2
LITERATURE REVIEW

2.0 LITERATURE REVIEW

2.1 Birth weight as criteria of growth.

Measurement of growth forms the basis of most performance recording systems for goat meat production. Growth and reproductive performance are clearly related to production. Some are related to pre-weaning and weaning traits and others to post-weaning growth traits. A number of studies have been related to the efficiency of growth and maintenance as determined in stall-feeding experiments (Devendra, 1980, 1983).

Birth weight is an important economic trait which can influence post-natal growth and survivability. It is also an indicator of genotype and performance of the parents. The heavier the birth weight the faster is its rate of growth.

Birth weight of goats is affected by a number of factors such as sex (Castillo et al., 1972; Mittal, 1979; Mukundan et al., 1981; Sinha and Sahni, 1983; Wilson, 1987), litter size (Mittal and Pandey, 1978), type of birth (Singh, 1973; Singh et al., 1977), parity (Alkass et al., 1986), dam weight (Devendra and Burns, 1970; Prasad et al., 1972; Khan 1980; Mukundan et al., 1981; Sinha and Sahni, 1983), breed of dam (Nath and Chawla, 1978), breed of sire (Abdul Wahid et al., 1987), genotype of kid (Castillo et al., 1972), year (Moulick and Syrstal, 1970), season (Khan et al., 1979), and plane of nutrition especially during the last two months of pregnancy (Epstein and Herz, 1964).

The variability in birth weight per se and the factors that influence birth weight in different breeds and crosses is well illustrated by the following research workers.

2.1.1 Effect of sex

Sex of an animal has a significant effect on the birth weight of kids (Mukundan et al., 1981; Mukherjee et al., 1982; Darokhan and Tomar, 1983; Mishra and Patro, 1983; Koul and Biswas, 1987; Wilson, 1987). Male kids are generally heavier than the females by 1.0 to 20.0% (Moulick and Syrstal, 1970) and can be as high as 44% in male Katjang goats (Devendra, 1962); and the females of Anglo Nubian were found to be upto 64.1% less in weight than the males. The difference between the sexes may range between 0.1 to 1.4 kg or even more.

The male kids are found to be heavier than the female counter parts at each stage of growth, and Mahmud and Devendra (1970), Mishra and Patro (1983) and Wilson (1987) found the difference to be significant ($P<0.05$). This effect may be due to the anabolic effect of the sex hormone, testosterone, which, secreted by the gonads, induces faster rate of growth during post-natal development (Hafez, 1974). It appears that the male foetus grows faster during prenatal development.

The difference between the sexes is also evident in the twin births as well as larger-sized litters. Epstein and Herz, (1964) reported the difference between the males and females in twin births to vary upto 30%.

However, some reports have given contradictory results by suggesting negligible or no difference between the sexes (Paramsothy, 1957; Datta, 1963; Devendra, 1966; Mittal and Pandey, 1978; Ali, 1980).

At the Bangladesh Agricultural University farm, the growth performance of Black Bengal goats purchased from various parts of the country was found by Ali et al., (1973) to be 0.73 kg with a range of 0.23 to 1.36 kg. Male kids were significantly heavier than females at birth.

Belinchon and Marques (1971) have given the average birth weight of female Murcian kids as 2.55 ± 0.37 kg and that of the males as 2.70 ± 0.40 kg, the average of the two sexes being 2.64 ± 0.40 kg. They also recorded the birth weight of the singles and twins to be 2.82 ± 0.58 kg for the single birth females, 2.90 ± 0.39 kg for the single birth males, 2.52 ± 0.46 kg for the twin birth females and 2.78 ± 0.39 kg for the twin birth males.

Castillo et al., (1972) recorded the birth weight to average 3.6 kg for Criollo x Nubian male and 3.1 kg for female singles, 2.6 and 2.4 kg for male and female Criollo singles and 3.3 and 2.9 kg for male and female Nubian singles. The birth weight of twin born male and female of the above 3 types were 3.2 kg and 3.0 kg, 2.3 kg and 2.0 kg, and 2.9 and 2.7 kg respectively.

A study on growth rate in Barbari kids by Mittal and Pandey (1978) showed that the average birth weight of male and female Barbari kids was 1.95±0.295 kg and 1.98±0.184 respectively. Such non-significance has also been observed in Jamnapari (Datta et al., 1963), Barbari (Mittal and Pandey, 1978), Black Bengal (Ali, 1980) and Katjang goats (Mahmud and Devendra, 1970). In twins of similar sexes (Mittal and Pandey, 1978) the males were 1.74±0.203 kg and females were 1.82±0.168 kg. In twins of dissimilar sexes the males were 1.78±0.159 kg and females were 1.70±0.196 kg.

2.1.2 Effect of litter size/birth type

Litter size has a pronounced effect on the birth weight of a kid (Dickinson et al., 1962; Singh, 1973; Metz et al., 1985; Noraidah Ismail, 1986; Wilson, 1987). The mean birth weight of a kid decreases according to litter size and single born kids of either sex are usually heavier than the twins and triplets, and the twins are heavier than the triplets and quadruplets. The larger the litter size the smaller the kid weight, and the weight of the twins may be as low as 25-75% the weight of singles (Mishra et al., 1978; Deichert, 1981; Mukundan et al., 1981). Such an effect is quite pronounced (Mukundan et al., 1981; Amoah and Bryant, 1983; Metz et al., 1985; Noraidah Ismail, 1986; Wilson, 1987).

Singh (1973) and Singh et al., (1977) reported significant effects of type of birth on birth weight in Jamnapari kids and Barbari kids, and Mukundan et al., (1981) in Malabari and crossbreds. Mittal (1979) also found the Jamnapari kids to be heavier than Barbari kids ($P<0.01$). The difference between singles and twin born kids, however, was not significant.

The male and female single local goats of Malaysia were recorded having birth weights of 1.7 and 1.4 kg and the male and female multiple birth kids 1.6 kg and 1.4 kg respectively (Mahmud and Devendra, 1970). Deichert (1981) observed that in the local goats the twins, triplets and quadruplets weighed about 84, 77 and 58% respectively of the weight of the single births.

2.1.3 Effect of parity

Parity is often confused with the age of the dam whereas the two words have confounded effects and have to be considered together. Parity is more related to the status of the animal being at the first or second or third kidding whereas age is the actual number of days the animal has been alive from the time of birth. Therefore, the doe could be young or old but its status being at the first kidding or second kidding, et cetera.

Mittal (1979) found that the age of dam had no significant effect on Jamnapari kid weight, but the dam's body weight was significantly correlated with kid birth weight (0.69 to 0.99). It is evident that heavier dams produce kids of higher birth weight (Khan, 1980; Mukundan et al., 1981; Sinha and Sahni, 1983) due to the fact that the heavier dams produce better pre-natal environment for the foetus (Devendra and Burns, 1970; Sinha and Sahni, 1983).

Age of dam and litter size also caused significant variation in birth weight of Black Bengal kids (Moulick and Syrstal, 1970). The birth weight of kids from older dams were found to be heavier, and so was the birth weight of kids from does which were at later stage of kidding such as third, fourth, fifth kidding, etc..

2.1.4 Effect due to breed of dam

Buvanendran et al., (1974) recorded the birth weight of Jamnapari males and females as slightly lower than that of Anglo Nubian (3.50 kg and 1.96 kg) but significantly greater than that of the Kottukatchia male and female (1.91 kg and 2.09 kg) and Jamnapari x Kottukatchia crossbred male and female (2.14 kg and 2.00 kg). The similarity in birth weight of Kottukatchia and Jamnapari x Kottukatchia crossbreds indicated that birth weight is largely determined by the maternal breed although heterosis and maternal environment also are contributary.

In another group of kids from native and Anglo Nubian crossbred dams, birth weight averaged 2.6 kg and 2.5 kg respectively. In Malabar, Malabar x Saanen and Malabar x Alpine goats (Mukundan and Bhat, 1978), the mean birth weight for the three breedgroups averaged 2.39, 1.95 and 1.79 kg for males and 2.11, 2.33 and 1.76 kg for the females respectively

2.1.5 Effect due to breed of sire

Wilson and Katsigianis (1980) comparing the native to the Anglo Nubian crossbreds demonstrated that for kids sired by native and Anglo Nubian bucks, the body weight at birth averaged 1.9 kg and 2.5 kg respectively illustrating the effect of the breed of the sire on the birth weight of the kids.

2.1.6 Effect of genotype of kid

Significant effect of breed group on birth weight data of kids of Barbari, Jamnapari, 1/2 Saanen + 1/2 Jamnapari, Black Bengal and 1/2 Jamnapari + 1/2 Black Bengal has been reported by Das et al., (1982). The mean birth weights of the above breed groups were 1.429, 2.227, 2.346, 1.160 and 1.425 kg respectively. Birth weight could vary from 0.23 kg (Ali et al., 1973) to 3.90 kg in the purebreds (Montemurro, 1966).

The indigenous Katjang goat recorded 1.5 kg as compared to 3.1 kg recorded by Anglo Nubian goat. Rajendram and Pillay (1976) recorded slightly lower weights for both Katjang (Female=1.3 kg; Male=1.4 kg) and Anglo Nubian x Katjang crossbreds (Female=1.5 kg; Male=1.8 kg). The Mauritius goats recorded a birth weight of 1.5-2.0 kg and a mature weight of 25-30 kg as compared to the Zambian goats (Fielding, 1980). The local goats of Congo recorded average weight of 1.2-1.7 kg (Henrotte, 1961) resembling the Red Sokoto in Nigeria. And, the Maltese goats recorded 3.35 kg (2.40-4.20 kg) for the males and 3.11 kg (2.60-3.90 kg) for the females (Montemurro, 1966).

Significant effect of genetic groups on birth weight of kids was also observed by Mishra (1977), Singh et al., (1977), Mittal and Pandey (1977) and Nath and Chawla

(1978). Sinha and Sahni, (1983) also recorded highly significant effect ($p<0.001$) of breed groups, season of kidding and type of birth on birth weight.

The variations due to effect of breed and the type of birth on birth weight were found to be statistically non-significant contrary to earlier reports of Singh et al. (1977), Khan et al., (1979), and Mukundan et al., (1981). Gill and Dev (1972) in their study on the performance of two exotic breeds of goats under Indian conditions found the birth weight to average 3.5 and 2.9 kg, respectively. But, Bhatnagar et al., (1971) involved in the All India coordinated research project on breeding and management of goats for milk indicated that the birth weight of the French Alpine kids averaged 3.0 kg, that of Beetal averaged 2.8 kg and that of French Alpine x Beetal averaged 3.5 kg. The overall average of birth weight (both male and female) of Saanen x (Alpine x Beetal), Alpine, Saanen x Beetal and Alpine x Beetal breeds was recorded as 3.33 ± 0.08, 3.30 ± 0.05, 3.18 ± 0.06, 3.12 ± 0.06 and 2.81 ± 0.06 kg, respectively (Nath and Chawla, 1978).

Crossbred kids weighed heavier at birth than those of native Beetal breed. Similar results indicating higher crossbred weights were also reported by Pant (1968) in Angora x Gaddi crosses.

2.1.7 Effect of year

Moulick and Syrstal, (1970) demonstrated a significant effect of year on birth weight but not of season.

The interaction of year and season was also significant. Martinez et al., (1992) also demonstrated significant effect of year of birth on birth weight.

2.1.8 Effect of season

The effect of season is evident on growth (Khan et al., 1979; Rana, 1980) as well as reproduction (Chemineau, 1992). Rana (1980) found significant effect on birth weight of Black Bengal kids due to season of kidding, sex of kid and litter size. Season of birth not only produced heavier kids but also had a significant effect on age at first kidding.

Mittal (1979) reported that Jamnapari kids born in summer were found to be heavier than those born in winter ($P>0.01$). Khan et al., (1979) also reported significant effect of season and type of birth but not of year and sex in Jamnapari kids. The birth weight of the Jamnapari kids was found to be 3.04 kg.

2.1.9 Effect of nutrition

To demonstrate the effect of nutrition, the works of Reddy (1990), Sitorus (1990) Mudgal (1992) are quite illustrative. Goats are normally reared on browse and pasture forage. In view of stemmy and fibrous nature of crop residues they cannot be utilized by small ruminants unless they are subjected to physical processing like size reduction. Simple physical processing like chopping/ grinding increases bulk density and reduces transportation cost. Supplemental feeding before conception and parturition can increase kidding percentage, litter size and rearing rate (Alam, 1992).

2.2 Pre-weaning and Weaning weight

Compared to birth weight, a much wider use is being made of the growth performance between birth and weaning measured either as absolute weaning weight adjusted to a standard age of weaning or as average daily gain. The high phenotypic correlation of weaning weight and average daily gain between birth and weaning indicate that they are the measurements of the same character and either can be used for evaluation (Seebeck and Campion, 1964). When weaning weight is used, the weaning weight is adjusted to a standard age of weaning. In goats and sheep the common standard age of weaning used is 90 or 120 days, in cattle is 200 days (Donaldson and Larkin, 1963), 205 days (Mason and Beilharz, 1970, or 210 days (Creek, 1964).

Different authors (Ali et al., 1973; Castillo et al., 1972; Quatermain, 1973; Mittal and Pandey, 1978; Rana, 1980) have given different weaning weights for different breeds at different ages. Weaning weight also varies according to the purpose of rearing, genotype of progeny, season of kidding and litter size.

The weaning weight in the Katjang, Black Bengal and Barbari was lower as compared to some of the foreign breeds such as Anglo Nubian, Jamnapari, Alpine and Maltese, et cetera (Montemurro, 1966; Ali et al., 1973; Rajendram and Pillay, 1976; Mittal and Pandey, 1978).

2.2.1 Effect of sex

As the effect of sex on birth weight was significant it is only natural to assume that the effect of sex on subsequent body weights would be also significant as reported by Mukundan et al., (1983), Malick et al., (1986), Noraidah Ismail (1986), Wilson (1987) and Panandam (1992). The male kids are generally heavier than the females and this advantage is maintained throughout the growth period to adulthood. The difference in body weight attributable to sex is more profound in the adults than in the kids.

A study on growth rate in Barbari kids by Mittal and Pandey (1978) showed that at 3 months the males and females weighed 7.80$\pm$0.046 kg and 6.00$\pm$0.230 kg respectively. The male kids were heavier than the female at each stage of growth. As growth progressed the 3 month body weight was 7.3 kg and 6.4 kg in the male and female respectively, whereas in the Jamnapari x Katjang male and female was 11.8 kg and 10.5 kg respectively (Rajendram and Pillay, 1976). However, these differences were statistically non-significant ($P>0.05$).

Quartermain (1973) working on Zambian goats had recorded body weight at 12 weeks to be 6.6 kg (range 4.5-8.5 kg) in single-born female kids and 7.5 kg (range 4.5-10.5 kg) in single-born male kids. At 40 days the kids averaged 9.31 and 8.10 kg, with range of 5.50-11.60 kg and 6.50-10.81 kg in the male and female respectively. The correlation between weight at birth and that at 30 days was 0.83 which was quite high (Montemurro, 1966).

In another group of kids from native and Anglo Nubian crossbred dams, the 90-day body weight for the male and female averaged 12.0 kg and 10.7 kg. For the twins the weaning weight averaged 7.2 kg and 6.4 kg in the male and female Criollo goats respectively, and 12.1 kg and 11.5 kg in the male and females of Nubian goats.

Similar observations were made by Mukherjee et al., (1983) while working with Katjang goats crossed with Improved German Fawn.

2.2.2 Effect of litter size

The effect of litter size on body weight post-weaning is variable. Wilson (1987) reported the effect of litter size to be significant ($P<0.05$) until 240 days of age, whereas, Mukundan et al., (1983a) reported the effect to be significant ($P<0.01$) only during the first month, and Sharma et al., (1981), on the other hand, reported total absence of the effect on the body weights at one to three months of age.

Litter size, breed group and season of kidding had significant effect on weaning weight (Rana, 1980). Castillo et al., (1972) recorded the body weight at weaning for singles averaged 13.2 kg and 10.1 kg for Criollo x Nubian, 8.0 kg and 6.6 kg for Criollo and 12.9 kg and 11.4 kg for Nubian. For the twins the weaning weight averaged 7.2 kg and 6.4 kg in the male and female Criollo goats respectively and 12.1 kg and 11.5 kg in the male and females of Nubian goats.

2.2.3 Effect of breed of dam

Live weight before weaning largely depends on the genotype of the dam and mothering ability of the doe. Growth will not be affected if there is enough milk for the kid either in single litter or in multiple birth. The lack of milk and competition between the litter mates for the limited volume could affect the growth performance; and if not resorted to supplemental feeding could cause the kid to be stunted or might even cause high kid mortality. Different authors (Ali et al., 1973; Quatermain, 1973; Castillo et al., 1972; Mittal and Pandey, 1978; Rana, 1980) have given different weaning weights for different breeds at different ages.

2.2.4 Effect of breed of sire

Wilson and Katsigianis (1980) comparing the native to the Anglo Nubian crossbreds observed that for kids sired by native and Anglo Nubian bucks, the 90-day body weight was 9.3 kg and 11.4 kg respectively. In another group of kids from native and Anglo Nubian crossbred dams, the 90-day body weight averaged 12.0 kg and 10.7 kg.

2.2.5 Effect of genotype of kid

Weaning weight also varies according to the purpose of rearing, genotype of progeny, season of kidding and litter size. The weaning weight in the Katjang, Black Bengal and Barbari was lower as compared to some of the foreign breeds such as Anglo Nubian, Jamnapari, Alpine and Maltese, etc. (Montemurro, 1966; Ali et al., 1973; Rajendram and Pillay, 1976; and Mittal and Pandey, 1978). Quartermain (1973) working on Zambian goats had recorded body weight at 12 weeks to be 6.6 kg (range 4.5-8.5 kg) in single-born female kids and 7.5 kg (range 4.5-10.5 kg) in single-born male kids. At

40 days the kids averaged 9.31 and 8.10 kg, with range of 5.50-11.60 kg and 6.50-10.81 kg in the male and females respectively. The correlation between weight at birth and that at 30 days was 0.83 which is quite high (Montemurro, 1966).

The weaning weight of the Black Bengal (Ali et al., 1973) at 131.4 days (range 85-180 days) was 8.86 kg (range 4.54 to 13.64 kg).

2.3 **Post-weaning weight / adult weight**

Post-weaning growth of dairy goats has been related to age, level of nutrition, mother's adult weight, size of litter, breed and season of birth among other factors (Morand-Fehr, 1981; Galina and Silva, 1983; Palma and Galina, 1995)

Growth was found to be static when the goats were about 25 kg live weight at 14 months of age. The females increased in weight from birth to 12 months by 557% which is somewhat less than dairy cows (708% for small breeds and 825% for large breeds). From 3-12 months cattle usually increase in body weight by 187-200% which is higher than 160% for female goats. Although changes in weight were lower than for cattle, the ratio of changes in body length, height at withers and fore-chest girth from 3-12 months were nearly the same as for cattle, 120-140%.

2.3.1 Effect of sex

The mature female Zambian goat averaged 24 kg (Quartermain, 1973). The Mauritius goats, however, recorded a mature weight of 25-30 kg as compared to the Zambian goats (Fielding, 1980).

A study on growth rate in Barbari kids by Mittal and Pandey (1978) showed that at 6 months and 9 months the male and female were 11.75±1.90 kg and 9.53±0.48 kg, and 18.31±1.032 and 16.03±1.225 kg respectively. The male kids were heavier than the female counter parts at each stage of growth.

At 12 months of age (which is the market age in Malaysia), Rajendram and Pillay (1976) recorded the male and female Katjang to attain 26.4 and 24.5 kg respectively, and, the Jamnapari x Katjang crossbred achieved 31.8 kg.

2.3.2 Effect of litter size

Castillo et al., (1972) while working with Criollo, Nubian and Nubian x Criollo recorded the body weight at 6 months for the singles as 18.2 kg, 9.2 kg and 16.3 kg in the males and 16.8 kg, 7.5 kg and 13.3 kg for the females as compared to the body weight of twin births which averaged 16.8 kg, 10.3 kg and 15.0 kg in the male and 14.9 kg, 7.9 kg and 14.2 kg in the female for the three breed groups respectively. At one year old the average body weight was 24.6 kg and 18.2 kg for Nubian male and female singles and 22.7 kg and 21.0 kg for the twins. The Criollo x Nubian averaged 33.2 kg and 30.1 kg for male and female single and 31.2 kg and 28.7 kg for male and female twins.

2.3.3 Effect of Birth type

Type of birth had highly significant effect on 0-3 months growth only. A non-significant effect of type of birth on weight gain from birth to one year of age was, however, reported by Guha et al., (1968), Prasad et al., (1972) and Mukundan (1980) in dwarf breeds of Indian goats.

2.3.4 Effect of genotype of kid

Variability in the adult weight of goats is illustrated in different reports. Ali et al., (1973) reported the adult weight of Black Bengal females to be 10.45±1.8 kg. Comparing the Brown Bengal to the Grey Bengal, Mukherjee et al., (1979) noted that the Brown Bengal goats not only weighed heavier than Grey Bengal (16.2 kg vs. 15.3 kg) but were also significantly longer (45.8 cm vs. 43.9 cm) and had larger chest girth (63.9 cm vs. 62.7 cm). The local goats of Congo (Henrotte, 1961), achieved 21 kg at 18-24 months of age.

Crossbred kids at birth weighed heavier than those of a native breed (Pant, 1968; Buvanendran et al., 1974). The performance of the crossbreds as compared to the native breeds and existence of hybrid vigour have been also documented by Rajendram and Pillay (1976) and Panandam (1992) in Malaysia. The crossbreds showed hybrid vigour for 6 month weights under a particular environmental condition. In an earlier study the authors recorded the 6 month body weight as 18.3 kg for Jamnapari, 15.1 kg for Katjang and 17.5 kg for the crossbreds.

When the Jamnapari and Anglo Nubian crossbreds with local were compared with the indigenous at 6 months of age, it was found that both the crossbreds were more than twice the live weight of the indigenous Katjang goat (Jamnapari x Katjang = 24.09 kg; Anglo Nubian x Katjang = 22.36 kg). Comparing goats to sheep, Datta et al., (1963) recorded the nine month body weight of the Jamnapari male and female kids to be 24.9 and 21.6 kg respectively as compared to Bikaneri lambs which weighed 29.97 and 23.66 kg respectively.

2.3.5 Effect of year

Year of birth and sex had no effect on growth rates in any of the periods studied. Male kids had higher growth rate in 3 periods though statistically non-significant. However , Guha et al., (1968) reported a highly significant sex difference in weight gain in Black Bengal and Singh (1974) in Jamnapari goats.

2.3.6 Effect of season

Season (Knoess, 1976; Rana, 1980), sex (Mittal and Pandey, 1978) and litter size (Castillo et al., 1972) have been reported to have significant effect on live weight of goats. Knoess (1976) found that under rainfed condition in Ethiopia it was possible to produce a male kid of 20-25 kg in 10-12 months if the kid was born during the rainy season, but if birth occurred during the dry season the time to reach 25 kg would be at least 40% longer.

Data on body weight of Jamnapari kids indicated that season had significant effect only in group of 0-3 month and not on groups of 3-6 months and 3-12 months. Kids born in summer grew faster than those born in winter. Similar trend in growth rate was reported by Mukundan (1980) in Malabari goats and their Saanen half-breds. However, Dilwali (1943) and Guha et al., (1968) reported a significant effect of season on body weight gain in Jamnapari and Black Bengal goats.

2.3.7 Effect of nutrition

Studies on the growth rates of kids subjected to various planes of nutrition and weaned at 3 months of age (Devendra, 1962) indicated that the live weight at the end of 4.5 months was only 13.18 kg that is at 7.5 months of age. Under village conditions the growth rate declined from 400-500 gm per week at birth to 200-300 gm per week at 4 months of age and remained more or less constant at this level there after.

2.4 Body measurements as criteria of growth

It is accepted that body weight alone is not enough to depict growth but other body measurements such as body length, height at withers, heart girth, pouch girth, length of cannon and shank and other measurements should also be included. This data would provide information on the speed of growth processes concerned with mass, volume and length of the bones.

Comparing the Brown Bengal to the Grey Bengal, Mukherjee et al., (1979) noted that the Brown Bengal goats not only weighed heavier than Grey Bengal (16.2 kg vs. 15.3 kg) but were also significantly longer (45.8 cm vs. 43.9 cm) and had larger chest girth (63.9 cm vs. 62.7 cm). The body given purpose. It is a short time technique to maximize commercial usefulness of existing purebred breeds to develop new breeds. With the increasing demand for meat and milk products, crossbreeding has gained popularity among commercial producers, as a technique for improving production.

Crossbreeding is one technique for improving body weight in livestock and other organisms (Moav and Wohlfarth, 1973; Lesley, 1978). The wide variability in body weights and reproduction rates can be effectively utilized for improving meat production through crossbreeding. Though crossbreeding has a slow influence in changing the breed type over a large population, it is still considered or regarded as the best method for genetic improvemnet (Mukherjee, 1992). Reports of Buvanendran et al., (1974), Mishra et al., (1978), Mukherjee et al., (1983), Horst et al., (1984), Metz et al., (1985), Malik et al., (1986), Magland and Kudouda (1987), Kanaujia and Pander (1978), and Panandam et al., (1990) suggest considerable improvement in body weight, milk production, reproductive efficiency and survival in the F1 cross compared to their local contemporaries. However, this improvement is to some extent minimized in subsequent generation if selection is not practised simultaneously as has happened in the cases of the Katjang goat (Devendra, 1966; Rajendram and Pillay, 1976; Deichert, 1981; Abdul Wahid, 1987).

Crossbreeding using imported Jamnapari goats has been done in Indonesia, Malaysia, and Sri Lanka (Quartermain-measurements and body length showed highly significant ($P<0.01$) differences with respect to months and animal within treatment. They opinioned that possibly in small-sized ruminants, weight and height serve as a better criteria for assessing growth pattern, at least in the early age since there is a priority for bone growth from two axes that is from head and limb to loin region.

2.4.1 Correlation of body weight and body measurements

In the Black Bengal breed of goat (Prasad, 1977) which resembled the Katjang goat of Malaysia, the correlation of body weight with length, height, chest girth and pouch girth were significant in all the age groups (0.64, 0.57, 0.74 and 0.74, respectively) except in the adult animals with different body measurements. The correlation coefficient of body weight was highest with pouch girth (0.74) and chest girth (0.74) which was assumed as natural because the major body weight is due to these two portions of the body. Highly significant positive correlations were obtained between growth of cannon and body length and cannon length and body weight at all stages of growth studies (birth to 9 months) (Mittal and Pandey, 1978). Positive and significant correlations of body weight with the above body measurements were also reported by Mukherjee (1978) in Brown and Grey Bengal goats.

Ghanekar, Bhatawadekar and Gholap (1973) observed that external body measurements were significantly higher in 3/4 Patanwadi than in 1/2 Patanwadi sheep. It was also observed that significant positive correlation existed between length and height, length and girth, length and weight, height and girth, height and weight and girth and weight. Similar results were reported by Taneja (1982) in Marwari sheep. It is, therefore, evident that selection of one of the body measurements will produce correlated responses in the same direction as other body measurements.

The effects of various body measurements and their correlations with mohair production in the Angora goats were studied by Koratkar and Patil (1982). Sexual dimorphism in respect to body weight, body length, chest girth and height at withers after shearing was significant in agreement with Zondarkin (1952) and Gribovski (1956). The correlation of mohair yield with body weight ranged from 0.49 to 0.644, with body length ranged from 0.118 to 0.477, with chest girth ranged from 0.367 to 0.703, and with height at withers was 0.203 to 0.219 (Koratkar and Patil, 1982; Pretorius, 1970; and Marincowitz, 1971). The correlations were all positive.

Multiple regression analysis of body weight and body measurements of German Improved Fawn showed that not only the body weight but 80% of the total variation in milk yield was also related to variation in body measurements (Gall, 1973). Schadlick (1964) recorded the repeatability for body weight to be 0.97, loin length 0.97, depth of abdomen 0.91, breadth of abdomen 0.95 and for forehead to nose length to be 0.98. The correlation between body weight and milk yield was 0.132. Although abdominal depth showed the highest correlation of any linear body measurements with milk yield, its predictive value was low.

2.5 Growth Rates.

Interrelationships among various growth traits and various aspects of production are reasonably well documented in cattle and sheep which have provided criteria for selection or the basis of performance recording. In goats, few studies have been done on specific relationships between various stages of growth, and growth rates are important selection criteria because they can be easily measured and are economically important. It is evident that growth is closely related to economy and efficiency of production.

The preweaning growth rate is largely a function of the maternal performance which is largely exerted through suckling (Mavrogenis et al., 1980). Postweaning growth performance between weaning and yearling is used in conjunction with preweaning growth performance to assess the actual growth potential of the offspring by eliminating the maternal and environmental effects. Most measurements of postweaning growth involve estimation of live weight changes in time. During the post weaning period the contribution of the between dam variation become seemingly less and less and the growth rate clearly reflects the genetic potential of the animal for growth (Mavrogenis et al., 1980).

Rapid growth rate is desirable in most cases for best efficiency in meat production. Reported average daily gains (ADG) show an extreme range from 18 gm per day for native breeds to more than 200 gm per day postweaning for improved breeds on a high plane of nutrition. Some breeds of goat appear to have the potential for good rates of growth but in general growth rate is slower than for the sheep eg. 150-270 gm per week vs 300-540 gm per week.

Studies on the growth rates of local kids subjected to various planes of nutrition and weaned at 3 months of age (Devendra, 1962) indicated that the growth rate was very slow indeed about 51.9 gm live weight increase per day. Some of the factors that influence growth rate upto 20% or more are differences among breeds in size at maturity, large variations in DM intake between individual goats (Devendra, 1977), and seasonal availability of browse. Growth rate can be increased by provision of feed supplementation and drenching (Alam, 1992).

As in other domestic animals males grow faster than females (Amble et al., 1964; Mishra et al., 1978; Malick et al., 1986). Differences between castrates and intact males as regards to rate of gain is unclear. Males will gain faster in the earlier months of life (Malick et al., 1986), but as they reach sexual maturity they become temperamental, feed intake is reduced and gain slowed (Mc Dowell and Bove, 1977). Nitter (1975) found that the intact males of German Improved Fawn had higher daily gains of 270 vs 185 gm and averaged higher in dressing percentage (49.2 vs 47.6) than castrates; and yearling male castrate goats gained as little as 73 gm per day (Ladipo, 1973).

Singh and Sengar (1970) found significant breed effects in growth rate irrespective of level of feeding (overall 35 gm ADG for Barbari and 39 gm for Jamnapari). The level of protein and energy influenced rate of development. Rate of gain usually up to 12 month for kids is influenced by year, month and sex of kid. Some have found that growth rate is significantly lower in male kids from 4-8 month than from birth to four months. Rate of gain usually rises again between 8 and 12 months. Puberty and resulting lively temperament causes the setback in rate of weight gain around 6 months of age. This phenomenon has not been observed in the ram and the bull.

The similarity in rate of gain suggested that yearling Angora billies do not exhibit the degree of compensatory gain normally expected in sheep or cattle when placed on high feeding because of individual differences (Manzies and Basset, 1968).

Heritability estimates for growth rate (0.78 for weight at 7 month and 0.58 for mature size) suggest that potential for growth rate could be increased through selective breeding (Bouillon and Ricordeau, 1975; Shelton, 1961) and cross breeding.

2.6 Growth Curves.

It has been recognized by Wishart (1938) and Rao (1958) that growth rate is an important growth parameter which is not uniform at different periods of measurement and which differs from individual to individual (Prothers and

Sereno, 1982; Mc Mahon, 1985; Scott, 1985, 1987; Bertran and Biewener, 1990; Bou et al., 1987; Godfrey et al., 1991). The various anatomical parts and tissues of the body have a definite order of development and achieve their maximum rates of growth at different ages. Mayers (1960), Krause (1963), Calder (1984), Schmidt-Nielson (1982), Jungers, (1985), and McMahon and Bonner (1985), have presented several models for describing the growth pattern and suggested that variations observed between measurements at a given time were a reflection of the variations in the parameters of the model. Thus, the growth of every individual would be distinct and different individuals would follow different models.

Snedecor and Cochran (1967) have given a review of the three major non-linear growth curves. The first is the exponential growth curve which is represented by the equation:

$$w = ax^b$$

Where w is the body weight, x is the time and a and b are constants (b is always positive and greater than 1). In the logarithmic form the equation becomes:

$$\log w = \text{Log } a + b \log x$$

$$\text{or} \quad W = K + bX$$

where Y = log y, K = log a and X = log x. This equation represents a straight line with a slope b and intercept log a or K. The fractional coefficient 'b' has no biological significance but on the other hand is the ratio of the growth rate of the organ to the growth of the body which is constant. The parameter b which may be greater than, equal to or less than unity is the growth coefficient of organ weight relative to body weight.

Other instances where the allometric equations have been found to describe relative growth of various body dimensions very satisfactorily are of Kidwell and Williams (1956), Burmeister (1965), Stahl and Gommerson (1967), Stahl (1965), Trieb et al. (1976), Eisen (1976), Berg (1978), Marks (1978), Schmidt-Nielsen, (1984), Mac Mahon and Bonner, (1985). Actually there are several ways by which the relationship of organ weight and body weight can be expressed (Brody, 1945; Addis and Gray, 1950; Angerval and Carlstrom, 1963; Stahl, 1965; Sperling, 1953; Reqoeczi and Taylor, 1978; Schmidt-Nielsen, 1984; Mac Mahon and Bonner, 1985; Mattfeldt and Mall, 1987; Shohogi and Sasaki, 1987; etc.). One of the most widely used form is the simple bivariate allometric equation above. This equation has a linear relationship for many physiological parameters, (Brody, 1945, Gehr et al., 1981; Hoppeler et al., 1981).

The growth between fixed ages varies from breed to breed primarily due to the genetic differences between the breeds (Mukundan et al., 1982). The authors studied the growth curves in Malabari goats and their Saanen half-breds using linear, quadratic and exponential functions on adjusted average monthly body weights and found that linear function provided the best fit followed by quadratic function and then the exponentials indicating that growth did not stop at the

12th month but continued to grow beyond this age. Similar results were obtained by Amble et al., (1964).

On the other hand, Dilwali (1943) fitted quadratic function for growth in Jamnapari and Barbari goats and observed that the value of 'a' was negative indicating that the growth rate in general decreased as the age advanced.

The asymptotic growth curve which is also referred to as exponential decay growth curve or as the von Bertalanffy curve (Fabens, 1965; Radway Allen, 1966; Rohrs, 1961; Gould, 1966, 1975a,b) is used to describe growth which is greatest initially and decreases exponentially in time. It is expressed by the formula:

$$W = a\,(1-be^{-kt})$$

or

$$W = a - ab\,\exp(-kt),$$

Where W is the body weight, t is the time and a, b and k are parameters characteristic of the animal being studied and they do not change as the animal grows.

Von Bertalanffy (1960) has pointed out the good fit obtained with this curve as observed in a wide variety of cases presented by Hancock, (1959), Graham (1956), Beverton and Holt (1957), Butterworth (1961), Fabens (1965), Hayden and Gambino (1966), Grover et al. (1970) and Inch et al. (1970). The other common growth curve which is S-shaped is known as the logistic curve and is described by the equation proposed by Nair (1955) and used by Carmen (1965):

$$W_t = \left(\frac{k}{1+be^{-at}}\right)-at$$

Where W_t is the body weight at time t, and k, b and a are the parameters of the equation to be estimated.

Yet another type of an S-shaped growth curve was proposed by Benjamin Gompertz in 1825, who suggested an asymmetrical sigmoid curve that would be expressive of the law of human mortality. This has since been used by actuaries for graduating life tables and even by statisticians, though to a lesser degree, for describing the growth of industries. Windsor (1932) discussed its application to the growth of an organism for cases where the relative growth rate decreases exponentially with time. One form of the formula is:

$$W = ka^{b^{t}}$$

In the logarithmic form, the above equation is reduced to a simple linear regression:

$$\log W = \log k + (\log a)\, b^{t}$$

Where W, k, a, b, and t are as above.

The Gompetz-type model used by Laird (1965) is as follows:

$$W = W_o \operatorname{Exp} \{\frac{A_o}{Alpha}(1-\operatorname{Exp}(-at))\}$$

Where W is the weight or volume at time t, W_o and A_o are the initial mass and initial specific growth rate respectively for the period of observation and 'a' is the rate of exponential decay of the specific growth rate.

The growth of several species of animals has been demonstrated to fit the Gompetz curve. Examples include heart of a chicken (Medawar, 1940), Hereford cattle (Kidwell et al. 1952), Dark Cornish fowl (Kidwell and Williams, 1956, Abdul Wahid, 1973), avian and mouse embryos (Laird, 1966), beagles, (Tyler and Norris, 1968), the rat foetus (Sikov and Thomas, 1970), white rabbit (Mc Cormick et al., 1972), and dogs (Anderson and Goldman, 1970; and Deaver et al., 1972). Recently, Seber and Wild (1989) had presented that the Gompertz model was the best goodness-of-fit model for animal growth.

A slight modification of the Gompetz-type model has been proposed by Laird (1965, 1966, 1967) who has pointed out that during the postnatal growth of many organisms, growth continues beyond the theoretical upper limit predicted by the early growth measurements. This later growth is more or less linear on a plot of weight against age, and this postnatal growth can be defined by the compound Gompetz-linear model which is an extension of the Gompetz-type model:

$$W = W_g + B \{\int_{t=0}^{t=t} \frac{W_g}{W_g(^{\sim})} \propto t\}$$

where W is the weight at time t.

The Gompetz and logistic curves are similar in that they both described increasing trend which is increasing by a decreasing percentage of growth. They differ in that the Gompetz curve involves a constant ratio of successive differences of log W while the logistic curve entails a constant ratio of successive differences of the 1/W values. Growth can also be fitted by the polinomial equation:

$$W = a_o + a_1 t + a_2 t + a_3 t + \ldots\ldots$$ (Kidwell and Howard, 1969)

where W is the body weight measured at different time (t) intervals, and a_o, a_1, a_2........ are fitted constants.

If measurements (body weight, height, length, etc.) are made at equally spaced intervals, the methods of fitting by orthogonal polinomials used by Fisher (1937), Snedecor (1956) and Carlson (1978) can be used. This is done because sometimes the Gompetz model does not provide a satisfactory fit as in the case where the animal either lost weight in one or more weeks or failed to gain for two or more consecutive weeks (Kidwell and Howard, 1969).

2.7 **Crossbreeding**

Crossbreeding is the mating of animals of two or more breeds, varieties, strains or lines. It is used either to introduce new genes into an existing population effectively resulting in the formation of a new breed, or to enable advantage to be taken of heterosis.

Breed crossing is more important than crossing of lines and it is done to exploit the potential of different breeds by combining the desired qualities in them. This has been used to develop or evolve new breeds or synthetic breeds and for the production of commercial crossbreds. The dominance of favourable alleles results in the crossbreds being better than mean of purebreds.

Crossbreeding is used to combine as many favourable traits and the resultant crossbred being best suited for a given purpose. It is a short time technique to maximize commercial usefulness of existing purebred breeds to develop new breeds. With the increasing demand for meat and milk products, crossbreeding has gained popularity among commercial producers, as a technique for improving production.

Crossbreeding is one technique for improving body weight in livestock and other organisms (Moav and Wohlfarth, 1973; Lesley, 1978). The wide variability in body weights and reproduction rates can be effectively utilized for improving meat production through crossbreeding. Though crossbreeding has a slow influence in changing the breed type over a large population, it is still considered or regarded as the best method for genetic improvemnet (Mukherjee, 1992). Reports of Buvanendran et al., (1974), Mishra et al., (1978), Mukherjee et al., (1983), Horst et al., (1984), Metz et al., (1985), Malik et al., (1986), Magland and Kudouda (1987), Kanaujia and Pander (1978), and Panandam et al., (1990) suggest considerable improvement in body weight, milk production, reproductive efficiency and survival in the F1 cross compared to their local contemporaries. However, this improvement is to some extent minimized in subsequent generation if selection is not practised simultaneously as has happened in the cases of the Katjang goat (Devendra, 1966; Rajendram and Pillay, 1976; Deichert, 1981; Abdul Wahid et al., 1987).

Crossbreeding using imported Jamnapari goats has been done in Indonesia, Malaysia, and Sri Lanka (Quartermain, 1979) and the crosses are said to have improved growth, reproduction and carcass weight (Obst et al., 1980). Besides Jamnapari, Anglo Nubian, British Alpine, Saanen, Toggenburg as well as the Australian Feral goats have been imported to crossbreed with the local indigenous at Kluang and Serdang, but due to the problems of adaptability, the does failed to breed and the growth of the kids was below the potential of the breed.

2.8 Factors affecting milk production in goats.

Although the goat is primarily reared for meat production, milk is also another important product from the goats both in the developed and developing countries. The tremendous production efficiency of milch goats, their high yield of milk which is used for dairy purposes, culinary purposes and in the nutrition of those infants and invalids who are allergic to cow's milk, makes them an extremely valuable asset to man.

Milk is a complex fluid containing proteins, fat, carbohydrate, vitamins, minerals, enzymes, etc. The nature and concentration of the above constituents vary with production and processing factors. Goat milk composition varies appreciably according to breed, the locality, the stage of lactation,the season of the year, the feeding and management, the incidence of oestrus and the state of health of the nannies.

It is evident that there is great variation in the production of milk among breeds. It can range from 0.16 kg (Clamohoy et al., 1983) in the indigenous goat to 4.2 kg in the Saanen (A.G.B.S.J., 1978). The best dairy goats can produce on average 2 kg/day but there are those that produce less.

There are large differences between the milk producing capability of the temperate and tropical breeds of goats (Table 2.01). Variation between individual goats is hereditary but is superimposed by environmental factors. Milk yield of tropical breeds in the tropics ranged between 60 to 500 kg (average 280 kg), temperate breeds in tropics ranged from 143 to 1011 kg (average 577 kg) and temperate breeds in temperate countries ranged from 245 to 2707 kg (average 1476 kg) (Mukherjee, 1991). A comparative performance of some temperate breeds in different environments is illustrated below:

Temperate breeds	Temperate environment	Tropical environment
Saanen	682 kg	389 kg
Alpine	642 kg	283 kg
Toggenburg	631 kg	267 kg

Besides breed, age (Mittal, 1979), plane of nutrition (Sachdeva et al., 1974; Singh and Mudgal, 1985), season, stress (environmental or otherwise), milking procedures, stage of lactation (Agrawal and Bhattacharya, 1978; Singh and Sengar, 1990; Kala and Prakash, 1990; Prasad et al., 1990) and disease also influence the daily milk yield and total milk output.

Table 2.01: Milk producing capability of some breed groups of goat.

Breed group	Daily Yield (kg)	Lactation yield (kg)	Lactation length (days)	References
Alpine	1.2	297	233	Bhatnagar & Mishra, 78
Alpine	3.44	904	263	Hofmeyer, 72
Br. Alpine		274	109	Devendra, 71
Br. Alpine		1037	287	Joubert, 74
Fr. Alpine	1.4	313	219	Dickson et al 92
Fr. Alpine		263	140	Mabrouk et al 89
Anglo Nubian		289	240	Gill & Dev 72
Anglo Nubian	1.0	191	195	Dickson et al 92
Barbari	0.5	67	129	Bhatnagar & Mishra 78
Barbari	0.8	96	152	Acharya 82
Beetal	0.91	188	207	Knob 71
Beetal	0.9	188	224	Bhatnagar & Mishra 78
Beetal	1.3	174	182	Acharya 82
Beetal		226	192	Kamujia et al 89
Black Bengal	0.24		32	Hussain 93
Black Bengal		53	119	Acharya 82
Boer	1.3	160-228	120	Ueckermann et al 74
oer	1.5-2.5	63-175	84	Raats et al 83
heng du Brown	1.0-1.5	150-240	150-250	Jiang et al 87
amascus	1.9	523	269	Louca et al 75
amascus		600-700	276	Gall 75
era Din Pannah	1.5	240	140	Khan et al 92
ndi Thai	0.75	162	197	Bhansiri et al 81

(cont.)

Jamnapari	0.5	90	143	Bhatnagar & Mishra 78
Jamnapari	1.0	158	188	Acharya 82
Jamnapari		280	270	Mishra 78
Katjang	0.5		90	Metz 90
Katjang	0.2			A. Rahman & M.Khusahry 79
Katjang	0.6-0.8	90	126	Devendra & Burns 83
Katjang		31.5	180	M.Khusahry 83
Katjang x German Fawn	0.9	165.4	180	Stemmer 93
Katjang x A. Nubian	1.3	296	235	Paramsothy 57
Kilis	0.8-3.2	95-441	102-343	Soenmez et al 74
Kilis	1.1	80-642	260	Eker et al 75
Kutchi		85	130	Mishra 78
Leizhou	0.3-0.4			Jiang et al 87
Ma		50	136	Pu et al 87
Ma x Saanen		135	235	Jiang et al 87
Ma x Toggenburg		123	189	Jiang et al 87
Malabari		190	210	Mishra 78
Malabari	0.45	54	172	Acharya 82
Marwari		109	209	Acharya 82
Marwari	0.9	75	120	Mishra 78
Mongolia	0.2-0.4	90-150	150-180	Jiang et al 87
Nubian	0.7		112-224	El-Gallad et al 88
Nubian	1.5-2.0	.	.	
Saanen	1.2	393	287	Bhatnagar & Mishra 78
Saanen	0.9-3.0	139-863	133-364	Soenmez & Sengonca 60

(cont.)				
Saanen	1.06	295	278	Garcia et al 72
Saanen		532	300	Pegg 57
Saanen x Beetal		370	282	Chawla & Bhatnagar 85
Saanen x Malabari		127	191	Acharya 87
Sirohi		130	180	Kropf et al 92
Sirohi	1.0	171	175	Acharya 82
Sirohi		245	180	DeGroot et al 92
Taiwanese	0.8			Hwang et al 90
Thai x	1.1	379	326	Bhansiri et al 81
Toggenburg	2.0	683	343	cited by Stotz 81
Toggenburg	1.0	283	283	Garcia et al 72

Milk production is influenced to a certain extent by genotype, genotype x environment and nutritive values of diet including protein content and protein:energy ratio. Thus, some of the factors that contribute to the differences in quantity and quality of milk are inherent genetic differences among breed groups, level of nutrition, age and weight of animal, season of parturition, milking technique and some environmental factors (Sands and Mc Dowell, 1978; Acharya, 1992; Stemmer, 1993).

2.8.1 Variation due to genotype

Variation in milk yield between individual goats may be due to hereditary differences superimposed by differences due to environmental factors. Genotype influences both lactation yield and lactation length.

The indigenous tropical breed groups are usually low producers of milk compared to the temperate breed groups (Stemmer, 1993). Daily milk yield of the tropical breeds in the tropics range from 0.5 to 1.8 kg (average 1.4 kg), of temperate breeds in the tropics range from 1.3 to 3.0 kg (average 2.6 kg) and of the temperate breeds in the temperate countries range from 1.4 to 3.7 kg (average 3.2 kg). Under subtropical conditions British Alpine and Toggenburg have yielded 1037 kg and 991 kg respectively over a 285 day lactation and therefore has potential for dairying and for crossing with the local goat breeds.

The Jamnapari breed which is originated from India has been successfully introduced into South East Asia, South

America and Africa. The average milk yield is 250-300 kg in 250 days with top yields of 500-800 kg. The Damascus goat yields 300-600 kg for a lactation period of 240 days. Anglo Nubian produces 250-300 kg but also contributes hardiness, prolificacy, adaptability and improved growth. For the Saanen goat milk yields of 500-800 kg can be considered an average performance under tropical condition, but top yields of 1200 kg in the Carribean and 1060 kg in South Africa have also been achieved (Peters et al., 1986/87). Milk yield in India is 280 kg in 270 days for Jamnapari, 195 kg in 224 days in Beetal and 125 kg in 227 days for Barbari goats (Mishra, 1978).

The Chengdu Brown of China is reported to yield more than 1 kg/day (Jiang et al., 1987). The Boer of South Africa produced 1.5-2.5 kg daily during 84-120 days (Ueckermann et al., 1974). Crossbreds of Alpine or Toggenburg with locals produced 0.3-1.2 kg/day (Bhatnagar and Mishra, 1978; Kropf et al., 1992; Jacob, 1992), whereas, the Saanen crossbreds produced 0.4-2.3 kg/day (Ecker et al., 1976; hansiri et al., 1981; Jiang, 1986; Acharya, 1987; Guney et al., 1992).

Latest work by Stemmer (1993) in University of alaya indicated that genotype significantly (P<0.05) ffected total yield and early lactation yield while yields n late lactation were not affected by genotype.

Genetic differences influence composition of goat ilk. Among the temperate breeds, the Nubian produce milk which is richer in fat and SNF (Prakash and Jennes, 1968; Devendra, 1972). The percentage of milk components in Katjang goats are much higher than crossbreds (Metz, 1990; Mukherjee, 1992; Stemmer, 1993). They also showed that the local goats of Malaysia have high fat content which ranged from 4.6 to 6.2% (Mukherjee, 1991).

The concentration of total protein, whey protein and casein vary widely due to breed and stage of lactation (Singh and Singh, 1980a, 1980b). The free fatty acid content of goat milk also varies with breed and stage of lactation.

Goat milk is a relatively poor source of essential fatty acids: linoleic, linolenic and arachidonic acids. Total N in Jamnapari goats milk has been reported to be 0.749% and is higher than that reported by Macy et al., (1983) in temperate goats, Sirry and Hassan (1954) in Egyptian goats and Devendra (1972) in imported goats in the tropics. Total Calcium and Phosphorus content of goat milk and concentration of trace elements is similar to cow's milk but goat milk has much lower contents of vitamin B_6 and B_{12}. The goat's milk is devoid of carotenoid pigments and carries vitamin A intact.

2.8.2 Effect of persistency

Total milk yield depends on persistency of milk production (Mukherjee, 1994). Higher producing does are found to be less persistent than lower producing does (Gipson and Grossman, 1990). Lactation length has a significant effect on lactation yield (Prakesh and Khanna, 1972). The maximum daily yield has been reported to be achieved between the eighth and twelveth week in temperate breeds (Rako 1950; Sands and McDowell, 1978); between second and tenth week (Gall, 1981b); second week in Red Sokoto (Ehoche and Buvanendran, 1983) and week 1 to 3 in Nubian (El-Gallad et al., 1988). The lactation curve tends to slope steeply after the twelveth week and the milk tend to dry out by the 38th week. In those animals that lactate for two years, there is another peak production at 28 weeks which declines at 68th week (Malins, 1971).

Lactation length of goats in temperate countries is usually 200-300 days with one kidding per year (Gall, 1981). Lactation length of tropical breeds in tropics range from 126 to 272 days (average 199 days), temperate breeds in tropics range 106-336 days (average 221 days) and temperate breeds in temperate countries range 180-730 days (average 455 days), though the normal lactation length varies between 37-48 weeks (Stemmer, 1993).

2.8.3 Effect of nutrition

Although the goats can exist on browse and many aromatic and other weeds refused by other ruminants, milk production can be increased by improved stability of the composition of the goat's diet. It has been demonstrated that dairy goats increased their milk production when given energy (Morand-Fehr and Sauvant, 1980) or protein supplement (Hadjipamayiaton, 1987), although response was limited by the milk potential of the breed (Zoweta et al., 1985; Gihad et al., 1987). Dairy goats that produce 1.2 kg and above per day are supplemented with concentrate feeds to replace the nutrients lost through the milk. Earlier, the mineral requirements and potential toxicities had not been established conclusively for goats as such the NRC (1985) requirements for sheep were used for the goats until the specific goat requirements were established.

Milk composition was not affected by the different management systems (grazing on natural pastures and stall feeding) (Museio, et al., 1992).

Merlin et al., (1988) reported that type of feed affected the total protein content of milk, while fat content was not altered. Total daily milk fat and protein yield of the Alpine and Saanen in Italy were increased ($P<0.05$) by feeding liquid whey. Liquid whey fed to dairy goats as supplementary energy source improved milk yield and quality Egwu, et al., 1995. However, Rubino et al., (1995) working ith Maltese and Rossu Mediterranea goats found no ignificant difference between breeds or feeding regime in otal milk production.

Water deprivation for 48 hrs results in ower milk volume, and higher lactose and protein levels Dahlborn, 1987).

.8.4 Effect of age and weight of doe

Milk yield normally increases with body weight. aximum daily output reaches between 8 and 12 weeks after dding, whereas maximum lactation yields are recorded etween 4 and 6 years of age.

While studying the effect of certain growth attributes on milk production traits in Barbari goats, Mittal (1979) noted that body weight and all body measurements showed an increasing trend with age, with significant differences (P<0.01). The age of goat was significantly correlated with daily yield, lactation yield and fat content. Body weight was found to be highly and significantly correlated with the three production traits.

The correlation between cannon length and above production traits was very low. Tsonchev (1978) also recorded significant correlation between body weight and milk yield (0.54 in first lactation, 0.36 in second lactation, 0.35 in third lactation and 0.53 in fourth lactation).

Gall (1973) showed that about 60% of the variation in milk yield was attributable to body weight, rumen volume, skeletal size, muscle volume and body fat. Body weight was correlated significantly with milk production in Don goats (Orlynskii and Zaporozhsev, 1972). For 136 dam-daughter pairs of Don goats, milk production in the first lactation had a .39 correlation with body weight. In the second lactation this correlataion was 0.43. Lampeter (1970) calculated the correlation between body weight at kidding and milk yield as .23 to 0.33 and as 0.19 to 0.29 the correlation between 5 eeks after kidding with milk yield.

Stemmer (1993) reported that the effect of parity as not significant (P>0.05) although earlier Sachdeva et l., (1974) and Roy et al., (1992) showed that parity had a ignificant effect on milk yield. Neither litter size nor month of parturition had any significant effect on milk yield. In Philippines, the native goats gave 66.33±17.61 kg on the average where the bigger animals gave 146.98 kg in 243 days lactation and the smallest gave 19.11 kg in 117 days lactation. Milk in the morning was more than that in the evening (Clamohoy et al., 1959).

2.8.5 Effect of season

Goats have greater ability to withstand both hot and cold conditions provided the humidity is low. Goats are quite sensitive to cold but can withstand high temperature. The elevated temperature can disturb goat heat-regulatory mechanism which influences its morphological, physiological, behavioural and productive adaptability and subsequently milk production and quality.

Goats kidding in winter had higher milk fat and total solid than those kidding in Spring (Kala and Prakash, 1990). Seasonality in fat and SNF content is well documented (Chandan et al., 1992). Fat may vary as much as 2% and SNF as much as 1% depending on the season. The low level of fat and SNF in goat milk during late summer coincides with low levels generally observed in the fourth month of lactation (Prakash and Jenness, 1968).

Important considerations in the genetics of dairy goats performance are relationships between breeding season and kidding interval, kidding percentage, twinning percentage, triplet percentage, birth weight, and gestation length. The main selection objectives for dairy goats are yield and quality of milk (Ricordeau et al., 1992).

2.8.6 Effect of milking technique

Milking is done after weaning or when animals are still nursing their young. It has been shown that combined suckling and milking results in greater production of milk than without suckling (Acharya, 1992).

Frequency of milking and milking procedure also influenced lactation yield. Does milked twice a day yielded more milk. Machine milking have demonstrated higher yields compared to hand milking (Bouillon, 1975).