Pastures for Prosperity — Conference Posters

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Genetic engineering to improve *Stylosanthes*

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Recombinant DNA technology is being used to improve the profitability and production of pastures in northern Australia. Our current research on nutritional quality in stylo and disease resistance is focussed on the following areas:

Improvements in digestibility

Lignin is a major component of fibre in tropical forages. However, high lignin concentrations are associated with poor digestibility and low nutritional value. We have genetically suppressed one of the enzymes of lignin biosynthesis in Townsville stylo (*Stylosanthes humilis* cv. Paterson) and found a corresponding change in lignin concentration. We are now testing the effect of altered lignin levels upon digestibility. This technology could then be applied to improved digestibility in pasture grasses.

Disease-resistance genes

Useful genes providing anti-fungal activity have been identified, isolated and characterised, and combined with appropriate genetic control elements. The new genes are being inserted into single plant cells, which are then regenerated into whole plants by tissue culture. We are now testing the resistance of these engineered plants to anthracnose and other fungal pathogens. Similar strategies are being used to improve resistance in other crop and pasture species.

Pathogen variability

We are studying the genes that regulate host range and disease severity in the anthracnose fungus (*Colletotrichum gloeosporioides*). We have shown that transfer of genes between fungal biotypes can occur naturally and may extend their range to previously resistant plants such as *Stylosanthes scabra*. These studies are important in understanding the breakdown of disease resistance in new cultivars.

This project uses the latest techniques of molecular biology to improve the yield and quality of crop and pasture species. The outcomes of this research will be new pasture plant cultivars with reduced lignin and higher digestibility, and new crop and pasture plant cultivars with enhanced resistance to fungal pathogens.

Risk of serious anthracnose damage to stylo cultivars

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In Australia, the anthracnose fungus has adapted to attack previously resistant cultivars, resulting in the demise of once productive Townsville, Fitzroy, Endeavour, Graham and Cook stylos, among others. As a result, commercial seed of only 5 cultivars is now produced, although 12 have been released. Seca, resistant to all known races of anthracnose at its release, was affected by a new race within 5 years. These examples reinforce the view that the threat to our stylo-based pastures from new anthracnose races cannot be ignored.

This threat may come from within Australia, where 4 races within each of the 2 biotypes of the fungus may change to damage newly released cultivars. The recent discovery of a new biotype, which arose through a genetic change in one of the races, is a case in point. We already know that, as cultivars such as Seca are grown over a period of time, frequency of the Seca race increases relative to other races. For example, at a site near Calliope, the frequency of the Seca race increased from 26% to 49% between 1991 and 1994. Whether this will lead to the selection of a more damaging race on Seca, as the area under Seca continues to expand, is not known.

The Australian population of anthracnose represents only a small part of the overall genetic diversity found in its centre of origin in South America. There is a potential risk of damage to our cultivars from races, which may be accidentally introduced from overseas. Research is needed to characterise the diversity that exists in global populations of the fungus, so that the full genetic potential of the fungus to change is well understood. Studying the evolution of the fungus in Australia, and field surveys to detect the appearance of new races, must be a part of ongoing research. As stylo technology relies mainly on a few selected cultivars such as Seca, there is an urgent need to establish the potential risk of serious damage from a new pathogenic race accidentally introduced into Australia and/or evolving locally.

Protecting stylo from anthracnose

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Stylo has proved to be the most important legume for improving native pastures in tropical and subtropical Australia, with around 1 M ha already established. With a projected growth to around 2.5 M ha by the year 2010, supporting some 1 M beef cattle equivalents, stylo pastures will continue to be economically important to the beef industry of northern Australia. These projections are conservative at best, as the geographical range for the utilisation of stylo will be expanded significantly by soon-to-be-released cultivars of *S.* sp. aff. *scabra*. In addition, the requirement of a stable feed base for Australia's expanding live cattle export trade will further increase demand for a robust legume such as stylo.

An examination of the range of stylo cultivars used in Australia shows a heavy reliance on Seca and Verano, both of which suffer slight to moderate damage from existing anthracnose races. Given the history of serious damage to so many previously released cultivars, the threat to our existing cultivars from new anthracnose races cannot be ignored. To keep a step ahead of the variable anthracnose fungus, a team of researchers at the CSIRO and the CRC for Tropical Plant Pathology is developing strategies for the stable management of anthracnose. The strength of this team is in the range of expertise it has applied in addressing this problem. Activities range from field-based evaluation and selection, breeding, anthracnose epidemiology and race survey work, to laboratory-based testing of anthracnose resistance, race determination, development and use of molecular markers to map resistance genes and use of molecular techniques to understand how new races develop and to improve resistance and digestibility.

Research achievements by the team include: detection of changes in the population structure of fungal populations infecting Seca; identification of resistant accessions of *S.* sp. aff. *scabra*; and progress in breeding a cultivar of *S. scabra* with broadly based resistance to anthracnose. Modification of enzymes in the lignin biosynthetic pathway has been used to improve digestibility and enhance disease resistance.

Progress on tagging genes conferring anthracnose resistance in *Stylosanthes* spp.

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Stylosanthes spp. are extensively used as pastures in northern Australia. Increased virulence of *Colletotrichum gloeosporioides* on *Stylosanthes* would have a devastating effect on beef production and severely inhibit the potential expansion of stylo pastures. One means of protecting stylos from anthracnose is to tag resistance genes and pyramid them into a single cultivar. These are the initial objectives of this project.

To tag anthracnose resistance genes in stylos, a linkage map needs to be constructed. This map-based approach is not only more efficient than 'random marker' methods to map single gene characters, but also essential to map polygenic characters, which include most characteristics of agronomic importance.

To select potential parents for mapping populations, a panel of 17 genotypes were analysed using 50 RAPD (Random Amplified Polymorphic DNAs) primers. The results have been used to select a tetraploid cross between *S. scabra* cv. Fitzroy and *S. hamata* cv. Verano and a diploid cross between *S. viscosa* 33941 and *S. viscosa* 34904 as the mapping populations.

These 4 parental genotypes were further tested using 2 marker systems, RFLP and RAPD. In RAPD analysis, 300 primers were screened. On a band-by-band basis, the levels of polymorphism detected between the 2 tetraploid genotypes was 44%, and that between the 2 diploid genotypes was 12%. The best 70 primers have been used for screening the segregating population between the 2 tetraploid genotypes.

In the RFLP analysis, some 400 genomic and 200 cDNA probes have been screened against the 4 parental genotypes. The levels of polymorphism detected by RFLP probes (47% between the 2 tetraploids and 16% between the 2 diploids) were slightly higher than that by RAPD primers. The levels of polymorphism detected by cDNA and genomic DNA probes were not significantly different. Forty-nine percent of genomic DNA probes revealed polymorphism between the 2 tetraploid genotypes, compared with 46% by cDNAs. The level of polymorphism detected between the 2 diploid genotypes was much lower, 15% by genomic DNAs compared with 17% by cDNAs.

The polymorphic probes are being used for map construction, and cuttings of individual F_{2s} have been assessed for anthracnose reaction against 2 anthracnose pathogen isolates (Races 1 and 4). Further, to facilitate transfer of markers to tag genes not segregating in the mapping population, a selected set of RFLP probes are being converted into STS (Sequence-Tagged-Sites) primers.

Breeding shrubby stylo with durable anthracnose resistance

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Anthracnose is a major threat to the productivity and persistence of *Stylosanthes* pastures. Resistance to anthracnose must be both broadly based and durable, because of race specialisation of the causal fungus, *Colletotrichum gloeosporioides*, and the perennial nature of pasture systems. A recurrent selection program to combine partial resistance from a number of lines of shrubby stylo (*Stylosanthes scabra*) is being undertaken to develop a productive cultivar with stable anthracnose resistance.

In separate field experiments, a total of 63 F_2 populations from first cycle crosses between 19 parents were evaluated for anthracnose resistance and agronomic characters. Cuttings from resistant, high yielding plants were established in the glasshouse to initiate the second selection cycle. Selections from crosses between Seca and resistant plants from the F_2 population were included in the second cycle to increase drought tolerance in the population. Similar procedures were used to generate third cycle crosses. Field selection for the second and third cycle crosses was conducted at Southedge and Samford.

Selection was continued at Southedge in the F_3 (113 families) and F_4 (91 families) generations derived from the third cycle crosses. Good progress was achieved in selection for anthracnose resistance, with some 80% of the families being at least as resistant as Seca. Elite F_5 lines are now being tested at regional sites in north and south Queensland. Ten lines from each of the F_4 and F_5 generations are also being exposed to South American races of the fungus at 2 sites in Brazil. We hope to expand this evaluation to other sites in Brazil, so that we can sample a representative range of the diversity in the fungal populations from the centre of origin of stylo and the anthracnose fungus.

Stylosanthes sp.aff. *scabra* — a potential new forage plant for northern Australia

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Stylosanthes sp.aff. *scabra* is a legume with potential as a forage plant for tropical and subtropical regions of northern Australia with clay soils, cool winters and distinct wet-dry seasonal conditions. The species is apparently restricted to central Brazil. A collecting expedition in 1994 expanded the ATFGRC collection from 13 to 32 accessions.

Performance data from evaluation trials in Queensland indicate that several accessions of *S.* sp.aff. *scabra* have an advantage over shrubby stylo in cooler environments, yield 2–10 times more dry matter than *S. scabra* cv. Seca, depending on site and year. Also, it has better winter persistence, with higher numbers of both seedlings and perennial plants in the season following establishment.

S. sp.aff. *scabra* has a highly specific requirement for effective nitrogen-fixing strains of *Bradyrhizobium.* It nodulates sparingly, if at all, with indigenous Australian strains and very few of these are effective in nitrogen fixation. New strains have been isolated from the 1994 collecting trip and form part of a currently active project evaluating new strains of *Bradyrhizobium* and accessions of *S.* sp.aff. *scabra.*

The genetic relationship between *S.* sp.aff. *scabra* and *Stylosanthes scabra* was evaluated using Sequence-Tagged-Sites (PCR-STS) as genetic markers. This work has shown *S.* sp.aff. *scabra* to be distinct from *S. scabra*, although they are more closely related to each other than to other species of *Stylosanthes.*

Verano and Seca stylos — comparative digestibility, crude protein and mineral levels of plucked shoots

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The quality of Verano (*Stylosanthes hamata* cv. Verano) and Seca (*S. scabra* cv. Seca) stylos was compared by analysing plucked shoots for *in vitro* digestibility (IVD), crude protein (CP), and a range of minerals. Shoots were plucked from some or all of 16 grazed paddocks sown to a mixture of the stylos and *Urochloa mosambicensis*. Samples were collected across seasons over 2–5 years.

The major findings were as follows:

Item	**Verano**	**Seca**	**Comment**
IVD (%)	56	48	11 harvests 1985–86
CP (%)	14.3	12.8	30 harvests 1983–87
P (%) unfertilised	0.104	0.113	30 harvests 1983–87
+ 10 kg P/ha/yr	0.133	0.146	30 harvests 1983–87
S (%)	0.194	0.158	7 harvests April 1983–May 84
	0.174	0.176	9 harvests July 1984–Oct 87
Mg (%)	0.32	0.18	4 harvests
Na (%)	0.02	0.18	16 harvests
Ca (%)	1.3	1.3	16 harvests
Cu (mg/kg)	9	9	16 harvests
Zn (mg/kg)	48	34	6 harvests

Some of the differences between Verano and Seca are potentially important for cattle productivity, particularly differences in digestibility and Na concentration. Differences in P concentration could be significant, but those in CP levels are probably of little importance. Levels of Ca, S, Mg, Cu and Zn in both species were sufficient to meet animal requirements.

Back-up legumes for stylos

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Seca stylo is the most widely used pasture legume in northern Australia, averaging 180 tonnes of seed production each year. The confidence of the pastoral industry in northern Australia is largely based on this one legume. Any detrimental happening to Seca in particular, and stylos in general, would devastate confidence in legume-based pasture systems as an option for better meeting beef market requirements. Seed production of Verano-Amiga stylo averages around 70 t/yr. The back-up pasture legumes currently available include *Aeschynomene americana* cvv. Glenn and Lee (averaging 50 t/yr seed production), *Chamaecrista rotundifolia* cv. Wynn (10 t seed), *Desmanthus virgatus* var. Jaribu (new, limited use on lighter soils, several tonnes), *Macroptilium atropurpureum* cv. Aztec (new, rust-resistant, several tonnes) and *A. falcata* cv. Bargoo (no commercial seed).

A research project was commenced in 1992 to focus the search for back-up legumes. Managed by the Queensland Department of Primary Industries and involving the Northern Territory Department of Primary Industry and Fisheries, CSIRO Division of Tropical Crops and Pastures and James Cook University Department of Botany and Tropical Agriculture, the project receives financial support from the Meat Research Corporation. A network of adaptation, grazing evaluation and plant nutrition sites, covering the 600–1000 mm rainfall zone on soils suitable for growing stylos, stretches from Gayndah in the south to Katherine in the Northern Territory.

The new legume performing closest to the stylo standards, Seca-Siran and Verano-Amiga, is *Aeschynomene brasiliana* CPI 92519. It has a strong perennial crown, and prostrate/trailing branches and has established and persisted better than Wynn cassia under variable rainfall. Data is required on its contribution to liveweight gain. *A. villosa* CPI 91209 and 93621, *A. histrix* CPI 93599, 93636 and 93638, *Desmanthus virgatus, Chamaecrista, Macroptilium* and *Alylosia* lines have good potential in various environments.

Legumes for clay soils — an integrated research project

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Background

There is increasing interest in legumes that can maintain the productivity of grazing and cropping on the heavier textured soils of the tropics and subtropics. Legumes are needed in grass pastures for finishing beef cattle and in ley cropping systems to maintain soil fertility. Research aimed at finding better legumes for clay soils has been supported by industry (MRC, AWRAP and GRDC). The scope of the MRC-funded project "Legumes for clay soils", which has the objective of improving animal liveweight gain by using legumes in permanent and ley pastures, is outlined.

The "Legumes for clay soils" project

The approach is multi-organisational (DPI, CSIRO, UQ and MRC), multi-site [16 established from Roma (27°S) to Middlemount (23°S)] and multi-level (glasshouse studies to grazing demonstrations). It comprises the following:

- *Grazing studies and demonstrations of desmanthus*
  The development of *Desmanthus virgatus* under grazing and its effect on animal liveweight gain is being measured at Wandoan, Theodore, Biloela and Middlemount and at Narayen, Brian Pastures and Brigalow Research Stations.
- *"On-farm" testing of new cultivars and elite lines*
  The establishment, production and persistence of 20 promising lines is being compared and demonstrated on 12 properties in the central and northern brigalow region. (See posters by Conway *et al.* and Jones *et al.*).
- *Small plot evaluation*
  Over 120 accessions from the genera *Aeschynomene, Alysicarpus, Arachis, Cajanus, Centrosema, Clitoria, Desmanthus, Desmodium, Galactia, Glycine, Indigofera, Lablab, Macroptilium, Macrotyloma, Medicago, Psoralea, Rhynchosia, Stylosanthes, Teramnus* and *Vigna* have been sown at Narayen, Brigalow and Emerald Research Stations over the last 3 years. Some are promising.
- *Supporting research*
  These studies provide the best information on how the new legumes can be used. They include seed production, harvesting and treatment; *Rhizobium* strains; establishment techniques; nutritional requirements; and herbicide tolerance-susceptibility.
- *Communication*
  A regular newsletter, displays, talks, interviews, newspaper articles, farm walks and field days keep primary producers and agribusiness informed.

Legumes for clay soils — demonstrating establishment, production and persistence

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Introduction

Clay soils occur on some 6 M ha in the 600–800 mm rainfall zone from Wandoan in the south to Collinsville in the north. These areas are mainly open downs and brigalow lands, that grow either pastures or forage crops for finishing beef cattle, or annual grain crops. Legumes that can provide high quality feed and maintain soil fertility are needed to retain high animal and crop production.

Methods and results

Tropical legumes were sown in large, cultivated plots on producers' properties at Clermont, Springsure, Biloela, Theodore and Taroom in January 1994, and at Chinchilla, Roma, Arcadia Valley, Bauhinia Downs, Capella and Middlemount in January 1995. Legume yield and density were measured.

Legumes exhibited a wide range of agronomic characteristics. Those that established easily and produced high yields in the first year were lablab, clitoria, *Vigna trilobata, Macroptilium bracteatum* and Siratro. Lablab and *V. trilobata* have not persisted, although there has been some regeneration. Clitoria, particularly on the downs soil, *M. bracteatum* and Siratro have persisted.

Establishment of *Desmanthus virgatus* and *Stylosanthes scabra* (aff) has been variable. These have smaller seeds (3–400 000 seeds/kg) and will not establish if planted too deep (>20 mm) or if covered too deeply with soil, especially in cracking self-mulching clay soils. Consequently, establishment is very dependent on soil surface condition at sowing and on the type of rainfall following sowing. Individual plants of these legumes have persisted, and in the case of stylo, regeneration of seedlings has been high.

Conclusion

A range of persistent and short-term legumes for use in grazing and ley cropping systems have been grown and demonstrated.

Producers, by attendance at field days, farm walks and discussion groups, are gaining a better understanding of characteristics of the legumes and their management.

Indigofera schimperi — A promising legume for permanent pastures on clay soils

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There is increasing recognition of the need for persistent tropical legumes for pastures in the extensive areas of clay soils in Queensland and northern New South Wales. Three species show potential: *Desmanthus virgatus* (now commercial), *Glycine latifolia* and *Indigofera schimperi.*

I. schimperi occurs naturally on clay soils in southern and central Africa. It is a long-lived, herbaceous perennial and plants can grow up to 80 cm high and over 1 m across. First sown in Queensland in the mid-1970s, it has been evaluated since 1987 in small plots on clay soils at several sites, with average annual rainfalls from 500–750 mm. Despite its small seeds (*c.* 400 000 seeds/kg), it usually establishes adequately.

Individual plants of *I. schimperi* live longer than plants of desmanthus, but seedling recruitment is lower than for cv. Marc desmanthus. Dry matter yields have been comparable with or sometimes higher than those for desmanthus. The superiority of indigofera appears greater in older stands.

I. schimperi is free of the toxin, indospicine, that occurs in other species in the genus. Testing has involved both plant analysis and feeding trials with rats and rams, followed by histological examination of the liver and other organs.

What are its potential limitations?

- As with any small-seeded legume sown into heavy soils, there will always be a risk of establishment failure.
- Little is known of its reaction to grazing pressure or how readily it is eaten. It has been well grazed at some sites, but not at others. We are checking evaluation sites to rate acceptability of indigofera relative to desmanthus and Seca.
- We are collecting data on forage quality (acid detergent fibre) of indigofera leaf and stem to compare with other legumes. However, there are no data to show whether it can improve animal production over that from pure grass pastures.

Acknowledgement

Evaluation of *I. schimperi* has been supported by MRC and AWRAP.

New plant collections bring opportunities for central Queensland graziers

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The Australian Tropical Forages Genetic Resource Centre (ATFGRC) has national responsibility for assembling, maintaining and distributing germplasm of tropical forage plants. The collection comprises about 25 000 accessions, with an emphasis on legumes. Directly or indirectly, the ATFGRC has been responsible for the development of 70–80% of the tropical forage cultivars grown in Australia.

Despite the large collection, some tropical regions are poorly represented. Recently, we have targeted the Kruger Park in South Africa, and the Chaco region of Paraguay, for collecting expeditions, because both have climates which are comparable with that in central Queensland.

The Kruger Park is potentially a rich source of grasses adapted to heavy grazing, as it has been grazed heavily by native ungulates for millenia. Soils are variable, and mostly light-textured. A total of 150 accessions of grass were collected in the northern, drier part of the Park. The main species in the collection were: *Digitaria eriantha, Panicum coloratum* and *Setaria incrassata*. Collections were also made of: *Schmidtia pappophoroides, Cenchrus ciliaris* and *Bothriochloa radicans*.

The Chaco of Paraguay includes both sandy and clay-loam soils, with the latter more widespread in the northern Chaco. The collection of 150 accessions included some germplasm from the higher-rainfall East Paraguay. The most abundant herbaceous legume from the heavier soils of the Chaco was *Desmanthus virgatus*. From the lighter soils, species of *Macroptilium, Chamaecrista* (*Cassia*), *Aeschynomene, Galactia* and *Arachis* were collected. Of particular interest was a report that introduced Australian cultivars of *D. virgatus* were defoliated by frost, whereas local ecotypes sown nearby retained green leaf following frosting.

Both collections are currently (April 1995) being grown through post-entry quarantine and should be available for evaluation in the 1995–96 season. We believe that this new material is a potential source of new cultivars for Queensland.

An initial agronomic assessment of 10 South American forage legumes during drought years, 1993–1995

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Introduction

The recent drought years have provided an opportunity to evaluate "new" and known pasture legumes for their drought tolerance.

Materials and methods

South American genotypes, *Arachis paraguariensis*, *A. pusilla*, *Centrosema brasilianum*, *C. pascuorum*, *Desmanthus virgatus* CPI 38351 and CPI 79653, *Macroptilium bracteatum*, *M. martii*, *Stylosanthes scabra* cv. Seca and *S. hamata* cv. Verano, were established in plots on duplex soil in Townsville during 1993. They were irrigated until March 1994 and not subsequently.

Seedling recruitment for most of the accessions was recorded in January 1994 and January 1995, following 131 mm of rain in November–December 1994. Plant survival (the total number of plants/m^2 in November 1994, compared with the number of original plants plus seedlings/m^2 in January 1994) was recorded. Data for Seca and Verano were recorded only in March and November 1994.

Results

Seedling and plant counts were as follows:

Genotypes	January 1994			November 1994	January 1995	
	Original plants/m^2	Seedlings/m^2	Total plants/m^2	Plants/m^2	Seedlings/m^2	Total plants/m^2
A. paraguariensis	7	3	10	1	137	138
A. pusilla	7	1	8	1	7	8
C. brasilianum	7	12	19	6	24	30
C. pascuorum	0	47	47	0	64	64
D. virgatus 38351	8	9	17	4	116	120
D. virgatus 79653	6	2	8	4	11	15
M. bracteatum	7	117	124	3	72	75
M. martii	2	52	54	2	84	86
S. scabra cv. Seca	8	NR[1]	136[2]	51	NR	NR
S. hamata cv. Verano	0	NR	383[2]	2	NR	NR

[1]Not recorded, as naturalised in landscape and extremely abundant.
[2]Mean plant counts taken in March 1994.

Conclusion

Verano had 383 plants/m^2 in March 1994, which dropped to only 2 plants/m^2 by November 1994. A number of other genotypes were equal to or better than Verano stylo at this time, i.e. *C. brasilianum*, both *Desmanthus* genotypes and *M. bracteatum*. Both *Arachis* accessions had fewer plants/m^2 than Verano. Seca had the highest number of plants/m^2 in November 1994 after a very dry period indicating its superior drought tolerance. *C. pascuorum* (an annual) failed to survive, although *M. martii* (another annual) did survive.

By January 1995 (following rain), there were large increases in the abundance of most seedlings, particularly *A. paraguariensis*, *D. virgatus 38351*, *M. martii*, *M. bracteatum* and *C. pascuorum*. Seca and Verano were extremely abundant at this stage and could not be counted, thus confirming their value and adaptation to this subhumid environment.

A biochemical approach to improving survival of salt- or drought-stressed plants

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High risks for pasture establishment are a major limitation for the sowing of improved pastures in northern Australia. Seedling mortality in saline soil or during prolonged dry spells is a major factor in establishment failure.

Plants may accumulate various organic compatible solutes to alleviate stress effects. A group of N-methyl amino acids, known as betaines, are particularly effective in stress alleviation. Betaine application has proven beneficial for seedling survival of crops such as cotton in a prolonged water stress situation. Further investigations revealed that betaine application reduced plant water use by about 50%. Aspects of our research are described below:

(a) *Desmanthus virgatus* was sown in soil salinised with 0, 0.05 and 0.1 M NaCl solution, in all combinations with 0, 1, 2 and 4 g/l betaine solution. Germination of this legume was about 95% at 0 and 0.05 M salinity irrespective of betaine application. At 0.1 M salinity, germination fell to 36% in the absence of betaine, and betaine application at 2 g/l increased germination to 52%.

(b) Six-week-old *Stylosanthes* accessions were water-stressed for 1 month. Water use and relative water content (RWC) during the stress, and % leaf survival were estimated by re-watering 2 weeks after the soil moisture in the pots was almost completely used. Water use of *S. hamata* (cv. Amiga), *S. scabra* (cv. Seca) and *S. viscosa* was in significantly decreasing order. Leaf survival of Amiga was lower than for Seca or *S. viscosa*. Leaf RWC of Amiga, Seca and *S. viscosa* was in increasing order. Biochemical analyses will be conducted to determine whether these physiological differences can be explained by the accumulation of compatible solutes.

This study has shown that it is practical to treat seeds of various species with betaine to increase tolerance of seedlings to water stress or salinity.

The response of some introduced tropical pasture legumes to shade — a preliminary study

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Introduction

Pasture species are generally evaluated on open cleared land. However, there is an increasing need for pasture species, which will grow satisfactorily under tree canopies.

Ten legume genotypes i.e. *Arachis paraguariensis, A. pusilla, Centrosema brasilianum, C. pascuorum, Desmanthus virgatus* CPI 92803 and CPI 79653, *Macroptilium bracteatum, M. martii, Stylosanthes scabra* cv. Seca and *S. hamata* cv. Verano, were grown in pots using grey-duplex soil under conditions of full sunlight (zero shade) and 22% of full sun (78% shade). A single plant was grown in each pot, with 5 replicates, and all plants were harvested 3 times.

Results

Total dry matter yields of plant tops (g/plant) resulting from shade and full-sun treatments, respectively, were: *M. martii* 58.5 and 37.4; *M. bracteatum* 55.9 and 39.3; *C. brasilianum* 54.4 and 31.7; *D. virgatus* CPI 92803 36.7 and 38.1; *C. pascuorum* 30.1 and 58.5; *D. virgatus* CPI 79653 24.3 and 21.9; *A. paraguariensis* 16.4 and 19.4; *A. pusilla* 14.9 and 19.8; Seca 25.7 and 53.5; and Verano 28.5 and 46.1.

Root biomass was higher in full sun than in shade for most genotypes. The root dry weights (g/plant) in shade and full sun, respectively, were: *A. paraguariensis* 2.2 and 7.6; *A. pusilla* 2.9 and 6.7; *D. virgatus* CPI 92803 2.6 and 13.0; *D. virgatus* CPI 79653 4.9 and 16.8; *M. bracteatum* 6.6 and 9.1; Seca 23.6 and 47.2; Verano 21.4 and 34.1; *C. brasilianum* 11.5 and 10.5; *M. martii* 16.8 and 16.6; and *C. pascuorum* 0 (died out) and 13.3.

Discussion and conclusion

The most promising genotypes for shaded environments were, in order: *M. martii, M. bracteatum, C. brasilianum, D. virgatus* CPI 79653 and *D. virgatus* CPI 92803. *C. brasilianum* and *M. martii* were the only genotypes with root biomass production in shade equal to that in full sun.

Based on herbage production, Seca, *C. pascuorum*, Verano, *A. pusilla* and *A. paraguariensis* grew 108, 94, 62, 33 and 18% better, respectively, in full sun than in shade. However, *M. martii, M. bracteatum* and *C. brasilianum* grew 56, 42 and 72% better in shade. These initial findings indicate that further detailed investigations are warranted.

What grows in the "desert"?

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Background

Two holding paddocks on a large station near Tennant Creek were densely populated by woody shrubs, including turpentine (*Acacia lysiphloia*), scrubby wattle (*A. stipuligera*) and petalostylis (*Petalostylis cassioides*). Mustering was difficult with trapping cattle at a waterpoint often the only option.

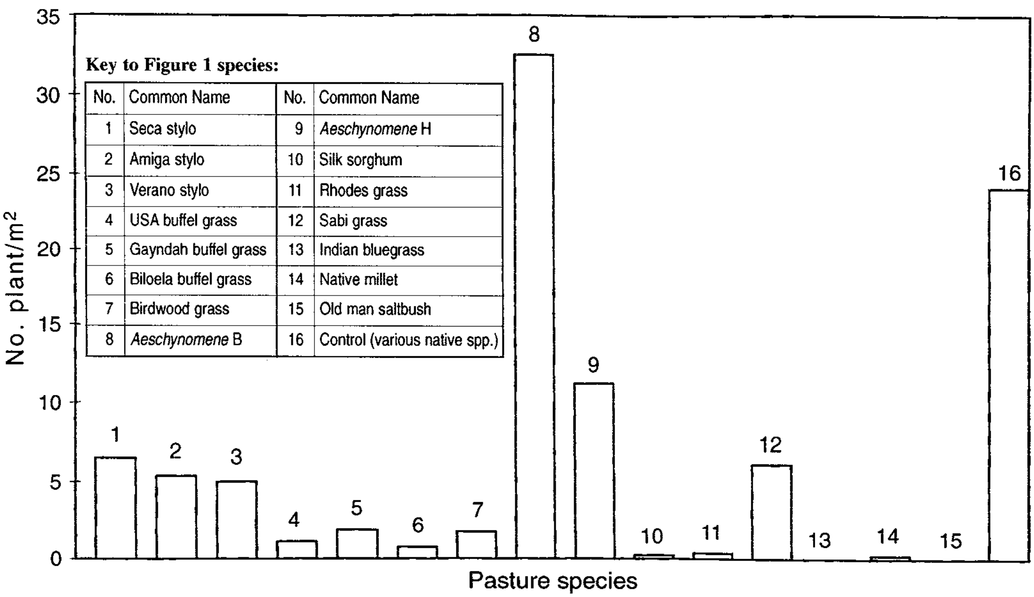
With the approval of the Pastoral Land Board, strips were cleared along the contour lines, using a 3m wide blade plough. The blade-ploughed strips provided an opportunity to test several exotic and native pasture species on these red sandy soils in the 400mm rainfall zone of the semi-arid tropics.

Methods

In December 1994, 15 grass and legume species, plus a control treatment, were sown. Rainfall from November–April totalled 354mm, with some late rain falling in May. In most cases, rain was followed by hot, dry periods of up to 2 weeks. Plant density counts were completed in April.

Results

Presently, only plant establishment data are available. Figure 1 shows just how successfully jointvetch B (*Aeschynomene brasiliana* CPI 92519) has established at this site.



No.	Common Name	No.	Common Name
1	Seca stylo	9	*Aeschynomene* H
2	Amiga stylo	10	Silk sorghum
3	Verano stylo	11	Rhodes grass
4	USA buffel grass	12	Sabi grass
5	Gayndah buffel grass	13	Indian bluegrass
6	Biloela buffel grass	14	Native millet
7	Birdwood grass	15	Old man saltbush
8	*Aeschynomene* B	16	Control (various native spp.)

Figure 1. Plant densities of the 15 introduced grasses and legume species plus the native and naturalised species 4 months after planting.

Most of the other 14 species were represented by some established plants, with the exception of saltbush (*Atriplex nummularia*) and Indian bluegrass (*Bothriochloa pertusa*).

Sabi grass (*Urochloa mosambicensis*) and the legume species *Aeschynomene* and *Stylosanthes* have been the most successful pasture species to date. The *Aeschynomene* species have not been tested previously in this region, so their initial densities are quite encouraging. In the past, *Stylosanthes* spp. have been sown in mixes in small areas of the Barkly district with varying degrees of success. Along with sabi grass and various buffel grass (*Cenchrus* spp.) ecotypes, stylos are naturalised along Barkly watercourses and the Stuart highway.

Conclusion

This observation will provide information on the productivity and persistence of pasture species introduced to the Barkly region, to augment that gathered in nearby regions. Hopefully, future recommendations will be based on local information, instead of that from other regions, where the climate is almost always wetter, drier, hotter, colder or just plain different!

Nutrient concentrations and *in vitro* degradability of shrubs used by ruminants in New Caledonian extensive lands. 1. Typology

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In recent years, beef production in New Caledonia, as in most tropical areas (e.g. Australia, Indonesia and the South Pacific), has been seriously reduced. The reduction in cattle production can be attributed to a reduction of feed supply.

To alleviate the lack of feed supply, following the demise of *Leucaena leucocephala* devastated by psyllids (*Heteropsylla cubana*), experiments were conducted on biological control, with limited success, and on psyllid-resistant shrubs. Also, our study shows an initial evaluation of native and cultivated shrubs, which are known either to be used to varying degrees by domestic and feral animals or to belong to nitrogen-fixing legumes.

From a sample of 45 shrubs, this study defined 6 groups, which are characterised by their nutrient concentration [crude protein (CP), CP bound to acid detergent fibre, acid detergent lignin and condensed tannins] and their *in vitro* degradability (organic matter solubility and digestibility and *in vitro* degradability of CP) (Figures 1 and 2).

The species with high degradable CP and OM concentrations, plus low fibre and condensed tannin concentrations are the more interesting from a nutritional point of view. The most promising species are: *Gliricidia sepium, Leucaena leucocephala, Acalypha grandis, Samanea saman, Albizia lebbeck, Erythrina* sp., *Acacia farnesiana* and *Sesbania grandiflora.* On the other hand, data are disappointing for *Desmanthus virgatus, Parkinsonia aculeata* and *Acacia ampliceps.*

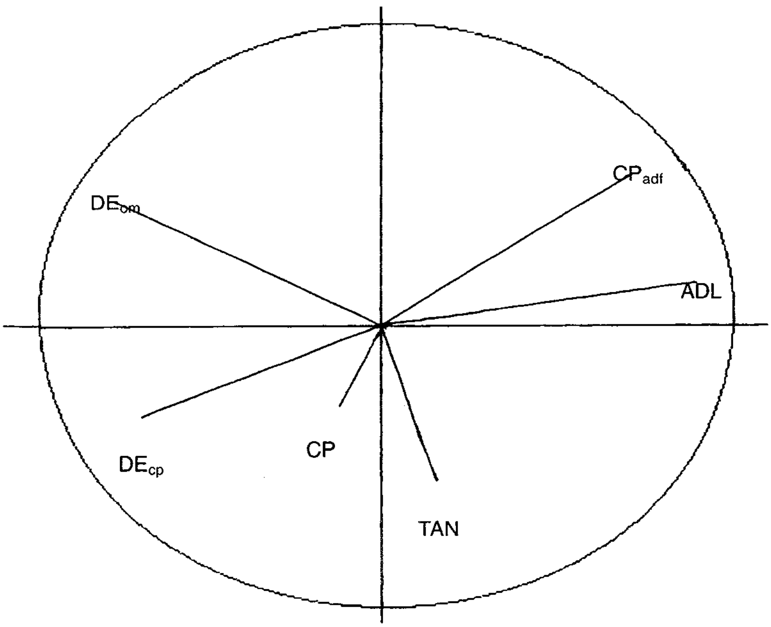

Figure 1. Correlation circle showing crude protein (CP), *in vitro* degradability of CP (DE_{cp}), acid detergent lignin (ADL),

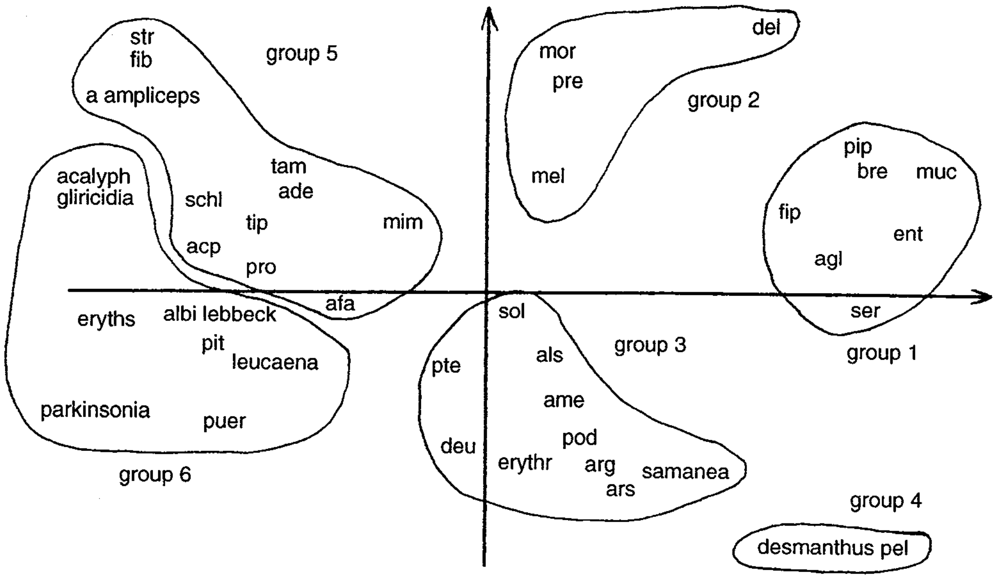

Figure 2. Homogeneous groups from Correspondence Analysis: Group 1 (low DE_{om}; low DE_{cp}; high CP_{adf}; high ADL); Group 2 (high DE_{om}; low DE_{cp}; high CP_{adf}); Group 3 (low DE_{om}; variable DE_{cp}; variable CP_{adf}); Group 4 (high TAN; low CP); Group 5 (high DE_{om}; medium DE_{cp}; variable CP_{adf}; low ADL); Group 6 (high DE_{om}; variable DE_{cp}; variable CP_{adf}; low ADL; high CP).

Lablab purpureus — breeding and genetic diversity study

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Lablab purpureus, commonly known as *Dolichos lablab* or hyacinth bean, is popular as a vegetable or pulse in Asia, and as a forage or green manure crop in the tropics and subtropics worldwide. The plant is highly adaptable, drought and high-temperature tolerant, and can thrive in deep sands to heavy clays. A well established plant can persist long into the dry season, and provides a large amount of protein-enriched green material as food, fodder, and soil protection, when many other plant species have become desiccated.

To enhance the potential of *L. purpureus* as a forage or green manure crop in Australia, a breeding program was commenced with the objective of breeding large-seeded, vigorous, perennial cultivars. To achieve this objective, the annual cultivars, Rongai and Highworth, were crossed with perennials introduced from Africa. Such crosses produced highly fertile progeny. A large percentage of the F_1 and first backcross progeny survived the 1993 winter, while neither of the annuals did. Many F_{3s} and F_{4s} appear to be more vigorous than the annuals even in the first season.

To optimise the breeding program, genetic diversity in this species was evaluated using random amplified polymorphic DNAs as markers. Among the 40 accessions analysed, the average 1-F value was 0.110, with the highest value of 0.372 detected between CPI 52552 and CPI 24973. The high level of dissimilarity, however, was mainly restricted to the difference between cultivated and wild forms. When the 40 genotypes were analysed on the basis of forms (cultivated vs wild), only moderate dissimilarity was obtained among the cultivated accessions (1-F = 0.055). The average 1-F value among the 5 wild accessions was high (0.130), and this was mainly contributed by CPI 31113, which was collected in Uganda. When analysed against their origins, it was clear that the genetic variation among the African collections (1-F = 0.046) was substantially lower than that among the Asian collections (1-F = 0.068). Further, the African and Asian collections did not form distinct subgroups in cluster analysis. Instead, they mixed together and formed a single group.

The genetic diversity study also clearly showed that the 2 commercial forage varieties, Rongai and Highworth, were not very different, in spite of the fact that one was from India and the other from Kenya. The 1-F value between them (0.025) was less than half the average 1-F value among all the cultivated genotypes (0.055). Clearly, a wide range of germplasm is available for selecting cultivars suitable to our widely different soil and climatic conditions.

Evaluation and development of *Arachis glabrata* in northern Australia

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Rhizoma peanut (*Arachis glabrata*) is a strongly perennial, low-growing rhizomatous legume originating from Brazil, Argentina and Paraguay. It has been evaluated in many adaptation and productivity experiments since 1963, at sites from northern New South Wales to north Queensland and the Northern Territory. It is capable of producing high yields of high quality forage and has proven very persistent under regular defoliation or continuous grazing on various soil types over a wide latitudinal range. It is drought-tolerant, but appears to require an average annual rainfall over 900 mm. Its main role will be as a forage or hay crop, but it will also find application in soil conservation and as an ornamental. An elite variety, CPI 93483, has been selected from 29 lines in the Australian collection, and a recommendation for its release will be made at the next meeting of the Queensland Herbage Plant Liaison Committee. Seed yields are low, necessitating vegetative propagation. Machines developed to harvest and plant rhizomes have been purchased from the USA under a DRDC-funded project. These will be used to extend the existing rhizome nursery and to establish on-farm demonstrations.

Arachis pintoi cv. Amarillo shows potential in grazed pastures under coconuts

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The productivity and persistence of *Arachis pintoi* cv. Amarillo were tested in a series of experiments in Bali, Indonesia. In single species plots grown under coconuts, Amarillo was evaluated over 14 months with other *Arachis* spp. under 58% light transmission. DM production of Amarillo was highest, with total DM yield of 750 kg/ha/2 months with 92% leaf.

In grass-legume mixtures under mature coconuts, Amarillo combined productively with *Paspalum malacophyllum*, *P. dilatatum*, *P. notatum* and *Stenotaphrum secundatum* (Vanuatu ecotype), yielding 5900, 5400, 5300 and 4200 kg/ha, respectively. Amarillo combined most effectively with *P. malacophyllum*, contributing 29% of the DM. Amarillo significantly improved the nutritive quality of shaded pasture grasses.

The DM digestibility was also measured in 1 experiment. The mixtures of Amarillo and *S. secundatum* contained 18% Amarillo and had the highest digestibility (63.6%).

In a grazing trial, Amarillo proved to be persistent under heavy grazing pressure. Amarillo contributed 21% and 26% to DM of *P. notatum* and *S. secundatum* pastures, but the contribution declined following the initial 90-day grazing period to 15% and 13%, respectively.

Experimental results indicate that, in combination with suitable grasses, *Arachis pintoi* cv. Amarillo has great potential for cattle production under coconuts in Indonesia. On-farm evaluation of Amarillo is continuing in Bali and North Sulawesi.

Sowing medics into buffel grass in the Maranoa Region, south Queensland

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Buffel grass has naturalised over large areas of semi-arid box woodland in the Maranoa Region of south Queensland. The long-term stability of this community will depend on nitrogen supply; pasture legumes can enhance the supply of this nutrient. Barrel medics (*Medicago truncatula*) are adapted to the moderately fertile woodland soils. This demonstration recorded the effect of different methods of sowing, and pre-grazing with cattle on germination of Cyprus barrel medic.

Methods of sowing were: surface broadcast and trampled; bandseeded without herbicide; bandseeded + glyphosate; and crocodile seeding. Pre-grazing with cattle was for a period of 8 weeks at nil, 2.25 and 4.5 hd/ha. With the broadcast method, seed was surface sown into dry soil after 6 weeks of grazing and trampled for the final 2 weeks of grazing. The mechanical sowing methods were applied at 8 weeks, when seed was placed in moist soil. Pre-grazing reduced the standing herbage from 2900 kg/ha DM (nil grazing), to 1300 kg/ha (moderate grazing) and 800 kg/ha (heavy grazing). Rainfall conditions were favourable for germination.

Pre-grazing increased germination where seed was broadcast. However, as seed was trampled into dry soil, *Rhizobium* inoculation was ineffective and seedlings might not survive. Seed sown into moist soil nodulated effectively. Bandseeding was not influenced by the amount of standing herbage, germination being satisfactory throughout; glyphosate had no effect on germination. With the crocodile seeder, germination was reduced at the highest level of standing herbage; at the 2 lower levels of standing herbage, it was as effective as the bandseeder.

Naturalised burr medic in the northern grain belt of Australia

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Burr medic (*Medicago polymorpha*) is widely naturalised on cracking clay soils in the northern grain belt of Australia. A joint GRDC-funded project, carried out by the Queensland Department of Primary Industries and the New South Wales Department of Agriculture and Fisheries, will determine the variability, adaptability and productivity of burr medic naturalised in that area. This links with other projects evaluating medics, particularly barrel (*M. truncatula*), snail (*M. scutellata*) and button (*M. orbicularis*) medics in Queensland, and burr medic (*M. polymorpha*) in the national annual medic improvement program.

In summer 1993/94, seed of naturalised annual burr medic was collected from about 170 locations, mainly on cracking clay soils, in a total of about 20 climatic regions in both states. At each collection site, surface soil was sampled for chemical analysis and the determination of *Rhizobium* populations.

The collection was grown out in 1994 to identify phenotypic and agronomic variation within the naturalised population. Wide variation for more than 30 attributes was identified. From an initial population of about 8000 plants, 120 superior lines were selected as the most vigorous and with the highest seed yields, within a range of pod spine types and maturity (flowering time) categories. There was also a conscious selection for a range of habit types, leaf-mark morphologies, grey and green plants, plants with small and large leaves, and plants with dentate and non-dentate leaf margins.

These 120 lines, including representatives from all geographic regions defined in both states, were selected for further evaluation in marginal environments in both states.

Urochloa mosambicensis: A grass with potential for coal mine revegetation in central Queensland

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Tertiary clay sediments from pre-strip coal mining operations in the Bowen Basin of central Queensland are the predominant surface spoil material in many overburden dumps. Rehabilitation of these materials is difficult due to their moderate–extreme salinity, neutral–strong alkalinity, heavy clay content and poor texture. These problems are aggravated by unreliable and low (*c*. 600 mm) annual rainfall.

Past rehabilitation programs of BHP Australia Coal have been aimed at establishing improved pastures in an attempt to return the land to a productive state. Buffel and rhodes grasses have commonly been used, but these often fail to provide an erosion-free landform, when sown onto Tertiary spoils.

A trial sown at the Saraji mine in December 1993 tested 10 grasses that included buffel and rhodes grasses as controls. The trial was sown on a moderately saline and alkaline (7.4 mS/cm; pH 8.11) Tertiary spoil, as well as an area which had been covered with local topsoil. CPI 60128, a stoloniferous form of *Urochloa mosambicensis*, was the most promising of the grasses, on both topsoil and spoil material over the first 2 growing seasons. The rainfall in the establishment season (Jan–Apr 94 inclusive) was 396mm, and in the second growing season (Oct 94–May 95 inclusive) it was 297mm.

The young plants of CPI 60128 showed good drought tolerance and their strongly stoloniferous growth habit gave good ground cover. CPI 60128 has a basal cover of 18% one year after sowing on the spoil material, compared with 0.3% and 10% cover for buffel and rhodes grass, respectively. Due to high competition from native annual grasses, most sown grasses died out on the topsoil plots, but CPI 60128 survived, and in December 1994, had a basal cover of 10%, increasing to 20% by late February 1995.

We concluded that this accession of *U. mosambicensis* could be useful in revegetating mine spoil materials in central Queensland.

Acknowledgement

We are grateful to BHP COAL AUSTRALIA for funding this project.

Maintaining and establishing grass on oversown pastures

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The project aims to develop grazing, spelling and burning strategies to maintain palatable perennial native grasses in oversown, legume-dominant pastures; and to develop economical methods of establishing and maintaining introduced grazing-resilient grasses in oversown legume-dominant pastures, with failed or failing native, perennial grasses.

The 3 techniques for maintaining native grasses are: spelling the pasture early in the wet season to allow grasses to flower and set seed; burning the pasture late in the dry season to favour the native grasses at the expense of sown legumes; and reducing stocking pressure.

Introduced grasses, *Bothriochloa pertusa* (Indian couch), *Cenchrus ciliaris* (American buffel) and *Urochloa mosambicensis* (Sabi grass), were established using cultivation and phosphatic fertiliser.

The experimental site had been aerially sown with *Stylosanthes scabra* cv. Seca and *S. hamata* cv. Verano about 1982. It was fenced and 10% of each paddock, in a discrete block, was sown to grass in December 1993, and stocked in April 1994 after 335mm of rain — less than half the expected 796mm annual rainfall.

Decreasing stocking rate (1.75 ha/hd to 5.25 ha/hd) increased pasture yield from 150 kg/ha to 600 kg/ha by the end of the dry season in 1994. Spelling for the wet season of 1993–94 allowed perennial grasses — *Chrysopogon fallax* (1.3 plants/m^2) and *Aristida* spp. (0.2 plants/m^2) — to grow from the grass crowns present at the end of the dry season. Annual grasses dominated grass cover (32 plants/m^2), while Seca had 52 plants/m^2 and Verano 1300 plants/m^2.

Pasture yield was insufficient to carry a fire.

The introduced grasses sown on the cultivated areas did not establish and were resown in 1995. Grazing during the early wet season of 1995 suppressed the growth of USA buffel and Sabi grass, while encouraging Indian couch. Frequency of native perennial grasses was below 10% in 1994 and 1995. Seca frequency declined from 53% to 31% between 1994 and 1995.

High nitrogen on grass

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After phosphorus, nitrogen is the major limiting nutrient in producing good quality grass pasture on the Mackay wet coast. Legumes in mixed pastures provide a protein source, but generally cannot tolerate heavy grazing. For years, local graziers have applied high rates of N fertiliser to pure grass stands to produce large quantities of quality forage for special purposes, e.g. hay making, bull paddocks, holding paddocks etc.

Dr Jim Tietzel was able to fatten beef cattle on signal grass (*Brachiaria decumbens*) at Innisfail, when he fertilised it with 180 kg N/ha/yr, after correcting all other nutrient deficiencies.

Demonstrations on the Mackay coast over 4 years sought to verify these findings in this seasonally drier and cooler tropical environment.

Several sites were set up to:

- compare the liveweight performance of animals on 2 fully fertilised pangola (*Digitaria eriantha)* paddocks, one with 180 kg/ha N and the other without the nitrogen;
- compare pangola and signal grass under these high-N regimens; and
- alter stocking rates to enable fattening on high-N grass pastures.

Three sites were chosen, ranging from Mt Christian in the south to Proserpine in the north.

All sites were fertilised with phosphorus, potassium and sulphur.

It was found that:

- pangola was more productive than signal grass;
- it took 2 years of fertilising the same pasture for positive financial results to be obtained;
- to fatten cattle on pangola, maximum stocking rate was around 3.2 beasts (400 kg)/ha; and
- both signal grass and Callide rhodes grass can be used successfully for this purpose.

Conclusions

The technology is useful in circumstances where a lot of cattle need to be held on a small area of good grass pasture. They can be fattened if the correct stocking rate is adopted. There is a definite advantage to pangola in the Mackay region.

The system proved very profitable when buying large-framed steers to fatten in 3–5 months, as the weight gains from these animals have averaged 0.8–0.9 kg/hd/d (includes some compensatory gains).

Acknowledgement

This project was partly funded by MRC.

Performance of Brahman weaners grazing signal grass (*Brachiaria decumbens*) in Papua New Guinea

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Introduction

Papua New Guinea has 5.5 M ha of grasslands with kunai (*Imperata cylindrica*) as the dominant grass. Kunai pastures support low stocking rates (1 beast/3 ha) and growth rates of 0.1–0.2 kg/hd/d. PNG imports approximately 38 000 tonnes of meat, with annual beef production of 2000 tonnes. In excess of 8000 ha of signal grass (*Brachiaria decumbens*) have been planted, with some ranches having small areas of buffel grass, Nandi setaria and para grass. Weaners are the first priority for the signal grass pastures.

Weaner productivity

Some ranches have data for weaner liveweight gains on signal grass, ranging from 0.06–0.17 kg/hd/d (wet season) and 0.2–0.29 kg/hd/d (dry season) (S. Jephcott, personal communication). Slightly higher gains in some seasons were achieved with supplementation programs. On some ranches, photosensitisation affects 3–5% of weaners annually. A trial on 'Gusap Downs' (Ramu Sugar) compared weaner performance on natural (mainly kunai) and signal grass pastures. Animals weaned in October 1993 (early wet season) were randomly split into 2 equal groups (350 animals per group), one group being allocated to each pasture. Thirty-five animals per group were tagged as a subgroup for weighing. Mineral blocks and molasses-urea licks were available (at equal rates) to each group.

Daily gains on the signal grass and kunai were 0.29 and 0.30 kg/hd/d and –0.03 and –0.04 kg/hd/d for 83 days and 136 days post-weaning, respectively. The trial was terminated due to the poor condition of the signal grass group, with some dying from starvation. At this stage, the signal grass was 1 m high, green and leafy. Animals appeared to have actively avoided grazing it. Adults later grazed the same pasture down within 2 weeks.

Conclusion

Weaners on signal grass pastures do not gain well, even when supplements are given. Apparent low intakes, photosensitisation, and low liveweight gains up to 200 days post-weaning warrant further investigation.

How *Hymenachne* spp. survive flooding

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Grasses capable of growing in deep water are being utilised to maintain cattle liveweight gain during the dry season. *Hymenachne amplexicaulis* and *H. acutigluma* can grow in water over one metre deep. Understanding how these grasses overcome the problems of flooding enables application of management practices that increase their ability to survive. Alternatively, environmental conditions that limit survival will determine the areas where each species will or will not survive. Growth physiology of both species was contrasted to determine how they coped with flooding.

Under flooding, energy demand increases due to anaerobic respiration, while the capacity of the plant to produce energy decreases. Both grasses avoid anaerobic respiration by absorbing oxygen through the leaves located above the water surface and circulating it through the plant via aerenchyma. Further, energy requirements are reduced through restricted growth of the roots and rapid senescence of submerged leaves.

Gas exchange is reduced during flooding. Again, this problem is alleviated in both species by the movement of gases through leaves above the water. In addition, both species increase the exchange of carbon dioxide by the bicarbonate-using system. Gas exchange may also be increased through the formation of adventitious roots.

The survival of *Hymenachne* spp. depends on growth to maintain leaves above the water surface and this relies upon the supply of energy from photosynthesis. Limitations to photosynthesis determine the depth of water, rate of inundation and duration of flooding each species can tolerate.

Any practices that limit photosynthesis will reduce each plant's capacity to survive flooding. In addition, environmental limitations to photosynthesis will determine the areas where the species will or will not survive.

Successful reproduction strategies of *Hymenachne* spp.

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Hymenachne amplexicaulis and *Hymenachne acutigluma* are used as fodder resources in flooded areas of northern Australia. To be a sustainable resource, reproductive strategies must survive the pressures of both grazing and flooding. Both species can reproduce by seed, as well as vegetatively through stoloniferous growth after flooding. They differ in that *H. acutigluma* is a perennial that propagates principally by vegetative means. *H. amplexicaulis* acts as an annual, producing large quantities of viable seed, but has the capacity to reproduce vegetatively.

The sustainability of *Hymenachne* spp. was assessed by a comparison of their reproductive strategies at 3 growth stages: seed, seedling and floral initiation.

- Seed production in *H. amplexicaulis* is prolific and commences around the end of summer. In contrast, less than 1% of *H. acutigluma* florets form filled caryopses, and this is confined to a short period at the height of flooding.
- *H. acutigluma* seedlings produce numerous tillers, giving it the ability to form dense swards rapidly under favourable conditions. In comparison, *H. amplexicaulis* forms only a few large tillers.
- The trigger for floral initiation of *H. acutigluma* is complex, with juvenility, availability of water, photoperiod and temperature thought to be involved. *H. amplexicaulis* is a synchronously flowering short-day plant.

The effect of grazing on reproduction varies with flooding. Grazing immediately prior to and during flooding renders both species vulnerable to drowning. Grazing at the end of the wet-beginning of the dry season will endanger the survival of *H. acutigluma* by removing stoloniferous and erect growth. Conversely, the effect on *H. amplexicaulis* and seed production will be minimal.

H. amplexicaulis and *H. acutigluma* are sustainable resources provided grazing is confined to the dry season.

Flooding — some tropical species show promise

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Seasonal flooding can severely limit pasture production in the tropics. As an aid to management, the flooding and waterlogging tolerance of a range of pasture grass species including bambatsi (*Panicum coloratum* var. *makarikariense* cv. Bambatsi), purple pigeon grass (*Setaria incrassata* cv. Inverell), floren bluegrass (*Dichanthium aristatum* cv. Floren), sheda grass (*Dichanthium annulatum* CPI 104923) and creeping bluegrass (*Bothriochloa insculpta* ssp. *glabra* T-587) were investigated in a pot experiment conducted in a glasshouse at The University of Queensland, Gatton Campus, in early 1994.

Grass species were germinated from seed in 15cm pots, thinned to 4 plants per pot at 5 wk and then grown for 10 wk. Plants were trimmed to 5cm and allowed 2 wk regrowth before being subjected to 3 water conditions (control, waterlogged to soil surface and fully submerged) for durations of 1, 2 and 4 wk. All grasses were allowed a 1 wk recovery period before harvest.

Bambatsi was confirmed as a flood-tolerant species after 4 wk flooding, and both purple pigeon and creeping bluegrass died within 2 wk. Both of these latter grasses were highly susceptible to waterlogging. Floren bluegrass and sheda grass were tolerant of 4 wk flooding, although growth was restricted and little development of aerenchyma occurred at the base of the stems. Floren bluegrass showed no visible signs of stress following flooding, while sheda grass and bambatsi were wilted after 4 wk.

Floren bluegrass has a similar flood tolerance to bambatsi. It established vigorously, tillered freely and produced more leaf than bambatsi prior to treatment and could be used as an alternative species in areas experiencing seasonal flooding. Further study is required to better understand the flood tolerance of sheda grass.

Forages for smallholder livestock production in South-east Asia

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Smallholder forage production — what has gone wrong in the past?

Despite increasing pressure on traditional feed resources in South-east Asia, especially grasslands and agricultural by-products, there has been little adoption of the concept of sown forages by smallholder livestock farmers. This is partly due to a lack of expertise in practical delivery systems and partly due to the testing of sometimes-inappropriate germplasm on research stations. Farmer adoption and feedback have often been the last consideration in R&D programs.

Putting the last first — a farmer-based approach

A small project, funded by AusAID (formerly AIDAB) and managed by CSIRO and CIAT, commenced farmer-based forage evaluations in Indonesia, Malaysia, Thailand and the Philippines in 1992. Six broadly adapted forage species were identified or confirmed:

Andropogon gayanus cv. Kent and CIAT 621;
Brachiaria brizantha CIAT 6780;
Brachiaria decumbens cv. Basilisk;
Brachiaria humidicola cv. Tully, CIAT 6369, CIAT 16886 and CIAT 6133;
Centrosema pubescens CIAT 15160;
Stylosanthes guianensis CIAT 184.

Other species showed promise for particular farming systems.

The Forages for Smallholders project

As a result of this earlier work, a 5-year project (the Forages for Smallholders project), commenced in January 1995 conducting on-farm work with promising forage and tree species to:

- evaluate their potential contribution to existing feeding systems and environmental management (soil stability, soil fertility, weed control, weed potential);
- enhance adoption of these species in target areas;
- ensure feedback of farmers' needs to R&D workers; and
- develop local delivery systems of planting material to make these forages available to farmers in other regions.

The project is operating in Indonesia, Laos, Malaysia, Philippines, South China, Thailand and Vietnam, with particular emphasis on agroforestry and upland agricultural systems.

Perceived threats and limitations to the future use of sown tropical pasture plants

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In Australian tropical pasture-based livestock production systems, threats and limitations to the successful introduction and use of new plants include: the limited number of successful pasture plants available; difficulties with management of these pastures; unreliable climate; reduced government and industry funding for research into new pasture plants; and increasing concern over the introduction of exotic species into the Australian environment.

To measure the level of concern about these threats among those involved with the livestock industry, a survey of 824 people was conducted in March–April 1995. Those surveyed consisted of a selection of graziers, farmers, researchers, advisers, extension workers, consultants and agribusiness personnel, working in a spread of geographic regions from northern New South Wales to Queensland, the Northern Territory and northern Western Australia. An excellent response of 55% was achieved.

Participants rated 20 different potential threats to the future use of sown tropical pasture plants on a 5-point scale: nil, low, moderate, high and very high.

The 3 major limitations were perceived to be: reduced government and industry funding for research; and high establishment costs, with 74%, 63% and 62%, respectively, of respondents rating them as high or very high. Other topics rated as high–very high by 50% or more of the respondents were: commodity prices; unreliable climate; legume availability; unreliable establishment; and high maintenance costs.

The perceived least threat or limitation was grass disease, with 69% rating it as nil or low. Other topics perceived as lesser threats were: availability of adapted grasses (43% nil–low); activities of conservationists (43%, although 38% also rated this as high–very high); legume disease (37%); and lack of technical information (37%).

Lack of finance was not perceived as a major limitation; however, establishment costs were, suggesting that a major limitation lies in the financial risks associated with pasture establishment. Given the unreliable climate, this problem will be hard to address. One valuable outcome of this survey is the indication that an appropriate share of the declining funds should be directed towards developing methods of reducing the cost and unreliability of pasture establishment.

The effect of increasing tree basal area on pasture production following various woodland development strategies at "Wandobah", Dingo

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Abstract

Queensland's woodland communities are characteristic of tropical savannas, which account for more than 50% of the world's tropical land mass. Savanna vegetation is defined by a continuous grassy layer with a variable tree-shrub overstorey. Managing these communities to maintain the optimum balance between woody plants and the grass layer presents a continuing challenge. It is predicated by the fact that woody plants and grasses are competing for the same resources, with the level of competition differing greatly between sites.

Traditional methods of tree and shrub removal have included ringbarking, stem injection, bulldozing and stickraking with retained trees scattered over the paddock. The benefits of increased grass production (up to 2–4 times that on undisturbed sites) can in time be offset by regrowth and seedling recruitment, which inevitably follow such disturbance. These methods can also lead to substantial habitat fragmentation. To minimise these problems, Burrows (1990) proposed development guidelines recommending *inter alia*, the retention of 20% of the woody vegetation in intact strips and clumps, although pastoralists saw this as limiting potential productivity gains from development.

Accordingly, the following new and traditional methods of developing woodlands (applied by commercial contractors) were compared in poplar box *Eucalyptus* woodlands in central Queensland:

(i) Control — woodland left untouched;
(ii) Strips — 20% of woodland left in intact strips, remainder treated with aerially applied, soil-absorbed arboricide;
(iii) Clumps — 20% of woodland left in intact clumps, remaining trees stem injected at waist height;
(iv) Scattered — 20% of trees > 7m tall left scattered over the plot, remaining trees stem injected at waist height;
(v) Pull — 100% of plot pulled by 2 bulldozers drawing a chain;
(vi) Pull and burn — as for (v) but burnt 12 months later;
(vii) All killed — all trees on the plot stem injected at waist height.

Seven years after the treatments were applied, the "Strips" treatment was still producing more pasture per hectare than traditional development methods which left trees scattered over the plot or treated 100% of the area. This is a function of the soil-absorbed arboricide controlling regrowth as well as seedlings < 1.5m tall (while not damaging grass). Monitoring data show this size class is dominant in most eucalypt woodlands. Detailed examination of tree-grass relationship curves clearly shows that pasture production is maximised by retaining trees in strips cf. scattered ("savanna") treatments, whenever there is a negative curvilinear relationship between woody plant basal area and pasture yield. The more pronounced the relationship, the greater is the "strip" advantage.

We suggest that these results are a powerful message to grazier and environmentalist alike. It is possible to combine the needs for production and conservation by employing efficient approaches to woodland development and regrowth control. In addition to tebuthiuron, a new formulation of hexazinone also appears suited to this type of application. A combination of mechanical methods and fire could produce the same result, but at greater environmental risk.

Acknowledgement

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Reference

BURROWS, W.H. (1990) *Agricultural Science*, **3**, 19–24.

Fire directly promotes the germination of dormant speargrass (*Heteropogon contortus*) seed

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In native pastures of south-east Queensland, large-scale germination of speargrass seed occurs immediately after burning in spring, provided there is adequate soil moisture. This increased germination has been attributed to more favourable soil temperatures created by the removal of plant cover. However, in late winter and early spring, most speargrass seed is still dormant and will not germinate by the removal of plant cover alone. It is only following burning that the germinability of this seed increases.

Studies were undertaken to determine whether exposure to either plant-derived smoke or high temperatures stimulated speargrass seed to germinate. In both studies, the seed used was mainly dormant when treatments were applied. For the first experiment, smoke generated by burning grass material in a bee keeper's smoker was pumped into a partially sealed container for periods of 0, 5, 10, 20 or 40 minutes. The second dry-heat experiment used a forced-draught oven to expose seeds to temperatures of either 60 or 80°C for 15, 30, 60, 120, 240 or 480 seconds.

Both plant-derived smoke and high temperatures promoted germination. Germination of smoked seed was more than twice that of untreated seed and increased independently of the period of exposure. With dry heat, exposing seeds to temperatures of 60°C did not affect germination, irrespective of the duration. At 80°C, germination increased after exposure for 60 seconds and peaked following 240 seconds exposure.

It can be concluded that, in late winter and early spring, it is the direct effect of fire on dormancy breakdown that increases the germinability of the speargrass seedbank. Once germinable, this seed can take advantage of the warmer soil conditions created by the removal of plant cover.

Seasonally flooded country of the Isaac — Comet River System

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The total area of alluvial floodplains on the Isaac — Comet River System is 580 000 ha, all of which undergoes periodic and seasonal flooding, with intensity ranging from low to high.

Of this, 330 000 ha is heavy clay soil, and despite being quite fertile, the land use options can be limited.

Flooding causes:

— pasture and crop damage through water-logging;
— grazing period limited to the dry season only (May–Dec);
— stock losses by drowning;
— damage to fences;
— heavy weed infestation, e.g. parthenium, parkinsonia and sesbania; and
— soil erosion and siltation.

The heavy nature of the clay soil causes establishment problems with small-seeded crops and pasture seed.

Subsoil salt levels are unpredictable as the degree and depth varies across the floodplain.

While uncleared native pasture production is low, the quality is high, and with clearing, a stocking rate of about 1 beast/10 ha is common over the dry season only. With the use of improved pasture, this can be increased to 1 beast/4 ha, and with leucaena, 1 beast/2.5 ha.

Development carries a fairly high degree of risk, which can be reduced by:

- developing only those areas with low intensity flooding;
- using conservation cropping practices, e.g. stubble retention and minimum tillage, when cropping;
- cropping for winter grain;
- assessing subsoil salt levels; and
- considering alternative enterprises, e.g. agro-forestry, using native hardwood species.

Currently, the Department of Primary Industries is assessing the flood tolerance and persistence of some pasture grass and legume cultivars (including leucaena), together with native grasses such as Mitchell grass (*Astrebla* spp.).

Jap ox at 24 months — grass fed

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Brigalow Area III graziers are having difficulty getting steers to 300 kg carcase weight by 36 months of age, by growing and fattening them on buffel grass established for 25 years.

A leucaena demonstration block, funded by the MRC under its PDS project, was planted on Robert O'Rourke's property, "Connors Junction", in the Barmount district in March 1991.

A centre-pivot irrigation system was installed several years previously on the Connors River flats as a drought mitigation scheme, and the area planted to Callide rhodes grass.

In April 1993, an 80 ha area was replanted with ryegrass plus Callide rhodes grass. In June 1993, 1066 weaners plus a few bigger heifers were placed on the ryegrass.

The weaners were removed in November 1993 and placed in a buffel paddock. They gained an average of 0.35 kg/d on the ryegrass. This was influenced adversely by the absolute lack of roughage available. On January 25, 1994, 73 head of the steer portion were weighed on to a paddock containing 40 ha of leucaena plus 60 ha of buffel grass. These averaged 395 kg liveweight. Seven steers, carrying the DHP degrading microflora, were already grazing the area. At the end of March 1994, a further 6 steers were added. By the end of July 1994, 26 head from the paddock had been sold as Jap ox. The maximum age was 24 months, while the majority were 20–22 months of age.

The average weight gain between January and July was 1.15 kg/d at a stocking rate of 1 beast/1.16 ha (grass + leucaena).

After July 27, 1994, steers were sold as they reached the desired weight. The last 20 were sold on April 4, 1995, the oldest having 4 permanent incisors (approximately 30 months old). Average gain from July–April was 0.7 kg/d at an average stocking rate of 1 beast/2 ha.

The first 24 head sold gained more than 300 kg liveweight per year. However, the season was severe, as only 330 mm of rain fell from March 1994–April 1995. In March 1994, 154 mm was received, which enabled the first 24 head to achieve satisfactory weight gains.

Components of solar radiation and radiation use efficiency of two tropical grass species

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Growth of 2 tropical pasture species, green panic (*Panicum maximum* var. *trichoglume*) and Hatch creeping bluegrass (*Bothriochloa insculpta*) was compared under varying radiation conditions. Treatments imposed were full sun (as control), and birdguard and solarweave shadecloths, mounted on 3m high, igloo-type structures. The shading materials allowed similar light transmission (about 80%), but the diffuse component changed from 7 to 20% under solarweave. Therefore, treatments tested the effects of lower incident radiation levels, and increased levels of diffuse radiation on the radiation use efficiency (RUE) and growth of these species. Early results show that, although incident radiation differed across treatments, the proportion of radiation intercepted by 60-day regrowth was similar across treatments within species. Dry matter yield (at 60 d) was lower under birdguard, than for the remaining 2 treatments in both species. For solarweave, an increase in the diffuse component of radiation compensated for a 20% reduction in incident radiation, probably because RUE increased. Quantifying the effects of changing radiation conditions on RUE in tropical grass species will allow for better predictions of herbage growth in different environments, where clouds or trees affect incident radiation.

Diagnosis of the nitrogen status of grass stands — principles and uses of the Dilution Curves Method

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The nitrogen (N) or protein concentration of a grass crop is more closely correlated with accumulated dry matter (DM) than with other parameters such as phenological stage or age. This N dilution process during crop growth is a consequence of: i) a decrease in the metabolic N: structural N ratio at the plant level; and ii) the N distribution in the canopy, which is determined by the light extinction profile at the crop level (a consequence of light competition). The course of N dilution for an optimal N nutrition level may be described by the function:

$$\%N = \alpha(DM)^{-\beta}$$

where DM is expressed in tonnes/ha, α is the critical N concentration (4.8% for C_3 species and 3.6% for C_4 species when DM = 1 t/ha) and β is the dilution coefficient (–0.34 for both C_3 and C_4 species). These values were empirically determined and are consistent with published data (case of α), and with theoretical relationships between N and C influxes at the crop level (case of β).

When N availability for plants is less than optimal, the %N for a given biomass declines and the level of N nutrition of the crop is expressed by a lower curve. An index of N nutrition may be defined by the ratio between the actual %N and the critical %N for the same accumulated biomass in the crop. This ratio allows the evaluation of the effect of a N shortage compared with the non-limiting situation. This approach is more accurate than any evaluation where the control treatment is a level of N nutrition which is not easily reproducible.

Tropical forage wrapping in New Caledonia — quality of preservation and feeding value

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During the last 2 years, there has been considerable development of forage wrapping as silage in New Caledonia. The success of this technique comes from the security against risks of rainfall (during the growing season of tropical pastures), the possibility of outdoor storage and the flexibility of use.

Recent experiments have studied the effects of wilting on quality of tropical forages preserved in round bales of silage. More than 100 samples of ensiled forages have been analysed for pH, dry matter (DM) concentration, soluble nitrogen as a % of total nitrogen, and ammonia nitrogen as a % of total nitrogen. Desirable standards were: DpH > 0 (DpH = pH −0.04 DM% −3.8); soluble N < 50% of total N; NH_3-N < 7% of total N.

Quality of the preserved material was related to the DM concentration. Below 40% DM and above 60% DM, silage quality was poor when these forages (with low soluble carbohydrate concentrations) were preserved for more than 1 year. Good weather conditions at harvest, speed of wilting (forage with homogeneous DM concentration into each bale) and high bale density contribute to the successful ensiling of tropical pastures. When forage with varying DM concentrations was incorporated in the same bale, silage was contaminated by moulds. Development of moulds was greater with fibrous and wet forage (below 40% DM). No toxicity problems were observed when animals ate forage contaminated with mould.

Forage crops (forage sorghum, oats, maize) were always well preserved in round bales of silage. Drying rates varied between forages: guinea grass (*Panicum maximum*) > rhodes grass (*Chloris gayana*) > signal grass (*Brachiaria decumbens*) > grass–legume pastures > oats (*Avena sativa*) > forage sorghum. The silage wrapping has remained intact for more than 10 months under the climatic conditions in New Caledonia.

Two trials were carried out to study the utilisation of different tropical pastures in round bales of silage by growing steers. Intake of silage varied according to DM concentration and feeding value of forages. Tropical grasses ensiled between 40–60% DM were well preserved and gave satisfactory DM intake by steers (>2% liveweight). Very low liveweight gains were obtained with lowly digestible (50% of organic matter) grasses, harvested too late. Liveweight gains of 0.5–1.3kg/hd/d can be achieved with good quality forage (forage sorghum, grass-legume pastures) conserved in round bales of silage.

Diazotrophic bacteria in New Caledonia

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An analysis of ecological factors on the island of Maré (a coral island in the South Pacific, one of the Loyalty Group and part of the French Territory of New Caledonia) highlighted serious environmental concerns associated with the sustainability of artificially created pastures. There are 2 classic solutions to deal with shortage of fodder: cutting down of the primary forest cover followed by planting of graminaceous species; and introduction of often polluting fertilisers within the ecological context of the coral island and its vulnerable fresh-water table. These twin techniques contribute to damaging the environment through: an increase in erosion and rainwater runoff; a decrease in the organic matter content of the soil; and particularly, through pollution of the fresh-water lens by nitrates.

These factors have induced researchers to experiment with alternative, more acceptable methods of dealing with the fodder shortage. A promising avenue for research was identified: the development of a type of biological association between a graminaceous forage species and a free diazotrophic bacteria. In this type of association, the role played by each partner is well defined, and both profit: the bacteria fixes atmospheric nitrogen, multiplies, and produces a growth hormone (IAA); and simultaneously, the plant sheds carbon-based molecules, increases its leaf and root biomass, and intensifies its exchanges with the environment.

The research, planned to span a minimum of 3 years, consists of a series of steps leading eventually to field trials. The first step (currently underway) is crucial, and aims at identifying those diazotrophic bacteria that are endemic to the soil of Maré Island. A detailed description of this phase of the study is as follows:

- Bacteria-trapping plants (Poaceae and Leguminosae), selected for their suitability regarding the ecological environment, are grown for 2 months in pots.
- Sterilisation and root sampling.
- A suitable culture medium is inoculated with chopped and ground roots.
- Bacteria are isolated by successive smear cultures.
- Acetylene reduction tests by gas chromatography are conducted in order to assess the bacteria's nitrogen-fixing capabilities.
- Bacteria are described both phenotypically for complete or partial identification, using the techniques of molecular biology (PCR and RFLP), if necessary.

The selected bacteria shall then be studied in association with the appropriate plant, and the results compared with those obtained with the reference diazotrophic organism (genus *Azospirillium*) in future experiments.

Generally, the aim of the study is to eventually offer cattle farmers a type of plant-diazotrophic bacteria association that is easy to use, convenient, environmentally friendly and inexpensive. Thus, the ultimate goal of this line of experimentation would be to develop a type of plant-diazotrophic bacteria association easily implemented by the layman and corresponding with the economic needs and agricultural policies of the Loyalty Islands.

Monitoring trends in pasture condition for sustained production

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Monitoring the condition of native pastures assists in the maintenance of their productivity. Condition trends are seen and, with knowledge of past seasonal and stock-pasture management conditions, factors affecting condition trend can be deduced. Management options to maintain or change pasture condition can be examined.

Simple techniques, such as taking photographs, are quick and indicate broad changes in pasture condition (increases in woody weeds, changes in pasture quantity, scalding, etc.) We are using fire to control rubbervine (*Cryptostegia grandiflora*). Sequential photographs over time will be used to assess burn effectiveness and the need for further intervention. Photographs are more reliable than human memory!

More complex methods are required to show changes in pasture quality. These range from measuring the frequency of occurrence of plant species to including ground cover, soil characteristics and landscape condition. Measurements taken at the same time of year — end of summer growing period — enable valid comparisons. We are monitoring changes in species composition of a number of pasture communities near Charters Towers, north Queensland. At an *Aristida-Bothriochloa* pasture site, the desirable black speargrass (*Heteropogon contortus*) is decreasing, whereas the undesirable wiregrasses (*Aristida* spp.) are increasing. Cover has increased along with pasture bulk. Frequency occurrence of most species has declined at a spinifex (*Triodia* spp.) pasture site. Notable exceptions are golden beard grass (*Chrysopogon fallax*) and *Aristida* spp. — increases under grazing — and *Schizachryium* spp. — a seasonally fluctuating annual. Total cover remained the same, although spinifex cover appears less. Full interpretation of results requires knowledge of recent stocking rates and rainfall patterns. The experience of local graziers or pasture scientists can be used.

Many of these techniques can be found in the manual for "Grasscheck", a grazier-based pasture monitoring program offered by the Department of Primary Industries in Queensland.

Management concepts to aid profitable beef production

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The aim of the beef cattle industry in northern Australia must be to smaller, more productive herds, enabling flexible management. This will result in:

- improved economies of scale;
- more responsible land usage;
- healthier animals; and
- quicker response to market requirements.

Researchers, advisers and pastoralists have endeavoured to achieve improvements in beef productivity by tackling various contributing factors in isolation. An integrated approach is required for a successful result.

Nutrition is acknowledged as a major factor in lifting animal productivity; yet, finance can be wasted if resources are expended upon unproductive, unhealthy or unsuitable animals.

The following factors need to be considered in unison:

1. *The establishment of an economic and sustainable herd size, which considers property characteristics.*

   This sustainable herd size (SHS) may be assessed by:

   - arriving at the absolute carrying capacity (ACC) of the USEABLE land;
   - establishing an animal utilisation value; and
   - multiplying the ACC by animal utilisation value.

   The animal utilisation value would take into consideration:

   - the annual rainfall and its regularity;
   - pasture types; and
   - other significant physical or climatic factors.

   The following rules of thumb could be used as guidelines:

   - for a mitchell-flinders pasture with 500 mm rainfall, utilisation value is 0.75;
   - for an improved grass–legume pasture with 1000 mm rainfall, utilisation value is 0.9.
2. *Disease and parasite management strategies.*
3. *Bull testing and assessment.*
4. *Weaner management.*
5. *Culling of unproductive and late calving breeders.*
6. *Total herd nutrition.* This would entail supplementary feeding, with special attention to first- and second-calf heifers and early turnoff cattle.

Under these strategies, a healthy, well-managed beef herd will attain branding percentages approaching 90%, and provide a basis for efficient herd and property management, and quicker turnoff to enhance cash flow.

FEEDMAN — Decision support for the beef industry

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FEEDMAN is a decision support package that operates in the Windows environment and aims to serve beef producers in the "endowed" region of northern Australia.

It permits evaluation of a wide range of management options for growing cattle on individual farms. Descriptions of paddocks, in terms of land units and forages, are coupled with herd descriptions in terms of number, class, weight and breed of specific mobs. A paddock may contain more than one forage and more than one mob. Thus, different management options can be evaluated.

Forage production is generated from inputs of local or historical rainfall. Animal production is dependent on stocking rate and potential liveweight gain from a forage. Inputs of prevailing cattle prices, variable costs, and market specifications enable market options to be evaluated in economic terms. In short, the package can be customised to reflect local conditions.

Printed reports detail output at the paddock, mob and farm levels. These reports can be presented as tables or graphs to depict: forage production and utilisation; monthly changes in animal performance; market options and prices; variable costs and potential returns; and most profitable market option.

The package is in an advanced stage of preparation and is being prepared by the University of Queensland, Gatton College, the DPI and an agricultural consultant. Input from potential end users has been obtained during the development process.

AUSTRALIAN RAINMAN — a package of rainfall information for better pasture management

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Following the success of the RAINMAN program released in 1991, AUSTRALIAN RAINMAN was produced in 1994 to: (a) improve management of climatic risk and opportunities throughout Australia; (b) raise awareness and knowledge of the El Nino-Southern Oscillation weather system; and (c) deliver a high quality product that meets the needs of adult education.

The package can provide and analyse rainfall information for 3915 locations throughout Australia, as follows:

- *monthly rain* — historical data, averages, deciles and site information;
- *seasonal rain* — effects of Southern Oscillation Index (Pacific Ocean) and Sea Surface Temperatures (Indian Ocean), averages, deciles, chances of rainfall with and without using SOI/SST, and moving averages;
- *daily rain* — summary analyses and planting opportunity analyses for all locations and detailed analyses for some locations;
- *droughts* — historical drought information and severity of droughts;
- *temperature, humidity and evaporation* — long-term means for many locations;
- *enter/update your own data* — rainfall (including new locations), Southern Oscillation Index and Sea Surface Temperatures; and
- *export monthly and daily rainfall* — for historical data.

The package was developed mainly by the DPI, Bureau of Meteorology and Western Australian Department of Agriculture, and funded by the Rural Industries Research and Development Corporation and the Meat Research Corporation. It is retailed throughout Australia and is applicable to farmers and graziers, consultants, scientists, agri-business, schools and universities, Governments and the media.

Many decisions involving pastures may benefit from AUSTRALIAN RAINMAN, e.g. safe stocking rates for the coming season; stock movement on agistment; burning for regrowth control without feed shortages; and strategies to offset drought and improve sustainability.

Application of landsat TM data to estimate vegetation cover in the semi-arid tropics in Swaziland

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Satellite data are being used for mapping vegetative cover as a tool for developing indicators of the quality of forage and susceptibility to soil erosion in Swaziland.

A landsat TM subscene (20 km by 20 km) with 3 spectral bands (3, 4 and 5) was used. The image was acquired in January (wet season), 1993. E-R Mapper image processing was used to classify the data using 30 training areas, selected to represent: light-coloured soils — poor ground cover; dark-coloured soils — poor ground cover; medium ground cover; and dense ground cover.

A composite image of the 3 spectral bands was created. Normalised Difference Vegetative Index (NDVI) values were obtained from the training areas with different ground covers.

The NDVI depicts the general health of vegetation. Its sensitivity to green vegetation is based on the radiance reflected in the red (TM band 3) being related to the amount of chlorophyll, and the radiance in near infrared (NIR) (TM band 4) being related to the density of green leaves. The index ranges from −1 for least green vegetation (bare areas) to 1 for most green vegetation (densely vegetated areas).

It can be expressed as:

(NIR band–Red band)/(NIR band + Red band).

Ranges for NDVI were defined for the ground cover classes. Classification was done by density-slicing of the NDVI.

Satellite data can provide rapid and reliable assessments of ground cover. This tool is being used to investigate the environmental impact of cattle grazing under different land tenure systems in Swaziland; government lands, communal lands and private lands.

The dissemination of chinee apple (*Ziziphus mauritania*): a woody weed of the tropical subhumid savanna and urban fringe of north Queensland

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[2]*Kelso, Queensland, Australia*

Introduction

Little is known about the role that native animals play in the dispersal of woody weed seeds. Woody weed spread is often associated with the grazing industries. However, chinee apple is one of the most dominant woody weeds not only in the grazed savanna lands but also in urban fringe areas, which have no recent history of being grazed.

Near Townsville, an area of 100 m^2, 150 m from any chinee apple trees and being grazed by agile wallabies, eastern grey kangaroos and rufous bettongs, was raked and faecal pellets collected and identified. The pellets were macerated and chinee apple seed capsules counted. Chinee apple fruits on a tray were used to study the eating habits of the macropods.

Results

Two hundred intact faecal pellets, identified as being mostly from agile wallabies, were collected from the site. From those, 69 chinee apple capsules were recovered. The fruits on offer were consumed by agile wallabies and rufous bettongs only. Agile wallabies chewed and swallowed the fruits whereas rufous bettongs ate the flesh, then dropped the capsules.

Discussion

Agile wallabies are suspected of being the main vectors as they swallow the capsules, and numerous capsules were present in their faeces. Chinee apple seedlings were observed growing from faecal pellets, indicating that some remain viable after passage through the digestive system. Agile wallabies could disperse seeds over considerable distances depending on their home range. Rufous bettongs spit out the capsules, and would not spread seed far from its source.

Fruits mature in the dry season, when native grasses are of extremely poor quality. Results indicate chinee apple fruit are important at certain times of the year to the diet of the agile wallaby and possibly the rufous bettong. Their value, if any, to other livestock, is unknown and requires investigation.

As agile wallabies are quite abundant in these savanna grazing lands and urban fringe areas, the dissemination of chinee apple is likely to be sustained.