CARIBBEAN FOOD CROPS SOCIETY

23

Twenty Third Annual Meeting 1987

Antigua

Vol. XXIII

Leucaena leucocephala as a Feed for livestock in Barbados

R.C. Quintyne, D.O. Chase and R.C.A. Millington

Animal Nutrition Unit, Ministry of Agriculture, Food and Fisheries, Barbados

Leucaena is found in all parts of Barbados, where it has been traditionally harvested for feeding to all classes of livestock. Improved varieties, originally imported from Australia, have been used both in mixed pastures with productive grasses, and as protein banks for grazing or cutting at controlled times of the year. It can produce a high quality leaf meal when dried either in the sun or in a solar drier. Silage of high nutritive value can be produced either manually on a small scale or mechanically on a larger scale, but mechanization results in the harvesting of large quantities of woody material which can substantially reduce the protein content of the conserved forage. Leucaena silage is low in energy, but no toxicity symptoms have been seen in Barbados in either cattle or sheep. Used with a suitable energy source, it is capable of producing good levels of animal productivity. It is a valuable forage resource under Caribbean conditions. (Editor's summary)

Keywords: Leucaena; Leaf meal; Silage; Toxicity

Introduction

Leucaena leucocephala grows profusely in Barbados. Whether it is a native to the island or was introduced is not known. It is widely distributed, growing on all soil types and in all rainfall zones (630 to 2,000 mm annual precipitation).

Leucaena has been traditionally harvested by farmers and fed to all classes of livestock, both ruminant and non-ruminant. It is said by peasant farmers "to stop the pigs from getting fat." It is also readily eaten by rabbits and chickens. There are reports of Leucaena being fed to horses being prepared for shows. The initial loss of hair resulting from feeding the horse is followed by the regrowth of a beautiful coat.

Although Leucaena has been used for many years as a feed for livestock, it was only in 1976 (Quintyne, 1976) that any serious effort was made to begin studies with a view to using it in feeding systems or as a high protein feed ingredient. The aim of this paper is to review work done on and progress made in the development of Leucaena as a source of livestock feed in Barbados. This work has however been limited, being largely observation studies carried out at the Animal Nutrition Unit.

Forage production and utilization

In Barbados, Leucaena is usually harvested by hand, twigs and shoots being broken off and offered to animals. In Barbados, Leucaena is not eaten by humans as in some other countries.

In 1976 some seed of cv. Peru was received from Australia, while seed of cv. Cunningham followed in 1979, from the same source. The first attempts at cultivation were carried out in 1980 when Leucaena was sown into a newly planted field of elephant grass (*Pennisetum purpureum*). This field was grazed by a herd of dairy cows on a 6 - 8 week cycle. Later, pure stands of Leucaena were established, both at the research station and on farms.

The methods used in establishing pure stands were direct seeding, both by hand, by dibbling the seed in, and by a Stanhay seed planter, and by transplanting seedlings germinated in plastic pots. In the case of direct seeding, seeds were sown continuously in rows 1 m apart. Where seed had been germinated in pots, seedlings were planted on a 1 m grid.

On farms, pure stands of Leucaena are used as protein banks. Animals, whether they are cattle or sheep, are allowed access to the Leucaena for limited periods while grazing. In this way they are able to increase their protein intake. Leucaena is very acceptable to the grazing animal. Because of this, care has to be taken in managing the protein bank to ensure that animals are not allowed into the area before the plants have fully recovered. Although it is a very hardy plant, Leucaena can be killed by over grazing.

Leucaena may also be used in cut-and-carry systems. Stems are cut back and these, along with grass and other materials, are fed to animals. In this way, Leucaena may be included in the diet of other classes of livestock.

Leucaena leaf has also been dried and used as a leaf meal or has been chopped, mixed with molasses and ensiled.

Leaf Meal

Tremendous interest has been generated internationally in Leucaena leaf meal as a substitute for alfalfa meal (Brewbaker and Hutton, 1979). Leucaena leaf meal has been incorporated into rations for poultry as a source of protein and carotene and has been shown to be of value as a source of vitamin K (Brewbaker, 1976). Leaf meal has also been used as a protein source in fish rations (Ghatmekar et al 1982).

In Barbados, Leucaena stems have been cut and placed in the sun to dry. This process may take up to two days, depending on the volume of material. The leaves are then shaken or stripped off the stems, collected and stored in bags. An improvement on this method involved the use of a simple solar drier. This is a shed with a concrete floor 7 m x 3 m and covered with a clear rigid plastic material that allows the sun's rays to enter, and enclosed on the north and east to prevent rain from being blown in. There is, however, provision made on these two sides to allow wind circulation. Leucaena stems are cut and placed in this drying shed for 2 - 3 days, when the dried leaf is collected and stored in bags.

The dried leaf material collected is made up of leaflets and petioles. The material quite frequently also contains young pods and seeds. The chemical composition of the Leucaena leaf is shown in Table 1. As would be expected, the Crude Protein (CP) content and NVI of the leaflets were higher than that of either the leaf or the petiole. The CP of the petiole was remarkably high, while the NVI compared favorably with that of a grass, such as pangola, (*Digitaria decumbens*) of fair quality. The CP content of leaf meal obtained was similar to that reported elsewhere (e.g. Brewbaker, 1976).

Table 1 Chemical composition of Leucaena leaf

Source		Crude Protein	ADF	NDF	Ash	NVI[1)]
Leaflet	Barbados	33.4	19.0	32.0	12.4	89.3
Petiole	Barbados	20.8	44.1	62.7	10.3	46.8
Leaf	Barbados	31.8	21.6	36.8	10.9	80.7
Leaf	Antigua	26.2	21.1	33.4	13.0	75.9
Leaf	Antigua	27.4	18.5	31.0	13.6	84.3

1) NVI (Nutritive Value Index) = Digestible Energy Intake potential.

Silage

During the wet season, Leucaena grows profusely. During the dry season however, although there is continued growth, it is greatly reduced. In an effort to maximise the use of the wet season production, attempts were made to ensile Leucaena.

In preliminary studies, Leucaena stems were harvested, leaves and and soft stems were passed through a forage chopper for removal of the woody fraction. This chopped material was ensiled, with or without molasses in small plastic containers of about 30 kg capacity. The chopped leaf was compacted to remove as much air as possible. Before putting the covers on, a sheet of plastic was spread over the top in an attempt to produce an air-tight seal. The containers were opened six weeks later. The Leucaena leaf, both with and without molasses, ensiled very well. The resulting silage had good appearance and smell. There was no indication of putrefaction, nor any odour of ammonia, even where there was no added molasses. When offered to Blackbelly Sheep, both types of silage were readily consumed.

Small scale silage in drums: In a system that can be used by small farmers, silage was made in 208 litre steel drums. Leucaena stems were harvested by hand, the leaves and soft stems collected and chopped using a forage chopper. Before filling drums, the chopped material was mixed with molasses. As the drums were filled, the material was compacted by someone "running on the spot" in the drum. After the cover was placed on the drums a weight, either a sand bag or a large stone, was placed on it. The silage produced was of a high quality, with little sign of spoilage.

Silage Production in a trench silo: A trench was dug by means of a back-hoe and the removed soil was piled around it to give a trench approximately 8m x 4m x 1.5m. A field of cv. Cunningham was harvested using a New Holland Forage Harvester. The crop was approximately 1m tall. This was cut back almost to ground level and the chopped material blown into a forage wagon. The chopped material was placed in the trench silo, and molasses, at the approximate rate of 10 percent by weight was applied to the surface as each layer of chopped forage was spread. The whole mass was rolled by a tractor to ensure adequate compaction. When filling of the trench was completed, the silo was covered with a polythene sheet upon which soil was piled.

The use of the forage harvester proved to be quite effective, but the harvested material contained up to 41.6 percent wood (dry matter basis). This had an adverse effect on the feeding value of the silage.

This method of harvesting also had an adverse effect on the vigour of the Leucaena plants. After two cuts at eight week intervals, it was found that recovery was slow, resulting in a massive invasion of weeds in the harvested area. It was not possible to harvest again for 14 - 16 weeks, at which time the plants had grown to a height of approximately 1m.

Nutritive evaluations

Many studies have been reported which confirmed the high feeding value of leucaena (Oakes 1986). In an effort to better characterise Leucaena grown under Barbados conditions, a series of feeding studies was carried out at the Animal Nutrition Unit. These are described below.

Mimosine Toxicity

In spite of reports of animals fed high levels of Leucaena, suffering mimosine toxicity, no such condition has ever been seen in Barbados. A study was therefore designed to determine any possible toxic effect on Blackbelly lambs of feeding cv. Cunningham for an extended period.

Three groups of four weanling rams were offered one of three rations based on Leucaena. The rations were fresh (frozen) Leucaena, dried Leucaena and a complete feed containing a high level of Leucaena. Each group had free access to a mineral mix.

The composition of the complete feed and of the mineral mix is shown in Table 2 and growth performance data are shown in Table 3. .

Table 2 Composition of complete feed and mineral mix (percent dry matter basis)

	Feed	Mineral Mix
Leucaena	42.49	8.5
Molasses	20.00	
Maize	8.00	
Wheat Mill run Feed	25.00	
Soya Bean Meal	3.00	
Mineral Mix	1.00	88.0
Zinc Sulphate	0.05	3.0

The results indicate that Barbados Blackbelly Sheep full fed Leucaena not only survive, but they also put on weight, even though the weight gain is low. A ration of Leucaena alone is obviously deficient in energy and this deficiency had an adverse effect on growth.

Table 3 Growth characteristics of young Blackbelly rams on Leucaena rations

	Complete Feed	Fresh Leucaena	Dried Leucaena
No. of Days	112	112	112
Av. Daily Gain (g)	113.5	22.7	68.1
Av. Daily DM Intake (g)	953.4	499.9	726.4
Feed / Gain	8.3	22.1	10.2

There was no indication that Leucaena had any visible toxic effect on the animals. A study of internal organs after animals were slaughtered showed no lesions. An examination of thyroid glands revealed that only in one animal was there any enlargement of the thyroid, and in that case one gland was slightly larger than the other. It could therefore be concluded that prolonged feeding of high levels of Leucaena has no toxic effect on Blackbelly Sheep in Barbados.

Intake and digestibility of Leucaena silage

Leucaena harvested by means of a forage harvester and ensiled in a trench silo was fed to six mature Black-belly rams in metabolic cages. A preliminary period of fourteen days was followed by a seven day collection period during which there was total daily collection of faeces. Samples of feed offered and rejected were taken every day. Voluntary intake was 68.8 g of DM per kg of metabolic weight. At a dry matter digestibility of 64.4 percent, the intake of digestible DM on a metabolic weight basis was 44.4 g/kg.

There are few reports on the digestibility of Leucaena. The value noted above compares with published values of 50 - 71 percent for fresh Leucaena (Singh and Mudgal, 1976; Joshi and Upadhyay 1976). Similarly, voluntary intake compares with values of 58 to 85g reported elsewhere (Jones et al 1978).

Leucaena silage in steer fattening

Six weanling Holstein steers were introduced to a ration based on Leucaena silage and cassava silage. The Leucaena was included in the ration at a high level to permit an assessment of its contribution to energy, as well as its ability to supply a major part of the protein requirement. Ration 1 was fed to animals between 75 and 205 kg, Ration 2 between 205 and 260 kg and Ration 3 above this weight. The composition of the rations is shown in Table 4, while animal performance is shown in Table 5.

The average daily gain obtained was less than expected. This was partly attributed to the high percentage of indigestible woody material in the Leucaena silage, which had the effect of diluting the nutrients, resulting in a crude protein content of only 12.5% (Chase and Millington, 1986).

Table 4 Composition of Leucaena/Cassava silage rations (kg/animal/day)

Ingredient	Ration 1	Ration 2	Ration 3
Leucaena Silage	5.89	7.30	7.66
Cassava Silage	1.95	2.60	4.29
Molasses	1.13	1.41	1.65
Beef Concentrate 36%	0.38	0.43	0.47
Total kg	9.35	11.74	14.07

Table 5 Performance of 6 Holstein steers fed Leucaena silage for 196 days

Parameter	Performance Data
Mean initial wt. (kg)	111.2
Mean final wt. (kg)	223.0
Mean total gain (kg)	111.8
Mean daily gain (kg/day)	0.571
Mean daily intake (kg/day)	8.149

Leucaena silage in lamb growth

Leucaena cassava silage rations were compared with pangola hay lamb feed on weanling Blackbelly ram and ewe lambs. The experiment was replicated four times so that four pens of six rams each and four pens of six ewes each were allocated to each ration. The composition of the rations used is shown in Table 6, while animal performance is shown in Table 7.

Rations 1 and 2 were fed to the end of period 2 when they were replaced by Rations 3 and 4. The broiler starter in Ration 3 was included to compensate for the coccidiostat contained in the 18% lamb feed in rations 2 and 4.

As was expected, the ADG of the rams was higher than that of ewes and the performance of the animals on the hay and concentrate was better than that of the leucaena/cassava ration. The leucaena/cassava ration was designed to provide the major portion of protein requirement from the Leucaena. The protein content of the silage was only 12.5 percent, considerably lower than the figure used in formulation of the ration, due to a high proportion of wood in the offered feed.

Table 6 Composition of rations on dry matter basis (%)

Ingredient	Ration			
	1	2	3	4
Leucaena	48.55	-	21.72	-
Cassava	15.19	-	23.91	-
Molasses	22.42	9.28	20.90	8.12
Dairy Mineral Mix	13.84	-	12.04	-
Hay	-	21.91	-	20.46
18% Lamb Feed	-	68.81	-	71.42
Beef Concentrate - 36%	-	-	16.91	-
Broiler Starter + 100g Colban	-	-	4.52	-

Table 7 Growth of Blackbelly lambs on Leucaena silage

	Ration			
	Leucaena/Cassava		Hay/Concentrate	
	Ram	Ewe	Ram	Ewe
Mean Daily Gain (g)	127.1	104.4	236.1	186.1
Mean D.M. Intake (g)	1225.8	1044.2	1044.2	1089.5
Mean Feed/Gain	9.62	10.10	4.46	5.92

Conclusions

The potential for making silage out of surplus wet season Leucaena is very great, but methods of harvesting require more attention. Harvesting at an earlier stage and cutting at a higher level above ground should reduce the amount of wood collected by the forage harvester. The development of a new machine, or the modification of an existing one is a challenge that is not beyond the agricultural engineers. The dietary problem of low protein content in silage because of a high proportion of wood could be overcome by including Leucaena at higher levels or by supplementing with a non-protein nitrogen source. This requires further study.

Leucaena has considerable potential as a source of high protein leaf meal. This characteristic can be exploited more fully. Economical systems for harvesting and drying to produce a good quality, high protein feed ingredient will, however, have to be developed.

Because of the value of the crop in pasture systems, every effort should be made to encourage farmers to include direct grazed Leucaena in their forage production plans. Leucaena grows profusely in Barbados, and is readily eaten by animals. Results from research indicate that most livestock in Barbados suffer no adverse effect from consuming high levels of Leucaena. The high protein and mineral content of the leaves of the plant make it a valuable feed. Based on all of the information generated from research being done in Barbados and in other sister territories, it may be concluded that this crop has great future in livestock production in the whole of the Caribbean region.

Acknowledgments

The authors are grateful for financial support from the Organization of American States through the Regional Leucaena Project.

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