Chapter - 2

Review of Literature
Scientists from all over the world have conducted a lot of research work and reported energy and protein requirements for different Indian and exotic breeds of goat. But not a single study was conducted to determine the energy and protein requirements of Jaunpuri goat. In this direction, information available regarding different breeds of goat are summarised as under.

Sengar (1980) reviewed 20yr of Indian research on protein and energy requirements of goats. Aspects were divided into protein requirements from N - free feeding studies, energy and protein requirements from N- free feeding studies, energy and protein requirements based on metabolism trials and N-balances and requirements based on feeding trials.

Rajpoot (1976) estimated requirements for lactation with a feeding trial on 19 goats. Digestible crude protein requirements for gestation and for maintenance during lactation were 5.55 and 4.95 g/Kg body $W_{kg}^{0.75}$ respectively and for production of 1Kg 4% FCM was 46.56g corresponding requirements for digestible energy
were 221.79 and 198K cal/Kg body $W_{kg}^{0.78}$ and 1520 Kcal respectively.

Chakraborty et al (1982) reported digestible crude protein requirements 28.4g daily, with minimum 0.662g/Kg or 14.56g for a goat weighing 22Kg.

Devendra (1983) reported that the energy and protein requirements during pregnancy of 5 adult Katjang goats. The daily DM intake during pregnancy was 2.53% of body weight equivalent to $57.29/W_{kg}^{0.78}$. The mean daily live weight gain during the entire pregnancy period was 50g and body weight was significantly correlated with intake of metabolizable (ME) and of digestible energy (DE). The mean daily ME intake and digestible crude protein (DCP) requirement based on measurements during the last two months of pregnancy were 602.5KJ /$W_{kg}^{0.78}$ and 3.6g./$W_{kg}^{0.78}$ which were 14.0% and 20% higher, respectively, when the entire five months pregnancy period was considered. The relation between DE and DCP was 1MJDE=4.7g DCP. The results also indicated an increased requirement of 10%for ME and 44% for DCP for twin kid compared with single kids born.

Chandra et al (1984) worked with 12 non -lactating Beetal goats for 50 days weighted 40-57kg were given wheatstraw to
appetite and a concentrate mixture containing 0, 1 or 2% urea. The type of diet had no effect on nutrient intake, including DM, digestibility of crude protein (CP) and energy and nitrogen balance. The estimated daily maintenance requirements in g/W kg^{0.75} were CP 6.03 and digestible CP 3.53.

Kunjikutty et al (1985) worked for 125 days with 12 female Malabari goats of 4 to 5 years old fed diets based on Jack(canavalie esiformis) leaves and cassava flour to provide 75, 100 or 125% of a feeding standard (0.09 lb digestible crude protein and 0.9 lb starch/100 lb body weight).

Total daily digestible nutrient requirements for maintenance was 8.73 g 0.34 g/kg body weight corresponding to 7.59 g 0.30 g starch equivalent.

Nawab et al (1985) suggested on the basis of the evidence that the daily requirements of DCP and ME respect. per W kg^{0.75} are 2.6 g and 125 kcal for maintenance of non-producing goats, 3.9 g and 160 kcal for maintenance of lactating goats and 50 g DCP and 1220 kcal ME per kg milk with 3.5% protein and 4.5% fat for milk production.

Nawab et al (1986) studied with 18 Beetal goats for 47 days
in the early stage of their 2nd and 5th lactation were given ration supplying the same amount of DCP but with energy 125,100 and 75% of recommended values. Daily intake were DM 110.94 and 77g, TDN 88.74 and 61 g and average daily milk yield 773,535 and 393g respectively; Digestibility of protein, fat and Cellulose increased significantly from 70.9 to 74.3, 72.3 to 88.2 and 72.1 to 77.8% with increasing amount of energy in the diet. For maintenance of lactating goats TDN 44.89g/W_{kg}^{0.75} was required and for production of 1Kg. Milk 794.2g TDN.

Lu et al (1987) reviewed the evidence, progress, concepts and source of variation in the assessment of energy and protein requirements for growth and lactation in goats. Average growth requirements of 90 goats of 4 to 8 month old were 13.6 Kcal digestible energy (DE) or 12.3 Kcal Metabolizable energy (ME)/g gain and 0.65 g crude protein or 0.43 g digestible protein/g gain. Average lactation requirements of 144 goats from 0 to 20 weeks after parturition were 1415 Kcal DE or 1159 Kcal ME/Kg 4% fat corrected milk.

Colombani et al (1988) worked in two trials with 4 castrated male goats weighing about 50 Kg, digestibility of energy and protein of 2 cut lucerne and Trifolium pratense hays were
estimated. Mean daily DM intake was 87.97 and 65.05 g/Kg live weight\(^{0.78}\) corresponding to nutritive value of 1.10 and 1.31, respectively. Apparent digestibility of crude protein was 70.8 and 64.71 and of gross energy 54.44 and 54.31%. Requirements for digestible protein were 2.24 and 2.41 g and for metabolizable energy 0.368 and 0.409 MJ/ live weight\(^{0.78}\).

Bhaket et al (1987) studied the growth performance of 20 indigenous male goats of Bihar (3 months old) given concentrates with 17, 21, 25, or 29% crude protein (CP) and green para grass (Branchiaria mutica). In a 13-week trial, growth rate increased with increasing dietary CP and maximum growth was with 25% CP. DM intake was not affected by CP content of concentrates. CP and crude fibre digestibilities were not influenced by treatments but DM, nitrogen free extract and ether extract digestibilities were lowest in group I. It is suggested that a daily requirement of DCP 0.266 g/g gain was optimum for the growth of male indiginous goats.

Abate (1989) worked on twenty goats, aged 7 months and weighing between 13 to 18 Kg, were given diet containing 0, 20, 40 and 60% coffee palp and hay adlibitum for twenty weeks. ME intake was estimated in vitro during 12 and 8 week periods and related to live weight gain in a regression involving 40 sets of
data. A maintenance requirement of ME 556 KJ/W\text{kg}^{-0.75} \text{day}^{-1} was calculated, which was similar to some reports in the literature but exceeded other by 20%.

Onwuka et al (1989) studied with 20 west African Dwarf goats, 1 to 2 years old weighing 11 to 21 Kg, were given diets containing 0, 25, 50, 75 or 100%. Cassave laves supplemented with dried cassava peel for 3 months. Feed intake and live weight changes showed that digestible crude protein (DCP) intake of 0.51 g day\textsuperscript{-1} Kg\textsuperscript{-0.734} and metabolizable energy (ME) 97.6 Kcal day\textsuperscript{-1} Kg\textsuperscript{0.734} were required for maintenance. Corresponding values for liveweight gain were DCP 0.05g day\textsuperscript{-1}Kg\textsuperscript{-0.734} per g and ME 378.8 Kcal per Kg gain. Nitrogen utilization improved with increasing dietary energy levels.

Aguilera et al (1990) used twelve goats of the Granadina breed in mid and late lactation in two consecutive years to estimate their protein and energy requirements for lactation. The goats were singly fed on diets based on pelleted lucerne hay and barley. A total of 6 balance experiments were made. Gas exchange was measured using open-circuit respiration chambers. Total daily endogenous N, endogenous urinary N and maintenance requirement for N in lactating goats were 244 and 218 Kg N/W\text{kg}^{-0.75}, and 478 mg
total $N/W_{kg}^{0.75}$, respectively, from regression equations. There was a constant efficiency of use of dietary $N$ for milk $N$ plus retained $N$ of 51.0%. The daily maintenance energy requirement was estimated to be $401 \text{ KJ ME}/W_{kg}^{0.75}$. When estimating the corrected milk yield as milk energy $+(0.84 \times \text{negative energy retention}) + (1.05 \times \text{positive energy retention})$, regression analysis indicated that the overall efficiency of use of ME for lactation was 66.7%.

Ghosh et al (1990) studied on goats of 8 to 10 months old. Goats were fed on a concentrate mixture in which 100 or 50% of their crude protein requirement was provided by Leucaena leucocephala seeds. There were no significant differences between the 2 groups in nutrient digestibility and the balance of nitrogen, calcium and phosphorous was positive. L. leucocephala seeds contained 21.43% digestible crude protein and 73.72% total digestible nutrients. The results suggested that L. leucocephala seeds are a good source of protein, energy and minerals and can be used as component of concentrates for goats.

Teh et al (1991) studied protein and energy requirements and concluded that the average growth requirement of post weaned dairy goats was 13.6 Kcal DE or 12.3 Kal ME/g of gain and 0.65g CP/g of gain. Av. lactation requirement during early lactation was
Brun-Bellut et al (1991) reviewed nitrogen requirements of dairy goats for maintenance requirement of digestible crude protein was 1.9 to 3.7 g DCP/W_{kg}^{0.75} and efficiency of milk protein production from digested protein was 0.70. Rumen microbial protein was estimated to be 100 to 160 g/Kg dry organic matter. It seemed that urea in milk or plasma and urinary excretion can be utilized to estimate N status of goats.

Hadjipanayiotou et al (1991) stated that the growth rate of early weaned (52 days old) kids increases with increasing dietary protein concentration up to 180g CP/Kg feed DM. Data on N requirement of growing goats differ significantly. However, without consideration of physiological stage, growth rate, dietary energy, density and microbial degradation in the rumen, the NRC (National Research council) recommendations for goats (CP 0.28 g/g body weight gain) were comparable to those of the Agricultural Research council (CP 0.20–0.38 g/g body weight gain) and NRC (CP 0.30 to 0.36 g/g body weight gain) for sheep.

Alam et al (1991) studied energy and protein utilization by slaughtering 28 kids and 28 lamb having 13.8 Kg and 23.0 Kg body weight respectively. It was concluded that with high-quality
forage used to promote liveweight gain, the utilization of forage energy was similar in kids and lambs and that the efficiency of utilization of absorbed protein for protein deposition was lower than expected in both species.

Sanjiv et al (1991) reported that 20 female Gaddi goats (2-3 months old) were given a diet of concentrate plus white clover hay for 46 weeks that met the requirement (National Research council 1981) for crude protein (CP) and digestable energy (DE) (group 1) or supplied as a percentage of the requirements 115,115,85, and 85 CP and 115,85,115 and 85 DE (group 2-5 respectively). For the five groups, final body weight average 37.09, 40.05, 26.41, 41.98 and 27.90 Kg and feed conversion 13.59, 13.21, 15.90, 11.72 and 14.75 Kg DM intake/Kg gain (P<0.05 for both trails). They concluded that supplying 85% of protein requirement may be satisfactory; 115% of energy requirement gave better results.

Silva et al (1991) studied with 36 lactating goats from day 20 after parturition for 60 days. Goats were restricted in intake of metabolizable energy (ME) to that for maintenance or with additional 20 or 40% ME for production or were given feed freely. DM and protein intakes were greater for goats fed freely than for the other groups (P<0.05). Body composition did not differ among groups.
The equation used to estimate empty body weight in g/Kg live weight was \( Y = 2.02 + 0.71x \); where \( Y \) = empty body weight and \( X \) = live weight. Daily protein losses were estimated by the equation \( \log Y = 3.900 - 0.985 \log X \); where \( Y \) = g protein/Kg weight loss of empty body and \( X \) = weight of empty body. Protein gains were estimated using the equation \( \log Y = 1.873 + 0.381 \log X \); where \( Y \) = g protein/Kg weight of empty body and \( X \) = weight of empty body. The equation \( A = 0.15 LW^{0.54} \) was used to related body area (A) in M² and live weight (LW) in Kg.

Sahlu et al (1992) studied the effect of protein intake on nutritional state and performance with 44 primiparous Alpine goats during the second half of pregnancy and lactation. Goats were bred, confirmed pregnant and given a diet with 9% crude protein and metabolizable energy 2.04 Mcal/Kg DM for 2 week of pregnancy. Data suggested that low protein diet may be inadequate to meet protein requirement during the late gestation, but there was no apparent advantage in feeding the high rather than the medium protein diet. Intake of CP for the medium protein diet, 9.8 g/Wkg\(^{0.75}\), was 40% above NRC recommended values.

Reuben (1992) studied with 12 castrated cameroonion dwarf goats, 9-12 month old and weighting 8-13.5 Kg for 70 days
in a split plot experiment. The main treatments (protein sources) were unextracted soyabean meal and groundnut cake, while the subtreatments (protein source level) were 150 and 125 g/day. In addition, cassava flour 150 g/day and fresh Guatemala grass (Tripsacum laxum) were provided. Faeces and urine were collected during the last 7 days of the experimental period. No significant differences were observed among treatment in DM and CP intakes and digestibilities. For the two protein sources, respectively, metabolic faecal nitrogen estimated were 2.59 and 2.81 g/Kg DM, endogenous urinary N 0.16 and 0.25 g/W_{kg}^{0.75} daily, biological value 78 and 93%, net protein utilization 69.04 and 82.4% and the digestible CP requirement for maintenance 1.56 and 1.09 g/W_{kg}^{0.75} daily, and for growth 8.18 and 10.21 g/Kg daily (53 and 62 g/day).

Vaicu et al (1993) fed to suckling kids diets consisted of lucern hay, oat hay, maize, wheet brane and mixed feeds. Availability of energy and protein varied depending on physiological state and age. In pregnant goats, 21% of metabolizable energy (ME) was used as not energy for pregnancy. The amount of energy required for maintenance was 0.400 MJ/W_{kg}^{0.75}. The availability of digestible protein in the intestines (PDI) for pregnancy was 41.2q 3.1%, while
the amount of protein required for maintenance was $2.32 \text{ g/W}_{kg}^{0.75}$. In lactating goats 60.7% of diet ME was used as net energy, and 58.9%, of PDI as milk protein. Young femal goats had a daily net gain between 173 and 60 g; protein retention varied between 23g (month 2) and 12g (month 8) and that of fat between 8g (month 1) and 24g (month 6). Energy and protein requirements for maintenance were ME $0.45 \text{ MJ/W}_{kg}^{0.75}$ and PDI $2.43 \text{ g/W}_{kg}^{0.75}$, respectively. Net efficiency of ME for growth was 46.2% and of PDI for protein retention was 50.1%.

Cheema et al (1994) conducted study before and during pregnancy of dwarf goats, 2 to 3 years old weighing 15 to 20 Kg initially. These goats were given free access to chopped green fodder and dry feed (29% cotton seed oil meal 20% wheat bran, 25% molasses, 20% rice polishings, 4% wheat straw, 1% urea and 1% common salt). Average weight, which was 17.8 Kg before pregnancy, increased to 18.6, 21.00 and 25.15 Kg in early, mid and late pregnancy, respectively. Mean total digestible nutrients taken before and during early, mid and late pregnancy were 0.764, 0.887, 0.962 and 1.204 Kg daily. Requirement for DE during the same period was 14.06, 15.8, 17.7 and 22.2 MJ daily and utilization of ME was 485, 520, 517 and 542 KJ/W$_{kg}^{0.75}$. Ratio between percentage
increase in body weight and ME (with that before pregnancy as 1:1), were 1:2.79, 1:1.42 and 1:1.40 during early, mid and late pregnancy.

Pralomkarn et al (1995) conducted an experiment with 24 male weaner goats (body weight 15.7 g 0.45 Kg) and fed a concentrate diet (30% palm kernel cake; 44% maize, 17% soyabean meal, 5% fish meal) at maintenance (M), 1.2M, 1.4M or ad libitum for 3 months. The goats were purebred Thai, 75% Thai and 25% Anglo- Nubien (AN) or 50% Thai and 50% AN. There were no differences between genotypes for final body weight or DM intake. Goats of all genotypes fed adlibitum had higher (p<0.05) DM, OM, NDF and ADF digestibility coefficient than did goats fed at 1.2M or M. Linear regression equations combined across genotypes were used to calculate daily ME for maintenance (376, 18.5 KJ/Wkg\(^{0.75}\)) and ME for growth (25.9, 2.4 KJ/g). Minimum daily nitrogen requirement for maintenance of body weight was dietary CP 4.4, 0.24g/Wkg\(^{0.75}\) and requirement for growth was dietary CP 0.204g 0.33g/Kg gain.

Hussain et al (1996) reported that 188 goats were fed on wilted grass silage of good quality from tower silos, silage of poor Quality from aerobically damaged round bales or barn-dried grass
hay ad libitum plus concentrate 400g/Kg milk for the 1st 90 days of gestation from 91 to 120 of pregnancy goats were fed on roughage ad libitum plus concentrate 100g per day (high energy) or roughages to 70% of maintenance energy requirement (low energy). For day 121 of pregnancy until kidding all goats were fed on hay 200g/d, good silage ad libitum and concentrate 900g/day. Reproductive losses were significantly higher in goats fed on silage of poor quality than in those fed on hay or good silage. It was concluded that feeding silage of poor quality combined with a low energy intake in the period of 91 to 120 days of gestation increased the rate of abortion in goats. Underfeeding of good quality during the same period had no effect on the rate of abortion.

El-Badawi et al (1996) used antipyrine space method to calculate energy and protein requirements for growth of Baladi goats. Energy and protein requirements for growth were estimated to be 11.29 Kcal ME and 0.6g digestible CP/g weight gain respectively, for males and 13.47 Kcal ME and 0.72g digestible CP/g weight gain respectively for females. These values were higher than the value of 7.25 Kcal ME and 0.195g digestible CP/g weight gain recommended by the National Research Council (1981).

Haque et al (1997) studied with eight male Cheghu goats.
1-2 years old, 19.5 to 35.2 Kg live weight and divided into 2 groups of 4 each. Digestibility and N balance measurements were conducted on berseem (Trifolium alexandrum) based rations which are given alone (T1) or supplemented with crushed maize (T2) to provide different levels of energy about their maintenance requirements. Energy and N balance was determined by conducting respiration calorimetry trails on all individual goats in an open circuit respiration chamber. Energy requirement for maintenance (ME), was 476 KJ/W\(_{kg}^{0.75}\) daily. Starved heat production (FHP) was 326 KJ/W\(_{kg}^{0.75}\) daily with efficiency of ME for maintenance (Km) 0.686. It was concluded that the ME requirements for maintenance of Pashmina bearing Cheghu goats which inhibited the higher attitude of Himalyan range under severe cold and dry climate is similar to the goats found on the plains of India.

Kawas et al (1999) conducted two studies at a 60-ha area of caatinga during the wet and dry seasons to investigate the effect of grain supplementation on intake and digestibility of range diets consumed by goats. Although CP intake of unsupplemented goats was higher than the maintenance requirement, grain supplementation was required to allow for enough digestible OM and CP intake to meet energy & protein requirements for growth. Goats consumed a
diet composed mainly of grasses during the wet season while dry leaf litter appeared to be the main dietary component during the dry season. As indicated by the chemical composition of the diet and nutrient intake of goats, a supplement may be needed to satisfy growth requirements of energy and protein of goats grazing caatinga range, especially during the latter part of both seasons.

Sutton et al (2000) reported the basis for the recently published estimates of the requirements of lactating goats for ME and metabolizable protein in the Agriculture and Food Research Council Report (AFRC), 1998, the Nutrition of Goats. CAB International, Wallingford, UK) were presented and values were compared with earlier estimates of allowances from the Institute National de la Recherche Agronomique (INRA), 1988. It was concluded that good agreement exists between the recommendations for the energy and protein requirements of lactating goats for maintenance, milk production and LW change but there are serious differences were identified as composition of live weight change (LWC), particularly protein, ME and MP requirements for pregnancy and activity factors.

Biswal et al (2000) reported that sixteen adult Barbari bucks were divided into 4 homogeneous groups, and each group was offered wheat straw (WS) at level 75, 100, 125 or 150% of ad
libitum intake in a factorial randomized complete block design. All goats were uniformly fed a supplement (13.5g DM/W$_{kg}^{0.75}$) to fulfil their requirement for protein at maintenance level. The experimental feeding of goats at different level for 21 days was followed by a digestion trial of 6 days and determination of rate of passage of digesta for 144h duration, respectively. Intake (g/W$_{kg}^{0.75}$) of Dry matter (DM), organic matter (OM), digestible DM and digestible OM increased with increase in amount of WS offerend. The result suggested that DM intake and quality of ingested WS would improve with higher rates of offer and refusals (r 30% of DMO) without any pronounced effect on passage kinetics of digesta, because of greater opportunity offered to goats for selective feeding.