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An overview of forage trials conducted by CARDI in Dominica

G. Robin

CARDI, P.O. Box 346, Botanical Gardens, Roseau, Dominica

B. Clarke

CARDI, P.O. Box 971, Castries, St. Lucia

Since 1983, CARDI has been evaluating a "Livestock Management System" for small farms in Dominica, aimed at alleviating some of the major constraints associated with livestock production. This work is supported by on-station and on-farm trials with improved forages. An evaluation of ten grass and grass/legume mixtures for "cut and carry" systems, showed that dry matter yields of 20.4t/ha and 18.1t/ha came from grass mixes of *Pennisetum purpureum* plus *Brachiaria decumbens* and grass-legume mixes of *P. purpureum, Cyndodon plectostachysus, Centrosema pubescens* and *Stylosanthes hamata* respectively. The cutting interval was ten weeks. In a study of all year round production of *P. purpureum*, dry matter yields of about 25t/ha were obtained at two locations. In a trial evaluating four forage legumes, *S. hamata* and *Desmodium intortum* were the most persistent.

Keywords: Forage grasses; Forage legumes; Cutting materials; Sowing methods; Dominica

Introduction

The island of Dominica has a total land area of 977 sq. km. The topography is highly mountainous, with peaks rising to 1400 m above sea level. Annual temperatures average approximately 27°C near sea level, dropping to 21°C at higher elevations. Average annual rainfall varies from 1250 mm on the western side to 7500 mm in the central forest. The rainy season extends from May to December and the dry season from January to April. It is estimated that approximately 60 percent of the land area is unsuitable for agriculture due to the extremely mountainous terrain and heavy rainfall (Barker 1981).

The livestock production system on small farms is similar throughout the Windward and Leeward Islands. Cattle, sheep and goats are either tethered along roadsides, on fallow lands, on cleared lands with improved pastures, or on other peoples holdings, or they are allowed to roam free. Some farmers feed cut banana pseudostems or other crop residues, a limited amount of cut (improved) fodder and occasionally some dietary supplements, such as coconut meal (Robin and Clarke 1985).

Baseline surveys (Henderson and Gomes 1979; Archibald et al 1981; CARDI, 1983) indicated a need to increase local production of milk and meat. However, current livestock husbandry practices have several disadvantages, as follows:

- The nutritive value and productivity of native vegetation is low.

- The high cost of manufactured concentrates results in farmers purchasing feed supplements only irregularly and feeding limited amounts to their livestock.

- Tethering of animals on steep slopes often results in injuries and strangulation.

- The daily movement of animals to and from grazing areas is labour intensive.

- Pen manure is not easily collected for use in crop production on the farm.

This paper reviews the work done in evaluating various grasses, legumes and grass-legume combinations for productivity, nutritive value, seasonality, optimal management and persistence. The better pasture combinations will be sown on livestock farms in an attempt to overcome some of the problems listed above.

Materials and methods

Experiment 1

Ten combinations of grasses and legumes, as shown in Table 1, were evaluated over a period of 12 months in a split-plot experiment where species combinations formed the main treatments and cutting intervals (4, 6, 7, 8, 10 and 12 weeks) the sub-treatments. The main plots were 5 m x 4 m including discard areas, and the net sub-plots were 1 m x 1 m. The experiment consisted of three replications of all treatment combinations.

Land preparation involved clearing and ploughing. Species were selected for adaptability, palatability, nutritive value, high productivity, compatibility, establishment potential, persistence and availability of planting material. Where appropriate, tall grasses and tall legumes were arranged in alternate rows. Inter and intra-row distances were 1m. Short grasses were planted in rows 0.5 m apart, with intra-row distances of 10 cm. The shorter legumes were spaced midway between the tall grasses and legumes. After planting, a basal dressing of triple superphosphate (50 kg/ha) and sulphate of ammonia (20 kg/ha) were applied.

Sorghum bicolor cv Grazer was sown by seed (treated with fungicide) at a depth of 2 to 3 cm. All other grasses were planted as vegetative material. All legume seed was scarified except local pigeon pea and treated with fungicide prior to planting. Sowing took place at a depth of 2 to 3 cm, placing from 3 to 10 seeds in each planting hole.

At each harvesting date, data were collected on yields of fresh and dry forage, observations were made on persistence and samples were analysed for protein, energy, fibre and minerals.

Experiment 2

Four legume species (*Desmodium intortum*, *M. atropurpureum*, *N. wightii* and *S. hamata*) were shown as sub-treatments in a split-plot experiment to compare surface broadcasting of seed with shallow sowing. Three replicates were sown on each of three farms. At each site, the available area was different. Gross sub-plot sizes of 3.0, 4.8 and 15.0 square metres were sown, but evaluations were made using a quadrat of 1.0 sq. m.

Table 1 The grasses and grass-legume mixes evaluated in Experiment 1, Stock Farm Roseau

Treatment	Mix of Species	Description of Plant types[1)]
1	*Pennisetum purpureum* + *Macroptilium atropurpureum*	TG/VL
2	*P. purpureum* + *Brachiaria decumbens* + *M. atropurpureum*	TG/MG/VL
3	*Sorghum bicolor* cv. Grazer M AXY 392 + *B. decumbens* + *Neonotonia wightii*	TG/MG/VL
4	*P. purpureum* + *Cynodon plectostachyus* + *Centrosema pubescens* + *Stylosanthes hamata*	TG/MG/VL/BL
5	*Saccharum officinarum* + *Panicum maximum* + *Digitaria decumbens* + *Clitoria ternatea*	TG/MG/SG
6	*P. purpureum* (Control A)	TG
7	*P. purpureum* + *B. decumbens* (Control B)	TG/MG
8	*P. purpureum* + *C. plectostachyus* + *Cajanus cajan* + *Pueraria phaseoloides*	TG/MG/TL/VL
9	*S. bicolor* + *P. maximum* + *C. cajan* + *C. pubescens*	TG/MG/TL/VL
10	*P. maximum* + *D. decumbens* + *Teramnus labialis*	MG/SG/VL

1) TL = tall grass; MG = medium grass; SG = short grass
VL = vining legume; BL = bushy legume; TL = tall legume

After the experimental areas were cleared and forked, lime was applied at 3.5 t/ha. Sowing of the three sites took place on 23 July, 28 August and 12 September 1985 respectively. In the planting treatment, the seed was sown at a depth of 1.5 to 4 cm in rows 30 cm apart with 15 cm between planting holes.

Basal management included three weedings during initial crop growth, and application of NPK (16:8:24) at 250 kg/ha, three to four weeks after planting. For sown seed, this was banded around each hole, while for broadcast seed the fertilizer was evenly spread over the whole area.

Plots were harvested after seed and pod maturity, between 14 and 17 January and again between 15 and 25 September 1986, on two farms. The third farm had to be abandoned due to poor germination even after replanting. The forage legumes were cut from 3 to 5 cm above the ground with a cutlass. After the quadrat had been harvested, the remainder of the plot was cut to ensure uniform regrowth.

Data were collected on legume emergence, weed infestation and fresh and dry yields of both forage and weed components. After cutting, the legume regrowth and persistence were evaluated.

Experiment 3

Farmers at two sites (Morne Prosper, altitude 500 m, annual rainfall 5,000 mm and La Plaine, altitude 166 m, rainfall 2,500 mm) weighed the quantity of Elephant grass cut each day to feed their animals and measured the area harvested. On average, the areas were cut five time during the year. The yields measured were therefore of regrowth of from 2 to 3 months of age. Sub samples were periodically collected to estimate the dry matter content of the cut forage.

Results and discussion

Experiment 1

Total forage dry matter yields, collected over from 48 to 50 weeks after planting, are are shown in Table 2.

Table 2 Yields of forage dry matter (t/ha) from ten forage mixtures with six cutting intervals

Mixtures	Cutting intervals (weeks) 4	6	7	8	10	12	Mean[1)]
1	13.1	10.5	18.5	13.0	21.8	23.9	16.8 abc
2	18.0	17.0	18.2	15.9	24.4	27.2	20.1 a
3	10.0	10.0	9.5	10.0	13.3	12.1	10.8 d
4	17.2	14.3	18.1	17.5	29.9	19.7	19.4 ab
5	11.8	8.7	8.7	7.6	12.9	14.0	10.6 d
6	11.1	12.8	15.5	8.9	18.6	15.6	13.8 cd
7	19.0	20.4	18.6	13.4	31.7	27.5	21.7 a
8	15.2	11.1	12.7	13.1	16.7	17.7	14.4 bcd
9	13.5	7.7	12.7	10.6	14.0	11.3	11.6 d
10	9.1	8.7	11.0	7.4	12.6	8.2	9.5 d
Mean[2)]	13.8 bc	12.1 bc	14.4 b	11.7 c	19.6 a	17.7 a	

Means in either column (1) or row (2), followed by the same letter do not differ significantly ($p<0.05$)

S.E. of difference between cutting interval means (1) = 1.07
S.E. of difference between mixture means (2) = 2.28
S.E. of difference between interaction means = 3.37

The interaction of mixtures by cutting interval did not reach statistical significance. Highest yields were obtained from the combinations which included both Elephant and Signal grasses (treatments 2 and 7), while the lowest yields came from the treatments in which Elephant grass was replaced by either forage sorghum (treatments 3 and 9), sugar cane and /or Guinea grass (treatments 5 and 10) or where the elephant grass was sown alone (treatment 6). The longer cutting intervals (10 and 12 weeks) produced higher yields than the shorter ones.

Without data on the botanical composition, it is not possible to fully interpret these results. The 12 week interval may have led to suppression of the legumes and to woody growth of the grasses, giving low protein and digestibility levels. The 8 week cutting cycle, while probably giving forage of reasonable quality, produced the lowest yields in half of the pasture combinations. This result is not easy to explain, since generally, shorter intervals produce lower yields of high quality fodder.

Experiment 2

The data relating to seedling emergence and ratings of both weed and legume performance were subjected to square root transformations, while logarithmic transformations were applied to yield data before analysis. Table 3 shows the effect of establishment method (sown versus broadcast), averaged over the four legume species, while Table 4 shows the performance of the individual legumes, averaged over the two establishment methods. No data are presented for the second harvest at Farm 1 (Giraudel), since several of the sub-plots were subjected to an unplanned grazing.

The results obtained at the two sites were quite different. At Farm 1, with relatively low legume populations, the sown plots had significantly greater weed populations and poorer legume performance than the broadcast treatments. At Farm 2 (La Plaine), where the legume population was much higher, this trend was reversed. Weeds were of great importance at both sites, however, and at the second harvest at Farm 2, the legumes contributed an overall average of only 52 percent of available dry matter.

At Farm 1, *Desmodium, Neonotonia and Macroptilium* appeared to compete best with the weeds up to the time of the first harvest, when they gave significantly higher yields than the *Stylosanthes*. After this time, *Stylosanthes* and *Desmodium* appeared to regrow better than the others, while the vigour of the *Macroptilium* was greatly reduced. At Farm 2, the *Macroptilium* was the poorest species right from the start. *Neonotonia* was almost as good as the other two up to the time of the first harvest, but subsequently faded. On the relatively acid soils of Dominica, *Desmodium* and *Stylosanthes* were the most promising of the species used.

Experiment 3

Fresh forage yields from 2 to 3 months regrowth of Elephant grass at two contrasting sites are shown in Table 5, together with rainfall data for the same period. While grass yields were, in general, higher during the wetter months, there was little direct correlation between total monthly rainfall and forage production during the same period. This is hardly surprising in view of the high levels of rainfall experienced in these parts of Dominica. At the wetter site (Morne Prosper) yields of fresh forage cut each month ranged from 33 to 123 t/ha, with an average of 77 t/ha cut per month. An area of 0.23 ha produced a total of 28.6 t (124.3 t/ha) over a period of a complete year from July 1984. At the drier site (La Plaine), amounts cut each month ranged from 29 to 100 t/ha, for an average of 57 t/ha cut each month. A total of 25.1 t of fresh forage was cut from 0.18 ha (139.4 t/ha) in a year from October, 1984. The dry matter content of the forage ranged from 16 to 25 percent. These results indicate that elephant grass can make a substantial contribution to animal production on a year round basis under Dominican conditions.

Conclusions

The results of the first experiment provided guide lines for future on-station and on-farm research. Elephant grass was pre-dominant in all the treatments which gave high yields and made up 75-80 percent of

Table 3 The effect of sowing or broadcasting on the performance of four pasture legumes in Dominica

Parameter	Drilled		Broadcast	
	Farm 1	Farm 2	Farm 1	Farm 2
Emergence (plants/sq m)	38.0	124.3	26.3	196.3
First Harvest				
Weed rating (0-10)	4.8	3.2	4.3	2.6
Legume vigour (0-10)	2.1		2.6	
Legume, fresh wt (kg/ha)	1,700	3,310	3,580	5,350
Legume, DM (kg/ha)	380	1,440	920	1,210
Regrowth (0-10)	3.5	4.8	4.8	4.3
Vigour after 6 months (0-10)	2.8		5.8	
Second Harvest				
Legume, fresh wt (kg/ha)		7,700		5,000
Legume DM (kg/ha)		1,520		1,640
Weeds fresh wt (kg/ha)		3,760		6,530
Weeds DM (kg/ha)		1,030		1,900

Note: Farm 1 Drilled data are means of three legumes (without *Neonotonia*).
Farm 2 Broadcast data are means of three legumes (without *Macroptilium*).
Other data refer to means over four legumes.

Table 4 The performance of four pasture legumes in Dominica

Parameter	Desmodium		Neonotonia		Stylosanthes		Macroptilium	
	Farm 1	Farm 2	Farm 1	Farm 2	Farm 1	Farm 2	Farm 1	Farm 2
Emergence (plants/sq m)	20.0	196.0	39.2	132.3	23.0	179.5	33.5	91.3
First Harvest								
Legume, fresh wt (kg/ha)	2,040	5,810	2,000	1,370	1,500	7,000	5,170	960
Legume, DM (kg/ha)	580	1,560	660	730	380	1,950	760	860
Legume vigour (0-10)	6.5	7.0	5.0	6.0	5.5	6.5	6.5	2.0
Regrowth (0-10)	3.5	6.0	5.0	5.0	4.5	6.5	6.5	1.0
Vigour after 6 months (0-10)	4.5	6.5	8.0	4.8	7.5	4.8	1.0	4.0
Weed rating (0-10)	5.8	2.3	6.0	4.2	4.0	2.5	3.5	5.7
Second Harvest								
Legume, fresh wt (kg/ha)		8,390		2,940		9,720		3,720
Legume DM (kg/ha)		1,830		860		2,370		900
Weeds, fresh wt (kg/ha)		3,900		5,990		5,240		4,400
Weeds DM (kg/ha)		1,100		1,700		1,430		1,470

Note: Farm 1 Neonotonia data apply only to broadcast plots
Farm 2 Macroptilium data apply only to drilled plots
All other data are means of broadcast and drilled plots

the sub-samples taken for analyses. The persistent forage legumes in the grass/legume mixes, Siratro (*M. atropurpureum*) and stylo (*S. hamata*) contributed 15-20% of the sub-samples. This low percentage was due to continuous competition from the more vigorous grasses.

Experiments 2 and 3 evaluated four forage legumes and Elephant grass in pure stands. These trials were an attempt to move away from grass/legume mixes, which had not been amongst the highest producers in the earlier work.

To date elephant grass has been grown in pure stand on ten model farms and is the grass of choice for the cut and carry (zerograzing) Livestock Model Systems.

Stylo and *Desmodium* show most promise and have been established on three livestock farms. Further evaluations of the forage legumes are needed before full scale extension is implemented.

Table 5 Recorded rainfall and fresh forage yields from Elephant grass (2 to 3 months regrowth) harvested at two sites

Month	Morne Prosper		La Plaine	
	Rainfall (mm)	Forage (t/ha)	Rainfall (mm)	Forage (t/ha)
July (1984)	588.5	45		
August	321.8	33		
September	445.3	78		
October	308.1	88	325.4	50
November	835.9	111	718.3	100
December	310.6	41	206.0	85
January (1985)	253.8	70	115.8	74
February	220.5	96	67.8	29
March	257.6	90	110.5	35
April	194.0	123	342.9	62
May	176.3	78	86.0	39
June	130.0	71	38.0	60
July			159.5	30
August			316.5	28
September			315.0	92
Annual total	4,042.4		2,801.7	

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