GRAZING MANAGEMENT STUDIES WITH THAI GOATS
II. REPRODUCTIVE PERFORMANCES OF DIFFERENT GENOTYPES OF DOES GRAZING IMPROVED PASTURE WITH OR WITHOUT CONCENTRATE SUPPLEMENTATION

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Summary

Fifty-one Thai Native (TN) and Anglo-Nubian (AN) × TN does were studied. The purpose of the study was to investigate the reproductive performances of different goat genotypes grazing improved pasture with or without supplementary feeding. The feeding regimes were: 1. no concentrate supplement (T1), 2. supplemented for 15 days before mating and 45 days during mating period (T2), 3. supplemented from 15 days before mating to 42 days after kidding (T3) and 4. supplemented for 30 days before kidding, followed by 42 days after kidding. Cross-bred does tended to have higher conception rates, kidding opportunities and higher multiple birth rates than TN does. However, these differences were not statistically significant ($p > 0.05$), and concentrate supplementation under the various regimes did not increase reproductive performance. TN kids had significantly ($p < 0.01$) lower birth weights and lower weights at 3, 6 and 12 weeks of age than those of the cross-bred kids. However, there was no significant difference between the genotypes in growth rate (g/d or $g/kg^{.75}/d$) of kids during these periods. Supplementary feeding did not significantly affect either kid birth weight or weight gain in the first 6 weeks after birth and during this period supplementary feeding had no significant effect on milk production. These findings suggest that on improved pasture which was adequate in both quantity and quality, substantial reproductive performances were achieved from both TN and AN × TN does without concentrate supplementation.

(Key Words: Thai Goats, Nutrition, Supplementary Feeding, Reproductive Performances)

Introduction

Nutrition has an important impact on the reproductive performances in sheep (Smith, 1985). High energy diets, in particular, affect ovary activity (Haresign, 1981). Gunn et al. (1984) reported that a high energy diet fed to ewes 18 days before mating increased ovulation rates; similarly, Gunn et al. (1992a, 1992b) found that supplementation in the pre-mating period improved the reproductive performances of grazing sheep when sward height in pastures declined from 6 to 3.5 cm. As for goats, Zezza et al. (1991) found that goats fed a high energy diet showed significantly higher twin kidding rates than goats fed medium or low diets. Muscio et al. (1991) further reported that milk yields, and concentration of protein and casein (%) were higher in goats fed medium and high energy diets than those fed low energy diets. Saithanoo et al. (1991) found that Thai native does had significantly higher kidding rates than did cross-bred does (TN × AN), and Milton et al. (1991) showed that the reproductive performance of does in southern Thailand was high under optimum management conditions.

However, very little is known about the interaction between goat genotypes and nutrition. The following study was accordingly designed to investigate the reproductive performances of different goat genotypes on improved pasture with or without concentrate supplementation.

Materials and Methods

Location and climate

The experiment was conducted at the Small Ruminant Research and Development Centre Research Farm, Faculty of Natural Resources, Prince of Songkla University (PSU), Khong Hoi

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Received January 7, 1994
Accepted July 18, 1994

Kong, Hat Yai, Thailand. The climate, soil type and environment have been described previously (Kochapakdee et al., 1994).

Experiment design

The design was a 4 × 3 factorial, completely randomized. The factors were feeding regimes and goat genotype. Number of goats in each genotype was 14, 20 and 17 for Thai Native (TN), 25% Anglo Nubian (AN) and 50% AN, respectively. Feeding regimes were as follows: 1. no concentrate supplementation (T1), 2. supplemented for 15 days before mating and 45 days during the mating period (T2), 3. supplemented from 15 days before mating to 42 days after kidding (T3) and 4. supplemented for 30 days before kidding and 42 days after kidding (T4). Number of goats in each feeding regime was 13, 13, 12 and 13 for T1, T2, T3 and T4, respectively. Does were allocated to each treatment on a live weight basis and were mated with bucks from the same genotype to produce TN, 25% AN (F_2) and 50% AN (F_3) kids, respectively.

Diets and feeding methods

Animals in supplemented treatments (T1, T2, T3) received 0.75% of their body weight in concentrate per day. Concentrate was composed of corn, palm kernel cake, soybean meal, rice bran, molasses, ground oyster shell, salt and dicalcium phosphate. The approximate chemical composition of the concentrate was described by Kochapakdee et al. (1994). Concentrate supplements were supplemented in the morning by separating animals into group according to treatment and concentrate were offered from a feed trough in the shed. Supplement allocations were adjusted fortnightly. Clean water was freely available at all times from a water trough.

Animals and their management

Fifty-one female goats of different genotypes were used in this study. Means and ranges of the initial liveweight of does in each genotype were 23.2 (20.5-28.2), 25.4 (21.0-29.3) and 26.3 (22.2-30.5) kg for TN, 25% AN and 50% AN, respectively. These animals began grazing on pasture in April 1991. They were drenched with Panacur (1 g powder contains 40 mg fenbendazole, Hoechst Veterinary GmbH, Germany, 125 mg/kg LW) to control helminths before allocation into the various treatment regimes. On September 15, 1991, they were divided into three groups according to their genotype and ran in separate paddocks. On October, 1 1991, a buck of the same genotype was put with each group (three bucks in all). These bucks ran with their does for 45 days (until 15 October 1991). Then they were taken out and all does were run together in the same paddock. The does kidded in pasture and were run with their kids for 3 month post-partum.

Pasture management

Three 1 hectare paddocks of grass-legume pasture established in August-September 1990, were used for each genotype during the mating period. Then does were rotationally grazed for 1 month in each paddock during pregnancy and for 6 weeks during the lactation period. After each grazing, pastures were slashed to a height of 30 cm.

Measurements and sampling procedures

Pasture yield

Pasture samplings were carried out in all paddocks before and after the commencement of grazing. A 0.16 square metres quadrate was used to randomly sample 0.01% of each paddock. The area within the quadrate was cut with clippers and the harvested materials were oven dried at 70°C for 48 h to determine dry matter (DM) yield. Dried samples were then sorted to determine botanical composition (species, green leaf, green stem and dead material).

Animal weights

Does were weighed before allocation to a treatment regimen and weighed every two weeks thereafter, until kidding. After this time, does and kids were weighed at each milking time (1, 2, 3 and 6 weeks after kidding).

Milk production

Does were milked within 3 days of kidding and at 1, 2, 3 and 6 weeks thereafter. After weighing, does were suspended in a sling which provided holes for the udder and legs, then given an intravenous injection of 7.5 I.U. of oxytocin (General Drug House, Co., Ltd., Thailand) to stimulate milk let down, and then milked by hand. The time of completion of milking was recorded and the does were separated from their kids for about 4 h, during which time does had access to pasture. They were then milked again, and milk volume and the time of completion of milking were recorded a second time. The daily yield of milk for each doe was subsequently calculated from the rate of milk secretion between the first and second milkings, extrapolated to cover a 24 h period.

Postpartum oestrus

Vasectomized males (teasers) were put in the flock immediately after the first kidding and the incidence of oestrus was recorded for 3 months after kidding.

Chemical analyses

Sub-samples of dried pasture compositions and concentrate were ground through a 1 mm screen and analyzed for total nitrogen by Kjeldahl method (AOAC, 1960).

Statistical analyses

Analyses of variance and least significant difference (LSD) were used to measure the significance of the effects of different paddocks on pasture yields and botanical composition. Analysis of variance was also used to detect the significant differences between the factors (treatment and genotype) on doe weight change, conception rates, kidding opportunities and multiple birth rates; the live-weight at the joining of each doe was used as covariate (except for doe weight analysis). The effects of genotype, treatment, birth type and sex on doe milk production and birth weights and the growth rates of kids were also examined. The General Linear Model Procedure in the Statistical Analysis System (SAS, 1987) was used to accommodate unequal numbers in the treatments. Due to a shortage of TN kids, an interaction for weights and growth rates of these kids could not be analyzed.

Results

Pasture availability and composition

Table 1 shows mean values of total DM yields, composition (%) and DM/doe of pastures before and after the grazing of three different paddocks during the mating period. The major species of forage were *Centrosema pubescens, Brachiaria mutica* and *Stylosanthes hamata* cv. Verano. DM yields of pasture for TN does before grazing were significantly ($p < 0.05$) higher than those for 25% and 50% AN does. Consequently DM/doe for TN were higher than for other genotypes. The proportion of desired pasture components (except *C. pubescens*) and leaf/stem ratio of *B. mutica* before grazing was also higher in paddocks grazed by TN does than in those grazed by 25% or 50% AN does.

TABLE 1. MEAN VALUE OF DRY MATTER (DM) YIELDS (KG / HA), PASTURE COMPOSITION (%), LEAF / STEM (L / S) RATIOS OF *B. MUTICA* AND DM / DOE (KG) BEFORE AND AFTER GRAZING OF THREE DIFFERENT PADDOCKS DURING MATING PERIOD

Parameter	Paddock for						
	TN does		25% AN does		50% AN does		
	Before	After	Before	After	Before	After	SEM[1]
Dry matter	9,499^a	5,487	7,156^b	6,152	7,391^b	5,410	135.6
B. mutica	17.1^a	12.4	4.5^b	8.7	12.8^{ab}	12.7	1.28
L/S ratio	0.70^a	0.51	0.54^b	0.31	0.44^b	0.58	0.02
C. pubescens	20.8^a	39.7	29.4^b	26.8	20.5^a	24.5	1.11
S. hamata cv. Verano	13.5^a	6.8	10.7^a	1.4	1.3^b	9.7	0.73
Weeds	21.2^a	14.3	31.4^b	26.4	27.8^{ab}	30.3	1.13
Others	2.6	3.1	2.5	1.2	0.8	5.5	
Dead material	17.7^a	23.7	21.5^a	35.5	36.8^b	17.3	0.78
DM/doe	679	392	358	308	435	318	1

[1] Standard error of mean.
Mean within a row (before grazing only) with different subscripts differ significantly ($p < 0.05$).

Mean values of total DM, proportion of *B. mutica* and *C. pubescens*, leaf/stem ratio of *B. mutica* and DM/doe before and after grazing and during pregnancy and lactation periods, are shown in table 2. DM yields before grazing ranged from 7,064 to 11,665 kg/ha and proportion of *B. mutica* varied from 19.6 to 40.1% while that of *C. pubescens* varied from 7.2 to 30.6%. Leaf/stem ratio of *B. mutica* decreased significantly ($p < 0.05$) after grazing in every paddock.

TABLE 2. MEAN VALUES OF TOTAL DRY MATTER (DM) YIELD (KG / HA), DM / DOE (KG), MAIN PASTURE COMPONENTS (%), LEAF / STEM RATIO (L / S) OF *B. mutica*, WEED AND OTHER COMPONENTS (*INCLUDE DEAD MATERIAL*) *BEFORE AND AFTER GRAZING DURING PREGNANCY* (*PADDOCK 1-5*) AND LACTATING PERIOD (PADDOCK 6 AND 7)

Paddock	DM	*B. mutica*	L/S of *B. mutica*	*C. pubescens*	Weeds	Others	DM/doe
1							
Before	7,064	28.8	0.71[a]	30.6	9.7	30.9	138.5
After	6,742	23.7	0.33[b]	29.1	12.9	34.3	132.2
2							
Before	10,160[a]	38.4[a]	0.79[a]	14.4	23.6	23.6	199.2
After	8,173[b]	32.0[b]	0.46[b]	14.2	25.4	28.4	160.3
3							
Before	10,246	23.2	0.[illegible]2[a]	24.4	36.3	16.1	200.9
After	9,879	20.1	0.24[b]	24.9	27.7	27.3	193.7
4							
Before	10,672[a]	19.6	0.70[a]	9.9	24.5	46.0	209.3
After	8,592[b]	18.5	0.29[b]	10.7	16.1	54.7	168.5
5							
Before	9,287[a]	40.1[a]	0.77[a]	7.2	1.1	51.6	182.1
After	6,489[b]	31.9[b]	0.63[b]	6.7	6.3	55.1	127.2
6							
Before	11,582[a]	26.2[a]	0.87[a]	20.3	21.5	32.0	227.1
After	9,700[b]	20.6[b]	0.58[b]	23.4	22.0	34.0	190.2
7							
Before	11,665[a]	35.1[a]	0.61[a]	23.8	30.9	10.5	228.7
After	6,451[b]	23.3[b]	0.29[b]	19.4	20.3	37.0	126.5

Means within columns in each paddock with different subscripts differ significantly ($p < 0.05$).

Doe weight change and milk production

There were no significant differences in mean live weights of does during mating, pregnancy or lactation periods among genotypes and between treatments (feeding).

Due to a limitation of triple-born kids (only 1 doe), twin and triplet born kids were pooled as multiple-born kids. Does suckling multiples had significantly ($p < 0.05$) higher milk yields (968 ml/d) than did does suckling single kids (669 ml/d) immediately after birth (week 0). Apart from this, there was no significant ($p > 0.05$) difference in estimated daily milk yields (ml/d) among genotypes, feeding regimes and between birth type.

Conception rates (%), kidding opportunities (%) and multiple birth rates (%)

Table 3 shows mean values for the main effects of genotype and feeding regime on reproduction characteristics. There were no significant differences in any of the parameters among either genotypes or feeding regimes.

Birth weight, weight and growth rate of kids

Table 4 shows the results of an analysis of variance of the effects of genotype, treatment, sex and birth type on birth weight, weight at 3, 6 and 12 weeks of age and on growth rates of kids at various periods. There were significant ($p<0.05$) differences in birth weights and weights at 3, 6 and 12 weeks among genotype, sex and birth type. TN kids had significantly ($p < 0.01$) lower birth weights and lower weights at 3 and 6 weeks old than did 50% and 25% AN kids. Despite the fact that TN kids had significantly ($p < 0.05$) lower weights at 12 weeks (weaning) than did 50% AN kids, there were no significant ($p > 0.05$) differences in weaning weights either between TN and 25% AN or between 25% and 50% AN kids.

TABLE 3. LEAST SQUARE MEANS FOR THE MAIN EFFECTS OF GENOTYPE AND FEEDING ON REPRODUCTION CHARACTERISTICS (ADJUSTED FOR DIFFERENCES IN THE INITIAL LIVE WEIGHT)

	No. does	% Conception rate	No. of does kidded	% Kidding opportunity	% Multiple birth rate
Genotype					
TN	14	69.2	7	58.9	60.5
25% AN	20	90.0	15	80.3	81.5
50% AN	17	95.3	12	62.6	63.2
Feeding*					
T1	13	86.0	8	55.6	58.3
T2	13	93.7	10	78.6	77.8
T3	12	83.4	9	78.3	65.6
T4	13	86.9	7	55.7	73.7

% Conception rate = no. does conceived/no. does joined × 100.
% Kidding opportunity = no. does kidded/no. does joined × 100.
% Multiple birth rate = no. does with multiple births/no. does kidded × 100.
* T1: grazing only.
T2: supplemented for 15 days before mating and 45 days during mating period.
T3: supplemented from 15 days before mating to 42 days after kidding.
T4: supplemented for 30 days before kidding, followed by 42 days after kidding.

TABLE 4. THE EFFECT OF GENOTYPE, FEEDING, SEX AND BIRTH TYPE ON BIRTH WEIGHT, WEIGHT AND GROWTH RATE OF KIDS

	Genotype	Feeding	Sex	Birth type
Birth weight	**	NS	**	NS
Weight				
3 week	**	NS	**	**
6 week	**	NS	**	**
12 week	*	NS	**	**
Growth rate ($g/kg^{.75}/d$)				
0-3	NS	NS	NS	**
3-6	NS	NS	NS	**
6-12	NS	*	NS	NS
0-6	NS	NS	NS	**
0-12	NS	NS	NS	**

**, $p < 0.01$; *, $p < 0.05$; NS, not significant.

Male kids were born significantly ($p < 0.01$) heavier and had higher weights at 3, 6 and 12 weeks than female ones. Single born kids also weighed significantly ($p < 0.01$) more at birth and had higher weights at 3, 6 and 12 weeks than multiple born kids.

Table 5 shows least square means of the effects of feeding on birth weight and growth rates during various periods. Feeding regimes significantly affected kid growth rates only between 6-12 weeks. Kids from does supplemented for one month before kidding and 6 weeks during lactation period had significantly ($p < 0.05$) lower growth rates than those from does in other treatments.

TABLE 5. LEAST SQUARE MEANS WITH STANDARD ERRORS OF BIRTH WEGHT AND GROWTH RATE OF KIDS FROM DOES FED WITH DIFFERENT FEEDING REGIMES

Feeding*	T1	T2	T3	T4
Brith weight	1.7 ± 0.10	2.0 ± 0.10	1.9 ± 0.11	2.1 ± 0.13
Growth rate ($g/kg^{.75}/d$)				
0-3 week	57.0 ± 2.74	52.4 ± 2.56	54.4 ± 2.82	54.7 ± 3.48
3-6 week	25.8 ± 1.15	22.1 ± 1.08	24.6 ± 1.19	25.8 ± 1.47
0-6 week	38.7 ± 1.44	35.4 ± 1.34	38.1 ± 1.48	38.6 ± 1.83
6-12 week	17.9 ± 0.65^a	16.9 ± 0.61^a	16.9 ± 0.67^a	14.8 ± 0.83^b
0-12 week	26.3 ± 0.74	24.4 ± 0.69	25.6 ± 0.77	25.0 ± 0.95

Means within a row with different subscripts differ significantly ($p < 0.05$).

* T1: grazing only

T2: *supplemented for 15 days before mating and 45 days during mating period.*

T3: supplemented from 15 days before mating to 42 days after kidding.

T4: supplemented for 30 days before kidding, followed by 42 days after kidding

Post-partum oestrous

There was no significant difference in the number of days after parturition that the first oestrous occurred between the treatments (Table 6).

TABLE 6. NUMBER OF DAYS AFTER PARTURITION WITH STANDARD ERROR THAT FIRST OESTROUS OCCURRED

Parameter	Number of days after parturition
Feeding*	
T1	82 ± 17
T2	80 ± 14
T3	84 ± 11
T4	77 ± 8
Genotype	
TN	80 ± 10
25% AN	77 ± 12
50% AN	85 ± 14

* T1: grazing only.

T2: supplemented for 15 days before mating and 45 days during mating period.

T3: supplemented from 15 days before mating to 42 days after kidding.

T4: supplemented for 30 days before kidding, followed by 42 days after kidding.

Discussion

Effect of goat genotype on conception rates, kidding opportunities and multiple birth rates

In this experiment, although there were no significant differences in reproductive parameters among genotypes, cross-bred does tended to have higher conception rates (92.7 vs 69.2%), kidding *opportunities* (71.5 vs 58.9%) and *multiple* birth rates (72.4 vs 60.5%) than those of the TN does. However, the multiple birth rate of TN does in this study was higher than that of Katjang goats in Malaysia (20.6%) (Lee et al., 1979). The kidding rates of both TN and cross-bred does in this study, conducted at Khong Hoi Kong Research Farm (144 and 152%), however, were low when compared with does raised under improved management at Hat Yai campus (161 and 171% for TN and cross-bred does, respectively) (Saithanoo et al., 1991). This result may be due to a different environment (climate etc.) and animals (weight of doe, parity etc.).

Effect of goat genotype on birth weight and preweaning growth of kids

Cross-bred kids in this study were born significantly heavier and had significantly higher weights at 3 and 6 weeks after birth than native ones. Although there was no significant difference in growth rates during these periods either in terms of g/d or g/kg$^{.75}$/d among the genotypes, the results show that cross-bred kids grew slightly faster than the native kids. The trend of these results was in agreement with data from a study of Saithanoo et al (1993) which 50% AN kids had significantly higher growth rates than that of 25% AN and TN kids. It should be noted that, in the study of Saithanoo et al. (1993), all does and kids were raised under optimum management conditions so that each genotype would express full growth potential; whereas in this study, some animals were supplemented only in some periods.

Effect of feeding on conception rates and kidding opportunities, and multiple birth rates

Response to pre mating nutrition in sheep is complicated by the interrelationship between level of nutrition, body weight and body condition (Doney et al., 1982). In this study, concentrate supplementation either 15 days before mating or 15 day + 45 days during mating period did not significantly increase either kidding rates or multiple birth rates of goats grazing improved pastures. These results contrast with those found in a study of Garganica goats fed a high energy diet which displayed significantly higher twin kidding rates than those fed medium or low energy diets (Zezza et al., 1991). This can be explained by considering the body conditions of goat before mating and pasture condition. The initial mean live weights of does at the commencement of the present experiment were 26.3, 26.2, 25.2 and 26.4 kg for T1, T2, T3 and T4, respectively and all does in this study were in good conditions (score 3 and 4; from score 1-4). In Scottish Blackface sheep (Gunn et al., 1984) or Cheviot ewes (Rhind et al., 1983), ovulation rate was significant increased by pre-mating supplementation when ewes were in poor or moderate condition.

Herbage mass and sward heights are also interrelated with nutrition before mating. Gunn et al. (1992a) found that supplementation in the pre-mating period improved reproductive performance of ewes when sward height declined from 6 to 3.5 cm. During the mating period in this study, stocking rates were low (14, 20 and 17 head/ha for TN, 25% AN and 50% AN goats, respectively). Therefore, DM/doe of pasture was high in each paddock (table 1). In later periods, although stocking rate had increased to 51 doe/ha, forage available was still high (table 2). In addition to the availability of adequate forage, crude protein contents of main pasture species were sufficient for animals with values of 10.0, 25.2 and 20.2% for the leaf of *B. mutica*, *C. pubescens*, and *S. hamata*, respectively.

Since concentrate supplement were offered in group with sufficient space for each doe, each goat in supplemented treatments is assumed to consume the same amount of concentrate. Therefore, average concentrate weights consumed per doe in each treatment were 12.3, 52.2 and 17.9 kg for T2, T3 and T4, respectively. This indicates that concentrate supplementation would increase production cost (concentrate cost is 4 Baht/kg) without increasing animal performance. The results suggest that pasture conditions in this experiment were adequate and that supplementation was unnecessary.

Effect of feeding on birth weight and pre-weaning growth of kids

There was no significant effect of supplementary treatments on either kid birth weight or their weight gains in the first 6 weeks after birth and during this period supplementary feeding had no significant effects on milk production. These expected responses can be explained by associating milk availability with kid growth rates. However, kids from does on T4 had significantly lower growth rates than those from other treatments between 6-12 weeks of age. This difference can not be ascribed only to the effect of feeding of the does, since during this period, kids were able to feed on grass and legumes from pasture. The results suggest that due to sufficiency in both quantity and quality of pasture in the present study, the supplements did not affect kid performance.

Genotype-nutrition interaction

In the present study, no interaction between genotype and feeding on reproductive performance of does was found. This indicates that under improved pasture, both TN and cross-bred does could have similar reproductive performances and concentrate supplementation did not improve these performances.

Due to the shortage of TN kids, the interaction between genotype and feeding of does for birth weight, weights and growth rates of kids could not be analyzed. However, no interaction between the two treatments for these characteristics was found when analysis was carried out using only 25% and 50% AN kids. These results also show a similar trend as reproductive performances of does. The results of our study suggest that if the body conditions of does before mating are good and both forage availability and quality during pregnancy and lactation are adequate, concentrate supplementation does not increase either reproductive performances of does or pre-weaning growth of kids. However, at this level of concentrate supplementation, 50% AN does could not produce sufficient milk yields for their kids and resulted in low kids' growth rate. A further study should investigate the interaction between genotype and feeding regime on reproductive performance under both very low and very high nutritional regimes such as under village conditions or high level of concentrate supplementation.

Acknowledgements

The authors would to thank the Thai Australian Prince of Songkla University Project and the National Research Council of Thailand for providing facilities and funds for this study. The authors are also grateful to the graduate assistants of Small Ruminant Research and Development Centre for their assistance with animal care.

Literature Cited

AOAC. 1960. Official Methods of Analysis, 9th ed., (Ed: W. Hortwitz). Association of Official Analytical Chemists, Washington D.C.

Doney, J. M., R. G. Gunn and F. Horak. 1982. Reproduction. In: Sheep and Goat Production. (Ed: I. E. Coop). Elsevier Scientific Publishing Company. p. 495.

Gunn, R. G., J. M. Doney and W. F. Smith. 1984. The effect of different durations and times of high-level feeding prior to mating on the reproductive performance of Scottish Blackface ewes. Anim. Prod. 39:99-105.

Gunn, R. G., J. A. Milne, A. J. Senior and A. M. Sibbald. 1992a. Effect of feeding supplements in the autumn on the reproductive performance of grazing ewes: feeding fixed amounts of supplement before and during mating. Anim. Prod. 54:243-248.

Gunn, R. G., R. I. Jones and D. A. Sim. 1992b. Effect of feeding supplements in the autumn on the reproductive performance of grazing ewes: feeding supplements in relation to sward height. Anim. Prod. 54:249-258.

Haresign, W. 1981. The influence of nutrition on reproduction in the ewe: 1. effect on ovulation rate, follicle development and luteinizing hormone release. Anim. Prod. 32:197-202.

Kochapakdee, S., W. Pralomkarn, S. Saithanoo, A. Lawpetchara and B. W. Norton. 1994. Grazing management studies with Thai goats. I. productivity of female goats grazing newly established pasture with varying levels of supplementary feeding. AJAS 7:289-294.

Lee, K. A., Wan Mohammed, bin Wan Embong, L. H. Ng, F. C. Ng and A. K. Phang. 1979. Performance of sheep and goats under rubber: preliminary results. Proc. Sem. Integr. Anim. Pl. Crops. Pulau Pinang 1978. Malaysia Rubber Research Institute. pp. 206-212.

Milton, J. T. B., S. Saithanoo and L. Praditrungwatana. 1991. Goat management in the Asian humid tropics. In: Goat Production in the Asian Humid Tropics (Eds: S. Saithanoo and B. W. Norton). Proc. of an Int. Seminar held in Hat Yai, Thailand 28-31 May, 1991. pp. 91-107.

Muscio, A., S. Dell' Aquila, L. Taibi, A. Trana, G. Bufano and O. Montemurro. 1991. The influence of diet energy level on liveweight and daily milk yield in Garganica goats. In: Proc. of the Third Int. Symp. on the Nutrition of Herbivores. The Malaysian Society of Animal Production, Department of Animal Science, Universiti Pertanian, Malaysia. p. 88.

Rhind, S. M., R. G. Gunn and J. M. Doney. 1983. A note on reproductive performance and plasma progesterone level during early pregnancy of Scottish Blackface and Cheviot ewes in relation to body condition and level of nutrition prior to mating. Anim. Prod. 37:455-458.

Saithanoo, S., B. Cheva-Israkul and K. Pichaironarongsongkram. 1991. Goat production in Thailand. In: Goat Production in the Asian Humid Tropics (Eds: S. Saithanoo and B. W. Norton). Proc. of an Int. seminar held at Hat Yai, Thailand. 29-31 May 1991. pp. 30-39.

Saithanoo, S., W. Pralomkarn, S. Kochapakdee and J. T. B. Milton. 1993. The pre-weaning growth of Thai native (TN) and Anglo-Nubian × TN kids. J. Appl. Anim. Res. 3:97-105.

SAS. 1987. Generalized Linear Model Procedures. 6th ed. The Statistical Analysis Systems. SAS Institute Inc., Cary, North Carolina, U.S.A.

Smith, J. F. 1985. Protein, energy and ovulation rate. In: Genetics of Reproduction in Sheep (Eds: R. B. Land and J. J. Robinson). Butterworths, London. pp. 349-359.

Zezza, L., A. Muscio, P. Centoducati, Ceci, R. Manchisi and E. Bellitti. 1991. The influence of diet energy level on liveweight, glycaemia rate and reproductive performances in Garganica goats. In: Proceedings of the Third International Symposium on the Nutrition of Herbivores. The Malaysian Society of Animal Production, Department of Animal Science, Universiti Pertanian, Malaysia. p. 86.