

PRELIMINARY STUDIES ON THE UTILIZATION OF THE NATURAL VEGETATION IN THE HENEQUEN ZONE OF YUCATAN FOR THE PRODUCTION OF GOATS I. SELECTION AND NUTRITIVE VALUE OF NATIVE PLANTS

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The production of goats is proposed as a means of utilising the growing areas of natural vegetation (low secondary bush) in the henequen zone of Yucatán. In a preliminary investigation, the selection by goats of native plants during the whole of the dry season, the nutritive value of the selected plants and the yield of dry matter (DM) during one of the driest months (April) were studied. To study the selection of plants in the bush, direct observation of grazing and browsing goats was used. The selection pattern varied from month to month, an observation which is due in part to the changing availability of species of plants throughout the dry season. In November, species of trailing and climbing plants were highly selected, however, these largely disappear during December and therefore, in December and January the selection pattern changed and browse species (bushes and trees) were preferred. As the dry season progressed, selection of herbaceous species increased; between February and May the goats spent on average 65% of the total time eating consuming these plants. This can be explained, in part, by their high contribution to the total DM yield in April. Three herbaceous plants, *Bouteloua filiformis*, *Croton flavens* and *Viquiera dentata*, contributed 68% of the total DM yield, which was 448 kg/ha. There was no clear indication of a decrease in the nutritive value of the plants eaten by the goats as the dry season progressed. However, the plant of poorest quality, the grass *B. filiformis* (6% crude protein, 66% neutral detergent fibre 38% acid detergent fibre) was eaten in large quantities during April and May. In April, 50% of the total time eating was spent consuming this species. In spite of this, it is not considered that the diet selected by the goats was of poor quality, as all other species analysed in this month had a crude protein content of above 10%.

Key words: Goats, selection, native plants, secondary bush, Yucatán, México.

The agricultural and industrial activities of the henequen zone of the State of Yucatán in South-East Mexico are centred on the cultivation of henequen (*Agave fourcroydes*). At present this zone is passing through a crisis. The area planted with henequen has declined and many plantations have been abandoned, due to the reduced world demand for henequen fibre. The yield of fibre has also decreased by 27% between 1970 and 1979 (FIRA, 1981).

The decline in the henequen industry has resulted in large areas of land being allowed to return to natural vegetation, which is largely composed of herbaceous plants and semi-deciduous bushes (Pennington and Sarukhan, 1968). This secondary vegetation is described as 'monte bajo' (low bush).

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It has become necessary to diversify the agricultural activities of the henequen zone. The extremely rocky, alkaline soil, however, is not mechanizable and not really suitable for the cultivation of other crops (FIRA, 1981). The production of goats is proposed as a possible means of utilising the growing areas of bush in this zone. The feeding habits of the goat, that is its preference for browse; the selection of leaves, flowers and twigs of bushes as well as grasses and herbaceous plants (Devendra, 1978), make it very suitable for the exploitation of bushy vegetation. The goat also tends to vary its selection of plants as the seasons change (Huston, 1978), probably because of changes in the availability of different species (Devendra, 1978; Huston, 1978; Malechek and Provenza, 1981) and the ability of the animal to select a high quality diet from the existing vegetation (McCammon-Feldman et al, 1981).

The study described here was carried out to identify the plant species selected by goats grazing in low bush and to determine the proportion of the total time grazing which was spent eating different classes of vegetation throughout the dry season. Changes in the nutritive value of selected plants were also evaluated.

#### Materials and Methods

The study was carried out in the Centro Demostrativo Caprino Teya, of FIRA, Bank of Mexico. The centre is situated 15km to the east of Mérida, Yucatán, in an old henequen field with natural vegetation of approximately 10 years regrowth. The climate is classified as hot sub-humid (Pennington and Sarukhan, 1968), with an annual rainfall of 900 mm, distributed mainly between the end of May and October. The mean annual temperature is 26°C.

The centre has a herd of approximately 300 animals of various breeds, mainly Criolla-Nubian crosses. The goats are allowed to graze in the bush between 7:00am and 11:00am, daily. In the afternoon and at night they are housed in a single pen (50 x 20 m) with partial shade. During the driest part of the year (March to May) a supplement based on poultry litter and molasses is provided.

The feeding habits of the goats were studied between November 3rd, 1982 and May 10th, 1983, by direct observation. The following factors were considered: date, total grazing time, total time spent eating, total time not eating and the time eating each species of plant. In November, 10 goats were selected at random from the herd on each day of observation. They were identified with coloured collars and each one was observed for 10 minutes. Problems were encountered with this number of animals, since they dispersed throughout the bush making it difficult to locate the marked goats. From December onwards, one goat was studied on each day of observation for a period of two or three hours. The data for each month were combined to calculate the mean time consuming each of three classes of vegetation: bushes, herbaceous plants and herbaceous climbing and trailing plants (creepers).

Plants not known to the observer or to the goatherd were collected, pressed and dried in an oven, in which 100 Watt bulbs provided the source of heat. These plants were identified in the herbarium of the Centro de Recursos Bióticos de la Península de Yucatán.

At the end of each month of observations, samples of preferred species were collected, imitating as far as possible the way in which the goats harvest the plant material. The dry matter (DM) content of the plants was determined at 60°C for 48 hours in a forced air oven and the samples were subject to the following analyses:

- i) Crude protein (CP), using the Kjeldahl method (A.O.A.C., 1970).
- ii) Cell walls, by the neutral detergent fibre (NDF) method (Van Soest and Wine, 1967).
- iii) Lignocellulose, by the acid detergent fibre (ADF) method (Van Soest, 1963).

To determine the amount of DM available in the bush during the most critical part of the dry season, ten quadrats of 5 x 5 m were selected at random within the 17 ha study area. All edible vegetative material within the quadrats was harvested up to a height of 1.3 m, leaving the dry and woody material. The weight of each plant species in each quadrat was recorded immediately after collection and after drying at 60°C for 48 hours. The harvest was carried out between 11th and 19th April, 1983.

## Results

Fifty six plant species were identified in the study area during the seven months of observation. The number of species in each physiognomic class was: bushes 24, herbaceous plants 21, creepers 10 and grasses 1. The latter is included in the herbaceous class in the results presented below. The goats were not seen to eat 14 of the identified plants.

An interesting observation from the results of this study is the increase in the proportion of the total grazing time (i.e. time in the bush) which was spent eating as the dry season progressed (Figure 1). In November, December and January, the goats were eating for approximately 46% of the total grazing time. Later in the dry season, however, their grazing behaviour changed. Between February and May, the time dedicated to eating increased and less time was spent looking for forage. For example, in November, February and May the goats were eating for 47%, 65% and 90% of the total grazing time, respectively (see Figure 1). It could be considered that this observation is the opposite of that expected, since in November, December and January (early in the dry season), there is an abundance of vegetation and the goats should need less time to look for forage. It was observed, however, that in these months the high availability of forage allowed the animals to stand and take large bites of a plant before moving in search of another preferred species. Whereas in the drier months (March to May), they spent more time browsing on the move and therefore, took a smaller amount of plant material with each bite.

The number of species selected varied from month to month. The total number of plants eaten was greatest in January, February and March. In November, 17 species were consumed, compared with 19, 29, 31, 31, 17 and 15 in December, January, February, March, April and May, respectively.

Although the selection pattern of plants varied during the months of observation, a minimum number of three and a maximum number of seven plants always occupied more than 55% of the total time spent eating. Also, in spite of the variation from month to month in the selected plants, there was always a strong selection for a few species, notably the leguminous bushes; *Leucaena leucocephala* and *Mimosa hemiendytia*.

Figure 1

Changes in the percentage of the total grazing time used by goats in low bush for eating throughout the dry season.

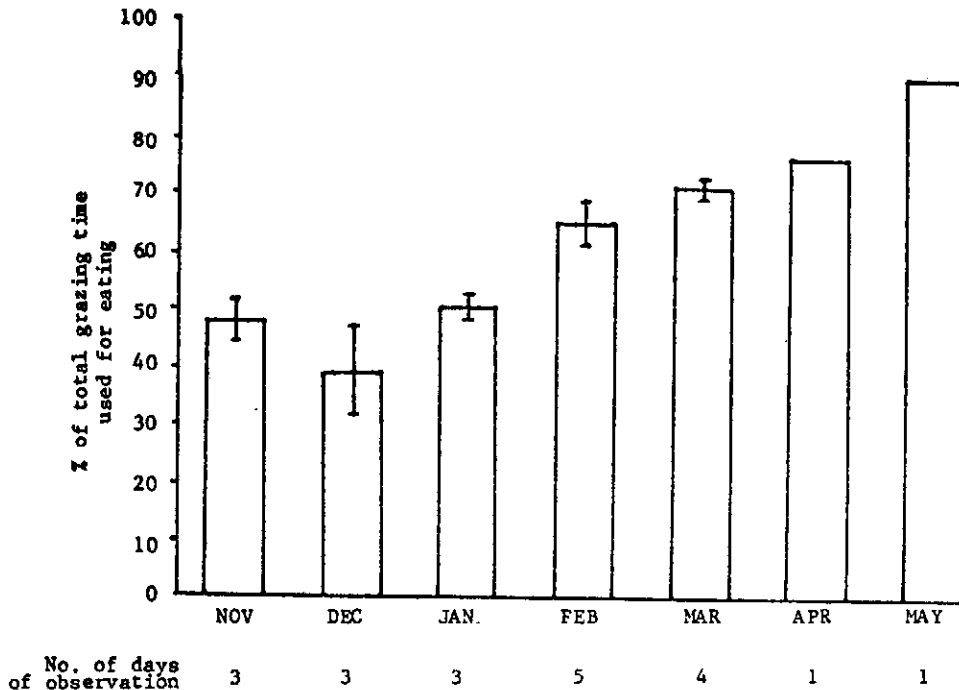
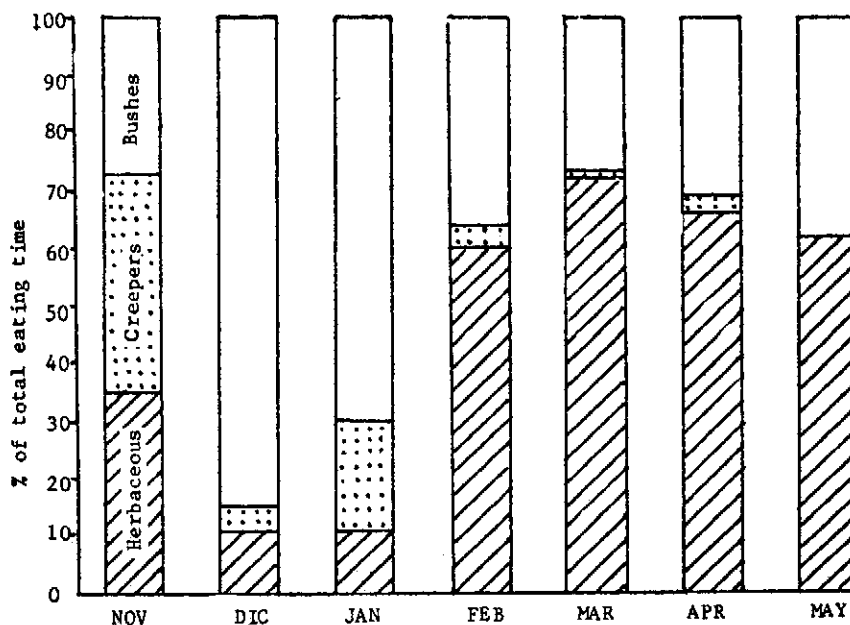


Figure 2 shows the proportion of the total time spent eating which was dedicated to each class of vegetation during the seven months of observation. The time was most evenly divided between the classes in the month of November, when 35% of the total time eating was spent consuming the herbaceous plants, 37% the creepers and 27% the bushes. In December and January, bushes were highly selected; 85% and 70%, respectively. From February onwards, a marked change in the selection pattern was observed, with only two classes, bushes and herbaceous plants, occupying a large majority of the time spent eating. On average, 33% of the time was dedicated to bushes and 65% to herbaceous species in the months of February to May. The range of herbaceous plants consumed in February and March was greater than in April and May. In these latter months, a single species; the grass *Bouteloua filiformis*, occupied 50% and 42% of the total time spent eating, respectively.

It is difficult to interpret the observed changes in the pattern of selection of the different classes of vegetation by the goats, as changes in the availability of plant species were not measured throughout the study. It was observed, however, that the creepers disappeared almost completely in December and January and this was reflected in the selection pattern of the goats.

Figure 2

The selection of plants by goats grazing in low bush throughout the dry season; % of total time spent eating dedicated to bushes, herbaceous plants and creepers.



In April, the total available DM in the bush was 448 kg/ha. The contribution of each species of plant to this yield and the selection of plants by the goats in the two months closest to the harvest are shown in Table 1. The high proportion of the total eating time which was used to consume herbaceous plants in the later months of the dry season, can be largely explained by the high contribution which these made to the total DM yield. Three herbaceous species (*B. filiformis*, *Croton flavens*, *Viguiera dentata*) provided 68% of the total DM. Although a similar amount of time was spent eating each of these plants in March, a marked change towards the intake of one species was seen in April, when 50% of the total eating time was dedicated to the grass, *B. filiformis*. The increase in the time spent eating this plant between March and April may reflect a decrease in the availability of preferred species.

The time spent eating a plant was not always determined by its availability. On the contrary, highly selected plants often contributed very little to the total DM yield, probably because they suffered from a continual selection pressure. For example, 2.4% and 4.0% of the total eating time was dedicated to *Leucaena leucocephala* in March and April, respectively, but in the harvest carried out between these two months this plant provided only 0.01% of the total DM yield. Similarly, *Gayoides crispum*, a herbaceous plant, contributed only 0.2% of the DM but was highly consumed

in both March (20.6%) and April (4.0%). The reduction in the time spent eating this plant may indicate that its availability decreased between March and April; the harvest was carried out between the two observation periods.

Table 1

Dry matter (DM) yield (kg/ha) in low bush in the month of April\* and the selection of native plants by goats in March and April.

Species	kg DM/ha <sup>1</sup>	% total DM <sup>1</sup>	% of total eating time	
			March	April
<1.0% of total DM				
BUSHES				
<i>Acacia gaumeri</i>	0.24	0.05	0.9	2.0
<i>Bauhinia divaricata</i>	0.22	0.04	0.7	
<i>Diphysa cartagenesis</i>	0.80	0.18	1.3	2.6
<i>Leucaena leucocephala</i>	0.08	0.01	2.4	4.0
<i>Parmentiera aculeata</i>	2.80	0.60	0.5	
<i>Pisoma aculeata</i>	0.10	0.02	1.4	
CREEPERS				
<i>Arrabidaea floribunda</i>	1.90	0.19	0.5	2.0
HERBACEOUS				
<i>Asclepsia curassavica</i>	0.04	0.01		
<i>Gayoides crispum</i>	0.90	0.20	20.6	4.0
<i>Heliotropium angiospermum</i>	1.50	0.33	0.4	
<i>Waltheria americana</i>	1.80	0.40	1.3	1.3
>1.0% of total DM				
BUSHES				
<i>Bauhinia pulchra</i>	4.80	1.07		
<i>Bumelia mayona</i>	13.20	2.95	2.6	2.6
<i>Bumelia retusa</i>	6.30	1.40		
<i>Bunchosia swartziana</i>	20.70	4.62	2.7	2.6
<i>Gymnopodium antigonooides</i>	6.30	1.40	2.4	1.3
<i>Jatropha curcas</i>	9.20	2.05		
<i>Mimosa hemiendytia</i>	13.40	2.99	2.6	12.6
<i>Pithecolobium dulce</i>	5.60	1.25	6.2	9.3
HERBACEOUS				
<i>Bouteloua filiformis</i>	225.80	50.40	9.7	50.3
<i>Croton flavens</i>	67.50	15.06	8.0	0.5
<i>Viquiera dentata</i>	10.30	2.29	6.6	4.0
POISONOUS WEED				
<i>Cassia uniflora</i>	50.20	11.20		
TOTAL	448.10	100.00		

\* The harvest was carried out between 11th and 19th April 1983, imitating as far as possible the way in which the goats select the plant material.

<sup>1</sup>Mean of ten 5 x 5 m quadrats

In Tables 2 and 3, values of DM, CP, NDF and ADF in some of the preferred plants are shown. There is no clear indication that the nutritive value of the plants decreased with time. Although the level of CP appeared to decrease in a few plants (e.g. *L. leucocephala*), no such decline was observed in the majority of the species studied. Similarly, there was no clear tendency for NDF and ADF values to increase as the dry season progressed. This was probably due to the high stocking rate in the area of bush under study, the preferred plants were highly selected and therefore, the goats' diet consisted of young shoots throughout the year, although the availability of these in the last months of the dry season was low.

Table 2

The dry matter (DM;% ) and crude protein (CP;% of DM) content of plants selected by goats grazing in low bush during the dry season.

	NOV		DEC		JAN		FEB		MAR		APR	
	DM	PC	DM	CP	DM	CP	DM	PC	DM	CP	DM	CP
<b>BUSHES</b>												
<i>Bumelia mayora</i>			32.0	14.3	46.4	15.3	51.2	13.4	50.0	13.2	52.0	19.1
<i>Leucaena leucocephala</i> (L)			32.5	26.5	19.9	29.8	42.5	19.0	31.5	23.4	32.0	16.0
<i>Pithecolobium dulce</i> (L)			37.7	17.0	49.3	16.4	53.2	13.8	49.0	14.6	49.5	14.6
<b>HERBACEOUS</b>												
<i>Aeschynomene americana</i> (L)	26.9	14.4										
<i>Croton flavens</i>			48.5	19.3	37.9	12.0	42.0	20.6	39.0	19.2	49.6	15.2
<i>Gayodes crispum</i>							48.8	-	35.0	17.0	25.3	12.2
<i>Waltheria americana</i>	36.4	8.6			35.7	15.1	45.1	13.4	41.5	13.2		
<b>GRASS</b>												
<i>Bouteloua filiformis</i>											68.5	6.0
<b>CREEPER</b>												
<i>Merremia aegyptia</i>	20.2	10.9										

L - Leguminous

Table 3

The content of cell walls (NDF) and Lignocellulose (ADF) in plants (% DM basis) selected by goats grazing in low bush during the dry season.

	NOV		DEC		JAN		FEB		MAR		APR	
	NDF	ADF	NDF	ADF	NDF	ADF	NDF	ADF	NDF	ADF	NDF	ADF
BUSHES												
<i>Bumelia mayana</i>			36.4	25.4	33.4	25.4	33.7	23.4	29.4	23.6	-	21.0
<i>Leucaena leucocephala</i> (L)			24.6	15.3	28.5	15.9	38.4	24.5	32.9	23.8	-	21.0
<i>Pithecolobium dulce</i> (L)			25.9	14.9	37.8	21.5	31.4	21.9	36.9	26.6	-	17.6
HERBACEOUS												
<i>Aeschynomene americana</i> (L)	47.7	33.2										
<i>Croton flavens</i>			32.4	22.2	36.6	25.2	36.8	22.4	36.0	23.0	18.8	15.4
<i>Gayoides crispum</i>							43.0	24.7	35.5	24.6	32.8	25.8
<i>Waltheria americana</i>	37.8	27.8					55.1	-	36.8	25.7		
GRASS												
<i>Scutelloua filiformis</i>											65.8	37.8
CREEPER												
<i>Neuremia aegyptia</i>	47.4	35.3										

L - Leguminous



## Discussion

Data on the eating behaviour of goats grazing in natural vegetation can be applied only to the region in which the study was carried out, since the availability and botanical composition of the vegetation is specific to that region (Malechek and Provenza, 1981). The comparison of results is also made difficult by the diverse methods which have been used to study selectivity. There are few reports in the literature, in which goats have been observed in the same manner as in the present study. Schwartz and Said (1981) in Northern Kenya, found a reduction in the time that goats spent eating as DM availability decreased, the opposite of the observations reported here. These authors, however, registered the total eating time in a different way. They measured the time which the goats spent eating whilst standing in one place and observed that the length of time at each eating site decreased in periods of low forage availability. In the present study, the time spent eating by both standing and moving animals was included in the total eating time.

The observation that the time which the animals spent eating grass increased in the driest months, when the availability of browse species was low, is in agreement with the results of several other studies. For example, Wilson et al (1975) used goats with oesophageal fistulae to study the selection of plants in plots of a semi-arid bush vegetation. In plots which had been grazed by sheep, the diet of the goats consisted of 70-90% trees and bushes. Plots which had been grazed by goats, however, had less bushy vegetation available and the fistulated goats selected a diet of 50% browse and 50% herbaceous plants and grasses. Similarly, Merrill (1975) found that goats prefer browse to grasses in a Texas range vegetation and therefore, emphasizes the usefulness of the goat for the control of bushes on the rangelands of the Western United States.

The plant which was most consumed during the more critical months of the dry season; the grass *B. filiformis*, had CP, NDF, and ADF values similar to those reported for other tropical grasses (Van Soest, 1982). The herbaceous and bush species, both legumes and non-legumes, had higher CP and lower values of NDF and ADF than the grass. Leguminous plants are higher in protein and lower in cell walls than grasses, but they have a lower digestibility because their lignin content is higher and they contain inhibitors such as tannins and alkaloids. The lignin content of legumes shows little variation with the age of the plant, whilst the opposite occurs with grasses (Van Soest, 1982).

## Conclusions

The ability of the goat to vary its selection of plants as the seasons change is confirmed by the results of this study. The laboratory analyses indicate that the majority of the selected forage was of high nutritional quality and this did not tend to decrease as the dry season progressed. The quantity of edible material in the bush in one of the driest months of the year, however, was low, probably because of the high stocking rate. To maintain acceptable levels of production during this period, therefore, it

will be necessary to provide the animals with a supplement or to develop a system of management of the bush and carefully control the stocking rate, to allow adequate forage availability throughout the year. In the accompanying study (Ríos and Riley, 1985), it was shown that the productivity of animals grazing in low bush during the dry season is indeed low, unless a supplement is provided.

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