EVALUATION OF HERBAGE SPECIES FOR HILL LAND IN THE DRIER ZONES OF VITI LEVU, FIJI

I. J. PARTRIDGE*

ABSTRACT

On hill land black soils in the drier zones of Viti Levu, Fiji, Brachiaria *spp.,* Setaria anceps *cv. Nandi and* Paspalum plicatulum *were the best of fifteen grasses under nitrogen fertilization.* Macroptilium atropurpureum *cv. Siratro,* Centrosema pubescens *and* Stylosanthes guianensis *cv. Schofield were the best legumes with a common companion grass,* Dichanthium caricosum. *In mixtures of selected grasses and legumes, the naturalised mission grass* (Pennisetum polystachyon) *combined with Siratro and stylo to yield the most dry matter and this mixture was readily grazed by cattle in preference tests.*

Current recommendations for pasture improvement on hill lands are to oversow Siratro and stylo with superphosphate into burnt mission grass.

None of the grass species tested ideally suited local ecological and management conditions.

INTRODUCTION

The areas for grazing in the seasonally dry zones (annual rainfall 2000 mm) of Viti Levu, the largest island of the Fiji group, consist of about 250,000 ha of steep hill land with a nigrescent soil type (Twyford and Wright 1965). These thin montmorillonitic clays, overlying tuff or basalt, are deficient in phosphorus and sulphur (Partridge 1973a), and crack when dry while being waterlogged in wet weather.

The main grass species present are mission grass (*Pennisetum polystachyon*), a fire-climax species which is replacing reeds (*Miscanthus floridulus*), and Nadi blue grass (*Dichanthium caricosum*) which was planted on the better class of rolling country in the 1930's (Parham 1955).

Hundreds of grasses and legumes have been introduced to Fiji since 1860 (Anon 1950, Parham 1949a, 1949b). Nadi blue and mission grass were introduced in 1905 and 1920 respectively, with many other potentially useful species since 1950. 'Fiji trefoil' (*Desmodium heterophyllum*) had become naturalised by 1920, *Centrosema pubescens* and *Stylosanthes guianensis* were introduced in the 1940's and *Macroptilium atropurpureum* cv. Siratro in the 1960's.

Cutting trials to evaluate grasses and legumes had been carried out over the years but were somewhat disjointed because of staff discontinuities and were often on atypical soil types.

A number of promising species and accessions were selected to allow for more detailed testing of grasses under nitrogen fertilization, legumes with a common companion grass, and grass-legume mixtures.

EVALUATION OF GRASSES

Methods

Nadi blue grass pastures on hill soils of moderate to steep slope at Nawaicoba and Sigatoka in southwestern Viti Levu were cultivated. The grasses listed in Table 1 were planted vegetatively in 2.3 m × 3 m plots in December 1970, after the application of 330 kg ha^{-1} superphosphate. Urea, at 110 kg N ha^{-1} yr^{-1}, was applied as split dressings after each harvest. Three replicates at each site were mown by motorscythe every two months in the wet season and every three months in the dry during 1971 and 1972.

* Sigatoka Research Station, Research Division, Department of Agriculture, Fiji.

Rainfall during the wet and dry seasons at each site was:

	Wet (Dec. 1971 - Apr. 1972)	Dry (May - Nov. 1972)
Sigatoka	757 mm	577 mm
Nawaicoba	1676 mm	255 mm

Yields were measured for growth between May 1971 and December 1972.

Results

The annual dry matter yields of the grasses at each site and the proportion of the 1972 yield occurring during the dry season are given in Table 1.

The patterns of growth of all species showed a first peak in December, a slight drop in February before a second peak in April, after which production dropped considerably in the dry season through to November. In the drier conditions at Nawaicoba, Nadi blue grass was the only species to give no yield over one harvest period but, by September, only the *Brachiaria* spp. remained green. These effects were less marked with the better distributed rainfall at Sigatoka. Plicatulum and setaria established quickly to give high yields in 1971 while the *Brachiaria* species were slow to establish but later filled the whole plots to become the highest yielding.

EVALUATION OF LEGUMES

Methods

Scarified and inoculated seeds of the legumes listed in Table 2, except for hetero which was vegetatively planted, were sown in plots of 2.4 × 3 m with three replicates at each site. Seed bed treatment and dates of sowing were the same as for the grass trial but were fertilized only with superphosphate at 440 kg ha^{-1}. Heavy rainfall at Sigatoka for three months after sowing caused poor establishment of all legumes except for Siratro, centro and hetero. Initial growth was slow at Nawaicoba but yields were recorded during 1972.

Results

The yields of the legumes and associated Nadi blue grass, ranked in Table 2, show Siratro to be the highest yielding legume and the only one to increase the growth of the grass. The regeneration of the annual Townsville stylo was negligible in the thick mat of blue grass.

EVALUATION OF GRASS-LEGUME MIXTURES

Methods

The six grasses listed in Table 3 were grown with either Siratro or stylo as a 6 × 2 factorial, with an additional plot of Koronivia grass-hetero.

Areas of sloping land at Sigatoka and Nawaicoba were cultivated to remove the existing sward of Nadi blue grass and fertilized with 450 kg ha^{-1} superphosphate. The grasses and hetero were planted vegetatively while Siratro and stylo seed was broadcast at 5 kg ha^{-1} in 10 m × 10 m plots in January 1973. The treatments were randomised in three replications at each site.

Yields were recorded in June and September 1973 and January 1974 at Sigatoka but the Nawaicoba trial was accidently grazed in June before being harvested in August 1973 and January 1974. At harvest, the herbage from a 1 m × 10 m strip cut by motorscythe across each plot was weighed and sampled for grass-legume separation. Cattle were then admitted and the number of cows grazing on each plot were counted every 15 minutes for 2¼ hours to give an estimate of grazing preference.

Results

Unusually dry weather after sowing in January was followed by excessive rainfall in March and establishment was slow. By the end of the 1973–74 wet season,

TABLE 1

Annual yields of grasses at two sites (t ha^{-1}yr^{-1}), with the percentage of yield occurring during the dry season of 1972.

Accession	common name or cv.	F.D.A.+	1971		1972			
			Sigatoka	Nawaicoba	Sigatoka	(%in dry)	Nawaicoba	(%in dry)
Brachiaria brizantha		15534	9.6	8.2	17.3	52	13.0	59
Brachiaria decumbens	signal	15632	13.2	12.4	16.4	54	14.8	50
Brachiaria humidicola	Koronivia	16707	8.9	9.0	17.5	49	15.4	45
Cenchrus ciliaris	Grasslands	15629	11.5	5.4	13.0	36	8.5	37
Chloris gayana	Callide	15939	9.2	5.8	9.1	24	6.4	23
Dichanthium caricosum	Nadi blue	local	10.2	6.5	12.8	31	6.1	18
Digitaria decumbens	pangola	15079	4.3	3.8	7.3	36	6.8	23
Melinis minutiflora	molasses	16076	10.6	9.7	12.4	42	10.2	31
Panicum maximum	guinea	local	13.1	7.5	13.1	31	8.7	42
Panicum maximum	Embu	16433	13.5	10.0	11.7	41	9.9	52
Panicum maximum	Dwarf	16422	8.9	6.5	7.1	40	5.9	29
Paspalum plicatulum	Rodds Bay	15099	16.2	9.4	11.2	20	14.3	22
Pennisetum polystachyon	mission	local	11.7	7.3	13.8	38	11.4	39
Setaria anceps	Nandi	15110	17.4	14.9	12.8	29	11.4	48
Urochloa mozambiciensis		16441	6.3	7.1	8.3	23	5.6	21
L.S.D. (P=0.05)			5.1	3.8	4.4		4.4	

+Fiji Department of Agriculture accession No.

TABLE 2

Annual dry matter yields (t ha^{-1}yr^{-1}) of legumes and associated grass (Dichanthium caricosum) *at Nawaicoba.*

Species		legume	grass	total
Macroptilium atropurpureum	Siratro	7.0	9.9	16.9
Centrosema pubescens	centro	4.7	7.4	12.1
Stylosanthes guianensis	Schofield	4.1	5.9	10.0
Desmodium intortum	Greenleaf	1.4	5.7	7.1
Desmodium heterophyllum	hetero	1.4	5.3	6.7
Stylosanthes humilis	Townsville stylo	0.2	6.3	6.5
Glycine wightii	FDA 15971	0	7.0	7.0
L.S.D. (P=0.05)		1.6	n.s.	3.8

n.s. Not significant.

Nadi blue grass was reinvading most of the plots and the trial was terminated. The means of total herbage production from three harvests at Sigatoka and two at Nawaicoba are given in Table 3. The data were analysed as a 6 × 2 factorial, under which the Koronivia grass-hetero yields are not statistcially comparable. The slow establishment of this mixture during the one year of recording gave low yields of about 5 t ha^{-1} and this is not shown in Table 3.

The herbage yields at Nawaicoba were lower due to the accidental grazing, but the ranking of mixtures for total herbage was similar at both sites, with mission grass mixtures producing the most dry matter. The mean yields of the Siratro plots were similar to those of stylo; Siratro yielded higher than stylo at Sigatoka but *vice versa* at Nawaicoba. At Sigatoka the legumes yielded best in combination with the erect grass species, plicatulum and mission grass, but at Nawaicoba they yielded highest when dominating the creeping grasses, Nadi blue and Koronivia.

TABLE 3

Yields of herbage (t ha^{-1} yr^{-1}) from grazed grass-legume mixtures.

	total yield	legume yield Sigatoka	legume yield Nawaicoba
Grass			
Pennisetum polystachyon	13.9	6.4	3.5
Paspalum plicatulum	12.4	6.6	3.8
Setaria anceps	11.6	4.8	4.0
Dichanthium caricosum	10.9	4.7	5.1
Panicum maximum	8.6	5.0	3.8
Brachiaria humidicola	7.2	4.6	5.5
L.S.D. (P=0.05)	2.2	n.s.	1.7
Legume			
Stylosanthes guianensis	11.1	4.2	4.4
Macroptilium atropurpureum	10.4	4.8	2.8
L.S.D. (P=0.05)	n.s.	n.s.	.8

n.s. Not significant.

When cattle entered the experimental area, guinea grass was their first choice while mission grass was readily acceptable in both wet and dry seasons. Setaria gave variable preferences depending on the season. Overall the Siratro-based mixtures were preferred to those based on stylo.

DISCUSSION

The final selection of herbage species depends on their yields, compatability in grass-legume mixtures, ease of establishment and management, seed production, persistence under grazing and long term capability for high animal production.

In these trials the grasses were planted vegetatively as quarantine requirements banned the import of grass seed from tick-infested areas of Queensland. This required all grass seed to be produced locally. Although the techniques of grass seed production and storage have developed since 1972 and trial seed yields (Partridge 1973b) could be improved, the high variability and intensity of rainfall in all areas of Fiji at the seeding period of improved grasses would make harvesting difficult. The harvested seed would then need controlled storage conditions and a good seed bed for establishment. In contrast, Nadi blue seed is easily harvested in early winter to give viable seed which can be stored at ambient temperatures and which germinates vigorously in poorer soils. Similarly seeds of the legumes of Siratro, centro and stylo can be hand-harvested in commercial quantities.

The *Brachiaria* species produced best during the winter period to become the highest yielding but they were slow to establish vegetatively and did not combine well with the taller legumes. Koronivia grass (*B. humidicola*) spreads best from vegetative planting because of its running habit. Guinea grass did not perform as well as setaria or plicatulum on these poorly draining black soils, but plicatulum has the reputation of poor palatability.

The twining legume, Siratro, produced the most herbage of all the legumes and increased the yield of the companion grass. Stylo was also selected for further testing as an erect species which may be better suited under poorer soil fertility. Neither species has to be inoculated with specific *Rhizobium*, a factor that may be important with untrained farmers. Hetero did not yield highly with the aggressive Nadi blue grass, this being only partly due to the harvesting techniques with a sickle bar mower. However it was included as an extra treatment in the grass-legume mixture trial because it is naturalised in the areas for grazing and is reputed to combine well with creeping grasses.

Long term persistence under frequent grazing was not measured in the grass-legume trial when this was stopped after 12 months. Nevertheless mission grass, a naturalised species which was previously regarded more as a weed in Fiji, combined well with both Siratro and with stylo to give the highest yields of total herbage. Moreover, it was readily eaten by cattle when fertilised and associated with legumes.

However, the poorer persistence of Siratro and mission grass and the good performance of hetero under grazing in a subsequent trial, particularly at heavy grazing pressures, illustrates that care must be taken when selecting any herbage species on the basis of total yield from small plots with cutting techniques.

Since steep slopes preclude cultivation of hill land to control the existing grasses and to provide a seed bed for improved grasses, pasture improvement is now orientated to oversowing Siratro and stylo into the naturalised mission grass after burning and applying superphosphate (Partridge 1975). As the fertility of the soil improves and the mission grass cover weakens under grazing, a more persistent grass may be needed. Nadi blue grass is presently the most practical choice for areas with higher winter rainfall but a better species is still being sought for drier areas.

ACKNOWLEDGEMENTS

I wish to thank those field assistants involved in all or part of this work, namely V. Kumar, P. Tagitagivalu, M. Mainabaubau and Miss P. K. Singh.

REFERENCES

ANON (1950)—Plant Introduction Lists. Department of Agriculture, Fiji.
PARHAM, B. E. V. (1949a)—List of grasses recorded in Fiji 1860-1948. *Fiji Agricultural Journal* **20**: 15.
PARHAM, B. E. V. (1949b)—List of introduced leguminous plants recorded in Fiji. *Fiji Agricultural Journal* **20**: 21.
PARHAM, J. W. (1955)—The grasses of Fiji. Bulletin 30, Department of Agriculture, Fiji.
PARTRIDGE, I. J. (1973a)—Plant Nutrition Studies Project 3/70/4 p. 13, Annual Research Report, Department of Agriculture, Fiji.
PARTRIDGE, I. J. (1973b)—Grass seed study. Pasture 8/72 p. 16 Annual Research Report, Department of Agriculture, Fiji.
PARTRIDGE, I. J. (1975)—The improvement of mission grass (*Pennisetum polystachyon*) in Fiji by top dressing superphosphate and oversowing a legume (*Macroptilium atropurpureum*) *Tropical Grasslands* **9**: 45-51.
TWYFORD, I. T. and WRIGHT, A. C. S. (1965)—The soil resources of the Fiji Islands. (Government Printer: Fiji).

(Accepted for publication June 5, 1979)