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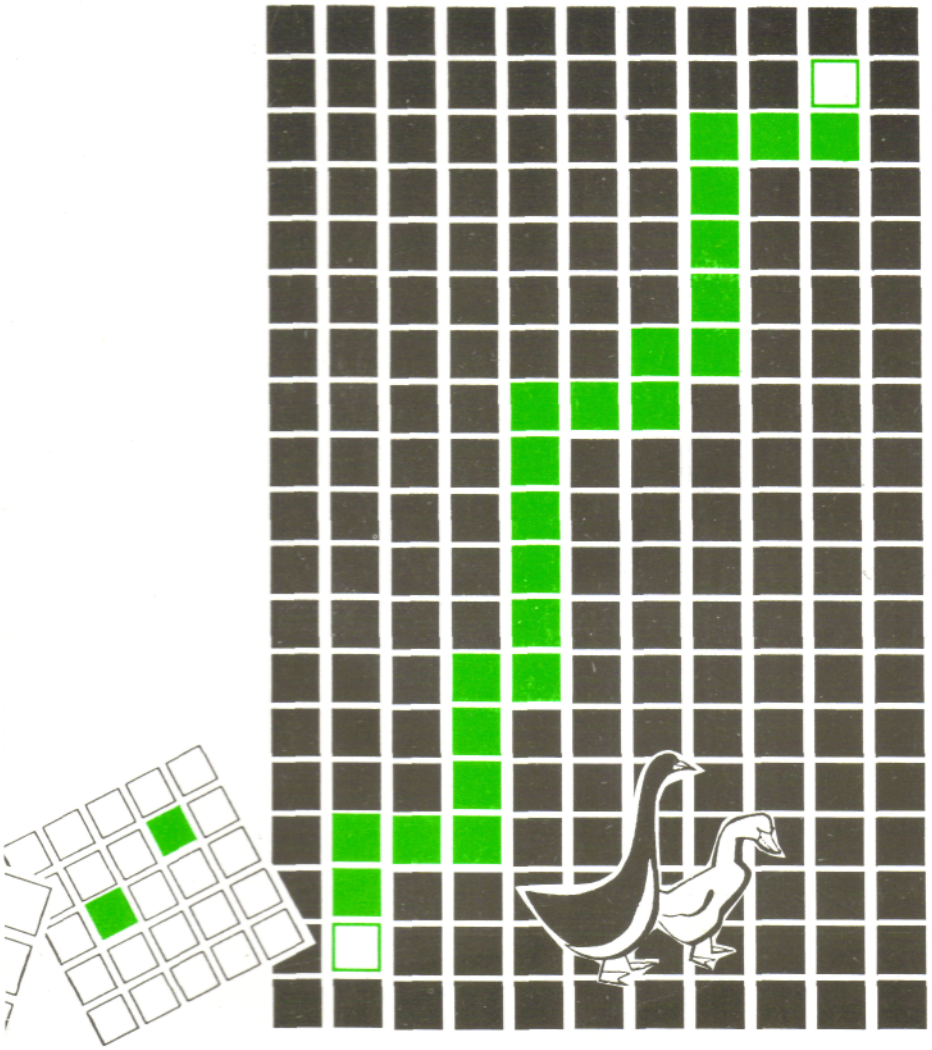

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THE FEEDING OF LEUCAENA (LEUCAENA LEUCOCEPHALA) FORAGE TO RUMINANTS

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ABSTRACT

The work done on Leucaena *(Leucaena leucocephala)* forage feeding to ruminants was reviewed from the standpoint of its use as a cut forage for beef and milk production which discussed its use with crop residues, with molasses-urea, in sugarcane forage-based diets, feeding to early weaned calves, feeding to growing dairy and beef cattle It also reviewed the feeding of Leucaena to sheep conservation of leucaena and the cost of leucaena forage production The annual total establishment cost was TTS849.00 (US$151.60)/ha. The cost per kilogram crude protein (CP) from leucaena was estimated at TTS6.78 (US$1.21) while that from the imported concentrates was TTS6.00 (US$1.07) The calculations were based on a low yield of 10 tonnes dry matter/ha/annum

INTRODUCTION

In Australia, ruminants fed solely on Leucaena developed toxicity symptoms such as hair loss from the tail. Such problems have not been observed in the Caribbean where in most countries Leucaena grows without effort and is considered as a weed. It has been determined that animals in Australia do not possess certain microbes in their rumen to break down the toxic substance in the Leucaena (Mimosine) into harmless compounds *(Jones and Magarrity. 1981).* Leucaena is a productive high protein forage which has a good nutrient profile and its use in feeding ruminants could aid in reducing or minimizing some of the high cost attached to importing animal feed ingredients *(Garcia, 1988).* It is however, a grossly under-utilized forage resource, regionally. Pond and Martinez Cairo (1983). Proverbs (1984), and

Batson, Ferguson and Archibald (1987) have suggested cultivation suitable methods to the Caribbean This paper reviews the work done on Leucaena as a cut forage, its incorporation into grass pastures, fed to sheep, conservation and its cost of production.

LEUCAENA AS A CUT FORAGE FOR BEEF AND MILK PRODUCTION

Leucaena has been fed in cut-and-carry systems to weaned calves, to growing beef and dairy cattle and to sheep in corporation with crop residues, with molasses urea, and in whole sugarcane forage based diets

With Crop Residues

(a) Rice Bran
Jones (1979) has reported that this is a traditional system used in the Philippines to finish cattle, where a mixture of Leucaena and rice bran is force-fed as a slurry in water.

(b) Banana pseudostems
Jones (1979) also reported that in Indonesia and Timor, cattle are fattened for about six months on a diet essentially made up of Leucaena and the banana pseudostems.

(c) Rice straw and crop residues
Perez (1976) as cited by Jones (1979) has reported that 40% dried Leucaena leaf gave 0.38 and 0.36 kg/day weight gains. He also reported that 50% concentrates plus 50% rice straw, and 35% rice straw plus 35% dried Leucaena leaf plus 30% concentrates gave 0.54 and 0.71 kg/day live weight gains: therefore Leucaena substituted for the low quality roughage and the expensive supplement. This system would be of benefit during the dry season when only high fibre low protein animal feed sources are available.

(d) As a supplement to pasture during the dry season
Sun-dried Leucaena leaf is used for this purpose in Malawi, with animals so fed, showing improved performance over those fed on pasture alone, and equal performance to those supplemented with groundnut cake fed to provide the same level of protein as the Leucaena *(Thomas and Addy as cited by Jones, 1979).*

(e) Sorghum hay
The best results observed were 0.52 kg/day with 20% fresh Leucaena forage and 80% sorghum hay, with a feed conversion efficiency of 7.62 kg feed/kg lightweight gain *(Jones unpublished as cited by Jones, 1979).*

(f) Maize stovers and maize bran
Another report from Malawi by Thomas and Addy (1977) (as cited by Jones, 1979) was 1.17 kg/head/day when one part of sun-dried Leucaena leaf meal and four parts of maize stovers and maize bran were fed.

With Molasses-Urea

The utilization of leucaena forage in molasses based diets has been reported by Pillot, Leclesio and Wong Yon Cheong (1976); Alvarez, Wilson and Preston (1977); Salias, Sutherland and Wilson (1977) and Hulman, Owen and Preston (1978). The function of the Leucaena forage was two-fold: (i) to act

as a roughage source and secondly to provide some by-pass protein One experiment in which leucaena forage was used as the sole source of forage and preformed protein was reported by Alvarez, Wilson and Preston (1977) and daily live weight gains of 0.481 kg were obtained, but this was less than the 0.615 kg/day gain obtained when the roughage source was leucaena fed with rice polishings. Another report with Leucaena forage *ad lib* with molasses urea gave better results with weight gains of 0.85 kg/day/head *(Hulman et al 1978).* The intakes associated with this study were exceptionally high of the order of 3.92 kg DM intake/100 kg body weight The other two experiments revealed a 0.618 kg/day and 0.588 kg/day weight gain when Leucaena was used as one of three roughage ingredients *(Salias et al 1977 and Pillot et al. 1976).* However it was concluded by Salias *et al..* (1977) that under the Mauritius conditions it was most economic to employ Leucaena forage in a molasses-urea based diet instead of fish meal or maize grain.

In Sugarcane Based Diets

Leucaena leucocephala forage was suggested to successfully substitute up to 75% of rice polishings. a good protein supplement for sugarcane based diets *(Alvarez and Preston 1976: Alvarez Wilson and Preston I978a and 1978b).* This statement however was not quite accurate for on closer examination of the data in Alvarez. Wilson and Preston (1978b) it. revealed that the leucaena forage protein did not displace the protein from the rice polishings but in fact displaced that part of the protein contributed by the urea. The data presented by Alvarez and Preston (1976) and Alvarez, Wilson and Preston (1978a) also suggested that Leucaena (restricted grazing) and rice polishings both gave favourable milk yields in the dry season, (6.19 to 6.9 kg/day), with positive live weight changes in the cows and favourable calf live weight gains (with restricted sucklings) to the order of 0.5 kg/day.

Leucaena and meat meal have both been used in whole sugarcane based diets by Siebert. Hunter and Jones (1976) showing equal performance of 0.61 kg/day live weight gains; but the experience here as well as with Alvarez, Wilson and Preston (1978a and b), and Alvarez and Preston (1977) was the reduction of sugarcane intake with the introduction of the fresh Leucaena forage. When this was done, the crude protein content of the sugarcane diet was increased at the expense of the sugarcane intake.

At the Sugarcane Feed Centre (SFC), cows fed dehydrated Leuceana forage at 20% of the diet's dried matter along with chopped sugarcane and a supplement, showed a more persistent lactation curve higher total milk yield and higher butter-fat yield than those that receiving no Leuceana. With a dry matter yield of 35 tonnes/ha./annum as fed and a protein content of 18%, one hectare of leuceana is sufficient to meet the protein requirement of any four cows producing ten litres of milk/day. At the SFC under a zero-grazing system a life cycle or phased feeding programme is practised according to the physiological state of the animal.

Feeding to Early Weaned Dairy Calves

At the SFC replacement dairy calves were weaned at 35 days old. Leucaena has been fed to these animals from the latter part of the milk feeding phase through to post weaning. The work involved feeding dehydrated chopped Leucaena forage as the only forage source. Table 1 presents some of the performances obtained. Table 2 presents a suggested system based on the SFC's experience. In stage I. while the calf is still on milk leucaena can be introduced after the animal has been consuming about 0.4 to 0.5 kg/day of DM (Diet 1. Table 1). Leucaena can therefore be fed at about 10% of the diet DM intake, and this could be increased to 29% of the diet DM intake at post-weaning (Diets 2 to 5, Table 1). The quality of the other feed ingredients however would be critical.

Feeding to Growing Beef and Dairy Cattle

It has been demonstrated by Siebert. Hunter and Jones (1976) that fresh chopped Leucaena and sugarcane fed to beef cattle could make up 100% of the diet. However, the live weight gains were low (ADG 0.26 kg/day, Table 3, Diet 6). The work of Garcia (1988), Diet 7 Table 3 supports this. The work has further shown that dehydrated leucaena can be the sole forage source in molasses based diets aimed at ADG approaching 1kg/d: Diets 11 and 13 Table 3. The analysis of Garcia (1988) suggests that the performance animal of on Leucaena based diets is dependent on the intake of energy and protein by the animals, since the performance shown, agreed consistently with the National Research Council (NRC) (1978) protein and energy requirements for dairy cattle.

Leucaena Feeding to Sheep

Diets of Leucaena forage alone have been fed either fresh, ensiled or dried to sheep for extended periods in Barbados *(Quintyne, 1987).* At the SFC dehydrated leucaena forage has been used as a source of fibre and protein in complete diets for sheep during lactation. Table 4 gives the formulation on a dry matter basis; this diet could also be used as a lamb starter, and it has been successfully foraged to goats at similar physiological states. As Leucaena forage contains about 20% CP is best fed in association with grasses or by-product feedstuffs which are low in protein.

LEUCAENA INCORPORATED INTO GRASS PASTURES

Animal performance on leucaena grass pastures is given in Table 5. The live-weight gain varied from 0.09 kg/day to 0.93 kg/day. The lower value was obtained when the leucaena was grown under a total annual rainfall of 510 mm *(Henke as cited by Jones, 1979),* and this was a good reflection of Leucaena's drought tolerance. Milk yields have also been acceptable (by developing tropical country's standards) in excess of 10 kg/day. The carrying capacity reported has been from 1.25 (in drought years) *(Henke as cited by Jones, 1979)* to as many as 6.1 animals/ha., giving 12 kg milk/day in the latter case; *(Plucknett, 1970).*

Jones (1979) has suggested that the variability in animal performance on

leucaena-grass pastures are due to (i) environmental factors and (ii) the degree of Leucaena intake and the development of toxicity symptoms. This may be overcome by limited grazing of the leucaena grass pastures, varying the stocking rate, as well as varying the ratio of Leucaena to grass in the pastures along with the selection of low Mimosine-content Leucaena varieties (if this is a problem, which fortunately does not exist in the Caribbean).

CONSERVATION OF LEUCEANA

The whole freshly chopped forage may be dried (to 15% moisture) either by natural or artificial means, and storage has been found suitable in woven feed bags. Leucaena leaves could also be collected (as it falls off the freshly cut stems quite easily) dried and stored. In this way it could be used as a source of protein to a limited extent, but moreso as a source of calcium and vitamin A under circumstances which these may be limiting. Chopped leucaena forage has been found to ensile well with the addition of five to ten per cent molasses *(Alii, Baker and Garcia. 1983 and Quintyne, Personal Communication).*

COST OF LEUCAENA FORAGE PRODUCTION

The cost of producing Leucaena forage can vary widely and was developed by Benn, Lallo, Garcia and Neckles (1992). This financial outlay, as indicated in Table 6, is dependent upon the system of production utilised (method of establishment, weed control and harvesting) and the yield obtained. The costings are also based on a *"worst case"* scenario of borrowing all money at an annual interest rate of 12 percent on the declining balance (10 years for the establishment cost and 1 year for operating cost) and the use of labour at unionized wage rates. Preliminary estimates based on ten years of experience in the production and management of Leucaena at the SFC and elsewhere indicated that under adequate management systems, cost of production and harvesting (manual) was TT$1.22/kg dry matter or $0.37/kg as fed (Table 6). On a per kilogramme protein basis, this was comparable with the cost of supplementing the animals' diets with a purchased 16% CP dairy ration formulation which costs $0.90 to $1.00/kg dry matter. The comparison was $6.78/kg CP for Leucaena versus $6.0/kg CP for purchased dairy ration concentrate (16% CP). Leucaena forage provides approximately 18% protein. A comparable figure for imported soya bean meal is $4.35/kg protein. It should however be noted that labour costs account for 75% of the total operating cost. On a farm where this labour was supplied by the farm family, there was no direct cash outflow and therefore the cash flow situation was not as affected as if large quantities of concentrates were to be purchased. It can be predicted therefore that with expected increases in the cost of these purchased supplementary feeds, more farmers will turn towards the cultivation and use of Leucaena or other high quality forages to assist in meeting the nutrient needs of their Ruminant Livestock. If forage production could be increased by 50% then the cost of producing Leucaena would be considerably reduced, as in the computation on the cost of producing

Leucaena it was assumed that only 10 tonnes DM/ha/annum would be attained and this can be considered as the lowest production level. Cost of establishment could be offset by planting it with a companion crop (e.g. Maize).

CONCLUSION

The literature suggests that leucaena is a tropical forage with a good nutrient profile and knowledge on its use as a ruminant feed is evident. It's use is quite flexible as it can be fed to ruminants under different situations.

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Table 1: Leucaena Feeding to Early Weaned Calves

Diets	1	2	3	4	5
	Milk Feeding Phase	Post Weaning Calves	Weaned Calves	Weaned Calves	Weaned Calves
Diet Composition (% DM Basis) Dehydrated Leucaena					
forage					
12 weeks regrowth 6 weeks regrowth				17	17
8 weeks regrowth	10	29	29		
Soya bean meal				20	20
Cracked Maize				55	55
Molasses				7	7
Biophos				1	1
Commercial 16%CP					
Diary Ration	46.0	57	71		
Milk Replacer	44.0				
Rice Bran		14			
Number of Days	19.9	26.3	27.9	16.5	35
Number of Animals	44	45	89	10	14
% Total Forage	20	29	29	17	17
Chemical Comp DM Basis % CP				19.8	19.8
% of total CP as NPN	0	0	0	0	0
% ADF estimated	5			10.4	10.4
Estimated DE(MJ/kg DM)				14.9	16.0
DM intake kg/day	0.87	1.51	1.40	0.89	1.51
% U veweight	2.20	3.10	2.80	1.90	2.80
Inital Lv. Wt (kg)	37.3	42.4*	41.8*	44.2*	43.3*
Final Lv. Wt. (kg)	40.9*	56.3	57.0	50.3	66.1
Average Lv Wt. (kg)	39.1	49.3	49.4	47.3	54.7
ADG kg/day	0.27	0.59	0.58	0.41	0.65
F.C.E. kg DMl/kg ADG	3.2	2.60	2.4	2.2	2.3

Source: Lallo, Neckles and Garcia^ 1988. * Weaning weight DMI - Dry Matter Intake

Table 2: A Suggested Early Weaning Calf Rearing System Using Dehydrated Leucaena Forage

STAGE	DESCRIPTION	FEEDING	ADG (kg/d)
I	Purchase to Weaning at 35 days age	(1) Arrival P.M. 1 litre electrolyte Day-1 with 1 litre milk replace (MR) A.M. and P.M. Day-2, A.M. previous day P.M. 2 litres *MR* (2) From day 3, 4 litre/day MR reduced to 2 litre? 1 week prior to weaning C3) 16% CP Dairy Ration (DR) (4) Feeding Leucaena after calf consuming of 400-500 g/d of DM	0.27
II	Weaning to Transfer into community pens at *(50-55* kg)	16% CP Dry Matter Basis Leucaena or Leucaena/Rice Bran	0.59
III	Community Pen Rearing	- Up to 100kg liveweight, it is suggested that leucaena 29%. Rice Bran 14%, Dairy Ration 40%, and Molasses 17% could be used for replacent heifers and bull calves	> Q . 5 expected

Note: The possibility of using fresh leucaena forage exists.

Table 3: Feeding of Leucaena to Growing Cattle

Diets	6	7	8	9	10	11	12	13	14
Source Code	1	2	2	2	2	2	2	2	2
Sex	Male	Male	Male	Male	Male	Male	Male	Female	Female
Diet Composition (% DM Basis) Chopped									
Sugarcane	69.9	61.51	68.12	67.42	22.1		19.9		20.3
Leucaena	30.1	27.79	13.62			21.2*		19.6	
Soya bean meal			6.81	13.48					
Molasses		4.26	4.93	12.18	26.6	26.9	26.8	26.7	26.6
Urea		1.90	1.85	1.94	0.8	0.9	0.8	1.2	0.9
Ammonium Sulphate		0.35	0.36	0.14	0.4	0.3	0.5	0.5	0.4
Trace Mineral Mix		0.95	0.96	0.95					
Sodium Chlorie		1.46	1.49	1.47					
Calcium Carbonate		0.95	0.97	1.35					
Dicalciumphosphate		0.85	0.88	1.06	1.0	0.8	0.7	0.8	0.7
Rice Bran					39.4	25.0	39.5	27.6	39.2
Cracked Maize					9.7	24.9	5.0	23.7	5.1
Poultry Rendering Meal							6.8		6.8
% Total Forage	100	89.30	81.74	67.42	22.1	21.2	19.9	19.6	20.3
Chemical Comp DM Base % CP	7.6	14.0	15.0	14,0	10	14	14	14	14
%oftotaJCPasNPN	0	40	40	40.	20	20	20	20	20
% ADF estimated	42 .	40	38	31	17	17	17	17	17
Estimated DE (MJ/kg DM)	10.7	11.0	11.1	11.3	13.2	13.2	13.2	13.2	13.2
DM intake kg/day	3.31	3.24	3.53	3.72	5.07	7.82	8.54	6.59	4.54
% Liveweight	2.46	2.51	2.62	2.78	2.37	3.40	3.38	3.09	2.28
Initdl Lv. Wt (kg)	126.5	115.1	118.5	113.3	203.2	199.2	230.6	188.0	182.7
Final Lv. Wt (kg)	141.8	138.6	150.5	160.3	222.5	261.3	274.3	239.2	215.8
Average Lv Wt. (kg)	134.2	128.9	134.5	136.8	212.9	230.3	252.5	213.5	199.3
ADG kg/day	0.26	0.28	0.38	0.55	0.35	1.14	0.76	0.91	0.59
F.C.E. kg DMl/kg ADG	12.7	11.57	9.29	6.76	14.49	6.86	11.24	7.24	7.70

* Dehydrated Leucaena Forage; 1-Siebert, Hunter and Jones (1976); 2-Garcia (1988); DM-Dry Matter; NPN-Non-Protein Nitrogen; ADF-Acid Detergent Fibre; DE-Digestible Energy; MJ-Mega Joules; ADG-Average Daily Gain; FCE-Feed Conversion Efficiency; DMI-Dry Matter Intake

Table 4: Composition (Dry Matter Basis) of a Diet Containing Leucaena Fed to Tropical Hair Sheep during Lactation

Pre-mix	1
Ingredients	% DM Basis
Dried Leucaena Wheat	15.0 20.0
Middlings Poultry By-	20.0 34.5
product Meal Maize	10.0 0.25
(Cracked) Molasses	0.25 % DM
(sugarcane) Mineral Mix	Basis
Salt Analysis	14.6
Digestible Energy (MJ)	22.0
Crude Protein	0.54
Ca	0.46
P	13.5
ADF	

Source: Lallo, Neckes and Garcia. 1988b

Table 5: Animal Performance on Orass-Leucaena Pastures Reported in the Literature

Location	Crass Species	Slocking Rate Animals/ha	Breed of Animal	Management Practice	Iv. wt gain kg/day	kg/ha/year 1. wt. gain	Milk Yield Kg/ha/annum	Calf Growth Kg/day	References
Australia					.2 -.52				Hill (1971)
Hawaii		1.25			.09 - .233				Henkeas cited by Jones (1979)
Hawaii	*Panicum-maximum*	6.1	Holste in Frasiar			400kg	9,770 (12 kg/day/cow)		Pluckncu (1970)
Mexico	Cynodon sp.	3.0	Holstein or brown swiss Swiss or Zebu	No Leucacna 6 hrs			(9. 19 kg/day/cow)	.563	Saucccdo. Alvercz, Juminez and Arriaga (1980)
				Lcucacna/day			(10.75 kg/day/cow)	.632	
Busbane Australia	Chloris-guyana cv Pioneer		Jersey	Control Control + 2 kg Leu. Control *t*- 4 kg Leu.			(9.6 kg/day/cow) (10.3 kg/day/cow) (10.3 kg/day/cow)		Flofcs-Ramos (1979)
Australia	Cclariannccps		SiecrsA calves		.93 - .88				Jones (1973) As cited by Jones (1979)
Fiji	Dichanlhium sp.	1.5			.3- .5				Partridge and Ranacou (1974)
Australia	Digitaria decumbcns	6.2 4.9 0.6			.37 .33 .29	830			Blunt as cited by Jones (1979)
Australia	Chloris guyana (Rhodes grass)	1.9 2.5		Continuous	.49	340 327			Jones (1979)
Australia	*Panicum maximum* cv. Tricha-glume	4.78	Jersey				6290 kg/ha (for 9 mlhs)		Stobbs (1972)

Table 8: Estimated Cost **per hectare per annum of Leucaena Forage Production in Trinidad and Tobago.**

		TT$*	
Establishment Cost			
1.	Land preparation (brushcut. plough, rotovate and bed formation)	2000.00	37.7
2.	Limestone (2 tonnes per ha.)	1000.00	18.7
	labour for application (10 man-days/ha.).	500.00	9.3
3.	Planting material - 5 kg. seeds.	400.00	7.5 9.3
4.	Planting (10 man days/ha.)	500.00	
5.	Weed control:		4.8
	Chemical- pre-emergent: Dacthal (a 8 kg/ha.	256.0	4.7
	Labour (5 mandays/ha. ro $50.00/manday)	250.00	
5.	Pest control:		3.7
	Basudin-	200.00	*AJ.*
	Labour *(a* 5 mandays/ha.	250.00	100.0
6.	Total	5356.00	
7.	Interest:	3137.00	
8.	Total Establishment Cost:	8493.00	
	Annual Cost**	849.30	
	Labour cost as a % of Establishment Cost		17.7
Operating Cost			
1.	*Fertilizer:*		1.2
	100kg Sulphate of Ammonia/ha.	139.00	1.2
	100kg Triple Super Phosphate/ha.	137.00	0.8
	50kg Muriate of Potash	91.00	26.5
	Mandays for application: 60 (6 applications)	3000.00	
2.	*Herbicide:*		12.6
	Roundup - 3 litres/ha, x 6 times/year	1425.00	13.3
	Labour- 5 mandays/ha. x 6 rimes per year	1500.00	8.8
	Stumping and manual weed control twice per year (fflO mandays/ha.	1000.00	
3.	*Harvesting:*		26.5
	10 mandays/ha./harvest (with 6 harvests/year)	3000.00	2 J
4.	Interest	1029.00	
5.	Total Operating Cost	11321.00	100.0
	Total Annual Cost	12170.30	
	Labour costs as a % of Operating Cost		75.1

Yield expected 10 tonnes dry matter (DM)/ha.
Cost/kg DM 1.22
Cost/kg as Fed 0.40

*Rate of Exchange TTSl - US$0.20 (1989): TTSl US$0.17 (1993)
**The annual cost of establishment is spread over ten years
Source: Benn, Lallo. Garcia and Neckles (1992).