MARDI Res. Bull., (1983) 11, 2: (193–205)

THE ENERGY AND PROTEIN REQUIREMENTS DURING PREGNANCY OF KATJANG GOATS IN MALAYSIA

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Keywords: Energy, protein, pregnancy, requirements, goats.

RINGKASAN

Kajian mengenai penentuan keperluan tenaga dan protin semasa bunting bagi Kambing Katjang dewasa di Malaysia telah dijalankan. Sepanjang masa bunting, kambing-kambing ini diberi makan di dalam kandang metabolisma. Kajian ini dijalankan ke atas 5 ekor ibu kambing.

Purata pengambilan bahan kering harian (DMI) semasa bunting ialah 2.53 peratus berat badan. Nilai ini adalah setara dengan 57.2 g/$W^{0.75}$kg sehari dan boleh menampung pertambahan berat badan sebanyak 52 g sehari sepanjang masa bunting dan 56 g sehari semasa dua bulan terakhir sebelum beranak. Berat badan mempunyai hubungan yang ketara ($P<0.05$) dengan pengambilan tenaga hadam (DE) dan tenaga ungkaibena (ME).

Keperluan-keperluan ME dan protein kasar yang dihadamkan (DCP) semasa dua bulan terakhir adalah 602.5 kJ ME/$W^{0.75}$ sehari dan 3.6 g DCP/$W^{0.75}$kg sehari. Nilai-nilai ini adalah 14.0% dan 20.0% lebih tinggi jika perkiraan dibuat berdasarkan sepanjang masa bunting. Penentuan ketika dua bulan yang terakhir memungkinkan ketinggian anggaran nilai keperluan tenaga dan protin. Hubungan di antara DE dan DCP ialah 1 MJ DE bersamaan dengan 4.7 g DCP. Keputusan juga menunjukkan pertambahan ME sebanyak 10% dan DCP sebanyak 44% bagi ibu-ibu yang beranak kembar dibandingkan dengan ibu-ibu yang beranak satu.

Data mengenai keperluan zat-zat makanan Kambing Katjang untuk beberapa tingkat pusingan hidup dibandingkan dengan nilai-nilai yang telah dilaporkan, dan dicadangkan bahawa baka ini mempunyai keperluan zat-zat makanan yang lebih rendah dalam kontek kecekapan penyesuaian terhadap taraf pemakanan yang kurang baik.

Cadangan-cadangan mengenai keperluan tenaga dan protin bagi Kambing Katjang yang mempunyai berat badan di antara 10–60 kg juga diberikan.

INTRODUCTION

The emerging importance of goats in the less developed countries of the tropics and sub-tropics during the last decade represents an important feature concerning the contribution of the species, its development and future potential (DEVENDRA, 1981). However, the maximisation of this contribution assumes that goats will be fully exploited, efficiently fed and managed. Implicit in high managerial efficiency and especially feed utilization is the need to ensure an adequate supply of energy, protein and minerals.

Precision in the supply of these nutrients requires as a first step, knowledge of nutrient requirements during the different phases (growth, pregnancy and lactation) of the life of the goat. With specific reference to the indigenous Katjang goat breed, determined values exist for the energy requirements for maintenance (DEVENDRA, 1967a), live weight gain (DEVENDRA, 1967b) and protein requirements for maintenance (DEVENDRA, 1980a). Nothing however is known about the requirements for pregnancy and the information on this aspect presently available is meagre. Elsewhere, only two values for energy requirements during pregnancy in goats have been reported, from Nigeria (AKINSOYINU, MBA and OLUBAJO, 1975) and India (RAJPOOT, 1979). In a continuation of the programme of work concerning nutrient requirements, this paper reports the results of studies on the determination of energy and protein requirements in Katjang goats in Malaysia.

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MATERIALS AND METHODS

1) Animals

A total of five goats, three to four and a half years old were used. These goats had all previously kidded once or twice. During the service period, they were hand mated. Following confirmation that they were pregnant, approximately three to four weeks after service, they were placed in metabolism cages for the entire duration of the trial. The goats were introduced into the trial as they became available over the period from December 1980 to September 1981. Details of the does and their reproductive performance during the pregnancy phase are given in *Table 1*. Their initial weight was 16–25 kg.

2) Management

The does were weighed initially prior to being placed in metabolism cages and at fortnightly intervals till parturition. They were given Napier grass *(Pennisetum purpureum) ad libitum* and 300 g of a concentrate mixture made up of 58.5% tapioca chips, 30% copra cake, 10% molasses, 0.5% salt and 1% mineral mixture. The chemical composition of both these components are given in *Table 2*. Feed offered, residues, faeces and urine produced were carefully collected and subsampled for chemical analyses. Clean drinking water was available to the does throughout the experiment. Variations in feed quality were made on the feed ingredients, feed offered and residues.

TABLE 1: PARTICULARS OF THE GOATS

Parameter	Goat No.				
	1	2	3	4	5
Age of dam (yr)	4	3	4+	4+	4+
Gestation period (days)	151	142	144	155	146
No of kids born	2	1	1	1	1
Weight of kids (kg)	1.8, 2.0	2.4	2.1	1.9	2.2
Sex of kids	F	F	M	M	F

F = Famele
M = Male

TABLE 2: AVERAGE CHEMICAL COMPOSITION OF NAPIER GRASS *PENNISETUM PURPUREUM* AND CONCENTRATE COMPONENTS FED
(% dry matter basis)

Conctituent (%)	Napier grass[+]	Concentrate[++]
Dry matter	19.8	93.2
Organic matter	93.41	92.55
Crude protein (N x 6.25)	11.07	8.54
Crude fibre	33.74	7.86
Ether extract	2.31	3.89
Nitrogen-free extract	46.29	72.26
Ash	6.59	7.45
Gross energy (MJ/kg)	16.66	17.16

\+ Approximately five weeks regrowth, fed chopped (2–3 cm)

++ Made up of 58.5% tapioca chips, 30% copra cake, 10% of molases, 0.5% salt and 1% mineral mixture.

3) Analytical methods

The techniques used for chemical analyses were those recommended by A.O.A.C. (1970). Dry matter was determined by drying at 102°C for 24 hours, ash by firing at 600°C for 24 hours, protein by micro-kjeldahl procedure, crude fibre by successive boiling with alkali and acid and ether extract by gently heating with petroleum spirit (40–60° B.P.). Gross energy was determined by using an adiabetic bomb calorimeter.

4) Determination of energy and protein requirements

The determination of energy and protein requirements during the pregnancy phase entailed an assessment of the daily feed intake and therefore the intakes of energy and protein. Two types of assessments were made: (1) for the duration of the entire trial and (2) for the last two months of pregnancy, it being understood that pregnancy refers to the last two months of gestation (N.R.C., 1981). It was felt that in this way, it was possible to compare the magnitude of the differences in the values so obtained for the two periods.

The actual intake of digestibility energy (DE) or metabolisable energy (ME) and digestible crude protein (DCP) was determined from concurrent balance studies during the last 10 days of pregnancy. This was achieved by applying the digestibility data to the feed intake data. The conduct of the balance were as has been previously described (DEVENDRA, 1975).

The daily energy and protein requirements for maintenance plus pregnancy were achieved from a consideration of the DE intake during the pregnancy phase less the expenditure for the daily gain in body weight mainly adipose tissue. For purposes of this calculation the factors used for the energy cost for live weight gain and protein requirements for growth were 37.6 kJ/g fat and 0.274 g DCP/g gain (DEVENDRA, 1967b).

RESULTS

1) Live weight data

The live weight performance of the does is given in *Table 3*. The mean live weight increase during the last two months of the pregancy period was 56.0 g/day (range 37.5 – 84.2 g). *Figure I* illustrates the pattern of live weight increase for the five does during the trial.

2) Dry matter intake

The daily total dry matter intake (DMI) from grass and concentrates is given *Table 4*. The mean total DMI was 611 g of which approximately 72% came from grass

TABLE 3: LIVE WEIGHT DATA

Goat No.	Body weight (kg)				Live weight increase^{+++} (g)
	Initial	At 12 wks	Final	$W^{0.75}$(kg)	
1	18.2	24.3	27.3	10.4	46.9
2	20.7	24.8	29.6	11.3	84.2
3	16.4	20.9	23.0	9.4	37.5
4	24.8	28.2	31.4	12.2	64.0
5	18.2	23.2	25.9	10.2	47.4
Mean	19.7±3.3	24.3±2.7	27.4±3.3	10.7±1.1	56.0±16.5

+ Stage of pregnancy
++ Immediately before birth
+++ Based on the last two months period

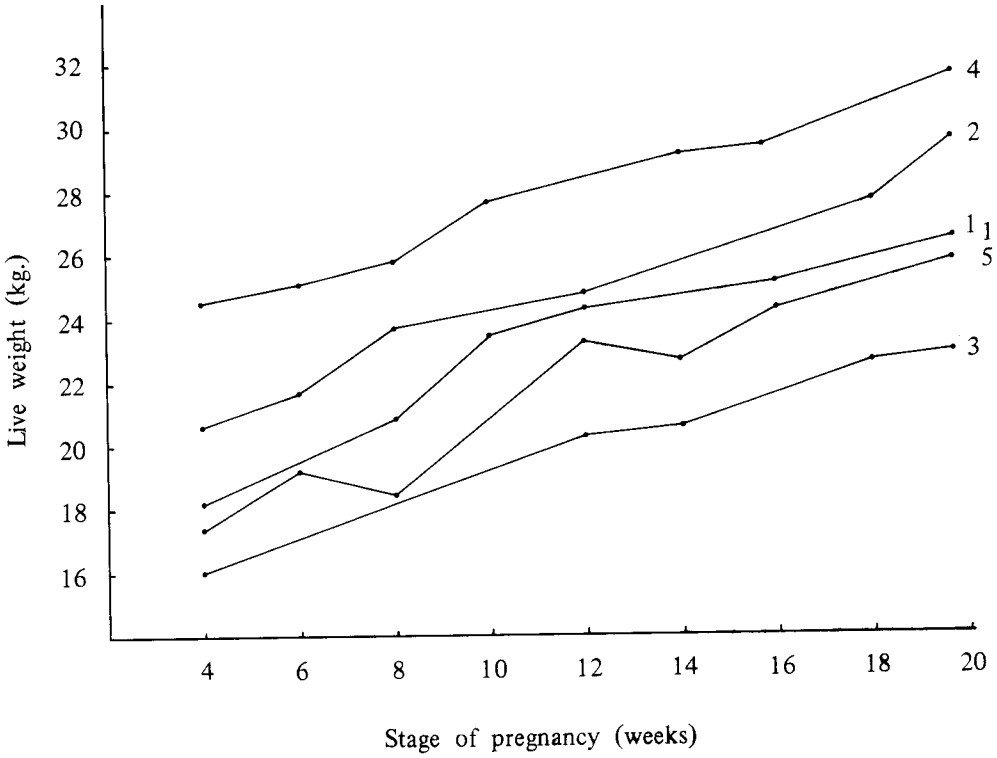

Figure 1: Growth performance of the goats through pregnancy.

TABLE 4: DAILY DRY MATTER INTAKE (DMI) DURING THE PREGNANCY PERIOD

Goat No.	Daily DMI from grass (g)	Daily DMI from concentrates (g)	Total daily DMI/(g)	DMI as % of body weight	DMI/$W^{0.75}$ kg/day (g)
1	355.7	172.0	527.7	2.25	50.7
2	430.9	172.0	602.9	2.41	53.4
3	368.0	175.2	543.2	2.37	57.8
4	530.7	175.2	705.9	2.42	57.9
5	502.1	175.2	677.3	3.20	66.4
Mean	437.5±78.1	173.9±1.75	611.4±79.1	2.53±0.4	57.2±6.0

and the remainder from concentrates. This was equivalent to 2.53% as percentage of body weight (range 2.25 – 2.81%) or 57.2g/ $W^{0.75}$kg/day. Body weight was not correlated to DMI, but was significantly correlated to DE and ME intake ($P<0.05$). *Figures 2* illustrates the pattern of mean DMI of the does in the trial.

3) Digestibility data

The apparently digestibility data of the mixed grass-concentrate diet is given in *Table 5*. The mean dry and organic matter digestibility coefficients were 68.7 and 70.4% respectively. Crude protein, crude

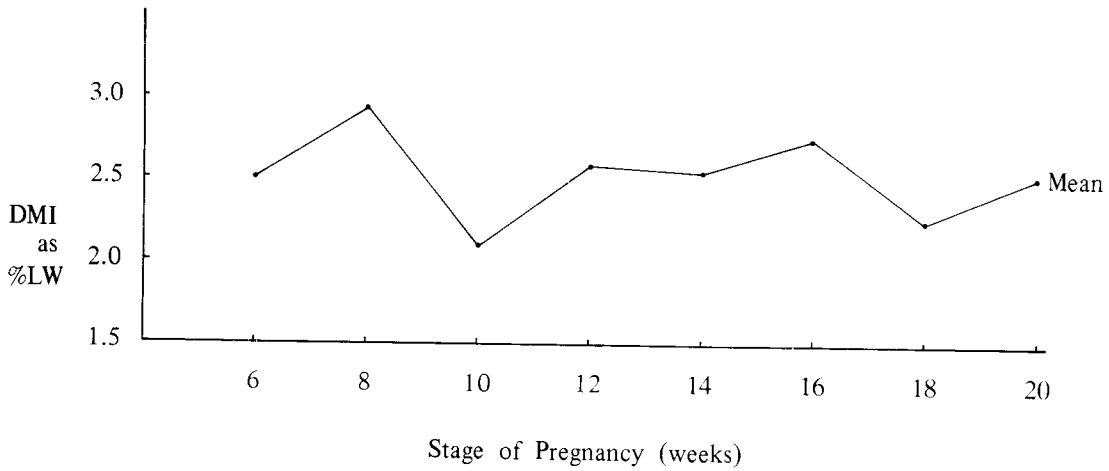

Figure 2: Pattern of mean dry matter intake of katjang goats during pregnancy.

TABLE 5: APPARENT DIGESTIBILITY COEFFICIENTS OF THE GRASS - CONCENTRATE DIET FED (%)

(Each value is the mean of 5 goats)

Constituent	%
Dry matter	68.7
Organic matter	70.4
Crude protein	64.2
Crude fibre	63.5
Ether extract	71.4
Nitrogen-free extract	61.4
Ash	48.3
Energy	68.5

fibre and energy were also well digested with values of between 63.5 to 68.5%.

4) Energy requirements

The calculations concerning the determination of the energy requirements for pregnancy (maintenance + pregnancy) were made for the two time periods of the entire duration of pregnancy and the last two months of pregnancy. In each case, from the total DE or ME intake based on the apparent digestibility of energy, the energy cost of body weight gain or loss was accounted for using the factor of 37.6 kJ/g fat deposited. The derived value then gave the energy intake for maintenance and pregnancy.

For the entire pregnancy phase, the ME requirement for pregnancy was found to be 529 kJ ME/$W^{0.75}$kg/day. This value compares with the higher value of 602.5 kJ ME/$W^{0.75}$kg/day calculated for the last two months of pregnancy which represents an increase of 13.9%. *Table 6* summarises the results.

Of the five does in *Table 6*, all of them except goat number one gave single kids. In order to make the figures comparable, an

TABLE 6: ENERGY REQUIREMENTS DURING PREGNANCY

Goat No.	Daily gain in body weight (g)	Daily gain for pregnancy (g)	Total energy intake (MJ/day)		Energy for body weight gain or loss (MJ/day)		Intake for maintenance and pregnancy (KJ/day)		Requirement/ $W^{0.75}$ kg/day (KJ/day)	
			DE+	ME+	DE	ME+++	DE	ME	DE	ME
1	6	46.9	10.56	8.66	0.27	0.23	10290	8438	791.5	649.0*
2	–9	84.2	6.38	5.23	0.43	0.34	6790	5568	600.9	492.7
3	3	37.5	5.57	6.20	0.14	0.11	7430	6093	790.4	648.1
4	–7	64.0	8.11	6.65	0.32	0.26	8430	6913	691.0	566.6
5	2	47.4	8.25	6.77	0.09	0.08	8160	6691	800.0	656.0
	Mean	56.0±16.5	8.17±1.4	6.70±0.1	0.15±0.1	0.25±0.1	8220±1113	6471±970	734.8±78.0	602.5±64.0

\+ Digestible energy
++ Metabolisable energy based on DE x 0.82 (Armstrong, 1964)
+++ Derived from energy cost of 37.6 kJ ME/g fat
* Adjusted for single kid progeny

adjustment was made to the higher ME intake because of the twin kids by 20% which reduced the intake from 811.3 to 649.0 kJ ME/$W^{0.75}$kg/day.

5) Protein requirements

The protein requirements during pregnancy was calculated in a similar manner to that of the energy requirements. For the entire duration of the trial, the requirement was 3.0g DCP/$W^{0.75}$kg/day while for the last two months of pregnancy, the value was 3.6g DCP/$W^{0.75}$kg/day. The latter value represents an increase of 18.8%. In view of the paucity of information concerning the DCP requirements for multiple births, no adjustments have been made in *Table 7* for goat number one with twin kids. *Table 7* presents the results of the calculation. In terms of true protein (TP) the two values are equivalent to 4.3g TP/$W^{0.75}$kg/day and 5.1g TP/$W^{0.75}$kg/day respectively, assuming a 70% average digestibility of total feed protein in the diet.

6) DE : DCP ratio

It was of interest to establish the relationship between the ratio of daily DE intake (MJ/day) and the daily DCP intake (g/day). It was found that the mean value relating these two components was 1 MJ DE and was equivalent to 4.7 g DCP *(Table 7)*.

DISCUSSION

Dry matter intake

The mean dry matter intake as percentage of live weight was 2.53% equivalent to 57.2 g/$W^{0.75}$kg/day. This value is smaller to the values of 3.07, 3.20, 3.48 and 3.32% equivalent to 77.2, 82.5, 83.8 and 74.9 g/$W^{0.75}$kg/day for Jamnapari, Beetal, Barbari and Black Bengal goats recorded by RAJPOOT (1979).

Live weight increase

The mean daily live weight increase for Katjang goats throughout the pregnancy period was 52 g/day, and during the last two months of pregnancy was 56 g/day. The latter value is comparable to the mean daily live weight increase during the growth phase up to 12 months of age of about 57 g/day (DEVENDRA, 1976).

Energy requirements for pregnancy

The mean value for the energy requirements for maintenance and pregnancy was 602.5 kJ ME/$W^{0.75}$kg/day or 734.3 kJ DE/$W^{0.75}$kg/day. It is of interest to compare this value with those reported by other workers. *Table 8* presents this comparison.

The present value for the Katjang goat breed is considerably lower to the values of between 655.3 and 883.7 kJ ME/$W^{0.75}$kg/day reported by ZWAGERMANN (1921), HUSTON, SHELTON and ELLIS (1971), AKINSOYINU, MBA and OLUBAJO (1975) and SENGAR (1980) based on the studies of RAJPOOT (1979). The present value is about 8 to 47% lower to these reported values.

Protein requrements for pregnancy

The mean DCP requirement for maintenance and pregnancy was 3.6 g DCP/$W^{0.75}$kg/day. This value can also be compared with those of other published reports in the literature. This comparison suggests *(Table 8)* again that the value determined in the present study is lower than the values of 6.9 g/$W^{0.75}$kg/day reported by ZWAGERMANN, 6.8 g/$W^{0.75}$ g/$W^{0.75}$kg/day by HUSTON, SHELTON and ELLIS (1971), 4.7 g DCP/$W^{0.75}$kg/day by AKINSOYINU, MBA and OLUBAJO (1975) and 4.8 to 6.1 g DCP/$W^{0.75}$kg/day reported by SENGAR (1980). The present value is about 28 to 92%.

The reasons for the lower values for the Katjang goat and also variability of the results of energy and protein requirements for maintenance merit some discussion. In general, the energy and protein requirements are affected by age; constitution; plane of nutrition; growth, pregnancy or lactation phases; size of foetus, functional importance of individual goat breeds. The value for energy and protein requirements

TABLE 7: PROTEIN REQUIREMENTS DURING PREGNANCY

Goat No.	Daily again in body weight (g)	Total crude protein intake (g)	DCP requirement for maintenance and pregnancy (g)	DCP requirement/ $W^{0.75}$ kg/day (g)	Equivalent DCP for 1 MJ DE (g)
1	6	72.81	49.60	4.77	4.9
2	–9	55.44	35.40	3.13	5.2
3	3	66.56	36.10	3.84	4.9
4	–7	75.75	35.40	2.90	4.2
5	2	79.94	34.40	3.37	4.2
	Mean	70.1±8.5	38.1±5.7	3.60±0.7	4.7±0.4

TABLE 8: ESTIMATES OF ENERGY AND PROTEIN REQUIREMENTS FOR PREGNANCY

Breed	Location	Requirements		Reference
		Energy ($kJ/W^{0.75}$ kg/day)	Protein (g DCP/$W^{0.75}$ kg/day)	
Unknown	W. Germany	757.0	6.9	Zwagermann (1921)
Angora	Texas	956.3	6.8	Huston, Shelton and Ellis (1971)
West African dwarf	Nigeria	726.3	4.7	Akinsoyinu, Mba and Olubajo (1975)
Jamnapari	India	833.7	6.1	Sengar (1980)
Beeetal		771.9	5.6	
Barbari		782.2	5.7	
Black Bengal		655.3	4.8	
Katjang	Malaysia	602.5	3.6	Present studies

reported by ZWAGERMANN (1921) can be ommitted because this is of temperate origin.

The values from India are consistently higher and part of this reason could be due to the dual-purpose nature of the breeds used: Jamnapari (milk and meat), Beetal (meat and milk), Barbari (meat and milk) and Black Bengal (meat and skins). This dual-purpose nature, especially to include milk production will automatically tend to establish a higher inherent energy and protein requirement. Indian data for lactation maintenance for example, gives a value of 679.3 kJ ME/$W^{0.75}$kg/day compared to 428.9 kJ ME/$W^{0.75}$kg/day, an increase of 58.4%. The highest value for the Angora goat of 956.3 kJ ME/$W^{0.75}$kg/day is obviously associated with the specialised mohair pro-

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A second important reason is associated with the fact that no partitioning or differentiation appears to have been made with litter size of the breed, that is if singles, twins or multiple births were recorded. Since the requirements increase with the number of kids born, it is essential to partition the requirements between dams based on litter size. Indeed, in most of the published data hitherto, either no mention has been made of the number of kids born or no differentiation has been made between does producing single kids and those producing twins. It is essential that studies on nutrient requirements during pregnancy specify the litter size at birth in order to then establish the requirements between dams with single or twin kids. A third factor may also be one of age of dam since a younger animal is likely to be in the stage of growth with a different requirement than an adult.

With respect to the requirements for the Katjang goat breed in the present study, it is of interest to note the mean energy requirement of 590.9 kJ ME/$W^{0.75}$kg/day for the four does (Nos. 2, 3, 4 and 5) were lower by about 10% to the value of 649.0 kJ ME/$W^{0.75}$kg/day for goat number one bearing twin kids. It may be of interest to note that an additional 20% allowance has been used for multiple births in sheep (MCDONALD, EDWARDS and GREENHALGH, 1973) and also in standards for nutrient requirements in goats (N.R.C., 1981). Likewise for DCP, the difference between goat number one and the mean of the other four does, was 44.1% which appears to be high. The lower value reported here compared to the other values, may also be associated with the fact that the Katjang goat breed is only a meat animal although twinning is common (DEVENDRA, 1966).

Relationship between digestible energy and digestible crude protein

In the studies reported here, the relationship between DE and DCP gave the value 1 MJ DE = 4.7 g DCP. This value is comparable to the figure of 4.6 g DCP reported by CRAMPTON and HARRIS (1969), but is lower to that of 6.0 g DCP reported by SENGAR (1980) specific to goats.

Experimental duration

Many studies of the type described here, aimed at establishing the energy and protein requirements during the pregnancy phase have been confined to a determination during the last two months of pregnancy. The values so determined have then been used to

be representatives of the entire pregnancy period it being assumed that pregnancy means the last two months of pregnancy (see for example SENGAR, 1980; N.R.C., 1981).

This assumption is of doubtful validity as indicated by the results of calculations in the present study as follows:

Pregnancy period	ME requirement ($kJ/W^{0.75}kg/day$)	DCP requirement ($g/W^{0.75}kg/day$)
Entire (5 months approx.)	529.0	3.0
Last two months	602.5	3.6
% difference	14.0	20.0

It is apparent from the above calculation that when the data for calculation is confined to the last two months, there is an 'overestimate' of about 14% for energy and 20% for protein compared to the entire pregnancy period. This difference is quite significant and cannot obviously be dismissed. It suggests that possibly a determination over the entire pregnancy phase is more accurate than just the last two months of pregnancy. It also emphasises the need to define precisely in studies of this nature during which phase the requirements were established. It might be of interest to note in this connection that in the recently revised reviews and nutrient requirements for ruminant livestock (A.R.C., 1980), the last three months have been used to define increasing nutrient needs.

Nutrient requirements of the Katjang goat

The energy (602.5 kJ $ME/W^{0.75}kg/day$) and protein requirements (3.6 g $DCP/W^{0.75}kg/day$) determined in the studies reported here, together with other values published for the same Katjang breed previously of energy requirements of 378.0 kJ $ME/W^{0.75}kg$ for maintenance (DEVENDRA, 1967a), energy requirements for gain of 42.6 kJ ME/g (DEVENDRA, 1967b), protein requirements for maintenance of 1.41 $g/W^{0.75}kg/day$ (DEVENDRA, 1980a) and growth 0.274 g DCP/g gain (DEVENDRA, 1967b) merits a special comment. A consistent feature about all these values, in comparison with other published figures in the Asian region (DEVENDRA, 1980b), and elsewhere (N.R.C., 1981), is that the values for the Katjang goat breed is distinctly lower. Breed difference apart, the conclusion may also suggest that this breed may have inherent lower nutrient requirements consistent with its ability to adapt and efficiently perform in lower planes of nutrition. It also further suggests that in situations where feeds are scarce, as is often the case, the Katjang goat is a particularly suitable species for meat production.

TABLE 9: REQUIREMENTS FOR ENERGY AND PROTEIN DURING PREGNANCY FOR INDIGENOUS KATJANG GOATS IN MALAYSIA

Live weight (kg)	Energy requirement		DCP requirement	
	Single	Twin+	Single	Twin++
	(MJ ME/day)		(g/day)	
10	2.9	3.2	16.2	22.7
20	5.7	6.3	32.4	45.4
30	8.6	9.5	48.5	67.9
40	11.4	12.5	64.7	90.6
50	14.3	15.7	80.9	113.3
60	17.1	18.8	97.0	135.8

\+ Additional increment of 10%
++ Additional increment of 40%

ME and DCP requirements for pregnancy: recommendations

It is appropriate, based on the present results, to provide recommendations concerning the energy and protein requirements for pregnancy. The recommendations *(Table 9)* are specific to the Katjang goat breed and is aimed at presenting important information on ration formulation. *Table 9* presents these recommendations for the live weight range of 10 to 60 kg. The table also accommodates additional increments of 10% for energy and 40% for protein based on the studies reported. The latter figure may not be entirely valid and needs to be investigated more fully.

Continuing studies are needed on the nutrient requirements during lactation and the requirements of the grazing and browsing animal. These, together with a search for more knowledge on nutrient allocation and efficient feeding systems represent some of the efforts for the future.

ACKNOWLEDGEMENTS

The author is indebted to Puan Jamiah Salleh, En. Naziri bin Nordin and Cik Jamaliah Yun for technical assistance.

SUMMARY

Investigations are reported on the determination of the energy and protein requirements for pregnancy of adult indigenous Katjang goats in Malaysia. The study is based on five does fed and maintained in metabolism cages throughout the pregnancy period.

The mean daily DMI during pregnancy was 2.53 as percentage of body weight equivalent to 57.2g/$W^{0.75}$kg/day. This supported a daily live weight increase of 52 g during the entire pregnancy phase and 56 g/day during the last two months of pregnancy. Body weight was significantly correlated to DE and ME intake ($P<0.05$).

The metabolisable energy (ME) and digestible crude protein (DCP) requirements, during the last two months of pregnancy were determined to be 602.5 kJ ME/$W^{0.75}$kg/day and 3.6 g DCP/$W^{0.75}$kg/day. These values are 14.0% and 20.0% higher when the calculations were made for the entire pregnancy period. The possibility exists that determinations of energy and protein requirements which are confined to the last two months of pregnancy are overestimated. The relationship between digestible energy (DE) and DCP was 1 MJ DE = 4.7g DCP. The results also indicated an increased requirement of 10% for ME and 44% for DCP for twin kids over dams with single kids.

A comparison of the data available concerning nutrient requirements for the different life cycle phases of the Katjang goat, with other published values suggests presently that this breed may have an inherently lower nutrient requirement in the context of efficient adaptation to low planes of nutrition. Recommendations of energy and protein allowances for Katjang goats over the weight range 10 to 60 kg are given.

REFERENCES

AKINSOYINU, A.O., MBA, A.U. and OLUBAJO, F.O. (1975). Studies on energy and protein utilization for pregnancy and lactation by West African dwarf goats in Nigeria. *E. Afr. agric. For. J., 41* : 167–176.

A.O.A.C. (1970). *Official Methods of Analysis.* 11th *Edn.* Washington D.C., Association of Official Agricultural Chemists.

A.R.C. (1980). The nutrient requirements of ruminant livestock. *Comm. Agric. Bur.,* Farnham Royal, Bucks, Commonwealth Agricultural Bureau, xvi + 351 pp.

ARMSTRONG, D.G. (1964). The evaluation of dried grasses as a source of energy for ruminant livestock. *Agric. Progress, 39* : 1–4.

CRAMPTON, E.W. and HARRIS, L.E. (1969). *Applied Animal Nutrition.* 2nd. *Edn.* W.H. Freeman and Co., San Francisco, U.S.A., p. 174–177.

DEVENDRA, C. (1966). Goat breeds of Malaysia. *Malays. agric. J., 45* : 268–274.

DEVENDRA, C. (1967a). Studies in the nutrition of the indigenous goat of Malaya. I. The maintenance requirement of pen-fed sheep. *Malays. agric. J., 46* : 80–97.

DEVENDRA, C. (1967b). Studies in the nutrition of the indigenous goat of Malaya. II. The requirement for live weight gain. *Malays. agric. J., 46* : 98–118.

DEVENDRA, C. (1975). The utilization of rice straw by sheep. I. Optimal level in the diet. *Malays. agric. J., 50* : 169–186.

DEVENDRA, C. (1976). Productivity of goats and sheep in Malaysia. I. The potential contribution from goats. *Proc. Symp. Smallholder Livestock Prod. and Development*, p. 29–47.

DEVENDRA, C. (1980a). The protein requiremets for maintenance of indigenous Katjang goats of Malaysia. *MARDI Res. Bull., 8* : 111–126.

DEVENDRA, C. (1980b). The nutrient requirements for maintenance, growth and lactation in the Asian region. *Proc. 1st Asian-Australasian Anim. Sci. Congr.*, p. 245–250.

DEVENDRA, C. (1981). Prospects for increasing food production from goats in the tropics. *J. Malays. Vet. Med. Ass.,, 7* : 1–18.

DEVENDRA, C. and BURNS, M. (1983). *Goat production in the tropics. Revised Edn. Tech. Commun. Commonw. Bur. Anim. Breed Genet., No. 19,* Farnham Royal, Bucks, Commonwealth Agricultural Bureau, (In press).

HUSTON, J.E., SHELTON, M. and ELLIS, W.C. (1971). Nutritional requirements of Angora goat. *Texas A & M Univ. Agric. Exp. Sta. Tech. Bull. B*–1105.

MCDONALD, P., EDWARDS, R.A. and GREENHALGH, G.F.D., (1973). *Animal Nutrition*, 2nd. *Edn.*, 407 pp.

N.R.C. (1981). Nutrient Requirements of goats : Angora, Dairy and Meat goats in temperate and tropical countries. *Nutrient Requirements of Domestic Animals, No. 15*, National Research Council, Washington D.C., 91 pp.

RAJPOOT, R.L. (1979). Energy and protein in goat nutrition. *Ph. D. Thesis*, Raja Belwant Singh College, Bichpuri (Agra), India.

SENGAR, O.P.S. (1980). Indian research on protein and energy requirements in goats. *J. Dairy Sci., 63* : 1655–1670.

ZWAGERMANN, O. (1921). Das futtern der Ziegen und futternormen. *Ziegenzuchter, 16* : 362–376.

Accepted for publication on 26th June, 1982.