month of birth had a significant effect on pre-weaning weights. Mukundan (1983) reported that weight at two months influenced by month of birth in Malabari and Saanen x Malabari kids. Significant effect of month of birth on pre-weaning body weights also reported by Ruvuna *et al.* (1998) in Small East African and Somali goats and Gokhale *et al.* (1996) in non descript and graded up Sirohi goats.

Kids born in May to August had higher weights in pre-weaning growth than those born from September to January. This might be due to lush natural vegetation in the period, which influence the milk yield of the dam. A non-

significant effect of month of birth on first month weight in Malabari and its crosses with Saanen is also reported by Mukundan (1983).

d. Sire

Sires did not have a significant effect on pre-weaning body weights except weight at 28 days. Raghavan (1980) reported a non-significant effect of sire on first month body weight in Alpine x Malabari, Saanen x Malabari kids. A non-significant effect of sire on pre-weaning body weights (at one and two months) was also reported by Mukundan (1983) in Malabari and its crosses with Saanen. He also reported a significant effect of sire on first month body weight in Malabari kids.

e. Dam's body weight at kidding

Dam's weight at kidding was found to have no significant effect on pre-weaning weights. Kumar *et al.* (1992), Khan and Sahni (1982) reported that in Jamunapari goats dam's weight at kidding significantly influences body weight of kids up to three months of age. The result in the present study may be due to the fact that the chance of twin and triplet birth were more in dams having higher body weight at kidding and the increased litter size might have contributed a reduced growth and held the effect of body weight class non significant on pre-weaning body weight.

5.1.3 WEANING WEIGHT

The over all mean for weaning weight in the present study was 6.48 ± 0.211 kg. This value was higher than that reported by Mukundan (1980) and

Mathew (1991) in Malabari goat. This might be due to variation in level of management in different periods.

5.1.3.1 Factors affecting weaning weight

a. Sex

Effect of sex was found to be significant on weaning weight. This is in agreement with the observations of Mathew (1994) and Mukundan (1983) in Malabari and its cross-breds. Males were found to be heavier than females at weaning. Higher weights in males might be attributed to sex modulated endocrine variation. The reports of Singh (1997), Mehta *et al.* (1997), Roy *et al.* (1997), Gokhale *et al.* (1996) Das *et al.* (1995), Sharma and Das (1995), Malik *et al.* (1993), Tyagi *et al.* (1992), Saxena *et al.* (1990) in various Indian breeds of goats also showed a significant effect of sex on weaning weight. How ever the findings of Singh *et al.* (2000), Singh and Singh (1998), Sheikh *et al.* (1996), Kumar (1992 indicated that the effect of sex on weaning weight was non significant.

b. Type of birth

Type of birth had no significant effect on weaning weight. Studies of Mathew (1994) and Mukundan (1983) also showed a non-significant effect of type of birth on weaning weight in Malabari and its cross breds. Insignificant effect of type of birth on weaning body weights were also reported by Sharma and Das (1995) in Jamunapari, Das *et al.* (1995) in Barbari and Tyagi *et al.* (1992) in Jakhrana goat. According to the findings of Singh *et al.* (2000) in Beetal half

breds, Singh and Singh (1998) in Black Bengal (BB) and its crosses with Beetal, effect of type of birth was non significant on weaning weight.

c. Month of birth

Effect of month of birth was non significant on weaning weight. According to the studies of Mukundan (1983) in Malabari and Saanen x Malabari kids, Reynolds (1979) in Malawi goat month of birth did not influence the weaning weights. But the results of the present study disagreed with finding of Gokhale *et al.* (1996) in non descript and graded up Sirohi goats and Kumar *et al.* (1992) and Saxena *et al.* (1990) in Jamunapari goats.

d. Sire effect and Heritability

Sire effect was not significant on weaning weight. The reports of Saxena *et al.* (1990) in Jamunapari kids also showed non significant effect of sire on weaning weight. According to reports of Roy *et al.* (1997) and Kumar *et al.* (1992) sire influences the weaning weight of Jamunapari kids. Weaning weight was found to be moderately heritable (0.35 ± 0.277). This result disagreed with the observations made by Mathew (1991) in Malabari goats and Mukundan (1980) in Malabari and Saanen x Malabari who reported high heritability estimates for weaning body weight, but was in close agreement with Roy *et al.*, 1997 (0.30 ± 0.15) and Singh, 1997 (0.42 ± 0.18) who reported that the weaning body weight is medium heritable.

e. Dam's body weight after kidding

Effect of dam's weight at kidding on weaning weight was non significant. Kumar *et al.* (1992), Khan and Sahni (1982) reported that in Jamunapari goats

dam's weight at kidding significantly influences body weight of kids at three months of age. The result in the present study may be due to breed difference in litter size and its association with the body weight of dams.

5.1.4 POST-WEANING BODYWEIGHTS

5.1.4.1 Factors affecting post-weaning body weights

a. Sex

Sex of the kid had a significant effect on all post-weaning weights. Raghavan (1980) found that sex significantly influenced fourth month body weight of Saanen x Malabari cross breds. Males had higher weights in post-weaning growth. The reason for the higher growth in males than females may be due to the fact that they have higher birth weight, weaning weight and also due to the endocrine variation.

Significant effect of sex on post-weaning body weights was also reported by Singh and Singh (1998) in Black Bengal and its crosses with Beetal, Gokhale *et al.* (1996) in non descript and graded up Sirohi goats, Malik *et al.* (1993) in Black Bengal goats and Khan and Garg (1983) in Jamnapari kids. There were also contradictory reports by Mukundan (1980) in Malabari and its crosses at fifth month weight and Raghavan (1980) in Malabari and its Alpine cross breds at fourth month weight.

b. Type of birth

The effect of type of birth was non significant on all post-weaning body weights. Raghavan (1980) found that birth type birth is not significant on weight at four

months in Malabari and its crossbreds. Khan and Garg (1983) also reported a non-significant effect at five months in Jamunapari kids.

Singh and Singh (1998) reported a significant effect of type of birth on post weaning body weights in Black Bengal and its crosses with Beetal. Similar observations were made by Gokhale *et al.* (1996) in non descript and graded up Sirohi goats.

c. Month of birth

Month of birth did not have a significant effect on post-weaning weights. This was in agreement with the reports of Mukundan (1980) that month of birth not significantly influenced the body weights at four and five months of age in Malabari and their Saanen halfbreds. But Gokhale *et al.* (1998) found that month of birth significantly affected body weights at four and five months of age in non descript and graded up Sirohi goats.

d. Sire

Sire did not have a significant effect on post-weaning body weights. This was in agreement with the findings of Raghavan (1980) on weight at four months of age in case of Alpine x Malabari, Saanen x Malabari kids. According to Mukundan (1980) sire had significant effect on body weights at fourth and fifth months of age.

e. Dam's body weight at kidding

Dam's weight at kidding was found to have no significant effect on post weaning weights except weight at 168 days. According to the reports of Raghavan

(1980), dam's weight at kidding had significant influence on body weights at one and four months of age in Malabari goats. Singh and Singh (1998) reported that dam's weight at kidding had significant influence on body weights up to three months of age in Jamunapari half breds.

5.1.5 WEIGHT AT 180 DAYS

The over all mean body weight at 180 days was 11.04 ± 0.322 kg. The body weight obtained in the present study was higher than that observed by Mathew, 1991 (9.3 ± 0.16).

5.1.5.1 Factors affecting weight at 180 days

a. Sex

Effect of sex of kid was found to be significant on weight at 180 days of age. This is in accordance with the findings of Mehta *et al.* (1997) in Sirohi goats; Roy *et al.*, (1997), Sharma and Das (1995), Kumar *et al.* (1992) and Khan and Garg (1983) in Jamunapari; Das *et al.* (1995) in Barbari; Malik *et al.* (1993) in Black Bengal and Tyagi *et al.* (1992) in Jakhrana goats. But non-significant effect of sex on six-month body weight were reported by Mukundan (1980) and Mathew (1991) in Malabari and its crosses. Male kids were found to be heavier than females at 180 days, possibly due to endocrine factors modulating difference in growth rate among sexes.

b. Type of birth

Type of birth had no significant effect on body weight at 180 days. The findings of Sharma and Das (1995) and Khan and Garg (1983) in Jamunapari; Das

et al. (1995) in Barbari; Malik *et al.* (1993) in Black Bengal; Tyagi *et al.* (1992) in Jakhrana, Mathew (1991) in Malabari and its cross-breds and Mukundan (1980) in Malabari and its Saanen half breds also revealed the similar results. How ever a significant effect of type of birth on body weight at six months of age had been observed by Singh and Singh (1998) in Black Bengal and its crosses with Beetal, Singh (1997) in Black Bengal and its half-breds.

c. Month of birth

The effect of month of birth was observed as non-significant on weight at 180 days. This was contradictory to the reports of Mukundan (1980) in Malabari and their Saanen halfbreds, Gokhale *et al.* (1998) and Kumar *et al.* (1992) in other Indian breeds. However the reports of Reynolds (1979) in Malawi goats showed that month of birth was not significant on body weights at 24 weeks.

d. Sire effect and heritability

Sires did not have a significant effect on weight at 180 days. The available literatures revealed significance of sire on body weights at six months (Mukundan, 1980; Roy *et al.*, 1997 and Kumar *et al.*, 1992). Weight at 180 days was moderately heritable (0.35 ± 0.276 kg). This value is higher than that reported by Mathew (1991) in Malabari goat. How ever majority of the values in Table 2.6 indicate that heritability of body weight at six months is moderately heritable.

e. Dam's body weight at kidding

Dam's weight at kidding was found to have a significant effect on weight at 180 days. Similar findings were also reported by Singh and Singh (1998) in Jamunapari half breds.

5.2 CORRELATIONS

Birth weight had significant and positive correlation ($p \leq 0.01$) with weaning weight (0.534). Sharma and Das (1995) found a significant correlation of birth weight with weaning weight in Jamunapari goats. Koratkar *et al.* (1998) noticed a positive correlation between birth weight and body weights at three months of age in Osmanabadi goats. Al-Shaikh and Mogawer (2001) found that correlation coefficient between birth weight and weaning weight in Aradi goats of South Arabia is 0.41. Weaning weight had a significant correlation ($p \leq 0.05$) with weight at 180 days (0.265).This is in agreement with the results published by Sharma and Das (1995) in Jamunapari goats, Koratkar *et al.* (1998) in Osmanabadi goats, Ebosoje and Ngere (1995) in West African dwarf goats and its half-breds. The correlation between birth weight and weight at 180 days was not significant. This may be attributed to the effect of dam's body weight at kidding on type of birth and effect of type of birth on birth weight.

Correlations between the dam's milk yield and pre-weaning body weights of kids were found to be positive (0.338 to 0.458) and highly significant ($p \leq 0.01$). Similar results were observed by Sangare and Pande (2000) in Sahel goats, Misra *et al.* (1985) in Sirohi kids and Ehoche and Buvanrndran (1983) in case of Red Sokoto goats.

Significant positive correlation between the dam's milk yield and body weight at kidding of Malabari goats was in agreement with the findings of Lendzion *et al.* (1999) in Podlasie goats, Misra *et al.* (1985) in Sirohi goat, Ehoche and Buvanendran (1983) in Red Sukoto goats and Betancourt (1982) in cross-bred

goats of Venezuela. Positive and significant correlations between dam's body weight with litter size and litter weight was in agreement with the observations of Garci *et al.* (1996) and Betancourt (1982) in tropical goats.

The present study revealed that the type of birth though had a significant effect on birth weight and early pre-weaning body weights, it slowly vanished with the advancement of age. It is because of the disadvantage due to sharing of nutrients faced by kids of multiple births in pre and postnatal growth and was neutralized by the compensatory growth in the post-weaning period. The body weight of dam significantly influenced the milk production of dam as well as the sixth month body weight. So the selection to evolve the meat type of breed should be directed towards type of birth. Body weight of dam is a prime trait to be considered in selection by which the litter size, milk production of dam and body weight of kids at the age of slaughter could be improved.

Summary

SUMMARY

The effects of sex, type of birth, month of birth, sire and dam's body weight at kidding on birth weight, weaning weight, weight at 180 days and body weights at fortnightly interval in 113 Malabari kids were assessed. Heritability estimates were made for body weights at different ages. Correlations were worked out between body weights of kids, between body weights of kids and milk yield of dam, and between dam's body weight at kidding and milk yield, litter size, litter weight.

The overall mean for birth weight was 1.79 ± 0.046 kg. Effect of sex and type of birth was found significant on birth weight. The means for males and females were 1.87 ± 0.059 kg and 1.73 ± 0.046 kg respectively. Males were found to be heavier than females at birth. The Least squares means for single, twins, triplets were found to be 2.03 ± 0.070, 1.83 ± 0.049 and 1.54 ± 0.096 kg respectively. Single born kids were found to be the heaviest at birth followed by twins and triplets. The effect of month of birth, sire and dam's body weight at kidding was observed as non-significant on birth weight. Birth weight was found to be moderately heritable (0.30±0.267).

The over all mean for pre-weaning body weights varied from 2.96 ± 0.077 kg at 14 days to 6.14 ± 0.196 kg at 84 days. Sex and type of birth and month of birth had a significant effect on pre-weaning weights. Males had higher body weights in pre-weaning period than females. Singles had a higher weights during pre-weaning age followed by twins and triplets. Kids born in May, June, July and August had higher

weights in pre-weaning growth than those born in September, October, November and January. Effect of sire and dam's body weight at kidding did not have a significant influence on pre-weaning body weights.

The mean for weaning weight was 6.48 ± 0.211 kg. Effect of sex was found to be significant on weaning weight. The means for males and females were 6.77 ± 0.267 and 6.19 ± 0.252 kg respectively. Males were found to be heavier than females at weaning. Type of birth, month of birth, sire and dam's body weight at kidding had no significant effect on weaning weight. The Least Square mean for single, twins, triplets were found to be 6.96 ± 0.319, 6.46 ± 0.226 and 6.01 ± 0.435 kg respectively. Weaning weight was found to be moderately heritable (0.35 ±0.277).

Overall mean for post-weaning body weights varied from 6.89 ± 0.214 kg at 98 days to 10.14 ± 0.310 kg at 168 days. Sex had a significant effect on the post-weaning body weights. Males had higher weights in post-weaning growth. Type of birth, month of birth and sire did not have a significant effect on body weights. Singles had higher weights in all stages post-weaning growth compared to twins or triplets. Triplets showed a higher growth rate followed by singles and twins. Dam's body weight at kidding had a significant effect on body weight at 168 days only.

Mean for weight at 180 days was 11.04 ± 0.322 kg. Sex and dam's body weight at kidding was found to have significant effect on weight at 180 days. The means for males and females were 11.79 ± 0.407 kg and 10.29 ± 0.384 kg respectively. Males were found to be heavier than females at 180 days. Type of birth, month of birth, sire did not have a significant effect on body weight at 180 days. Singles were found to have higher weight at 180 days, followed by triplets and twins. Weight at 180 days was moderately heritable (0.35 ± 0.276).

Birth weight had significant correlation (0.534) with weaning weight. A significant correlation was found between weaning weight and weight at 180 days. A significant correlation (0.265) was found among the post-weaning body weights. However correlation between birth weight and weight at 180 days was found non significant.

A significant correlation also noticed between milk yield and the pre-weaning body weights (0.338 to 0.458). Correlation of dam's body weight with milk yield (0.379), litter size (0.477) and litter weight (0.558) was found to be significant.

With the results obtained, the following conclusions can be made. Singles had higher body weight from birth to weaning followed by twins and triplets. But it was observed that there was no significant difference among kids of different type of birth in the post-weaning period. The triplets had a compensatory growth during the post-weaning period. Dam's weight at kidding influenced body weight of kids in the later part of the post weaning period. In the present study body weight of the mother seems to be the major factor, which decides the type of birth. Higher the weight at kidding larger will be the litter size and level of production of milk.

So based on the above result it is suggested that the selection to evolve the meat type of breed should be directed towards type of birth. Body weight of dam is a prime trait to be considered in selection by which the litter size, milk production of dam and body weight of kids at the age of slaughter could be improved.

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GENETIC AND ENVIRONMENTAL FACTORS INFLUENCING GROWTH RATE AND BODY WEIGHTS UP TO SIX MONTHS IN MALABARI GOAT

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ABSTRACT OF THE THESIS

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ABSTRACT

Goats contribute a major share of the meat produced in India so it is worthwhile to evolve and propagate meat type goats suited for the humid tropics of India particularly to Kerala state. Malabari goat has got high adaptability, crude fibre conversion efficiency and prolificacy. So breeding programs can be developed on that breed to evolve meat type. The effects of sex, type of birth, month of birth, sire and dam's body weight at kidding on birth weight, weaning weight, weight at 180 days and body weights at fortnightly interval in 113 Malabari kids were assessed. Heritability estimates were made for body weight at different ages. Correlations were worked out on body weights, milk yield and dam's body weight at kidding. This research approach was aimed at ascertaining the feasibility of evolving a selection criteria for the development of a meat type goat.

Overall means for birth weight, weaning weight and weight at 180 days were 1.79 ± 0.046, 6.48 ± 0.211 and 11.04 ± 0.322 kg respectively. Sex had a significant effect on birth weight, weaning weight, weight at 180 days, pre-weaning and post-weaning body weights. Means of birth weight, weaning weight and weight at 180 days for male kids were 1.87 ± 0.059, 6.77 ± 0.267 and 11.79 ± 0.407 kg and that of females were 1.73 ± 0.046, 6.19 ± 0.252 and 10.29 ± 0.384 kg respectively. Males were found to be heavier than females at all stages of growth.

Birth type of kids had significant effect on birth weight and pre-weaning body weights and no significant effect was found on weaning weight, post-

weaning body weights and weight at 180 days. Means body weights for single, twins, triplets were 2.03 ± 0.070, 1.83 ± 0.049 and 1.54 ± 0.096 kg at birth, 6.96 ± 0.319, 6.46 ± 0.226 and 6.01 ± 0.435 kg at weaning and 11.27 ± 0.487 kg, 10.80 ± 0.344 kg and 11.06 ± 0.664 kg at 180 days of age. Single born kids were found to be the heaviest followed by twins and triplets at birth and weaning. At 180 days of age singles were found to have higher weight, followed by triplets and twins. Singles had higher weights in pre-weaning growth followed by twins and triplets where as twins and triplets showed a compensatory growth in the post-weaning period.

Month of birth had a significant effect on pre-weaning weights where as the effect was not significant on birth weight, weaning weight, post-weaning weight and weight at 180 days. Kids born in May, June, July and August had higher weights in pre-weaning growth than those born in September, October, November and January.

Sire effect was found to be non significant on body weights at all ages. Heritability estimates of birth weight, weaning weight and weight at 180 days were 0.30 ± 0.267, 0.35 ± 0.277 and 0.35 ± 0.276 respectively. Dam's body weight at kidding was found significant on body weights from 168 days only.

Birth weight had significant correlation (0.534) with weaning weight. A significant correlation (0.265) was found between weight at weaning and 180 days. Correlations between Birth weight and weight at 180 days was not significant. A significant correlation also noticed between milk yield and the pre-weaning body weights of kids. Correlation of dam's body weight with milk yield (0.379), litter size (0.477) and litter weight (0.558) was found to be significant.

Singles had higher body weight from birth to weaning followed by twins and triplets. But it was observed that there was no significant difference among kids of different type of birth in the post-weaning period. The triplets had a compensatory growth during the post-weaning period. Dam's weight at kidding influenced body weight of kids from 168 days. The present study reveals body weight of the mother is the major factor, which decides the type of birth. Higher the weight at kidding larger will be the litter size and level of production of milk.

So based on the above result it is suggested that the selection to evolve the meat type of breed should be directed towards type of birth. Body weight of dam is a prime trait to be considered in selection by which the litter size, milk production of dam and body weight of kids at the age of slaughter could be improved.