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The Performance of Six Tropical Pasture Legumes when Sown as a Companion with Buffel Grass in the NT

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ABSTRACT

Six different tropical pasture legumes were sown into an established buffel grass pasture (*Cenchrus ciliaris*) to study the dry matter yield and pasture quality changes of the buffel grass and legume mixtures compared to buffel grass alone and buffel grass applied with nitrogen fertiliser.

The overall combined harvest results showed the nitrogen-applied buffel grass treatment gave the highest yield (12.2 t/ha). The Oolloo mix *(Centrosema brasilianum)* produced the highest legume content, but reduced the proportion of buffel grass. The three highest yielding legume/grass mixes were the buffel grass with companion Oolloo, Milgarra *(Clitoria ternatea)* and Maldonado *(Macroptilium gracile)* producing around 11.5 t/ha. The increase in legume content also increased the total crude protein percent. Crude protein fell to between 2.3% and 4.0% in the May harvest after a range of 4% to 9% in the February harvest.

INTRODUCTION

Buffel grass is a widely used tropical grass pasture in northern Australia and responds well to nitrogen fertiliser. However fertiliser is expensive to purchase and apply. Legumes grown as a companion to grass can supply high quality pasture and assist as a source of nitrogen through nitrogen fixation from rhizobia and plant mineralisation.

In the Top End of the Northern Territory buffel grass generally has a dry matter yield of 2.5 - 6 t/h (Cavaye, 1991; Cameron, 1996). It does not spread, or spreads only slowly, in the Top End (Cameron, 1996) and does not thicken-up, resulting in gaps between plants, which can make the area prone to erosion or weed invasion. Seeds from buffel grass do not germinate very well naturally, due to the "fluffy" nature of the seed. Soil gets very hot and tends to crust on the surface, making it hard for seedlings to establish. The fluffy nature of the seed prevents good soil-to-seed contact, which exposes germinating seeds to desiccation. A companion species can be grown to improve productivity and reduce bare soil areas in pure buffel grass swards.

Significant benefits have been demonstrated in the past by growing a grain crop following a legume pasture phase, because of the accumulation of nitrogen in the soil. This trial was carried out to determine whether similar benefits could be obtained from an introduced legume into a grass pasture. It is unlikely in most circumstances that the use of nitrogen fertiliser is going to be economic for producing beef, despite the significant improvement in dry matter production. If a legume can be established within an existing grass-only pasture and it then survives, grows and reproduces successfully, the need for nitrogen fertiliser could be eliminated by a cheaper alternative.

METHOD

In this trial six legumes (Centrosema pascuorum, Chamaechrista rotundifolia, Stylosanthes hamata, Macroptilium gracile, Clitoria ternatea and Centrosema brasilianum) were established in an existing buffel grass (Cenchrus ciliaris) pasture. Soil and plant nutrients and pasture yields were monitored up to 18 months post-planting.

a) Site

The experimental site was at the Douglas Daly Research Farm in the Northern Territory (13^{o} 50' S, 131^{o} 10' E) in a buffel grass pasture which had been established for seven years.

The trial site was selected where the buffel grass was even, containing no obvious cattle tracks and no abundance of weeds or other plant species. The soil was deep and well drained Blain sandy red earth, which is a dominant soil type throughout the area.

b) Treatments and design

The trial was a longitudinal comparison experiment of a randomised block design with eight treatments replicated three times.

The treatments were:

- Control - buffel grass only
- Applied nitrogen plots -- Using Prilled Urea (46-0-0-0) at 60kg/ha on 19/12/96 and again on the 22/02/98.
- Cavalcade centro (Centrosema pascuorum)
- Amiga stylo (Stylosanthes hamata)
- Wynn cassia (Chamaechrista rotundifolia)
- Maldonado (Macroptilium gracile)
- Oolloo (Centrosema brasilianum)
- Milgarra blue pea (Clitoria ternatea)

The planting rate of each seed lot was determined by the germination and purity of the seed aiming for a plant population of around 100,000 plants/ha.

The planting rates used were:

Amiga	5 kg/ha	Cavalcade	8 kg/ha
Milgarra	6 kg/ha	Wynn	4 kg/ha
Oolloo	8 kg/ha	Maldonado	3 kg/ha

Plot size and separations:

Plot size was 10m x 8m with a one-metre border between each plot of buffel grass. There was a 5m border of buffel only between each of the three replication blocks.

c) Trial operations

The buffel grass *(Cenchrus ciliaris cv* Gayndah*)* was established in the 1990/91 wet season, planted at approximately 4kg/ha. The trial site was established in the 1996/97 wet season and sprayed with Banvel® at 1 l/ha for broad leaf weed control.

Fertiliser and seed were mixed and applied by hand to each plot on the 19th December 1996. The fertiliser was equivalent to 110 kg/ha of NPKS (0-18-0-10), plus copper 0.5%, molybdenum 0.015% and zinc 0.5%.

The area was mown in June 1997 to simulate grazing and to promote new growth. Cut material was left *in situ.*

In February and May 1998 plant biomass of approximately 2.5 months growth was harvested and soil samples taken from each plot. Generally, the seasonal rains have stopped by May and soil moisture is in deficit, so the final harvest in May would probably not see any further growth.

After the February harvest, the trial area was forage-harvested and the harvested material removed to simulate an artificial grazing.

d) Data collection and measurements

The biomass harvests consisted of 4 x $0.5m^2$ random quadrats from each plot using a 1m x 0.5m quadrat and cutting each site within the plot using an electric knife. The plant samples were cut to approximately 30 mm above ground level. Biomass samples were separated into grass and legume to determine the dry-weight proportion of grass to legumes. All samples were dried in a forced-draught oven for 5 days at 65^oC before weighing.

The samples were analysed for the following:

- Nitrogen by acid digestion followed by a flow injection analysis procedure utilising a nitroprusside catalysed salicylate/chlorine spectrophotometric method.
- Phosphorus, potassium and sulphur by acid digestion followed by inductively coupled plasma measurement.

Soil samples were taken from each biomass harvest site to a depth of 20 cm and were analysed using the following soil extraction methods: Phosphorus-modified Olsen; Potassium-Ammonium acetate; Sulphur-phosphate; and nitrogen-sulphuric acid and copper catalyst.

Data was recorded for:

- Dry matter yields of buffel grass and legume;
- The four (0.5 m^2) quadrats from each plot were combined, then averaged for the total dry matter yield from each plot;
- Crude protein was calculated by N% x 6.25;
- Crude protein (kg/ha) was also recorded --(dry matter yield x crude protein %);
- Digestibility was analysed and recorded;
- Soil nitrogen was also recorded. Other soil properties will be compared to determine any changes in soil properties over time. These results will be used mainly for post project studies;
- Climatic conditions including rainfall, temperature and evaporation were recorded at the Douglas – Daly weather station approximately 1km from the trial site.

RESULTS

a) Yields

The dry matter yield for both the February and May harvests revealed that all legume /buffel grass treatments and the nitrogen applied grass had a higher total dry matter yield compared to the non-fertilised buffel grass pasture.

Table 1. Yield Results for Feb and May (1998) harvests and combined

Treatment	February Harvest Results			May Harvest Results			Combined Harvests
	Buffel Yield kg/ha	Legume Yield kg/ha	Total Yield Dry Matter kg/ha	Buffel Yield kg/ha	Legume Yield kg/ha	Total Yield Dry Matter kg/ha	Total Yield kg/ha
Applied N.	6290	0	6290	5950	0	5950	12250
Oolloo	2350	4860	7220	3310	1080	4400	11610
Milgarra	5960	830	6790	3910	690	4600	11380
Maldonado	5240	720	5970	4990	270	5260	11160
Amiga	5570	280	5850	4140	0	4140	9980
Wynn	5450	130	5580	4090	300	4390	9420
Cavalcade	5810	10	5820	3550	0	3550	9360
Control	5780	0	5780	3560	0	3560	9340
LSD@P<0.05	1550	630	NS.	1000	480	890	1380

b) Pasture Quality

1. Crude Protein

The total crude protein (kg/ha) produced from all treatments ranged from 350 (buffel only) to 891 (Oolloo/buffel mix) The crude protein analysed from the buffel grass in each treatment ranged between 3.3% and 4.4% (average over the February and May harvests). The crude protein in the buffel grass dropped dramatically between the February and May harvests as can be seen in Table 2.

The nitrogen-applied treatment had the lowest crude protein percent in February 1998, as the nitrogen fertiliser was not applied until after the February harvest.

Table 2. Crude Protein % for February and May (1998) harvests and combined.

Treatment	February Harvest Results			May Harvest Results			Combined Harvests
	Buffel Crude Protein %	Legume Crude Protein %	Average Crude Protein %	Buffel Crude Protein %	Legume Crude Protein %	Average Crude Protein %	Average Crude Protein %
Oolloo	5.8	11.9	9.9	3.0	6.9	4.0	7.0
Milgarra	4.8	13.1	6.0	2.6	7.8	3.4	4.6
Wynn	5.0	10.0	5.7	2.5	8.1	2.9	4.3
Maldonado	4.4	12.2	5.3	2.4	7.5	2.7	4.0
Cavalcade	4.8	20.9	4.8	2.8	NP	2.8	3.8
Control	4.6	NP	4.6	2.4	NP	2.4	3.5
Amiga	4.3	9.1	4.1	2.3	NP	2.3	3.4
Applied N.	4.0	NP	4.0	3.0	NP	3.0	3.5
LSD@P<0.05	0.8		0.8	NS.		0.8	0.6

Note: The crude protein % of each legume species was assumed to be the same throughout the 3 replications ie. a bulk sample was analysed. (NP = Not Present)

2. Digestibility

The digestibility of the buffel grass in all treatments was not significantly different. Cavalcade had the highest digestibility of 71 % and Oolloo the lowest at 41%. Amiga, Maldonado, Wynn and Milgarra had similar digestibilities of between 51% - 62% (Table 3).

Table 3. Digestibility Results

Treatments	Legume Digestibility Feb. 98 %	Legume Digestibility May. 98 %	Buffel Digestibility Feb. 98 %	Buffel Digestibility May. 98 %	Mean Buffel Digestibility %
Wynn	56	48	48	48	48
Milgarra	51	52	41	40	41
Maldonado	62	50	42	39	41
Applied N			36	44	40
Oolloo	41	47	41	39	40
Cavalcade	71		40	38	39
Control			37	42	39
Amiga	53		36	39	38

c) Soil Nitrogen

There were no significant differences in soil nitrogen levels between treatments, replications or harvest dates. From both harvests, soil nitrogen ranged from 0.04% to 0.05 % (total Kjeldahl nitrogen).

d) Rainfall

The long-term average annual rainfall of the Douglas Daly District is 1195 mm per annum. During the 1997/98 season the rainfall was above average at 1670 mm. Most of this rainfall fell in December and January with below average rainfall falling after this time.

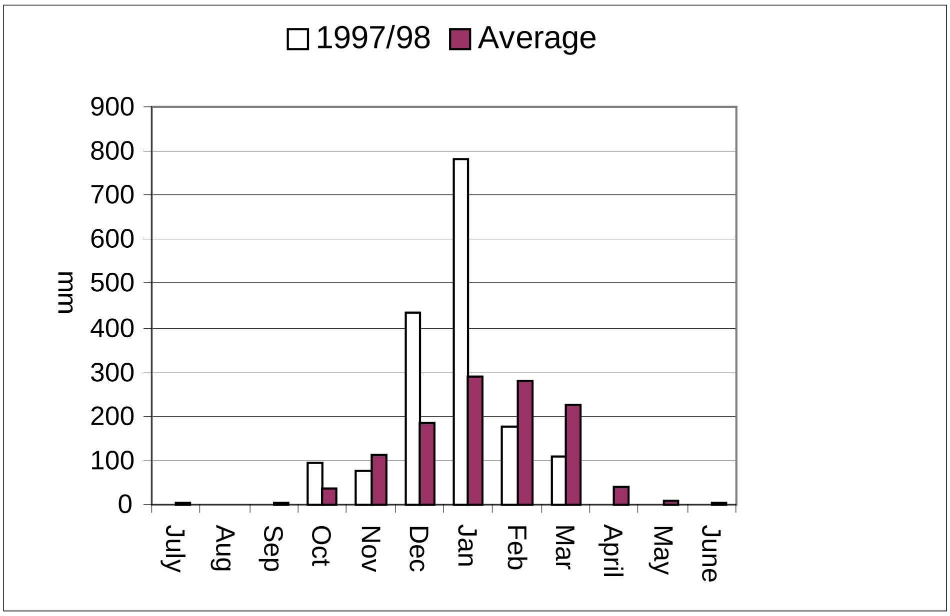

Figure 1. Comparison of the rain distribution of the 1997/98 season and the long-term average rainfall distribution at the Douglas Daly Research Farm

COMBINED HARVEST RESULTS

The total buffel grass yields of the combined harvests were higher in the mixed and nitrogen applied plots except for the Oolloo /buffel mix (5,660 kg DM/ha), which was considerably lower than the control.

Milgarra, Oolloo and Maldonado had similar total yields (over 11,000 kg/ha) but had varying contents of crude protein (4.0% - 7.0%). The results shown in Figure 2 indicate the higher the legume content, the higher the crude protein %.

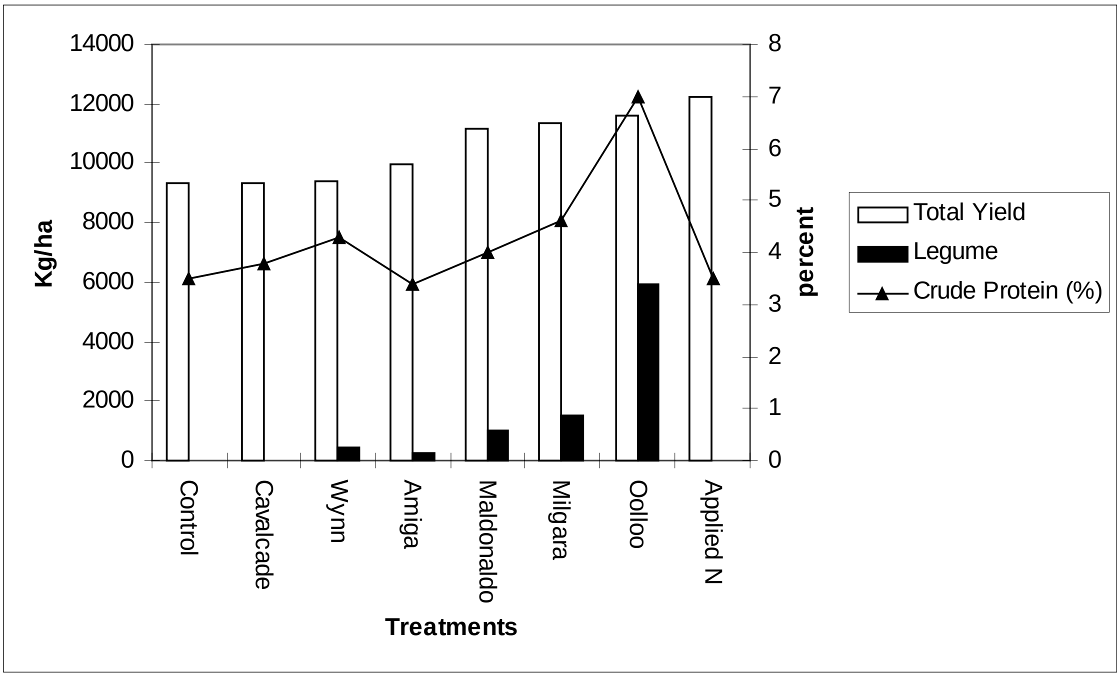

Figure 2. A Comparison between Total Dry Matter Yield, Legume content and the Crude Protein of the Combined Harvests, 1998

DISCUSSION

Introducing companion legumes and applying nitrogen fertiliser to buffel grass can increase the total dry matter yield of the mixed pastures in most cases. The highest increase in buffel grass yield was in the nitrogen-applied treatment in the May and combined harvests, suggesting that buffel grass responded well to the application of nitrogen fertiliser. However, this is an expensive alternative (O'Gara, 1998). One of the limitations of the trial was that nitrogen fertiliser was applied after the February harvest, which resulted in yield increase only in the May harvest.

Legume yields varied, but both Cavalcade and Amiga were depleted. This could be the result of insufficient rainfall (284.5 mm) after the February harvest, or that the legumes could not tolerate the mid-season harvest. Oolloo performed well producing a total legume dry matter yield of 5.9 t/ha, which was much higher than previous reports in pure stands (Cameron 1997). The Oolloo mix also had the lowest buffel grass yield, which suggested the legume was competing with the grass. However, this trial was conducted only in the second year of establishment of the pasture mixes. Some legume proportions initially may have been high, but legume persistence is often poor due to increasing competition from the grass, resulting in a decrease in legume content within 2-4 years (Cadish, *et al*. 1994).

The highest total dry matter yields of over 11.5 t/ha were recorded in the nitrogen applied and the buffel /legume mixes of Oolloo, Milgarra and Maldonado. Except for the Amiga, the crude protein percent of the legume / buffel mixes were all higher than the control plots, which indicates that the higher legume content increases the crude protein of the pasture mix (Shehu and Akinola, 1995). The crude protein content declined in the May harvest (2.3% - 4.0%) after the February harvest recorded 4.0% - 9.9%, supporting Shehu and Akinola's (1995) findings that crude protein diminishes as the plants become older.

The trial has shown that the introduction of legumes does increase the quality and quantity of the buffel/legume pasture mix and is a more ecologically preferable alternative to applying nitrogen fertiliser (O'Gara, 1998). The results of this trial indicate that the best performing legume companions for buffel grass are Oolloo, Milgarra*,* and Maldonado.

Further research needs to focus on grazing of these grass/legume combinations to establish long-term sustainability of legumes, cattle weight gains over time with varying legume content and grazing management practices.

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