Contents

Feeding systems for goats in the tropics

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Summary

The major factors that influence the choice of feeding systems for goats are: their feeding habits, as they prefer to "browse" rather than "graze"; the need and opportunities for recycling of nutrients through excreta; opportunities for biological control of intestinal nematodes through consumption of foliages with moderate concentrations of condensed tannins; the global need to promote storage of carbon in standing biomass (mitigation of the green house effect); the availability and degree of knowledge of local feed resources.

Recent research in Vietnam is reviewed in the context of increasing feed resources by growing plant species with high yield, good nutritive value and good adaptation to hilly areas, especially in the dry season. Examples are given of feeding systems using sugar cane and foliages from trees and shrubs, and of the benefits from combining different ingredients in the diet. The nutritive value of leaves of Jackfruit, *Trichantera gigantea*, Cassava, Gliricidia, Leucaena and Flemingia was shown to be less than that of traditional protein concentrates; however, the economic analyses indicated a higher net profit using these foliages.

Emphasis is given to the need for further research with local feed resources and of promoting farmer understanding and acceptance of these new feed resources and the ways to utilize them in production systems with small ruminants.

Key words: Feed resources, feeding systems, biomass, biological control of intestinal parasites, goats, sheep, fodder trees and shrubs

Introduction

Three factors influence the choice of feeding systems for goats. These are:

- Their feeding habits, as they prefer to "browse" rather than "graze"
- The need and opportunities for recycling of nutrients through excreta
- Opportunities for biological control of intestinal nematodes through consumption of foliages with moderate concentrations of condensed tannins
- The global need to promote storage of carbon in standing biomass (mitigation of the green house effect)
- The availability and degree of knowledge of local feed resources

Feeding preferences

Recent work in Cambodia and Lao has demonstrated the major differences in feed intake and digestibility when leaves are consumed from intact branches rather than as a separate feed (Figures 1 and 2). Both intake and digestibility of the DM were increased when the leaves were attached to the branches and suspended in the feed trough compared with the leaves offered alone.

Similar finding were reported by Toum Keopaseuht et al (2004) who fed goats with foliage or leaves of *Gliricidia sepium* and *Stylosanthes guianensis* CIAT 184. The goats ate faster (feed DM consumed per minute) when the leaves were attached to the branches. The mechanism responsible for these effects is not known but may be related to salivary secretion being stimulated and resultant increased production of proline, an amino acid that binds with condensed tannins. There is an urgent need to apply these findings to a production situation, as observations with farmers in Cambodia indicated that their preference was to offer foliages as branches and suspended in some way in the pen (Theng Kouch et al 2003).

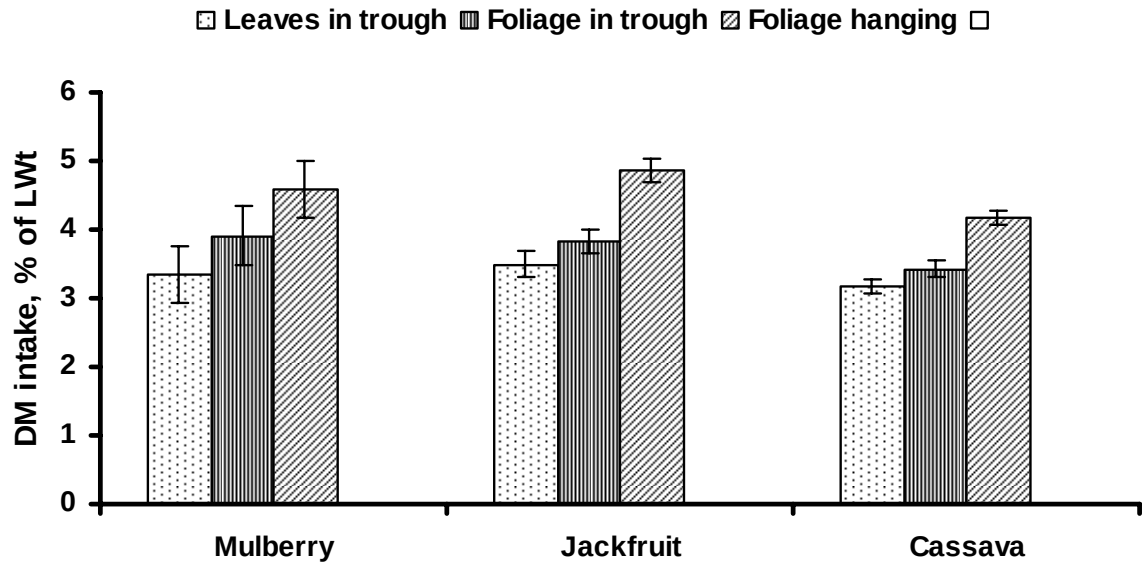

Figure 1: *DM intake by goats of foliage / leaves of three plant species, according to the method of offering the feed (Theng Kouch et al 2003)*

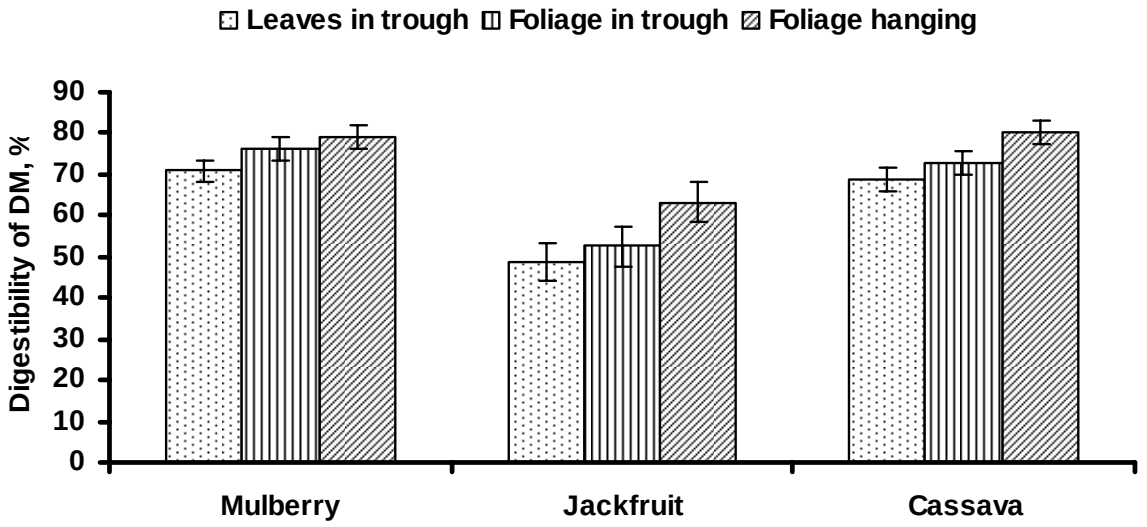

Figure 2: *DM digestibility by goats of foliage / leaves of three plant species, according to the method of offering the feed (Theng Kouch et al 2003)*

Recycling

The capacity of goats to select nutrient-rich foliage can be used to advantage when these animals are managed in a system, which facilitates collection and utilization of the excreta. Research at the Goat and Rabbit Research Centre showed that the excreta from goats supported better conversion rates of manure to earthworms than manure from rabbits, cattle and buffaloes (Figure 3). The residual compost (worm casts) after the worms had processed the goat manure, as well as the original manure, supported faster growth of maize than the manure and compost from the other animal species (Figure 4).

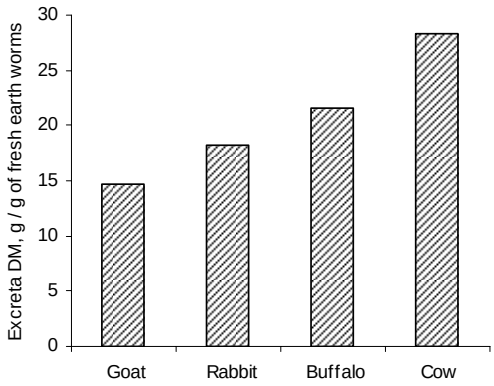

Figure 3: *Conversion rate of excreta DM into earthworms (Nguyen Quang Suc et al 2000)*

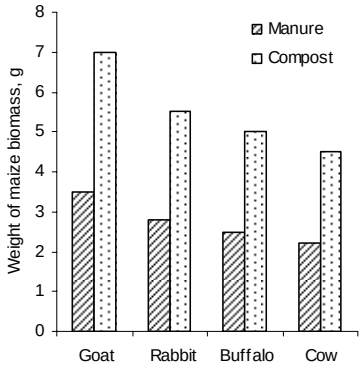

Figure 4: *Comparative growth rates of maize plants cultivated in manure or earth worm compost from different animal species (Nguyen Quang Suc et al 2000)*

Tree foliages to control intestinal nematodes

A number of studies have shown that condensed tannins can have direct toxic effects against intestinal nematodes that do not appear to be mediated through digestible protein supply (Kahn and Diaz-Hernandez 2000; Athanasiadou et al 2000; Butter et al 2001). The practical application of these findings in goats was reported in research from Cambodia (Seng Sokerya and Rodríguez 2001; Seng Sokerya et al 2003), where the feeding of cassava foliage (containing about 30 mg condensed tannins/kg DM) either as the sole forage or as a mixture with grass led to significant reductions in nematode faecal egg counts. Similar findings were reported from Vietnam (Nguyen Lin et al (2003).

Integrated use of biomass as feed and fuel

The realization that global oil availability is nearing, or may already have passed, the peak, together with the knowledge that burning of fossil fuels is the main cause of the "greenhouse effect", has focused attention on the need to develop alternate sources of energy that are renewable and are environmentally friendly (Preston and Leng 2004). Woody biomass, converted to a combustible gas by gasification, is one source of energy that fits into this category since the products of combustion are re-integrated into biomass by photosynthesis. Trees and shrubs are the logical source of woody biomass. However, their role as sources of fuel is enhanced if efficient use can be made of the leaves which have potential as sources of edible nutrients, especially protein. In this respect the goat, by virtue of its natural browsing habit, is likely to be the preferred animal species for such an integrated system. Trees and shrubs, which are quick growing, have associated symbiotic systems for fixation of atmospheric fixation and whose leaves and fine stems are consumed by goats, will have a major role to play in the development of these new approaches to the utilization of natural resources.

Availability and knowledge of local feed resources in Vietnam

Traditional feeding systesm for small ruminants

Small ruminants are considered one of five main domestic animals in Vietnam and the distribution of population depends on tradition and ecological conditions. The majority of goats (12,277 head) was found in Ninh Thuan, followed by Ha Tay (4,892 head) and Ninh Binh. The main breed is local, about 90% of the population, which is wide-spread various ecological areas and well adapted to poor nutrition and management. Most small ruminants are kept for meat

production and mainly kept by smallholders, with an average flock size of 10-50 animals. There are some flock sizes of 200-300 animals found in the forests, mountainous and hilly communes in Ninh Thuan. In this area, goats and sheep are grazed in the field during the day, while at night they are kept in the pens together with cattle without feed supplement or water. Generally goats and sheep are raised in relatively dry areas with poor vegetation and barren lands, and under harsh conditions, goats perform better than cattle and buffalo.

Goat and sheep production in Vietnam is based on small farms and mainly extensive farming systems. The limited amounts of quality roughage combined with intensive crop production have led to a heavy dependence on forest fodders especially in remote areas. This has led to increased cutting down of trees, without giving the forests enough time for regrowth of forest species.

In rice growing areas, weeds from the edges of roads and fields constitute about 30% of feed. Stall feeding and tethering of animals in uncropped and idle lands is practiced, whereby between crop seasons, rice fields become communal grazing areas. Some goats and sheep free graze existing shrubs and other vegetation.

In hilly areas, with shifting systems of cultivation, after burning forestry areas the land is used for planting crops for a period from 2 to 3 years and then these areas are left in fallow for 5-6 years. During this time cattle, buffaloes, goats and sheep are left to graze in these fallows until soil nutrient is recovered for the next cycle of cropping. Another system for raising goats is called “raising goats on the back” where farmers always cut grasses and foliages from trees in high mountains and bring on the back to feed animals at the house. Very few flocks are grazing in communal areas or land around the forestry land, where feed is available.

In general, forest fodder and grass from edges of roads and fields often has a nutritive value below required levels for production. Feed shortage in the dry season is one of reasons for the low small ruminant production in Vietnam. It is reported by communes that there is a high mortality of old and young animals in the dry season due to the lack of quantity and quality of feeds and to cold weather. Natural grasses, maize stover, cassava leaves and molasses urea blocks can be given to overcome this situation. Rice straw is the most important alternate feed source to scarce green grass. It is readily available locally throughout the areas, especially in mountain areas, but it is burnt or left in the field. Some is used as fuel or mixed with manure for use as organic fertilizer etc and is not much used for goat feeding.

New feeding systems

During the last ten years research in Vietnam has concentrated on increasing feed resources by growing plant species with high yield, good nutritive value and good adaptation to hilly areas, especially in the dry season. The cultivation of these trees by the farmers in their homestead is common, especially in hilly areas. The importance of fodder trees as a source of green forage is based on availability during the time when other feed resources are scarce. Moreover, they are cultivated mainly on land, which is not suitable for cultivation of food crops. This makes them a particularly important low cost resource. It is clear that the relatively high levels of protein in concentrates often have to be purchased at a high cost. The use of shrub legumes can provide some of the protein at a considerably lower cost.

Although the protein quality of leaves of Jackfruit, *Trichantera gigantea*, Cassava, Gliricidia, Leucaena and Flemingia was shown to be less than that of traditional protein concentrates, the economic analyses indicate a higher net profit using foliage. This is important to the Vietnamese farmers because of the low availability of cash for investments. Sugar cane and multi-purpose tree species have proved to be particularly suitable for these conditions and now form the basis of the goat feeding program in the dry season of Vietnam. The chemical composition and digestibility of the feeds are shown in Tables 1 and 2.

Sugar cane (*Saccharatum officinarum*) is a perennial crop, which can be used for animal feed as well as for sugar production (Preston and Murgueitio, 1992). Sugar cane is

Table 1. DM content (%) and chemical composition (% of DM) in some tropical feeds

	DM%	CP	Ash	NDF	ADF	Total tannin, %	References
Sugar cane leaves	29.6	7.58					Keir et al., 1997
Chopped whole sugar cane	25	2.5	2.4	40	24.6	-	Van et al., 2001
”	23.7	2.5	2.3	41.1	25.2	-	Van et al., 2001
”	20.9	1.2	2	41.7	26.9	-	Mui, 2001
”	22.1	2.1	1.5	39.1	29.5	-	-
”	25	1.3	1.4	48.8	22.5	-	-
”	26.6	1.3	1.4	44.1	23.2	-	-
”	29.8	17	4.9	57.3	43.6	-	Van et al., 2001
Rice straw	89.4	3.88	....	.....	....	....	Keir et al., 1997
Urea-treated rice straw	47.7	15.8	11.8	71.7	48.7	-	Dung et al., 2004
Flemingia macrophylla	39	22.1					Duyen et al., 1996
”	27.3	19.1	6.3	-	-	-	Huy et al., 1999
”		16	5.8	64.7	53.4	3.4	Mui, 2001
”		16.4	5.2	61	47.4	-	-
”		16.3	4.3	57.3	41.2	2.4	-
”	28.5	16.4	5	58.4	42.9	3.1	-
”	29.3	16.3	2.8	58.3	42.9	-	-
”	28.5	18.3	5.4	52	37.4	2.8	Van et al., 2005
”	29.8	17	4.9	57.3	43.6	-	Van & Ledin, 2002
Jack Fruit foliages		17.9	4.95				Man et al., 1995
	32.8	14.8	10.6	50.6	36	-	Van et al., 2001
	33.2	14.5	11.2	-	-	3.4	Mui, 2001
	30.3	16.4	11.4	62.6	52	3.32	-
	30.3	16.2	12.7	54.9	41.5	-	-
		16.2	9.8	51	40.8	-	-
		16.2	11.4	55.6	42.1		-
	35.4	13.3	11.1	40.7	29.2	4.2	Van et al., 2005
	35	14.8	10.6	50.6	36	-	Van & Ledin, 2002
Acacia mangium	26.9	18.1	-	-	-	-	Duyen et al., 1996
	31.6	16.2	4.6	49.8	34.7	4.9	Van et al., 2005
	32.4	13.2	3.9	53.3	32.5		Van et al., 2004
		16.6	3.19				Man et al., 1995
#	31.7	17					Duyen et al., 1996
Cassava hay	28.5	15.6					Keir et al., 1997
Fresh Cassava foliage	91.4	19.1	9.8	40.2	30.7	2.4	Dung et al., 2004
Gliricidia foliage	87	20.1	8.8	39.1	26.6	-	Hao &Ledin, 2002
Napier grass	22	29					Keir et al., 1997

Cassava pomace	23.1	24.8	11.4	42.6	32.1		Hao &Thiep, 2003
Rubber seed cake	12.5	14.8	5.9	34.7	64.2		Hao & Liem, 2003
Groundnut cake	88.1	3.02	1.3	26.2	53.4		-
Dried Cassava root	88.9	30	6.2	16.1	27.2		-
	90.4	38.7	4.51	13.5	16.5		-
	88.7	2.4	1.5	5.5	25	-	
	90	3.5	1.6	11.4	3.3		Van &Ledin, 2002

 # 218 g/kg DM of HCN

used as a feed primarily as an energy source during the dry season when the availability of conventional forage resources is limited (Jennings, 1986; Preston, 1988; Neckles, 1988). A model for utilizing sugar cane as a feed for ruminants, either for growth or milk production must take into account the high fiber, low crude protein (CP) and high energy content of sugar cane. The results of the intake studies in Vietnam indicated that DM digestibility of sugar cane varied from 62.2-66.7%, and there were no important differences between the different methods used for processing sugar cane leaves or tops in terms of DM voluntary intake. However, slicing the stalks into small pieces (1-3 cm) resulted in a significant increase in feed intake (Mui et al., 2000). The rate of inclusion of 30% total DM was optimal in terms of liveweight gain, feed conversion ratio and the feed costs when the goats were fed a basal diet of concentrate, a molasses-urea block and Jackfruit leaves (Mui et al., 2000)

Rice straw is low in energy, protein and vitamins and does not contain a balance of essential minerals. However, rice straw contains a large pool of structural carbohydrates which can potentially be degraded by rumen microbes into volatile fatty acids, and thus act as an energy source for ruminants. Urea treatment is the most applicable method for improving the quality of rice straw. Urea treated rice straw (UTRS) increases CP concentration and rumen degradability compared to untreated rice straw.

The traditional diets for growing, lactating and weaned animals in Vietnam consist of native fodders, cultivated grasses and concentrates. The escalating costs of commercial feed concentrates have focused the interest on multi-purpose trees as inexpensive alternative sources of nutrients. The leaves can provide protein to balance the carbohydrates in grasses, sugarcane and food crop by-products of low nutritive value (Preston and Murgueitio, 1992). Tropical tree legumes are rich in most minerals and generally have a range of digestibility similar to the tropical grasses (Leng et al., 1992). In addition factors like availability on the farm, accessibility, provision of variety in the diet, laxative influence on the alimentary system and reduction in the requirements for purchased concentrates (Devendra, 1991, Maasdorp and Dzowela, 1998) are important.

Flemingia (*Flemingia macrophylla*) is a legume shrub with deep roots, which can grow to a height of approximately 2.5 m. It is a hardy plant that can resist long dry spells and is capable of surviving on very poorly drained and occasionally water-logged soils. The species is found on both clay and lateritic soils and is tolerant to shade and fire. Binh et al. (1998) reported that Flemingia in Vietnam has an outstanding adaptation to acid (pH=3.5) soils with high contents of soluble aluminum. Flemingia has also been used for soil conservation with good results (Mui et al., 2000; Binh et al., 1998). The plant can provide fresh edible biomass in the range of 45 to 64 tonnes/ha/year (Binh et al., 1998). Flemingia has a protein content of approximately 19% of DM (Binh et al., 1998), which makes it interesting as a potential source of N in diets for livestock.

Jackfruit (*Artocarpus heterophyllus*) trees are planted for fruit in the homegardens of farms with 4-15 trees distributed per farm. The fruits are available in large quantities and no longer have any commercial importance. In recent years foliage of Jackfruit has been collected by pruning the trees, leaving enough branches for continued growth. Considerable amounts of edible biomass can be produced from a population of 250 trees/ha, and a fresh matter yield of between 37-63 tonnes of edible biomass can be achieved per ha annually (Tien et al., 1996).

Jackfruit leaves have a high protein content of approximately 17 % in DM, and the fresh leaves are a valuable feed resource for goats (Mui et al., 2000; Van et al., 2002; Viet, 1997; Nhan and Preston, 1997).

The new feeding system introduced for goats shows that both Jackfruit and Flemingia can be potential supplements for goats offered tropical grass and chopped whole sugar cane. Jackfruit can replace up to 100% of a concentrate based on protein content. Flemingia showed a poorer potential as a supplement for goats and replacement levels should not exceed 25% of the protein in the concentrate or 17% of DM for growing goats (Mui et al., 2001).

Trichantera gigantea is a tree that is native to the Andean foothills in Colombia. It is not a legume, but its vigorus regrowth even with repeated cutting and without fertilizer applications indicates that nitrogen fixation by Mycorrhiza or other organisms may take place in the root zone. The advantage of this tree is that the leaves are consumed readily by pigs, rabbits and chickens. Trichantera gigantea has adapted well to different ecological zones in Vietnam, the leaves are rich in protein and are of high digestibility (Keir et al., 1977). It grows better under partial shade than in full sunlight (Nguyen Thi Hong Nhan et al., 1996).

Table 2. Digestibility and nitrogen balance in goats fed different roughages as sole feeds or in combination

Diets	Digestibility				N balance, g/kg $W^{0.75}$/d	References
	DM	CP	NDF	ADF		
Sole feed						
Chopped whole sugar cane	67.7	-67.5	38.6	36.6		Mui et al., 2000
Para grass	66.8	70.2	70.0	68.5		
Flemingia	50.6	62.2	47.7	39.2		
Jackfruit	52.6	45.2	41.5	28.1		
Combinated diets						
Flemingia+CWSC (W.S)[a]	56.1	35.3	38.0	37.6	0.012	Mui et al., 2001[a,b,c]
Flemingia+CWSC (D.S)[b]	59.2	36.8	50.7	34.1	0.250	
Jackfruit+ CWSC (W.S.)	54.2	38.5	36.4	23.9	0.175	
Jackfruit+ CWSC (D.S.)	58.6	47.0	50.7	37.9	0.298	
SBM+CWSC (W.S.)	74.3	73.6	56.0	34.1	0.465	
SBM+CWSC (D.S.)	65.9	73.3	43.8	15.6	0.604	
Acacia+Para grass+concentrate	63.6	58.2	59.7	39.5	0.5 (g N total)	Van et al., 2004
Acacia+Para grass+concentrate+0.5g Charcoal/kg BW	68.2	68.6	58.4	38.4	6.5	-
Acacia+Para grass+concentrate+1g Charcoal/kg BW	65.8	65.7	53.0	31.4	6.7	-
Acacia+Para grass+concentrate+1.5g Charcoal/kg BW	62.9	60.7	52.1	30.3	4.0	-
Jackfruit+MUB	66					Keir et al., 1997
Tri. Gigantea +MUB	48					Keir et al., 1997
Effect of added substances						
Flemingia+PEG	41.5	41.5	46.5	32.5	-0.069	Mui et al., 2001[a,b,c]
Flemingia	40.3	41.8	37.8	35.0	0.032	
Jackfruit+PEG	55.7	59.0	51.8	40.3	0.428	
Jackfruit	45.0	50.5	43.0	34.2	0.335	

[a]: (W.S.): Wet season; [b] :(D.S.): Dry season

Using Leucaena foliage as replacement for concentrate in the diet of lactating goats has given good benefits in both milk production and feed cost. Milk yield and quality was

improved, 1.34 vs 1.01 kg/day in Bachthao goats when replacing 50% of the DM of a concentrate. When substituting 50% of DM of a high quality concentrate with L.L. KX2, the liveweight gain of weaned goats at 5 month of age was 92 g/day and when substituting 100% of the concentrate 59 g/day compared to 64g/day in goats fed 100% concentrate supplementation (Mui et al., 2002)

References

Athanasiadou S, I Kyriazakis, F Jackson and R L Coop 2000. Effect of short-term exposure to condensed tannins on adult *Trichostrongylus colubriformis*. Vet. Rec. pp 728–732

Butter N L, J M Dawson, D Wakelin and P J Buttery 2001. Effect of dietary condensed tannins on gastrointestinal Nematodes. The Journal of Agricultural Science,137 pp 461-469 Cambridge University Press

Binh, D.B., Tien, N.P. and Mui, N.T., 1998. Study on biomass yield and quality of Flemingia microphylla and on soil fertility. Proceedings of Workshop of Animal Nutrition Science, Ministry of Agriculture, Vietnam, p. 137.

Devendra, C., 1991. Nutritional potential of fodder trees and shrubs as protein sources in ruminant nutrition. Legume trees and other fodder trees as protein sources for livestock. FAO Animal Production and Health Paper 102: 95-113.

Hao, N.V. and Ledin, I., 1999. The potential of Gliricidia maculata leaves as a livestock feed in small holder farming systems in Vietnam. MSc thesis in the programme "Tropical Livestock Systems". SLU, Dept. of Animal Nutrition & Management, P.O. Box 7024, Uppsala, Sweden.

Huy, L.K., An, L.V., Ly, N.T.H., Dao, T.P. and Toan, N.H., 2000. Using the leguminous forages as protein source for feeding animals in small upland farming systems. Proceedings of National Workshop on Sustainable Livestock Production on Local resources. University of Agriculture and Forestry, Thu Duc, Ho Chi Minh City, 4 p.

Jenning P.G., 1986. Sugar cane in animal feeding in Jamaica. Sugar cane as Feed. FAO. Animal Production and Health Paper 72: 146-152.

Khan L P and A Diaz-Hernandez 2000. Tannin with anthelmintic properties. in Tannins in Livestock and Human Nutrition. Brooker, J.D (Ed)
www.aciar.gov.au/publications/proceedings/92/index.htm

Keir, B., Binh, D.V., Preston, T.R., Orskov, E.R., 1997.Nutritive value of leaves from tropical trees and shrubs (1 and 2) Livestock Research for Rural Development 9(4)

Leng, R.A. 1990. Factors affecting the utilization of poor-quality forage by ruminants particularly under tropical conditions. Nutrition Research Reviews 3: 277-303.

Neckles, F.A., 1988. Experiences with whole sugar cane feeding in Trinidad and Tobago. Sugar cane as Feed. FAO. Animal Production and Health Paper, 72: 83-92.

Nguyen Kim Lin, T R Preston , Dinh Van Binh and Nguyen Duy Ly 2003. Effects of tree foliages compared with grasses on growth and intestinal nematode infestation in confined goats. Livestock Research for Rural Development 15 (6). Retrieved December 4, 2004, from
http://www.cipav.org.co/lrrd/lrrd15/6/lin156.htm

Nguyen Quang Suc, Le Thi Thu Ha and Dinh Van Binh 2001. Manure from rabbits, goats, cattle and buffaloes as substrate for earthworms. Proceedings of Workshop-seminar "Making better use of local feed resources" SAREC-UAF, January , 2000. http://www.mekarn.org/sarpro/sucew.htm

Nguyen Van Hao and Nguyen Van Thiep 2003. Utilization of Gliricidia leaves (Gliricidia maculata) as a protein source for dairy goats. Workshop-seminar "Making better use of local feed resources" SAREC-UAF, Hue, March 2003

Ngo Van Man, Nguyen Van Hao and Vuong Minh Tri, 1995. Biomass production of some leguminous shrubs and trees in Vietnam. Livestock Research for Rural Development. 7, 2 http://cipav.org.co/lrrd

Nguyen Thi Duyen., Le Thi Bien., Nguyen Thi Mui, Dinh Van Binh and Preston, T.R., 1996. Foliage of Trichantera gigantea, Jackfruit (Artocarpus heterophyllus) banana (Musa sp) as protein resources for lactating goats fed a basal diet of rice straw and sugar cane tops. Livestock Research for Rural Development. 8, 3 http://cipav.org.co/lrrd

Nguyen Van Hao and Duong Thanh Liem, 2003. The utilization of rubber (Hevea brasiliensis) seed cake as protein source for growing goats Workshop-seminar "Making better use of local feed resources" SAREC-UAF, Hue, March 2003

Nguyen Thi Mui, Inger Ledin and Dinh Van Binh, 2000. Effect of chopping and level of inclusion of whole sugar cane in the diet on intake and growth of goats. Livestock Production Science 66: 25-34.

Nguyen Thi Mui, Inger Ledin, Peter Udén and Dinh Van Binh, 2001. Effect of replacing a rice bran – soya bean concentrate with Jackfruit (Artocarpus heterophyllus) or Flemingia (Flemingia macrophylla) foliage on the performance of growing goats. Livestock Production Science 72: 253-262.

Nguyen Thi Mui, Inger Ledin, Peter Udén and Dinh Van Binh, 2001. The foliage of Flemingia (Flemingia macrophylla) or Jackfruit (Artocarpus heterophyllus) as a substitute for a rice bran – soya bean concentrate in the diet of lactating goats. Asian Australasian Journal of Animal Sciences 15: 45-54

Nguyen Thi Mui, Inger Ledin, Peter Udén and Dinh Van Binh, 2001. Nitrogen balance from foliage of Flemingia (Flemingia macrophylla) and Jackfruit (Artocapus heterophyllus) in the diet and effect of a daily supplementation of polyethylene glycol (PEG) on intake and digestion of goats. Asian Australasian Journal of Animal Sciences 15: 699-707

Nguyen Thi Mui, Do Thanh Van, Dinh Van Binh, B.F. Mullen and R.C Gutteridge, 2003. Effect of replacing KX2 foliages for concentrate on live weight gain and milk yield of goats. Asian Australasian Journal of Animal Sciences (Submitted)

Nguyen Thi Mui, Ngo Tien Dung, Dinh Van Binh, B.F. Mullen and R.C Gutteridge, 2003. Biomass of Leucaena KX2 and its feed value for ruminants. Asian Australasian Journal of Animal Sciences (Submitted)

Nhan, N.T.H. and Preston R.T., 1997. Effect of sugar cane juice on milk production of goats fed a basal diet of Jackfruit (Artocarpus heterophyllus) leaves. Proceedings Regional Seminar Workshop on Better Use of Local Available Feed Resources in Sustainable Livestock-based Agricultural Systems in SE Asia. FAO project GCP/RAS/143/JPn. Ho Chi Minh City, pp. 62-65.

Preston T R and R A Leng 2004. Global decline in oil and natural resources; implications for the scope and content of papers for publication in LRRD. Livestock Research for Rural Development. Vol. 16, Art. #87. Retrieved from http://www.cipav.org.co/lrrd/lrrd16/11/pres16087.htm

Preston, T.R. and Murgueitio, 1992. Strategy for sustainable livestock production in Tropics. CIPAV, CONDRIT, Cali, Colombia, pp. 49-69.

Preston, T.R., 1988. Sugar cane as animal feed: an overveiw. Sugar cane as Feed. FAO. Animal production and Health Paper, 72: 61-71.

Tien. N. P., Mui, N.T. and Binh, D.V., 1996. Biomass production feed quality of multi-purpose trees. Proceeding of National Seminar-Workshop on Sustainable Livestock Production on Local Resources held in University of Agriculture and Forestry. Ho Chi Minh City, Vietnam.

Seng Sokerya and L Rodriguez 2001. Foliage from cassava, Flemingia macrophylla and bananas compared with grasses as forage sources for goats: effects on growth rate and intestinal nematodes. LRRD 13(2) http://www.cipav.org.co/lrrd/lrrd13/2/soke132.htm

Seng Sokerya and T R Preston 2003. Effect of grass or cassava foliage on growth and nematode parasite infestation in goats fed low or high protein diets in confinement. Livestock Research for Rural Development (15) 8 Retrieved from http://www.cipav.org.co/lrrd/lrrd15/8/kery158.htm

Theng Kouch, T R Preston and J Ly 2003a Studies on utilization of trees and shrubs as the sole feedstuff by growing goats; foliage preferences and nutrient utilization; Livestock Research for Rural Development (15) 7 Retrieved from http://www.cipav.org.co/lrrd/lrrd15/7/kouc157.htm

Theng Kouch, Nam Noch and T R Preston 2003b. Observations on goat raising system of farmers along the Mekong river. MSc Thesis, MEKARN-SLU

Toum Keopaseuht, Chhay Ty, Bounthong Bouahom and T R Preston 2004. Effect of method of offering foliages of Gliricida sepium and Stylosanthes guianensis CIAT 184 to goats on intake and digestibility; Livestock Research for Rural Development.16, 31. Retrieved, from http://www.cipav.org.co/lrrd/lrrd16/05/toum16031.htm

Van, D.T.T., Ledin, I. and Mui, N.T., 2001. Feed intake and behaviour of small ruminant fed sugar cane as sole roughage with or without concentrate. Msc. Thesis, Swedish University of Agricultural Sciences, P.O. Box 7024, 750 07 Uppsala, Sweden

Van, D.T.T. and Ledin, I., 2001. Effect of different foliages and the sugar cane in the diet in late pregnancy on ewe and lamb performance. Msc. Thesis, Swedish University of Agricultural Sciences, P.O. Box 7024, 750 07 Uppsala, Sweden

Van D.T.T. and Ledin. I, 2002. Effect of difference foliages and sugar cane in the diet in late pregnancy on ewe and lamb performance. Asian-Aust. J.Anim.Sci.15, 828-833

Van D.T.T., Nguyen Thi Mui and Ledin. I, 2005. Tropical foliages: effect of presentation method and species on intake by goats. Animal Feed Science and Technology 118: 1-17

Van D.T.T., Nguyen Thi Mui and Ledin. I, 2004. Effect of adding Bamboo charcoal to a diet of concentrate, para grass and Acacia mangium on digestibility and nitrogen balance in goats. Proceedings of the 11th Animal Science Congress The Asian-Australian Association of Animal Production Societies, volume II, 399-402.

Viet T.Q., 1997. Jackfruit and Gliricidia sepium leaves as sole feeds on intake, growth and rumen environment in growing goats. Proceeding of Regional Seminar Workshop on Better Use of Local Available Feed Resources in Sustainable Livestock-based Agricultural Systems in SE Asia. FAO project GCP/RAS/143/JPn. Ho Chi Minh City, pp. 82-84.

Table 4. Effects of feedstuffs and feeing method on production

Feedstuffs	Feeding level in diet,	Method of use		Production effects		References
		Supplement	Replacement for CP in concentrate	Traditional feeding,	New feeding	
Effects of feedstuffs and feeing method on liveweight gain (g/day) of goats and sheep						
CWSC in the DM of roughage	30-45%		x	46	65-54	Mui et al., 2000
Rubber seed cake	50-100%		x	113	110-116	Hao and Liem 2003
Urea treated Rice straw for sheep	260-269	x		-13	45	Hue et al., 2003
Flemingia for goats	53-100		x	56	49-22	Mui et al., 2000
Jackfruit for goats			x	57	58-30	Mui et al., 2000
Leucaena for goats	50-100		x	74	81-61	Mui et al., 2003
Effects of feedstuffs and feeding method on milk production (kg/day) of goats						
Cassava hay for goats	300-400	x		0.881	1.3-1.5	Dung et al., 2004
Gliricidia for goats	50-75%		x	1.810	1.520-1.610	Hao and Thiep 2003
Flemingia for goats	20 %		x	1.742	1.601	Mui et al., 2001
Jackfruit for goats	40 %		x	1.725	1.687	Mui et al., 2001
Leucaena for goats	25-50 %		x	1.012	1.330-1.290	Mui et al., 2003