

New Forage Species for Coconut Plantations in Bali

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Abstract

An experiment was conducted at Pulukan in Bali during 1988 and 1989 to evaluate the performance, in terms of dry matter yield and persistence under regular cutting, of 37 grass and 35 herbaceous legume species. Most species were selected from the CSIRO forage germplasm collection held in Brisbane, Australia for their assumed shade tolerance.

Species which showed both good regrowth and persistence, although lower total yields over 11 harvests than some less persistent species, were the legumes *Arachis* sp. CPI 29986 and *Arachis* sp. CPI 12121, and the grasses *Paspalum notatum* CPI 11864, *P. notatum* cv. Competidor and *Axonopus compressus* local variety.

THE successful introduction of forages under plantation crops requires high quality species that are well adapted not only to the soils and climate of the region but also to the special requirements of plantation crop systems. These special characteristics are (a) adaptation to reduced light regimes, (b) low growth habit (except for cut and carry situations) as tall species may interfere with normal plantation management, and (c) minimal competitiveness with the plantation crop. Leguminous species may meet this latter characteristic more readily than grass species.

There is a number of naturally occurring species which may be found in plantation crops in the tropics which meet some of these characteristics, namely *Axonopus compressus*, *Paspalum conjugatum* and *Centrosema pubescens*. However, they generally lack sufficient vigour to maintain weed-free swards under regular grazing regimes. There is a number of improved species which improve the productivity and quality of forages in plantation crops (Shelton et al. 1987). Nevertheless, new species are required which more specifically meet the range of plantation environments that occur in southeast Asia and the Pacific.

Accordingly, a series of coordinated species evaluation experiments was conducted in coconut plantations at Bali and North Sulawesi in Indonesia and at the Rubber Research Institute of Malaysia at Sungei Buloh. In Indonesia, species are required for 'cut and carry' and for intensively grazed sites. Species

which improve the quality of pasture and extend the growing season will be particularly valuable. In Malaysia, species are needed which are adapted to the declining light environment of maturing rubber and which are suitable for grazing by sheep. The overall objective was to identify new forage genotypes which were superior in their persistence of yield compared to existing species. This paper describes the materials and methods, which were common to all experiments, and the results of the Bali experiment. The results of the North Sulawesi and Sungei Buloh experiments are given in separate papers.

Materials and Methods

Location

The trial was conducted under a stand of old coconuts, with new palms interplanted, at Pulukan village about 60 km west of Denpasar, Bali. Average annual rainfall at the site is 2070 mm with most rain falling between October and April. There is a distinct dry season from June to August in most years. Rainfall during the experimental period followed the long-term trend. The soil is a fertile sandy clay loam with a pH of 6 to 7. The light transmission at 10 a.m. on a sunny day was 58% PAR.

Treatments and design

There were 37 species of grasses and 35 species of herbaceous legumes in Bali (Table 1). Grasses and legumes were chosen on the basis of their assumed shade tolerance and were obtained from Mr Ron Williams of the Tropical Forage Genetic Resources Centre, CSIRO, Brisbane, Australia.

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An unreplicated augmented design was used with a single plot of all species, and the systematic replication of two check grass species *Panicum maximum* cv. Riversdale and *Brachiaria decumbens* cv. Basilisk and two check legume species *Centrosema pubescens* and *Pueraria phaseoloides* to give five replications of each check species. Nursery plots, comprising two single rows of each species, were planted next to the main plots. These plants were grown without cutting to observe flowering behaviour, seed production, and disease and insect incidence.

Plot size was 1 x 1 m for main plots and 0.5 x 1 m for nursery plots. Seedlings, previously germinated in a shadehouse, were planted on 20 cm squares to give 25 plants per main plot and 10 plants per nursery plot. Plots were transplanted into the field in June 1988.

Measurements

Yield of each species was obtained by cutting the central area of each main plot (0.36 m² containing nine plants). Fresh samples were separated into leaf, stem and weeds and then air-dried before oven-drying in an oven at 70°C to determine total dry weight. The first harvest was taken three months after planting (18 September) and then plots were cut regularly every two months until 18 May 1990. There were 11 harvests.

The height of cutting varied from 5 to 20 cm, depending on the morphology of the species. Tall species were cut at 20 cm, prostrate species at 5 cm, while species of intermediate height were cut at 10 cm. The growth performance of the species including vigour, plant survival, pest incidence, flowering behaviour and seed production was assessed at each harvest using a rating system.

Results and Discussion

Legumes

The results of the yield measurements for legumes are shown in Table 1a. There was a general trend of reducing yield over the 11 harvests although this varied among species. The two highest-yielding species at harvest 1, *Desmodium intortum* CPI 46552 and *D. intortum* cv. Greenleaf, gave initial yields of 360 and 630 g/m² respectively, and remained the highest-yielding species until the final harvest although their yields and vigour were greatly reduced to 83 and 75 g/m² respectively. Another group of twining legumes was initially lower-yielding but gave moderate final yields (60-65 g/m²) indicating good persistence under the monthly cutting regime. These included *Pueraria phaseoloides* and *Centrosema pubescens* CPI 58575.

A further group of prostrate legumes was initially low-yielding but increased in yield over the period of the experiment. *Arachis* sp. CPI 29986 and *Arachis* sp. CPI 12121 were two species in this category.

Leaf percentage was generally higher than 50% for most species but was particularly high for the *Arachis* species. Insect and disease incidence was greater in legumes than in grasses and affected growth of some species seriously (e.g. *Neonotonia wightii*). Weed invasion was high in *Arachis* species plots.

Grasses

The grasses were higher-yielding than the legumes although there was a similar trend of decreasing yield with time (Table 1b). The species which were initially highest-yielding showed the greatest decline in vigour indicating poor persistence under the 2-monthly cutting regime and decline in soil fertility with time. These were the tall-growing species including the *Panicum maximum* species, the *Digitaria milanijana* species, *Paspalum dilatatum*, *Paspalum malacophyllum* and *Setaria sphacelata* cv. Splenda which produced yields in the range from 550 to 780 g/m².

The best prostrate species behaved differently. Their yields were initially low (60-110 g/m²) but they maintained or increased yields over the 11 harvests indicating excellent persistence under regular defoliation. The principal species were *Paspalum notatum* CPI 11864 and cv. Competidor, *Axonopus affinis* and *A. compressus* (local variety). The *Paspalum notatum* species were notable for their high leaf percentage and low weed content (Table 1b). Grass species were not greatly affected by insects and diseases.

Other species which were lower-yielding but formed dense relatively weed-free swards were *Brachiaria humidicola*, *Paspalum dilatatum*, *P. wettsteinii*, *Digitaria milanijana* CP159775 and *Stenotaphrum secundatum*.

Conclusions

The data obtained to date indicate that there is a number of species that should be further tested in farming systems. The tall-growing grasses may be suitable for cut-and-carry systems especially if cutting management is lenient. The use of fertilizers may extend the effective life of these species although this aspect was not tested. A number of twining legumes may be useful cover crops in new plantations for weed control and forage production.

However, for regularly grazed situations the prostrate grasses and legumes may have superior persistence and should be further tested in grass-legume combinations and on farms.

Table 1a. Dry matter yield, mean leaf percentage and maximum weed percentage of species evaluated under coconuts in Bali (each value = mean of one or more harvests).

Species	Dry matter yield			Mean leaf (%)	Max. weed (%)	
	Harvest	5-7	8-11			
	wet	wet	dry	wet		
		(g/m ² /2 months)				
a) Legumes						
<i>Desmodium intortum</i> Grp.J CPI 46552	361	219	100	83	46	2
<i>Desmodium intortum</i> cv. Greenleaf	633	214	103	75	40	14
<i>Pueraria phaseoloides</i> (commercial)	122	114	58	64	59	34
<i>Arachis</i> sp. CPI 29986 (vegetative)	67	114	33	61	64	37
<i>Centrosema pubescens</i> CPI 58575	136	108	33	61	63	58
<i>Neonotonia wightii</i> cv. Malawi	81	133	42	58	49	72
<i>Arachis</i> sp. CPI 19898 (vegetative)	108	92	39	58	70	11
<i>Arachis</i> sp. CPI 12121 (vegetative)	19	78	39	56	65	33
<i>Neonotonia wightii</i> cv. Tinaroo	169	131	94	47	54	8
<i>Teramnus labialis</i> cv. Semilla Clara	153	131	67	42	56	26
<i>Arachis pintoii</i> CPI 58113	117	69	33	42	69	81
<i>Psophocarpus palustris</i> (local) Bali	106	81	22	42	50	58
<i>Arachis repens</i> CPI 28273 (vegetative)	92	94	42	36	67	73
<i>Desmodium ovalifolium</i> Q 8194	86	117	33	33	61	40
<i>Desmodium intortum</i> Grp.C CPI 43201	136	86	44	31	58	52
<i>Desmodium aparine</i> CPI 33814	100	83	44	31	49	74
<i>Vigna hosei</i> CQ 729	56	67	28	31	63	78
<i>Centrosema pubescens</i> (common)	133	94	22	31	59	67
<i>Vigna lasiocarpa</i> Grp.A CPI 34436	50	58	17	28	47	67
<i>Centrosema pubescens</i> cv. Belalto	167	108	44	25	57	81
<i>Desmodium</i> sp. Grp. A CPI 49668	144	142	28	25	56	81
<i>Vigna luteola</i> cv., Dalrymple	97	78	31	22	55	71
<i>Macrotyloma axillare</i> cv. Archer	78	75	39	19	51	68
<i>Desmodium scorpiurus</i> CPI 87514	86	47	19	19	53	93
<i>Desmodium heterophyllum</i> cv. Johnstone	64	128	25	17	54	81
<i>Aeschynomene americana</i> cv. Glenn	139	172	14	11	45	0
<i>Centrosema sagittatum</i> CPI 82277	103	56	11	8	57	0
<i>Cassia rotundifolia</i> cv. Wynn	50	83	8	8	50	0
<i>Centrosema macrocarpum</i> CPI 95531	217	92	28	3	51	81
<i>Desmodium heterocarpon</i> cv. Florida	69	133	6	0	48	0
<i>Calopogonium mucunoides</i> (commercial)	164	97	6	0	53	0
<i>Lotus pedunculatus</i> cv. Maku	58	25	6	0	40	0
<i>Vigna parkeri</i> cv. Shaw	25	8	6	0	48	0
<i>Trifolium semipilosum</i> cv. Safari	19	8	6	0	43	0
<i>Cassia pilosa</i> CPI 57503	108	153	3	0	36	0
<i>Desmodium adsendens</i> GrpA CPI 93125	25	14	3	0	62	0
<i>Vigna oblongifolia</i> . aff CPI 60433	0	0	0	0	75	0
Harvest means	119	97	33	33	55	54

Table 1b. Dry matter yield, mean leaf percentage and maximum weed percentage of species evaluated under coconuts in Bali (each value = mean of one or more harvests).

Species	Dry matter yield				Mean leaf (%)	Max. weed (%)
	1 wet	Harvest 2-4 wet (g/m ² /2 months)	5-7 dry	8-11 wet		
b) Grasses						
<i>Panicum maximum</i> cv. Riversdale	872	261	108	186	54	0
<i>Paspalum malacophyllum</i> CPI 27690	731	222	175	156	47	0
<i>Paspalum dilatatum</i> (commercial)	567	253	122	156	63	9
<i>Paspalum notatum</i> CPI 11864	61	122	92	156	89	0
<i>Panicum maximum</i> cv. Gatton	708	381	161	147	35	0
<i>Paspalum plicatulum</i> cv. Bryan	427	281	117	147	60	0
<i>Brachiaria decumbens</i> cv. Basilisk	325	244	139	139	43	5
<i>Digitaria milanjana</i> CPI 41192	703	178	156	136	60	0
<i>Digitaria milanjana</i> CPI 59775	317	208	106	128	40	0
<i>Panicum maximum</i> cv. Petrie	697	208	169	125	40	0
<i>Axonopus affinis</i> (commercial)	100	119	78	117	73	28
<i>Paspalum</i> sp. (local) Bali	194	158	89	111	50	21
<i>Digitaria smutsii</i> cv. Premier	253	164	103	108	83	4
<i>Brachiaria brizantha</i> CPI 15890	494	225	83	108	45	14
<i>Bothriochloa pertusa</i>	314	192	111	106	50	46
<i>Paspalum notatum</i> cv. Competidor	81	106	100	106	80	0
<i>Digitaria milanjana</i> CPI 59721	586	247	94	106	49	0
<i>Setaria sphacelata</i> cv. Splenda	672	161	89	106	39	7
<i>Paspalum wettsteinii</i> (commercial)	281	153	89	94	61	0
<i>Axonopus compressus</i> (local) Bali	111	92	69	94	74	7
<i>Panicum maximum</i> cv. Rumuruti	633	170	56	94	41	0
<i>Brachiaria humidicola</i> cv. Tully	200	189	103	83	51	0
<i>Digitaria</i> sp. (local) Bali	297	150	53	69	43	73
<i>Paspalum simplex</i> CPI 27709	256	258	89	67	46	70
<i>Panicum maximum</i> cv. Embu	297	175	67	67	37	40
<i>Bothriochloa insculpta</i> CPI 59584	256	153	75	61	46	17
<i>Paspalum commersonii</i> CPI 15705	363	203	53	61	41	0
<i>Panicum laxum</i> CPI 113582	106	111	53	61	61	11
<i>Paspalum conjugatum</i> CPI 60059	242	153	64	50	43	0
<i>Panicum laxum</i> CPI 53932	106	94	64	47	61	36
<i>Digitaria pentzii</i> CPI 41190	147	83	53	44	78	37
<i>Avena</i> sp. (local) Bali	256	89	69	42	40	60
<i>Paspalum scrobiculatum</i> cv. Paltridge	378	125	42	39	47	77
<i>Acroceras macrum</i> CPI 62122	150	94	58	22	45	53
<i>Stenotaphrum secundatum</i> (ex) Brisbane	16	19	22	23	73	89
Harvest means	397	189	97	108	51	15

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Reference

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