Legumes for Clay Soils

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Final Report
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CSIRO AUSTRALIA
Meat Research Corporation

Legumes for Clay Soils

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1. Project Summary

Clay soils occur on some 6 million ha of land in central Queensland which supports extensive grazing and cropping enterprises. Summer growing legumes adapted to clay soils are seen as a viable means of providing high quality forage for finishing beef cattle and for maintaining soil fertility in ley cropping systems.

The "Legumes for Clay Soils" project was developed to identify further legumes that could be used in these grazing and cropping systems, develop technologies for the successful establishment and management of legumes, inform producers of the potential benefits of legumes and the need for more specialised management strategies and encourage producers to increase the use of legumes.

Research and Development has been undertaken in an approach that is multi-organisational (QDPI, CSIRO, UQ and MRC), multi-site (16 established from Roma (23°S) to Middlemount (27°S)) and multi-level (glasshouse studies to grazing demonstrations).

The development of *Desmanthus virgatus* under grazing and its effect on animal liveweight gain was measured in **Grazing studies and demonstrations of Desmanthus** at Wandoan, Theodore, Biloela and Middlemount and at Narayen, Brian Pastures and Brigalow Research Stations.

Despite low rainfall years these studies have shown that desmanthus can be readily established with grass on clay soils particularly where seedbed preparation is thorough and sub-soil moisture has accumulated. Established desmanthus plants can survive and in the case of cv. Marc set seed under drought conditions in association with drought resistant grasses. Desmanthus pasture can develop under all year-round grazing as evidenced by an increase in legume density and soil seed levels. Desmanthus is readily eaten by grazing stock throughout the season and there is potential for improvement in liveweight gains, particularly as grass only pastures continue to decline in quality as soil nitrogen runs down.

"On farm" testing of new cultivars and elite lines and small plot evaluation has compared and demonstrated the establishment, production and persistence of 20 promising lines on 12 properties in the central and northern brigalow region and over 120 accessions from 20 genera at Narayen, Brigalow and Emerald Research Stations. These 'on farm" sites and small plots have reinforced the value of lablab as an easily established annual forage and highlighted the potential for Milgarra butterfly pea as a ley legume. It has been persistent and tolerant of drought over a range of sites but particularly on downs soils. *Desmanthus virgatus*, *Indigofera schimperi* and *Stylosanthes spp* aff *S scabra* have been the most persistent and productive perennial legumes. There is potential for better adapted cultivars of other legumes to be developed.

Supporting studies have provided the best information on how the new legumes can be used. They have been invaluable in improving establishment, identifying nutritional requirements and developing effective *Rhizobium* associations.

Communication by regular newsletters, displays, talks, interviews, newspaper articles, farm walks and field days has kept primary producers and agribusiness informed and developed partnerships that will enhance the use of legumes and best practice management by the industry to meet more demanding market specifications for beef.

2. Executive summary: Legumes for Clay Soils (Project DAQ.086)

BACKGROUND

There are some 15 m ha of clay soils in Queensland and northern New South Wales which receive adequate rainfall for cropping or sowing of improved pastures. Maintenance of production is more difficult because of declining soil nitrogen levels. In cropping soils total and available nitrogen are declining causing a reduction in grain protein and yield, while in permanent grass pastures lower forage and animal production are the result of lower levels of available nitrogen. One possible solution is to use legumes. Lucerne, annual medics, lablab and leucaena have, until recently, been the only legumes available for these soils. However, all these species have limitations. Lucerne and medics become increasingly unreliable as cool season rainfall decreases with decreasing latitude. Lablab, although very useful for a one year ley, seldom persists into a second year and leucaena is a specialist pasture, not likely to be used over wide areas. *Desmanthus virgatus* became commercially available in the first year of the "Legumes for Clay Soils" project, but little was known about its area of adaptation and management requirements. Two other legumes, *Indigofera schimperi* and *Glycine latifolia,* had shown promise in small plot testing.

Consequently, the "Legumes for Clay Soils" project was commenced and operated at a number of levels. Priority was given to improving understanding of the agronomy of desmanthus and documenting its impact on animal production. Similar but more restricted studies were to be made on indigofera and glycine. Sowings of other "best bet" legumes were made in "on-farm" sowings to ascertain their persistence and productivity over a wide geographical area, and a preliminary evaluation of a much wider range of legumes was undertaken on three research station sites.

Achievements were restricted by low rainfall received during this period. For example, the annual rainfall at Narayen Research Station from 1991 to 1996 was 357, 569, 434, 442 and 677 mm compared with a long-term average of 717. Three of these years received less than decile 2.5 rainfall (425 mm). The below average summer rainfall was especially critical as it restricted opportunities to establish legumes in grazing and small sward experiments. Some sites were resown adding considerably to costs in worktime and in having to modify treatments because of shortage of seed or inability to prepare adequate seedbeds. Where establishment was successful subsequent plant density was often low affecting measurement of other plant characteristics. At some sites establishment did not occur or was so poor no measurements were taken. This meant that the project was unable to meet some of its objectives and a two year extension was requested.

PROJECT OBJECTIVES AND OUTCOMES

Objective 1. By June 1995, to develop methods for the successful establishment and management of Desmanthus virgatus pastures and incorporate them into suitable management practices for industry.

Interim guidelines were made available as a fact sheet at the time desmanthus seed was first sold in December 1994.

Since then, work on the establishment and management of desmanthus has had two main thrusts. The first was with establishment (sowing depth and *Rhizobium*) and the second with management (nutrition and ecology).

1(a) Field studies on *Rhizobium* strain CB3126 as an inoculum for desmanthus.

Observations of yellowing in field-grown desmanthus, combined with the finding that the commercial strain CB1397 was not effective, led to work on a replacement strain. Previous glasshouse trials had shown CB3126 to be a good alternative. In inoculated and uninoculated plots of desmanthus established at four sites positive responses to inoculation with CB3126 occurred at 3 in the year of establishment and at one site in the following year. The size of the growth response appeared to depend on a combination of factors including (a) prevalence of native *Rhizobium* strains, (b) nitrogen fertility of the soil and (c) level of grass competition.

CB3126 accounted for all the nodules formed at one site, where there were no effective native strains, and between 0-65% at other sites in competition with native strains. Observations of chlorosis at one site, despite the presence of healthy nodules, led to work on nutritional problems other than nitrogen.

1(b) Potential nutrient deficiencies of desmanthus in 7 clays soils

Despite being well nodulated with *Rhizobium* CB3126 desmanthus in a trial at one site (Brian Pastures) still exhibited chlorosis. Preliminary glasshouse work showed responses to sulphur and molybdenum and application of molybdenised superphosphate to established plants in a grazing trial reduced the severity of yellowing. A further experiment identified potential nutrient deficiencies in a range of 7 brigalow and downs soils.

Reductions in top growth of 30-50% over a 14 week period occurred in 5 soils with the omission of sulphur. A greater than 20% reduction in plant growth occurred with the omission of molybdenum in three soils and phosphorus in 3 soils. A critical level of 0.2% S in leaf tissue is proposed.

1(c) The survival of *Rhizobium* strain CB3126 on seed of desmanthus stored at different temperatures

To be successful, *Rhizobium* CB3126 must not only be effective, but must survive on the seed between planting and seed germination. Studies on depth of sowing have shown that the seed must be planted shallow and rely on follow up rain for germination. This exposes seed to high soil temperatures which on the surface of clay soils in summer can reach 55°C. Thus survival of CB3126 was followed over 6 weeks and at temperatures from 25 to 55°C.

Survival of *Rhizobium* for longer than 2 weeks occurred only at temperatures of 35°C or less. At temperatures greater than 45°C *Rhizobium* survived for less than one week. These temperatures are likely to occur in summer plantings of desmanthus, suggesting that inoculum could be short-lived.

1(d) Prevalence of native strains of *Rhizobium* and response to inoculation in 8 clay soils

Given the poor survival of *Rhizobium* under high temperatures, a glasshouse experiment examined the prevalence of effective native strains in clay soils from experimental sites where desmanthus was growing. Native strains were found in all but 2 of the 8 soils tested. Responses to inoculation were greatest in these 2 soils. However in 2 other soils despite the presence of native strains there were small responses to inoculation, either due to low *Rhizobium* numbers and/or less effective native strains in the soil. Although the introduced strain may die out prior to seed germination and effective native strains are present in most soils, the potential benefit of inoculation in some soils more than justifies the small cost of inoculation, which continues to be recommended.

1(e) Effect of sowing depth on emergence of legumes in clay soils

This study included work in the field and controlled environment cabinets. Potential ley legumes *Macroptilium bracteatum* and *Macrotyloma daltonii* were able to emerge from depths of up to 5 cm, but emergence of the smaller seeded *Desmanthus virgatus* and *Indigofera schimperi* decreased sharply below 2-3 cm. No legume was able to establish from surface sown seed. The narrow range of depths from which desmanthus and indigofera can establish was confirmed in field plantings.

1(f) Legume susceptibility and tolerance to herbicide

Twenty eight post-emergence herbicides were applied to 6 legumes and their tolerance and susceptibility were recorded. The legumes were desmanthus, indigofera, Milgarra butterfly pea (*Clitoria ternatea*), glycine, *Vigna trilobata* and *Macroptilium bracteatum.* The results are still to be finalised but will provide valuable information on weed control in seed crops or pastures, as well as on control of these legume species in environmentally sensitive areas. Some exploratory work with pre-emergents on desmanthus indicate potential for use in future seed production.

1(g) Persistence of contrasting desmanthus lines at five grazing pressures

A trial, established at Narayen Research Station in 1989, compared the persistence and productivity of 8 accessions of desmanthus at 5 grazing pressures. At least in dry years such as experienced since 1990, later flowering accessions or accessions that take a long time for seed to mature will set little seed. In contrast, early and rapid flowering accessions such as cv. Marc can set appreciable seed. Some plots of these lines have seed reserves of over 10,000 seeds/m^2. Plant density has been largely maintained in these lines, with potential for a major increase in density in good rainfall years. In contrast, there has been a steady decline in density in the lines unable to set seed. This has obvious implications for genetic drift in commercially sown desmanthus, which is a mix of early, mid and late flowering types. It also has implications for selection of improved cultivars. The trial ended in September 1996.

Objective 2. By June 1996, to quantify the liveweight gain from D. virgatus pastures on a range of clay soils....

The pasture and animal productivity of desmanthus/grass pastures have been studied at Brian Pastures and Brigalow Research Stations and in a grazing demonstration at Wandoan (Kookaburra). Another grazing site has been successfully established near Middlemount (Rolf Park).

A grazing trial at Narayen and two sites at Theodore (Rangeview), and Biloela (Kapalee) failed to establish because of the dry weather. These failures were not associated with failure of desmanthus to emerge. At Narayen desmanthus established satisfactorily but the companion grasses did not. Desmanthus emerged well when “band-sown” into established buffel or native grass in the two on-farm sites, but seedlings died following long periods without follow-up rainfall.

At Brian Pastures and Brigalow Research Stations, legume density has increased from low initial levels (Table 2.1). A large number of seedlings have emerged on several occasions but these have generally not survived because of inadequate follow-up rain. The pastures remain grass dominant and legume yield has always been low. Stock have grazed at 1 to 2 ha (Brigalow R/S) and 1 to 1.2 ha (Brian Pastures) since establishment, except for short periods when conditions were very dry and feed was inadequate. Steer liveweight gains have been similar on the grass and grass+desmanthus pastures (Table 2.1).

Excellent legume establishment has been achieved at Kookaburra (Wandoan) and Rolf Park (Middlemount) where desmanthus and buffel have been sown into cultivated seedbeds in old crop land. At Kookaburra, where grazing at 1 steer per 2 ha was commenced 8 months after sowing in July 1994, legume density has been maintained and desmanthus yields of up to 1000 kg/ha have been measured. Steer liveweight gains in the first year were slightly higher in the grass only paddock. Rolf Park was sown in 1995 and although legume density was high (12 plants/m^2), grazing was with-held until April 1996 to allow seed to develop.

Table 2.1 Soil type, pasture association, legume density and yield and grazing data from the desmanthus development sites

Site	Date sown	Soil/pasture association	Legume density plants/m^2		Legume yield (kg/ha) highest	Annual Steer liveweight gain (kg/head/day)	
			estab.	1995		Grass	Grass + desmanthus
Brian Pastures R/S	Nov 87	Black clay (basaltic) purple pigeon	1.2	4.5	<100	0.46-0.67	0.42-0.70
Brigalow R/S	Feb 90	Brigalow clay buffel	1.6	8.0	150	0.29-0.63	0.28-0.72
Kookaburra (Wandoan)	Dec 93	Brigalow clay buffel	9.8	10.2	990	0.71	0.67

Despite low rainfall years these desmanthus paddocks have provided a great deal of information that was not available when the project commenced. These are the most significant outcomes:

- desmanthus can be readily established with grass on clay soils particularly where seedbed preparation is thorough and sub-soil moisture has accumulated. Bandsowing also has potential, but requires higher rainfall or modification of the technology, such as a wider sprayed band, to reduce the effect of competition from resident grass.
- established desmanthus plants can survive and in the case of cv. Marc set seed under drought conditions in association with drought resistant grasses. This was most evident at Brigalow Research Station in the 1993 dry season when rhodes grass, green panic and Queensland bluegrass died but desmanthus and buffel grass survived.
- desmanthus pasture can develop under all year-round grazing as evidenced by an increase in legume density at 2 of the sites. Soil seed levels have also increased over this period (up to 1800 seeds/m^2) indicating a more rapid development of pasture could occur if conditions for seedling recruitment and survival were more favourable.

Objective 3. By June 1996, to have 10,000 ha sown to D. virgatus in Queensland.

Three tonnes of seed were sold in 1994/95 and about 7 tonnes in 1995/96. If all seed purchased was planted at a rate of 2-3 kg/ha, the current area planted is 3000 to 5000 ha. Although some 30 tonnes were available, sufficient to plant an area of 10000 to 15000 ha, the seasonal conditions mitigated against all but small, investigative type plantings.

Objective 4. By June 1996, to develop methods for the successful establishment and management of Indigofera schimperi and Glycine latifolia pastures and incorporate them into suitable management practices for industry.

Studies on emergence of indigofera have shown that it has to be sown at the same shallow depth as desmanthus (see 1(e)) whereas glycine could emerge at depths up to 5 cm under favourable conditions. Indigofera has a slower rate of germination than desmanthus and there is evidence that this could protect sown indigofera seed from complete germination in an isolated rainfall event without adequate follow-up.

As shown later, indigofera is outstanding in terms of persistence and production. Analysis of leaves and stems from the "grazed layer" of indigofera have shown that its quality, in terms of N, P and ADF, is similar to that of desmanthus. Chemical and bioassays have failed to find a trace of toxic compounds. The key question is whether it is acceptable enough, especially if only grazed at the end of the growing season.

Seed production of glycine has been rather erratic. In some instances seed yields, with complete recovery from small plots, have been up to 500 kg/ha, but have been very disappointing in other situations. Unless reliable management guidelines for seed production of glycine can be formulated, then this species is not likely to be acceptable to the seed industry. Consequently, an application for funding for seed production work on this species has been made by Dr. Don Loch to GRDC.

Objective 5. By June 1996, to quantify the liveweight gain from I. schimperi and G. latifolia on a clay soil.

This was not achieved. The accession of indigofera on pre-release (CPI 52621) was established in the grazing trial at Narayen previously mentioned, but there was very little perennial grass in the proposed experiment and it has been abandoned. This accession, with 4 other accessions, has also been established in paddocks sown at Brian Pastures in the 1995/96 season. These paddocks will be monitored, outside of the extended Legumes for Clay Soils project, to document the acceptability of indigofera and its affect on liveweight gain.

Objective 6. By June 1996, following the release of commercial cultivars, to have seed of I. schimperi and G. latifolia available to industry in Queensland.

Glycine has been accepted for PVR but has not been released because of difficulties with seed production and uncertainties about how well it is adapted to some of the brigalow soils. Its performance has varied and has been unpredictable across the range of established sites. The release of indigofera has been put on hold until it has been shown to be adequately accepted by stock.

Objective 7. By June 1996, to identify at least four new legumes accessions for further development in both ley and permanent pasture systems on clay soils.

Several new legume accessions have been identified and advanced towards release and use in other projects. These legumes have been identified at two levels. Approximately 20 accessions, considered to be the most promising in 1992-1994, were evaluated in "on-farm" sowings in large plots of 20 x 5 m and a much wider range of about 150 accessions were evaluated in small plot sowings at Narayen, Brigalow and Emerald Research Stations.

7(a) On farm testing

These trials measured establishment, production and persistence and demonstrated the value of commercial and near-commercial legumes for use in grazing and ley pastures on clay soils.

Methods

A range of legumes including known annual or short term and perennial cultivars and promising accessions was sown in large plots on commercial properties at 7 sites in 1994 and at 6 sites in 1995. The range of legumes was expanded in 1995. Of these sites, 5 from 1994 sowings and 5 from 1995 sowings were successfully established and legume density and yield have been recorded. One site was resown in 1996. Soil types are either black earths on open downs country or clay soils cleared of brigalow.

Legumes were sown onto cultivated seedbeds on land used for grain or forage cropping except for 2 of the sites sown in 1994. One of these was bladeploughed and one was sown on a downs soil without cultivation. Both failed to establish. At the other sites seed was sown onto the surface and rolled using press wheels. Sub-soil moisture varied from good to poor. Seed of Queensland bluegrass (*Dichanthium sericeum)* was oversown across all the legume plots at 1 kg/ ha, except at Kookaburra where bambatsi panic (*Panicum coloratum)* was used. All sites have been grazed, generally at the end of the summer growing season, but the intensity and length of grazing has varied because the areas are situated in paddocks used for cropping.

Results and Outcomes

Despite generally below average rainfall, establishment of all but a few of the legumes at the 10 sites was satisfactory. Grass establishment was good at most sites and successfully met the objective of helping to suppress weeds and being present to take up any nitrogen made available in the better legume plots.

Forage production, although limited by inadequate rainfall and soil moisture in most seasons at most sites, has been adequate to allow comparisons between legumes.

First year yields (meaned for 5 sites) from the 1994 sowings were highest for Highworth lablab. *Vigna trilobata* CPI 13671 (a legume on pre-release) was ranked second and *Desmanthus virgatus* cv. Uman, *Macroptilium bracteatum* CPI 27404 and *Stylosanthes* (aff.) *scabra* CPI 110361 were equal to or better than siratro. From the 1995 sowing at 5 sites which were more widely distributed than the 1994 sowings (from Roma to Middlemount), a similar pattern emerged. Highworth lablab was again the highest yielding with *V. trilobata, Macrotyloma uniflorum* cv. Leichhardt (a legume not sown in 1994) and *M. bracteatum* again better than siratro. Glasshouse studies have shown that *M. bracteatum* has much better tolerance of close defoliation than lablab or *M. daltonii.*

As expected the perennial legumes have yielded highest in the second year. *Indigofera schimperi* had the highest yield followed by siratro, *M. bracteatum,* Milgarra butterfly pea, desmanthus and *S. sp.* aff. *S. scabra*. Highworth failed to regenerate and although regeneration of *V. trilobata* occurred at some sites, forage production was limited.

Many legumes have persisted and some continue to improve into the third season. Indigofera has produced highest yields at most sites but on some, especially the northern sites Milgarra butterfly pea has persisted well and also produced high yields. It has attracted the attention of producers who are interested in legumes for the downs soils and for use in leys in cropping areas. In 3 to 4 year leys Milgarra could be used instead of Lablab which has to be planted each year. *S. sp.* aff. *S. scabra* continue to improve at some sites with a very high seedling recruitment and desmanthus is persisting. Leucaena growing in a sward has been high yielding at Biloela.

Results to date indicate that some legumes are more widely adapted than others and some generalisations can be made on where plants are best suited, eg. Indigofera and aff scabra are widely adapted, desmanthus is best suited to brigalow soils and Milgarra to downs soils and northern areas.

Good seedling regeneration of *S. sp.* aff. *S. scabra* and Marc desmanthus have been observed at some sites. Recoveries of seed from the soil at three sites, Kookaburra, Kapalee and Carramah, show that even after only one or two seasons soil seed levels of Marc can be very high (> 30000 seeds/m^2). Seed numbers of Bayamo and Uman were low (<500 seeds/m2). Despite heavy seeding and seedling recruitment, *S.* sp. aff. *scabra* soil seed numbers are generally low (about 500 seeds/m^2). This suggests that a high proportion of seed is either soft or softens quickly.

7(b) Small plot trials

COPE and other evaluation trials on clay soils have highlighted a number of legumes with potential on clay soils. Small plot trials tested these and other accessions on three contrasting soils.

Methods

One hundred and fifty two legume accessions were planted over three years (1992-1995) at three sites (Narayen, Brigalow and Emerald Research Stations). Selected groups of legumes were sometimes grown with and without a sown grass. The remainder were sown with a grass adapted to the local area. Measurements at each site included annual plant density and yield, with observations on flowering and seed production. Survival of marked plants was measured on some accessions.

Seventeen accessions of annual medics were established during the 1993 winter at three sites (Narayen, Emerald and Biloela). Irrigation was used to enhance emergence and growth in the establishment year, and to enable the all-important seed set, but was not used thereafter.

Results - legumes for permanent pastures

Most persistent at each site has been *Indigofera schimperi*, with over 80% survival of original plants at Narayen over a four year period. Accession 52621 and 69495 have consistently yielded greater than 1 t dry matter per hectare at all sites apart from the establishment year. Although the establishment and yield of *S.* sp. aff. *scabra* has been less consistent across sites, it has shown the potential to increase through seedling recruitment.

Early yields of desmanthus have generally been lower than those of indigofera. To date there has been little seedling recruitment in any of the desmanthus cultivars despite considerable amounts of seed being set, particularly by Marc. Desmanthus is also less persistent than indigofera (13 and 70% survival of original plants of Marc and Bayamo respectively at Narayen). Recruitment is expected to increase given good moisture conditions and continued softening of soil seed in the ground. No recruitment has yet been recorded in indigofera, although small amounts of seed have been set at most sites in late summer.

Ten desmanthus accessions, in addition to the 3 cultivars, have been tested at all three sites. There is potential for selecting accessions, such as CPI 40071 and TQ90, which are agronomically superior, with more yield and leafiness at the end of the growing season than Marc. They are earlier flowering than either Bayamo or Uman, and this should assist their long-term persistence.

Results - ley legumes

Legumes showing promise as potential ley species include the short lived perennial *Macroptilium bracteatum*, *Macroptilium lathyroides* and some *Vigna* species. *Macroptilium bracteatum* has persisted for 2-3 years at sites where it successfully established and has yielded up to 2.4 t/ha in the second year after planting. It is well eaten by stock. Seed is produced at the top of the plant, making harvesting potentially simple. Two accessions of *Macroptilium lathyroides* have perennated and produced yields of up to 1.5 t/ha at Narayen, and although lower yielding at Brigalow, were able to recruit from seed under conditions of low grass competition. Some *Vigna* and *Macrotyloma* species have also shown promise.

There was good emergence and production in the 1993 medic sowings. There was a good seed set at each site with up to 20000 seeds/m^2. During the next two years (1994 and 1995) there has been some emergence of seedlings but no seed set. There was further seedling emergence after the good early May 1996 rains. Soil samples were taken in winter 1996 to measure seed reserves from the 1993 seeding, before any seed was set. This will provide a good test of the ability of seed reserves of these medics to survive through three years.

INTEGRATION WITH OTHER R & D

Since the project commenced, every effort has been made to inform and interact with organisations and staff undertaking R&D in related areas. These projects include Back-up Legumes for Stylos, legume demonstrations in PDS, plant evaluation projects of QDPI and CSIRO and The University of Queensland. In particular, there has been considerable input into the newly funded GRDC project on ley legumes. Results from the DRDC funded work on ley legumes has been reported in the project newsletter. Good contact has been maintained with NSW Agriculture.

An extremely valuable association was developed between QDPI and CSIRO project staff and students of The University of Queensland, who undertook projects on nutrition and nodulation of desmanthus. This was very effective as students were able to do project work that could not have been done otherwise, while students benefited from the supervision of experienced scientists.

IMPLICATIONS OF RESULTS FROM NAP2

Industry has a greater recognition of the potential for legumes in clay soils, for both the grazing and cropping industries now, than at the start of this project. There has been a positive response from producers who have expressed strong support for this project and the need for continuation of work in this area. Legumes are seen as a viable option to assist in the maintenance of soil nitrogen levels. This is of critical importance in cropping lands where grain yields and quality is declining and the benefits of adding fertilizer nitrogen are unpredictable under highly variable rainfall. Also as premium beef markets are developed producers are seeking higher quality forage so that high animal growth rates can be obtained and age at turnoff can be reduced. Legumes in grass pastures and grown in rotation with crops on cropping land can provide higher quality feed. While these systems are complex and will take considerable time to develop in industry the Legumes for Clay Soils project is an important early step in determining what legumes are adapted to the range of soil, climate and cultural practices of the of industry, what are the limitations and what are the likely benefits to soil nitrogen and grazing animal performance.

Findings to date, on a range of topics including establishment, the need for inoculation, nutrition and management have given a much better base for the successful use of desmanthus. This basic agronomic information is needed to ensure effective use of new cultivars. Although desmanthus has not yet increased liveweight gains, this is not unexpected in view of the low rainfall experienced during the previous four years, the mineralisation of nitrogen from sowing into cultivated seedbeds and the high animal growth rates recorded on the grass only pastures.

The other short term benefit from this project has been to highlight the potential for Milgarra butterfly pea. It has impressed many producers as a legume for leys and demands for seed have increased. This legume is commercially available and seed production presents no major problems. There is potential for economic benefits from the use of Milgarra to flow through more quickly to producers than is the case with desmanthus, where there will be a greater time lag.

In the longer term, there is potential for commercial development of better adapted cultivars of desmanthus, and for cultivars of completely new species such as *Macroptilium bracteatum*. Also as more specialised production systems are developed and producers begin to manage for a range of outcomes, there is greater likelihood that legumes, perhaps already identified but not currently used because they are not suited to current management, will be recognised as having a useful role.

DIRECTIONS AND OUTPUTS FROM NAP WORK

The existing grazing trials and on-farm grazing studies will be continued to document the effect of desmanthus on animal production as the effect of mineralisation of nitrogen from sowing decreases and, hopefully, rainfall improves. We also plan to use these existing sites to check on nitrogen fixation by desmanthus - as studies reported here show that there may be some sites where desmanthus will not nodulate with native rhizobia. The existing trials will also be used to check on the extent of sulphur deficiency, which has been identified as a potential problem. Where possible, we will use carbon isotope measurements of faeces to determine the proportion of desmanthus in the diet throughout the year to assist in interpretation of pasture and animal production.

The existing on-farm and small plot studies will be continued to document persistence of the more promising accessions. These sowings were only made 2-4 years ago, and this time-span is inadequate to evaluate persistence. This is especially so where legumes are grown with a grass. Companion grasses can have a major impact on seedling recruitment, which is essential for long-term persistence in legumes such as desmanthus and *S.* sp. aff. *scabra*.

There will be increased emphasis on the agronomy of *S.* sp. aff. *scabra*. This legume will be commercially available this summer and has aroused great industry interest. Three demonstration sites will provide the base for this work. As well as documenting animal production and pasture yield and composition, these sites offer the opportunity to take measurements of the percentage of legume in the diet and the proportion of nitrogen in the legume that is derived from the atmosphere - similar to the measurements planned for desmanthus.

TECHNOLOGY TRANSFER AND PUBLICATIONS

Technology transfer

A strong effort has been made to interact with cooperating organisations, agribusiness and industry to communicate relevant research findings quickly and to respond to feedback. This has been achieved through:

1. The regular publication of a Legumes for Clay Soils Newsletter. To date 12 newsletters have been produced under the editorship of Neil Brandon. The mailing list now exceeds 140.
2. Project displays at Ag show in Toowoomba in 1994, 1995 and 1996, Emerald and Bundaberg in 1996 and the "Meat-for-profit" days at Gympie and Chinchilla, as well as local agricultural shows at Biloela and Gayndah.
3. Provision of information to extension officers in general and in particular help to officers at Biloela and Emerald with producer surveys on desmanthus and ley legumes.
4. Field days at Ellenvale (Chinchilla), Kookaburra (Wandoan), Kiamanna (Arcadia Valley), Rangeview (Theodore), Kapalee (Biloela), Birrong (Springsure), Carramah (Capella) and Mutation (Clermont).

5. Liaison with landcare groups at Chinchilla, Wandoan, Taroom, Theodore, Baralaba and Gayndah in the organisation of field days and bus tours and also displays at Landcare sites. Close contact with The Brigalow Floodplain Management Group at Chinchilla and Nev Douglas (the group coordinator) has been maintained through a number of field days and a bus tour involving LCS project sites.
6. Preparation of information leaflets on desmanthus and butterfly pea in association with the seed industry.

7. Conference Papers

Cook, B.G., Graham, T.W.G., Clem, R.L., Hall, T.J. and Quirk, M.F. (1993) Evaluation and development of *Desmanthus virgatus* on medium- to heavy- textured soils in Queensland. *Proceedings of the XVII international grasslands congress,* p.2148-2149.

Brandon, N.J. and Dalzell, S.A. (1996) *Macroptilium bracteatum*: a promising legume for leys. *Proceedings of the eight Australian Agronomy Conference,* p.625.

Clem, R.L. *et al.* (1995) Legumes for clay soils - an integrated research project. *Tropical Grasslands*, **30**, 136.

Conway, M.J., Esdale, C.R., Clem, R.L. and Brandon, N.J. (1995) Legumes for clay soils - demonstrating establishment, persistence and production. *Tropical Grasslands,* **30**, 137.

Jones, R.M., Brandon, N.J. and Conway, M.J. (1995) *Indigofera schimperi* - a promising legume for clay soils. *Tropical Grasslands*, **30**, 138.

8. Papers submitted

Dalzell, S.A., Brandon, N.J. and Jones, R.M. (1997) Response of *Lablab purpureus* cv. Highworth, *Macroptilium bracteatum* and *Macrotyloma daltonii* to different intensities and frequencies of cutting. (accepted for publication in Tropical Grasslands).

3. Introduction

Of Queensland's major pasture communities (Weston et al 1981), pastures growing on clay soils in the downs and brigalow regions cover an area of 11 million ha and support 2.5 million beef cattle (figure 3.1). These pastures are mainly native and naturalised tropical bluegrasses (*Bothriochloa* and *Dichanthium spp),* buffel grasses (*Cenchrus ciliaris)* and rhodes grass (*Chloris gayana)* that produce high animal growth rates of 140 to 180 kg/head/year.

At a time when high growth rates are required to meet emerging market specifications maintenance of pasture and animal production is crucial. However declining nitrogen availability (Graham *et al* 1981) and a general deterioration in pasture condition (Tothill Gillies 1992) is responsible for reduced productivity (Myers and Robbins 1991), and hence animal performance (Jones *et al.* 1995, t'Mannetje and Jones 1990) from permanent pastures.

Figure 3.1 Map of clay soil areas showing experimental sites

Approximately 800 000 ha of clay soils are used for cropping and although a further 2 million ha is potentially arable, (Weston *et al* 1981) large areas continue to be used for beef production or for beef production in association with cropping which includes some forage cropping. Although originally very fertile, continued cropping of these soils has reduced soil nitrogen levels to the extent that the yield and quality of wheat are limited (Dalal *et al* 1991).

Summer growing legumes adapted to clay soils are seen as a viable means of providing high quality forage and maintaining soil fertility in grazing and cropping enterprises. In permanent pastures systems that are used for grazing productive and persistent perennial legumes are needed that can establish and compete with the perennial grasses under conditions of highly variable rainfall. These plants will enhance the quality of the forage available to the grazing stock and assist in maintenance and improvement of soil nitrogen and organic matter. They provide opportunities, where sound grazing management strategies are used to prevent further degradation of these valuable grazing lands by increasing cover which can help to reduce soil erosion and prevent ingress of unpalatable weed species.

In cropping systems annual or short term perennial legumes for use in rotation with crops are needed as a cheap and more reliable source of nitrogen under the highly variable rainfall that is experienced in the region. To benefit subsequent crops as temperate legumes have in southern areas (Lloyd et al 1991) these legumes have to be easily established, produce high forage yields and high amounts of nitrogen but be manageable in the crop phase.

The range of forage legumes currently available that fulfil these roles on clay soils is limited. Those commercially available in the early 1990's included lablab (*Lablab purpureus),* leucaena *(Leucaena leucocephala)* and lucerne *(Medicago sativa*).

The annual lablab is widely used as a forage crop and short term ley although its value as a ley has only been recently recognised (Agnew, 1994). Leucaena, the tropical tree species which is being increasingly sown for long-term use in permanent pastures is well suited to only specific soils and management systems. Lucerne is a temperate species which does not persist in tropical grass pastures and needs to be replanted after 3-5 years.

There was also several legumes including, Centurian centro (*Centrosema pascuorum* cvv. Bundy and Cavalcade), butterfly pea (*Clitoria ternatea* cv. Milgarra), Dalrymple vigna (*Vigna luteola* cv. Dalrymple) and horse gram (*Macrotyloma uniflorum* cv. Leichhardt) which have been commercialised but have not been widely tested on clay soils or into the central and southern areas where only moderate (700 mm MAR) rainfall is received. More recently species such as *Desmanthus virgatus* and *Stylosanthes spp* aff *S. scabra* have been released following testing in evaluation programs but their response to grazing and management inputs was not known.

Consequently the areas on clay soils sown to legume based pastures are small and management systems that allow for successful use of them are not well developed. This project, through the following objectives, aims to:

- identify further legumes that could be used in these grazing and cropping systems
- develop technologies for the successful establishment and management of legumes
- inform producers of the potential benefits of legumes and the need for more specialised management strategies and
- encourage producers to increase the use of legumes.

Objective 1. By June 1995, to develop methods for the successful establishment and management of *Desmanthus virgatus* pastures and incorporate them into suitable management practices for industry.

Objective 2. By June 1996, to quantify the liveweight gain from *D. virgatus* pastures on a range of clay soils.

Objective 3. By June 1996, to have 10,000 ha sown to *D. virgatus* in Queensland.

Objective 4. By June 1996, to develop methods for the successful establishment and management of *Indigofera schimperi* and *Glycine latifolia* pastures and incorporate them into suitable management practices for industry.

Objective 5. By June 1996, to quantify the liveweight gain from *I. schimperi* and *G. latifolia* on a clay soil.

Objective 6. By June 1996, following the release of commercial cultivars, to have seed of *I. schimperi* and *G. latifolia* available to industry in Queensland.

Objective 7. By June 1996, to identify at least four new legumes accessions for further development in both ley and permanent pasture systems on clay soils.

4. Evaluation of *Desmanthus virgatus* and *Indigofera schimperi* under grazing

4.1 Persistence and productivity of eight accessions of *Desmanthus virgatus* grown at five stocking rates in subtropical Queensland

Background

Desmanthus virgatus is native to the Americas and the Caribbean, but has naturalised in many tropical and subtropical environments (Burt 1993). It has been used in many countries as pure legume stand in cut-and carry systems, but has been commercialised in Queensland as a legume for use in legume-grass pastures on clay soils. Three cultivars, which as sold commercially as a mixture, were released in Queensland in 1991. Their selection was based on the results from small plot studies, which had often run for less than 4 years (Cook *et al.* 1993; Clem and Hall 1994, Jones and Clem 1997). There were no experiments which had compared contrasting lines under a range of grazing pressures and very little was known about long-term desmanthus persistence.

This experiment examined the persistence of 8 accessions of desmanthus grazed at 5 grazing pressure over a 7 year period.

Methods

Site and treatments

The experiment was located on clay soils on the Narayen Research Station (25°, 41'S and 150°, 52'E) in subcoastal subtropical Queensland. The site was initially under a brigalow (*Acacia harpohpylla*) tree community, cleared in 1937. It was then part of the long term grazing study, described by McDonald *et al.* (1995), from 1968 to 1985. McDonald *et al.* give further details of land history and soil properties.

Eight accessions of desmanthus (Table 4.1) were sown into separate plots within each of 5 paddocks. These paddocks were of different sizes such that, when grazed by a single yearling animal yearlong, there were 5 stocking rates ranging from 0.8 to 2.0 head/ ha. There were 2 replicates of each accession, in a randomised block layout, within each paddock. The paddock sizes ranged from 0.5 to 1.25 ha.

The desmanthus accessions were sown in February 1989 at 4 kg/ha with seed scarified to give approximately 50% germinable seed. The seedbed was fully cultivated and there was good subsoil moisture. Desmanthus seed was inoculated with *Rhizobium* strain CB1397. The companion grasses were rhodes grass (*Chloris gayana*) cv. Pioneer and green panic (*Panicum maximum*) cv. Petrie, each sown at 2 kg/ha. These grasses were already present, to varying degrees, in the experimental area. An error was made when planting in that the sowing rate of desmanthus in the paddock to be stocked at 1.7 head/ha (stocking rate 4) was sown at twice the correct weight.

Experimental grazing commenced on February 1990, but prior to that all paddocks were periodically grazed in common. It became apparent by August 1990 that this range of stocking rates could be too low in good conditions and yet be too high in sustained dry conditions. The treatments were then changed to be 5 levels of presentation yield rather than 5 fixed stocking rates. Although the plots were still usually grazed by single animals, provision was made for an extra animal to be added or the single animal removed so as to give a range of 5 presentation yields. The target yields-on-offer in late autumn from May 1991 onwards ranged from *ca.* 5000 kg/ha at the lightest "stocking rate" to *ca.* 500 kg/ha at the highest. Decisions on the addition of an extra animal or removal of animals were subjectively based on feed on offer, current soil moisture and current and likely pasture growth rates. For simplicity, the treatments will still be referred to as ranging from stocking rate (SR) 1 (lowest) to (SR)5 (highest).

Table 4.1. A brief description of the accessions of *D. virgatus* sown in the grazing trial

Accession	Origin	Characteristics
33851 [1]	Venezuela	Tall, late flowering
40071	Brazil	Medium height, mid-late flowering
55719	Venezuela	Tall, late flowering
cv. Marc (78382) [2]	Argentina	Short-medium height, ascending, early and rapid flowering
78382	Argentina	Very similar to cv. Marc
79653	Cuba	Decumbent, early/mid flowering
85178	Mexico	Decumbent/prostrate, short, early flowering and heavy seeding
cv. Uman (82803) [2]	Mexico	Decumbent, long stems, late flowering

[1] CPI (Commonwealth Plant Introduction numbers
[2] More detailed description of these cultivars are given by Cook *et al.* (1993).

Measurements

Seedlings of desmanthus and the sown grasses were counted in April 1989, 6 weeks after germination. Thereafter, plant density was measured every spring, using a minimum of 10 quadrats (1 x 0.5m or 0.5 x 0.5 m) per plot. Any seedlings which had emerged since the previous winter were counted separately. Yield and botanical composition were estimated every autumn, with estimated yields corrected using a regression of estimated vs. actual yields in quadrats chosen to cover the range of yields recorded in the field estimations.

Ten fixed quadrat position were marked out in all plots sown to CPI 40071, 79653 and 78382. All original plants were marked in the autumn of the establishment year (1989) and their survival was measured annually. Survival of 4 seedling cohorts in these quadrats in SR4 was followed from 1992 to 1994.

Soil seed reserves were measured annually from 1990 to 1996 in all plots of the SR4 paddock, taking 30 soil cores of 7 cm diameter and 5 cm depth per plot. The plots sown to cv. Marc and CPI 78382 in the remaining stocking rates were sampled for seed reserves in spring of 1990, 1992, 1993 and 1996 at the same intensity. Seed was recovered using the method described by Jones and Bunch (1988a).

Regular notes were taken of attributes such as vigour, flowering, seeding and damage from native psyllids. When some desmanthus leaves appeared yellowish early in the 1995/96 summer, plants were dug up and the roots washed to check for presence of nodules and topgrowth samples were analysed for N and S. Daily rainfall and terrestrial minimum temperature data were collected approximately 1 km from the experimental site.

Results

Rainfall and minimum temperatures

Apart from the year of establishment (1989), all years received below average rainfall (Table 4.2). Three out of the 7 years from 1990 to 1996 received less than 475 mm which is equivalent to decile 2.5 (Cook and Russell 1983). Summer rainfall was also below average in each of these 7 years. Moisture stress during the 1995/96 summer/autumn was greater than the seasonal totals indicate as there was no effective rain between the January 10 and May 1. On average, there were 31 "frosts" with ground temperatures below zero each winter [recalculate after Sept 96], close to the long term average (32.5). The average lowest terrestrial temperatures in each year, *ca.* -5° C, was also close to the long term average.

Table 4.2. Seasonal rainfall data for summer (Dec, Jan, Feb), autumn (Mar, Apr, May), winter (Jun, Jul, Aug) and spring (Sep, Oct, Nov) at Narayen, with corresponding long term averages. Also listed are the total number of occasions when the terrestrial minimum fell below zero and the coldest temperature recorded in each winter. Bold type indicates rainfall below the corresponding long-term average.

Year	Rainfall (mm)					Temp < 0.0° C	
	Summer	Autumn	Winter	Spring	Year	No.	Lowest
1989	359	255	125	**163**	902	40	- 5.3
1990	**68**	307	**62**	**143**	**580**	42	- 5.5
1991	**181**	**65**	**49**	**62**	**357**	30	- 4.7
1992	**258**	**140**	**45**	**126**	**569**	23	- 3.8
1993	**201**	**15**	**58**	**160**	**434**	5	- 2.0
1994	**230**	**108**	**21**	83	**442**	47	- 6.5
1995	**201**	**73**	**26**	377	**677**	27	- 6.5
1996	**188**	**144**					
Long term	302	148	101	166	717	33	- 4.7

Long term data from Cook and Russell (1983)

Establishment

Desmanthus and sown grasses seedlings emerged in late March and April 1989. In early May 1989 the average seedling densities for desmanthus, rhodes and green panic were 9, 8 and 2/m^2. The desmanthus density averaged 8.0 seedlings/m^2 in SR1, SR2, SR3, and SR5 and 15 seedlings/m^2 in SR4 which had been sown at double the sowing rate.

Over 160 mm of rain fell in April after seedlings emerged in late March 1989. Grass growth was very vigorous whilst grazing was delayed to avoid excessive pugging and damage to legume seedlings. This resulted in severe competition to the establishing legume seedlings from the vigorous grass.

Yields and grazing pressures

The concept of controlling grazing to achieve a range of presentation yields was introduced in late 1990. However, the actual stocking rates imposed in the first 3 years, calculated on a grazing days/ha/year basis from February 1990 to August 1992, were 1.0, 1.3, 1.6, 1.7 and 1.9 head/ha for the treatments from the highest to the lowest presentation yield. These were very close to the stocking rates originally nominated. Due to dry seasons and the loss of perennial grasses at the higher stocking rates in the trial in 1991, these stocking rates could not be maintained. The calculated stocking rates for the period August 1992 to August 1996 were lower and with less difference between the treatments; 0.6, 0.6, 0.6, 0.8 and 0.9 head/ha from the highest to the lowest presentation yield.

The total DM yields, as measured in autumn of each year and averaged over desmanthus accessions, are listed in Table 4.3. The effect of stocking rate on pasture yield was least in the first year of grazing. Although the targeted linear range of yields from 0.5 to 5.0 t/ha was not achieved in every year after 1990, the average presentation yields from 1991 to 1996 ranged from 0.7 to 4.7 t/ha (Table 4.3).

Table 4.3. Total DM yield in late autumn of paddocks sown to 8 accessions of desmanthus. The r^2 of the regression between nominal stocking rate and yield is also given, with values in bold type from a quadratic regression where this was significantly better than that from the linear regression.

S.rate (hd/ha)	Total pasture yield (t/ha)						
	5/90	5/91	5/92	3/93	4/94	4/95	3/96
0.8	4.2	5.7	5.1	4.3	5.5	3.7	3.6
1.1	5.5	4.7	3.2	1.8	6.2	2.9	3.1
1.4	5.8	4.0	0.9	1.3	3.5	1.1	2.3
1.7	2.4	0.3	0.4	0.6	3.5	1.3	1.7
2.0	2.7	<0.1	<0.1	0.4	2.0	0.7	0.8
r^2	ns	0.91	0.98	0.96	0.81	0.87	0.99

ns = not significantly different

Botanical composition

Although all the paddocks were originally dominated by rhodes grass, the rhodes grass failed to persist at the higher stocking rates in the dry years experienced. By autumn 1994 the percent of rhodes grass in SR 1-5 was 63, 60, 5, 0 and 0%. This did not change over the next 2 years with the corresponding percentages in 1996 being 61, 43, 11, 0 and 0% respectively. There was always only a patchy occurrence of green panic, averaging 5% over all treatments in 1996. In 1996 the percentage of unsown species, mainly *Urochloa panicoides* and *Rhagodia* spp., ranged from 36% in SR1 to >99% in SR5.

The average percentage of desmanthus in the pastures from 1990 to 1996 is given in Table 4.4. Differences between accessions were least in the first year of grazing (1990). The accessions with the consistently highest percentage after that were CPI 78382 and cv. Marc. From 1992 to 1995 they had averaged about 10% of composition although their percentage declined to 5% in the final year (1996). In the final two years, these lines had the highest legume percentage of all the accessions in all 5 stocking rates. From 1992 to 1994 they also had the highest percentages in all stocking rates except for CPI 85178 in stocking rate 1 (1992, 1993 and 1994) and CPI 40071 in stocking rate 1 (1993 and 1994).

Table 4.4. Percentage of 8 accessions of desmanthus in pastures in autumn, averaged over 5 grazing pressures, from 1990 to 1996.

Accession	Proportion of desmanthus (%)					
	1990	1992	1993	1994	1995	1996
38351	4.4	13.0	2.9	4.0	1.0	0.3
40071	2.1	11.7	3.2	9.1	2.4	1.2
55791	2.6	6.2	1.1	3.1	0.2	0.0
Marc	5.8	19.9	11.5	7.6	7.2	3.0
78382	5.7	18.2	10.6	11.2	10.3	4.0
79653	0.2	4.3	0.0	0.0	0.0	0.0
85178	2.3	16.9	8.2	4.5	1.1	0.7
Uman	0.6	1.6	0.0	0.0	0.0	0.0
LSD (P<0.05)	2.7	6.6	4.8	4.7	4.7	1.1

The percentage of desmanthus was not estimated in autumn 1990.

Desmanthus density

There were significant differences between the densities of the different desmanthus accessions but no accession x stocking rate interactions. Therefore only the annual density of desmanthus accessions, meaned over stocking rates, is given in Table 4.5. Clearly, Marc and CPI 78382, followed by CPI 85178, had the highest densities in the latter years of the experiment. The densities for SR4, where soil seed reserves were measured, are given in Table 4.6. The same lines had the highest densities and these fluctuated over time whereas the density of other lines, such as CPI 38351, steadily declined.

Table 4.5. Density of 8 accessions of desmanthus, averaged over all stocking rates, in autumn 1989 and in spring from 1989 to 1996.

Accession	Desmanthus density (plants/m^2)								
	4/89	'89	'90	'91	'92	'93	'94	'95	'96
38351	5.1	1.8	0.6	0.6	0.4	0.2	0.1	0.1	0.2
40071	6.6	1.4	0.7	0.7	0.7	0.8	0.8	0.4	1.1
55719	4.1	1.5	0.5	0.2	0.2	0.0	0.1	0.0	0.0
Marc	7.3	3.6	1.3	2.3	3.6	2.4	3.5	1.4	5.3
78382	4.6	2.5	1.2	1.3	4.8	3.0	6.1	2.2	8.3
79653	3.2	0.6	0.1	0.2	0.1	0.0	0.0	0.0	0.0
85178	3.1	2.7	1.1	2.5	3.2	2.0	4.5	1.4	1.0
Uman	4.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
LSD (P<0.05)	1.9	1.5	0.7	1.2	3.4	1.6	3.1	1.3	5.5

Table 4.6. Density in 8 desmanthus accessions in SR4 - a stocking rate of 1.7 head/ha from mid 1990 to August 1992 and 0.8 head/ha from August 1992 to August 1993. All counts in spring (September to December) except for the autumn counts in 1989 taken 2 months after emergence.

Accession	Desmanthus density (plants/m²)								
	4/89	'89	'90	'91	'92	'93	'94	'95	'96
38351	11.0	4.6	2.5	3.0	1.6	0.8	0.3	0.6	0.7
40071	6.6	0.8	1.6	0.9	2.0	0.1	2.2	0.2	4.3
55719	6.9	3.0	1.6	0.7	0.5	0.0	0.3	0.0	0.1
Marc	12.2	9.6	3.8	6.3	14.4	2.6	11.0	3.2	17.3
78382	8.4	3.0	3.5	3.6	20.2	3.0	16.7	6.8	33.6
79653	5.1	1.8	0.2	0.3	0.0	0.0	0.2	0.0	0.0
85178	5.6	7.4	3.0	3.4	9.2	1.9	4.7	0.6	2.7
Uman	6.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0

Soil seed and seedling/plant survival

Soil seed reserves. The annual measurements of soil seed reserves in SR4 have been pooled into 3 time periods covering the early, middle and late stages of the experiment (Table 4.7). The seed banks of Marc, CPI 78382 and CPI 85178 were higher after the first two years of the trial and the far higher seed banks of CPI 78382 and Marc were maintained thereafter. Apart from these three lines, CPI 40071 was noted to seed more frequently than the remaining lines (CPI 33851, 55719, 79653 and Uman (CPI 92803) although its seeds reserves in SR4 were not significantly higher (Table 4.7). Some of the seed reserves measured in these five lines in later years may even have been contamination from the isolated invading plants of CPI 78382 and Marc.

Table 4.7. Soil seed reserves of 8 *D. virgatus* accessions in SR4 as sampled in late winter/spring in 3 time periods (mean of 1990 and 1991; 1992, 1993 and 1994; and 1995 and 1996 samplings) and seedling densities in May 1996

Soil seed reserves (/m²)				Seedlings
Accession	1990-91	1992-94	1995-96	May '96
38351	86(1.84)	186(2.16)	269 (2.32)	0 (0.0)
40071	58(1.70)	738(2.44)	466 (2.53)	10 (0.7)
55719	4(0.49)	132(1.91)	84 (1.92)	0 (0.0)
Marc	3550(3.48)	7900(3.88)	5430 (3.70)	83 (1.9)
78382	344(2.26)	15000(4.1)6)	11500 (3.94)	160 (2.1)
79653	10(0.68)	483(2.24)	121 (2.10)	0 (0.0)
85178	798(2.89)	2900(3.34)	1800 (3.18)	10 (1.0)
Uman	121(1.85)	280(2.41)	220 (2.10)	5 (0.5)
LSD (P=0.05)	(1.29)	(0.84)	(0.82)	(0.9)

Transformed values in brackets are Log(X + 1)

Seedlings

Seedling numbers were always higher in the lines with the highest seed reserves, as in the example given in Table 4.5.

Seedling emergence and survival of CPI 78382 in SR4 was followed for 1 seedling cohort in 1992/93 and 3 cohorts in 1993/94. The number of seedlings/m^2 emerging in these 5 cohorts, and their percentage survival to the following spring (given in brackets) was: 13 (0%), 3 (0.2%), 25 (0%). 43 (0%) and 194 (15%). It was this latter cohort which contributed to the increased density of CPI 78382 from 1993 to 1994 (Table 4.6). These measurements confirmed observations throughout the trial that most seedling cohorts died during dry periods in the growing season during which they emerged.

Plant survival

All 395 desmanthus plants, tagged in first spring following the year of establishment, had died after 6 years.

Other observations

Damage from psyllids was periodically noted, but never appeared to be a major limitation. The leaves of desmanthus were usually green. When paler plants were dug up in the 1995/96 summer, their roots were found to have pink nodules. However, nodules had not been found in a previous sampling. Nitrogen and S concentrations in the terminal 15 cm of shoots collected early in the 1995/96 summer were 3.0 and 0.23%.

Discussion

The limitations of the experiment will be considered first, followed by an assessment of the desmanthus accessions and finally by some practical considerations for the use of desmanthus.

Experimental considerations

There are 3 factors which must be allowed for when interpreting the results of this experiment.

Firstly, SR 4 was inadvertently sown at twice the sowing rate of the other stocking rates. This resulted in higher yields and densities of desmanthus in this stocking rate, but there is no evidence that this affected the relative performance of the different lines. However desmanthus yields and density in SR4 could not be directly compared with the other stocking rates.

Secondly, due to the wet conditions after emergence, insufficient grazing pressure was applied to the pastures during the establishment phase. This probably decreased the survival of desmanthus during the first year. The initial use of fixed stocking rates in 1990, when grass growth was still vigorous because of favourable moisture and mineralised nitrogen, also resulted in pasture being undergrazed. However, changing treatments to levels of presentation yield rather than fixed stocking rates provided a system of grazing which was well suited to coping with fluctuating growth varying between good and poor rainfall years. This is likely to be needed more on fertile heavy textured soils, in this instance with some 3% organic matter, than on a light textured soil. Most duplex soils have lower levels of organic matter, and hence limitations of available N for grass growth in a good rainfall year, but better ability to respond to lighter falls of rain than a heavy textured soil.

The third factor is the almost total death of rhodes grass during dry periods at the 3 higher stocking rates. This contrasted with the retention of good rhodes grass at the 2 lightest stocking rates, particularly the lowest. This greater death of rhodes grass at higher stocking rates during dry periods has been noted in earlier studies at Narayen (Jones *et al.* 1995). The death of rhodes grass reduced the potential productivity of the higher stocking rates. This explains why, in the last three years, the actual stocking rate on the nominally lightest SR 1 was similar to SR2 and SR3.

Assessment of desmanthus.

Despite the dry conditions, Marc and CPI 78382 usually had over 10% of presentation yield, averaged over all stocking rates, at the end of the growing season. Their percentage declined in 1996 but this sampling was carried out in late March after a long dry period and when plants had been heavily grazed at the higher stocking rates.

It was consistently noted that Marc, CPI 78382 and CPI 85178 could set seed after one isolated rainfall event as well as being able to flower early in the season. Their seed reserves of over 5000/m^2 in SR4 were similar to those of CPI 78382 measured in small plots at 2 sites by Jones and Rees (1997). They were far higher than the reserves of 150-450 seeds/m^2 of CPI 78382 measured by Burrows and Porter (1993). However, these authors point out that the desmanthus growth in their study was limited by severe grass competition and work by Brandon *et al.* (1997) has highlighted likely nutrient deficiencies at that site.

Four accessions (CPI 38351, 55721, 79653 and Uman) set little seed. CPI 40071 set more seed than these but much less seed than CPI 85178 and, in particular, Marc and CPI 78382. These 5 lines not only flowered later in the season but seed development was more protracted and they appeared to require a longer period of favourable moisture to flower and mature seed. Thus dry conditions, particularly late in the growing season, were the main factor limiting their seed set, but grazing pressure and frosting could also be involved. Frosting of stems over winter has a particular impact on cv. Uman which flowers so "late" that flowers appear in spring on growth from those old stems that have survived the previous winter. However these lines could well set more seed during seasons with longer spells of favourable soil moisture, especially in the second half other growing season when these lines flower and seed.

The density counts on SR4 suggest that individual plants of the robust and later flowering CPI 38351 persist better than the smaller and freer seeding CPI 78382 and Marc. However, in the absence of recruitment, the plant density of lines such as CPI 38351 gradually declined and their plant density was low at the end of the trial. In contrast, the fluctuating plant densities of CPI 78382 and Marc showed clear evidence of successful recruitment of new plants. This has also been documented for CPI 78382 by Burrows and Porter (1993) and for Marc by Clem and Hall (1994). Cv. Uman had poorer persistence than the other late flowering robust types. This has been noted in other adjacent experiments at this site (authors unpublished data)

Even though the failure of the later flowering lines to maintain density relates to the lower seed reserves of these lines, they still had reserves of some hundreds of seeds/m^2 in SR 4. Such reserves would be similar to those which could maintain a productive sward of siratro (e.g. Jones and Bunch 1988b). So why were these lines unable to maintain desmanthus density in SR 4? There are 2 possible reasons.

The first is that desmanthus is very hardseeded. Data on the rate of breakdown of hard seed presented by Burrows and Porter (1993) suggest that the half life for breakdown of hard seed is 60-70 months. Thus it may take some years for a seed input to be reflected in seedling numbers. However in SR 4 there is evidence of seedling recruitment of Marc and CPI 78382 in 1990/91, 2 years after sowing, and of substantial increase from seedling recruitment in the third year after sowing.

The second and probably the most important reason relates to the successive dry years experienced in our study. There was often seedling emergence following isolated rainfalls but on most occasions all the seedlings or small plants died due to lack of follow up rain.

Yellowing or unthriftiness of desmanthus was not a feature of this trial unlike other sites, e.g. Brian Pastures Research Station (Burrows and Porter 1993), where ineffective nodulation and/or sulphur deficiency have been measured in field and glasshouse studies (Brandon *et al.* 1997). Sulphur levels were above the tentative critical level of 0.2% S (Brandon *et al.* 1997) On the one occasion when some yellowing was observed these factors did not appear limiting. Although infestation from native psyllids was noted on occasions, it did not appear to be a serious limitation to yield. Observation suggested that cattle preferred to graze grass leaf rather than desmanthus during active growing periods in summer, although desmanthus was grazed, at times quite heavily.

Practical implications

Desmanthus is sold commercially as a mixture of early, mid and late flowering lines - cvv. Marc, Bayamo and Uman. We did not have Bayamo in this experiment but in more recent sowings at Narayen it has shown a limited ability to set seed, similar to CPI 55719 and 38351 in this study. Thus it is likely that, in years such as we experienced, that commercial sowings will drift towards dominance by Marc which will have far higher seed reserves and plant recruitment. The dominance of Marc will increase as original plants of the other lines gradually die.

However Uman and Bayamo have higher yield potential and it could be desirable to keep these lines in the commercial pastures. Thus it is suggested that, when these lines are flowering and seeding following favourable conditions, grazing could be controlled to ensure that seeding is not prevented by heavy grazing. Such seed input would not be required every year, once in every 3-4 years may be adequate. Unless pastures were overgrazed, it is unlikely that any specific grazing management would be required for cv. Marc to seed.

Our experiment has also highlighted the "trade-off" between yield and seed production - the latter being essential for long term persistence. There may be a place for a cultivar which can seed more freely than Bayamo or Uman but have greater productivity than Marc. Observations from other trials suggest that lines CPI 40071 and TQ90 may be more of this type although the seed set of CPI 40071 was not significantly better in SR4 this experiment.

The final implication relates to grazing management during the establishment phase. In hindsight we could have maintained higher grazing pressure at this time so as to reduce grass competition, though it is possible that this could have increased death from pugging, as noted by Burrows and Porter (1993).

4.2 Production and persistence of *Desmanthus virgatus* and *Indigofera schimperi* under grazing

Background

The objective of this experiment was to compare 2 lines of *Desmanthus virgatus* (Marc and Bayamo) and 2 lines of *Indigofera schimperi* (CPI 52621 and 73608) at 5 grazing pressures, with Uman desmanthus at 2 grazing pressures. Cultivar Uman was only included at two grazing pressures as other studies have shown that it does not persist at Narayen. *I. schimperi* CPI 52621 is the accession of indigofera that is on pre-release and is showing promise at many sites. CPI 73608 had shown promise in drier areas, but preliminary small plot work suggested that it was less persistent than CPI 52621 in the 600-700 mm rainfall zone.

Although animal production was to be measured, the key thrust of the trial was on persistence and productivity of the legumes in response to grazing pressure. The trial, however, should have been adequate to compare animal production from desmanthus and indigofera and to confirm that there are no toxicity problems with indigofera.

1993/94 sowing - methods

The trial was first sown in the 1992/93 season. Although there was some scattered establishment, the legume density was inadequate for the trial to proceed and it was re-sown with a bandseeder in the 1993/94 summer, with buffel grass and rhodes grass as the companion grasses. *Glycine latifolia* was included in the first sowing but, due to lack of seed, was replaced by Uman desmanthus in the second sowing.

Results and discussion

The main emergence was in February 1994 and, despite well below average rainfall, there was a satisfactory density of legumes in the year of sowing and persisting through to the following summer (Nov. '94):

Accessions	Seedlings/m^2				
	Feb 1994	Apr 1994	Nov 1994	Nov 1995	Oct 1996
Marc desmanthus	6.0	4.2	2.9	1.3	0.7
Bayamo desmanthus	7.7	4.8	3.7	1.6	1.1
Uman desmanthus	3.5	2.4	1.1	0.0	0.0
I. schimperi CPI 52621	5.6	3.0	2.2	1.5	1.5
I. schimperi CPI 73608	5.6	2.6	1.8	0.4	0.2

From February to November 1994 there was a greater decline in the density of Uman than of the other accessions. Marc was the only accession to set seed and it had an average seed reserve of some 300 seeds/m^2 as measured in spring 1994. Despite the well below average rainfall, plants grew well and the larger plants of both species were over 40 cm diameter at the end of the 1994/95 season. There was further seeding of Marc in 1994/95 but very little seeding of Bayamo.

However, although there was a good strike of rhodes grass and a poorer strike of buffel grass from the January 1994 sowing, most of the grass seedlings died. This is largely attributed to lack of follow-up rain and the inability of the grasses to survive without secondary roots. Consequently, the pastures were again oversown with buffel and rhodes grass in November 1994 and again in early March 1995. The November sowing failed and there was no effective autumn rain after the March sowing so it also failed.

Gramoxone spray, used to suppress the annual urochloa, resulted in massive leaf and upper stem death of both legume species. This, combined with the dry conditions, may have been responsible for the increased death of legume plants between November 1994 and November 1995. Gramoxone had previously been used when oversowing and caused only minor leaf death on isolated plants. Consequently the adverse effect of spraying in March 1995 was not anticipated.

However, the decline from 1994 to 1995 was still greater in Uman and, to a lesser extent, *I. schimperi* CPI 73608, as was the case prior to spraying. *I. schimperi* CPI 52621 had the best survival from 1994 to 1995, as was also the case prior to spraying.

In the final measurement of plant density in October 1996, the same trends were evident. The density of desmanthus continued to decline, although Bayamo was persisting better than Marc, as documented in the small plot trials at Narayen. There were a low number of small Marc plants (0.1/m_2) surviving from the May 1966 rains but no seedlings of Bayamo or Uman. Although seed reserves of Marc were low and rainfall conditions have not been favourable, this further points to the ability of Marc to persist through seedling recruitment, noted elsewhere in this report. Unlike CPI 73608, the density of *I. schimperi* CPI 52621 had not changed between spring 1995 and spring 1996, confirming the good persistence of this accession noted elsewhere. Growth of *I. schimperi* 52621 has been very good during periods of favourable rainfall, and, under common and mostly continuous grazing, it has been eaten to almost the same extent as desmanthus.

Conclusions

Although the grazing treatments were never imposed, this trial has shown that Uman desmanthus persisted poorly at Narayen, confirming results from other experiments. It has also shown that individual plants of Bayamo desmanthus persist better than plants of Marc, and has confirmed the ability of Marc to seed with slight seedling recruitment two years after seed set.

This trial has also shown that *I. schimperi* CPI 52621 can be established under conditions when buffel grass and rhodes grass could not be established. It has also shown that CPI 52621 is a persistent line, despite being seriously affected by herbicide, and can be adequately eaten if subject to grazing over the whole growing season.

However, we were unable to proceed with this experiment as there was no perennial grass component. Following the recommendations of the NAP2 review team, this experiment will be terminated. However, CPI 52621, along with four other indigofera accessions, has been established in two paddocks incorporated into the existing Mt. Brian grazing trial at Brian Pastures Research Station. This should enable us to answer two questions. Firstly, how well is CPI 52621 eaten under year-round grazing and what impact does it have on animal production. Secondly, are there other accessions of indigofera which are as persistent as CPI 52621 but more acceptable to cattle.

5. Development of desmanthus pastures under grazing

Background

Desmanthus virgatus is a perennial summer-growing legume suitable for growing on clay soils in tropical and sub-tropical Queensland. Unlike other tropical legumes currently available to livestock producers for sowing in heavy soils, desmanthus is well suited for use in extensive grazing areas of native and sown grasses. Desmanthus offers good prospects for restoring animal production from pastures which are deteriorating in condition, pasture quality and animal production (Burrows 1990), providing they can be successfully established and managed. These studies aimed to monitor the development of *Desmanthus virgatus* pastures under commercial grazing conditions and to quantify animal liveweight gains.

5.1. Comparison of grass and grass + desmanthus under grazing

5.1.1 Brian Pastures Research Station

Methods

The experiment of 3 pasture treatments by 2 replications is situated on a black earth (Ug 5.24) at Brian Pastures Research Station (25° 39′ S and 151° 45′ E). Initially in November 1987 paddocks of 2.4 ha each were sown to either purple pigeon grass (*Setaria incrassata* cv. Inverell), purple pigeon grass + lucerne or purple pigeon grass + desmanthus (accession CPI 78382). Establishment of grass was good, lucerne density was 12 plants/m^2 and desmanthus 2 plants/m^2. Lucerne declined and in January 1991 these paddocks were oversown with Marc desmanthus using a band seeder. Establishment from this sowing was poor and rainfall since (Table 5.1) has generally been below average. In November 1995 all paddocks were fertilized with molybdenised superphosphate to supply 20 kg/ ha S, 16 kg/ ha P and 5 g/ ha Mo.

Table 5.1 Monthly rainfall (mm) at Brian Pastures Research Station

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Yr
1990/91	22.0	4.4	22.8	62.4	41.4	44.2	86.8	122.0	71.0	0.4	32.6	15.6	526
1991/92	18.6	0.0	0.0	74.2	40.0	136.7	96.6	196.0	102.8	12.9	103.4	0.6	782
1992/93	20.2	20.2	82.6	7.8	84.8	108.0	139.2	69.6	57.4	0.0	10.0	15.5	615
1993/94	38.0	31.6	75.2	34.2	79.2	75.4	49.4	110.5	165.4	17.6	5.0	14.6	696
1994/95	17.8	0.6	1.8	57.8	34.2	105.6	45.8	78.2	51.4	41.0	42.2	8.4	484
1995/96	3.8	9.8	17.6	87.0	143.0	132.6	259.4	37.4	21.3	21.6	102.1	11.0	825
Longterm average	34.0	28.5	29.2	61.0	70.3	104.5	106.8	95.5	72.3	37.7	38.6	29.9	708

Pastures were grazed at various stocking rates until October 1993 and at 1 steer/1.2 ha since. Animal liveweight gains, pasture yield, legume density and legume soil seed have been measured.

Results and discussion

Desmanthus has been slow to develop in these vigorous purple pigeon grass pastures and the legume contribution to pasture yield remains low (Table 5.2). Purple pigeon grass remains the dominant species yielding over 85% of the total pasture yields which in April 1991 were again relatively high. Seedlings have emerged on a number of occasions but have not been able to survive under dry conditions in competition with the grass.

Consequently legume density has not changed although there has been a small increase in soil seed (Table 5.3).

Table 5.2 Pasture yield and botanical composition (kg/ha) in the grass and grass plus *Desmanthus* paddocks and legume density in the *Desmanthus* paddocks at Brian Pastures.

Paddock	Species	Oct 1994	Jun 1995	April 1996
Grass	P. pigeon	1059	714	3036
	Q. Blue	241	265	188
	Other species	40	41	126
	Total Yield	**1340**	**1020**	**3350**
Desmanthus 78382	P. pigeon	1789	1294	2828
	Q. Blue	181	140	84
	Other species	32	105	322
	Desmanthus	8	21	77
	Total Yield	**2010**	**1560**	**3310**
Desmanthus density/m^2		5.2	4.5	3.3
Desmanthus 78373	P. pigeon	1370	825	2872
	Q. Blue	154	107	165
	Other species	14	36	101
	Desmanthus	2	2	12
	Total Yield	**1540**	**970**	**3150**
Desmanthus density/m^2		0.6	0.4	0.5

Colour and growth of legume improved following superphosphate fertilizing of all paddocks in November 1995 and sulphur concentration in legume tops was higher than in unfertilized areas. Previously desmanthus growing in pots of this soil had responded to adding sulphur and molybdenum.

Table 5.3 Legume density (plants/m^2) and soil seed (seed/m^2) in desmanthus treatments at Brian Pastures

Accession	Plant density (plants/m^2)			Soil seed (seed/m^2)		
	May 94	Jun 95	Aug 96	Jul 93	Sep 94	Oct 95
78373 (Marc)	0.6	0.4	0.5	23	30	45
78382	5.2	4.5	4.7	526	1225	518

The difference in liveweight gain between steers grazing grass and grass/desmanthus pasture has been small but marginally higher in the legume paddocks (Table 5.4). This is not unexpected given the very small amount of desmanthus available for grazing and the high yield and quality of the purple pigeon grass pasture. Desmanthus plants have been grazed at most times of the year but tend to be browsed over the summer period when grass is actively growing and grazed more heavily (back to crowns) during the dry season.

While performance of desmanthus has been disappointing established plants have persisted under conditions of extreme dry and in competition with vigorous growing grass. There is now a likelihood that the legume will improve provided average or above average summer rainfall is received and it is worthwhile monitoring for a further 2 years to confirm the effects of adding fertilizer and measure improvements in legume density and growth.

Table 5.4 Liveweights and liveweight change of steers grazing grass, grass/desmanthus (CPI 78382) and grass/desmanthus (CPI 78373).

Draft 5 1 steer/0.6 ha	**14/05/92 to 19/05/93 (370 days)**			
	L/wt 14/05/92	L/wt 19/05/93	Change (370 days)	kg/head/day
Grass + *Desmanthus* CPI 78382	193	386	193	0.52
Grass + *Desmanthus* CPI 78373	194	370	176	0.48
Grass	194	377	183	0.49
Draft 6 1 steer/1.2 ha	**18/10/93 to 23/05/94 (217 days)**			
	L/wt 18/10/93	L/wt 23/05/94	Change (217 days)	kg/head/day
Grass + *Desmanthus* CPI 78382	206	380	174	0.80
Grass + *Desmanthus* CPI 78373	208	378	170	0.78
Grass	226	396	170	0.78
Draft 7 1 steer/1.2 ha	**23/05/94 to 14/06/95 (387 days)**			
	L/wt 23/05/94	L/wt 14/06/95	Change (387 days)	kg/head/day
Grass + *Desmanthus* CPI 78382	204	367	163	0.42
Grass + *Desmanthus* CPI 78373	204	381	177	0.46
Grass	205	381	176	0.45
Draft 8 1 steer/1.2 ha	**14/06/95 to 20/05/96 (340 days)**			
	L/wt 14/06/95	L/wt 20/05/96	Change (340 days)	kg/head/day
Grass + *Desmanthus* CPI 78382	204	360	156	0.46
Grass + *Desmanthus* CPI 78373	205	364	159	0.47
Grass	204	354	150	0.44
Draft 9 1 steer/1.2 ha	**20/05/96 to 16/09/96 (119 days)**			
	L/wt 20/05/96	L/wt 16/09/96	Change (119 days)	kg/head/day
Grass + *Desmanthus* CPI 78382	197	228	31	0.26
Grass + *Desmanthus* CPI 78373	199	236	37	0.31
Grass	198	226	28	0.24

5.1.2 Brigalow Research Station

Method

Two paddocks of 10 ha each on brigalow clay soils (Ug 5.16) at Brigalow Research Station were cultivated and sown to either buffel grass or buffel grass + desmanthus in February 1990. Previously the area had been cleared of brigalow and used for cropping and pasture for some 20 years. Some areas were resown in February 1992.

Paddocks have been grazed since May 1991 at a stocking rate of 1 steer/ 2 ha except for the 1992/93 season when heavier stocking was used over the summer but paddocks were destocked over winter and spring when rainfall was very low (Table 5.5).

Steer liveweights, pasture yield and composition, legume density and legume seed in the soil have been measured.

Results and discussion

Establishment of the sown buffel grass and desmanthus was satisfactory although a severe infestation of sesbania (*Sesbania cannobina)* occurred. Many seedlings did not survive and legume density has remained low although survival and seedling recruitment of the early flowering lines Marc and 78382 has been better (Table 5.6). Soil seed levels in these areas have also increased although they were lower in October 1995 than in 1994. Legume density is trending upwards although severe seedling loss again occurred over the dry autumn/winter of 1995.

Pasture yields were initially high and dominated by Queensland bluegrass (*Dicanthium sericeum)* although botanical composition has always been different in the 2 paddocks. Buffel grass survived the drier periods in 1992 and 1993 better than the other grasses and in June 1993 was contributing almost 90% to pasture yield in the grass paddock. Queensland bluegrass has been able to re-colonise and is now a significant portion in both paddocks (Table 5.7). The desmanthus paddock has a greater diversity of grasses but the amount of legume remains low.

Table 5.5 Monthly rainfall (mm) at Brigalow Research Station (1990-1996), and the long term average for Banana. (Planting date was 15/02/90 and 3.4 ha of the paddock was oversown on 20/02/92).

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Yr
1990/91	1	0	6	44	16	175	117	77	17	8	11	48	520
1991/92	39	0	0	15	28	176	66	126	37	33	71	2	593
1992/93	0	21	73	9	55	81	61	35	4	0	6	8	353
1993/94	29	10	77	42	52	15	76	88	179	14	25	30	637
1994/95	0	0	22	77	53	125	157	11	33	79	124	17	696
1995/96	1	13	16	115	69	128	219	126	13	37	88	11	836
Average Banana (1880-1990)	33	23	29	53	67	91	100	98	72	36	34	39	674

Table 5.6 Changes in plant populations (plants/m^2) of *Desmanthus* accessions under grazing and soil seed reserves (seeds/m^2).

	Plant density (plants/m²)						Soil seed (seed/m²)		
Accession	Apr 90	Dec 90	Mar 90	Mar 93	Feb 94	Aug 95	Jul 93	Sep 94	Oct 95
38351*	3.6	0.9	0.4	0.3	1.6	0.9	30	Nil	Nil
78373 (Marc)	0.6	0.2	1.0	0.5	4.9	0.9	60	1290	525
78382	1.7	0.8	1.6	1.6	13.6	7.0	361	3080	975
92803 (Uman)*	0.3	0.1	0.1	0.3	3.5	0.9	45	150	120

*These areas oversown with 78382.

Table 5.7 Pasture yield and botanical composition (kg/ha) in the grass and grass plus *Desmanthus* paddock and legume density in the *Desmanthus* paddock.

Paddock	Species	Apr 92	Jun 93	May 94	Jun 95	Mar 96
Buffel	Buffel	620	423	1624	2667	2059
	Rhodes	1390	493	15	1	131
	G. Panic	370	13	80	119	17
	Q. Blue	1676	498	291	190	1320
	Other grasses	185	62	152	56	145
	Weeds	113	0	670	61	59
	Total Yield	**4354**	**1489**	**2832**	**3094**	**3731**
Buffel + *Desmanthus*	Buffel	243	430	1476	806	1371
	Rhodes	435	166	14	23	42
	G. Panic	1047	49	376	788	290
	Q. Blue	2498	1365	767	973	1934
	Other grasses	88	26	184	89	211
	Desmanthus	51	1	148	38	114
	Weeds	97	3	204	14	1
	Total Yield	**4459**	**2040**	**3169**	**2731**	**3963**
Desmanthus density	Old plants	0.9	1.2	2.7	8.0	4.3
	Seedlings	0.5	-	-		1.3

(b) Animal liveweight gains

Both paddocks have been grazed throughout the year at a stocking rate of 1 beast/2 ha since 17 May 1991 except for 1993 when stock grazed at 1 beast/ha from September 1992 to June 1993 and paddocks were destocked from June 1993 to December 1993

Animal liveweight gains have been high (>0.45 kg/head/day) except for draft 2 when the pasture was grazed at a higher stocking rate. Growth rates of stock have been similar for both the grass and grass + desmanthus paddocks although for draft 3 there was an advantage to the legume paddock.

Except for draft 3 there has been no advantage to animals in the Desmanthus paddock (Table 5.8).

Table 5.8 Liveweights and liveweight change of steers/heifers in the grass and grass + *Desmanthus* paddock.

Draft 1 1 steer/2 ha				
	L/wt 17/05/91	L/wt 06/10/92	Change (507 days)	kg/head/day
Grass	195	454	259	0.51
Grass + *Desmanthus*	195	429	234	0.46
Draft 2 1 steer/ ha				
	L/wt 06/10/92	L/wt 23/06/93	Change (260 days)	kg/head/day
Grass	266	342	76	0.29
Grass + *Desmanthus*	265	339	74	0.28
Draft 3 1 heifer/2 ha				
	L/wt 09/12/93	L/wt 05/07/94	Change (208 days)	kg/head/day
Grass	356	488	132	0.63
Grass + *Desmanthus*	361	511	150	0.72
Draft 4 1 steer/2 ha				
	L/wt 05/07/94	L/wt 22/06/95	Change (352 days)	kg/head/day
Grass	231	436	205	0.58
Grass + Desmanthus	233	424	191	0.54
Draft 5 1 steer/2 ha				
	L/wt 21/06/95	L/wt 21/06/96	Change (366 days)	kg/head/day
Grass	333	499	166	0.45
Grass + Desmanthus	335	504	169	0.46

5.2 Grazing development of desmanthus

Methods

Four sites have been sown. Kookaburra (Wandoan), Rangeview (Theodore) and Kapalee (Biloela) were sown in the 1993/94 summer and Rolf Park (Middlemount) in January 1995. All soils are clays (Ug, Uf) with alkaline pH at the surface but soil phosphorus is variable (Table 5.9) Kookaburra and Rolf Park were sown onto fully prepared seed beds on country previously cleared of brigalow and used for cropping. At Rangeview (open downs) and Kapalee (Brigalow) desmanthus was oversown using a bandseeder. Rainfall (Table 5.10) has generally been below average and difficult for establishment especially at Rangeview and Kapalee.

Table 5.9 Details of soil, sowing times and seedbeds for grazing development sites.

Site	Lat °S	Soil type	Soil surface pH	Characteristics P(ppm)	Sowing date	Seedbed
Kookaburra (Wandoan)	25°55'	Ug5.16	8.5	6	20/12/93	Full cultivation
Rangeview (Theodore)	24°43'	Ug5.12	7.9	7	17/01/94 (Oversown 22/12/94)	Bandseeding
Kapalee (Biloela)	24°24'	Ug5.16	8.3	24	24/01/94 (Oversown 19/01/95)	Bandseeding
Rolf Park (Middlemount)		Uf6.31	7.5	n/a	23/01/95	Full cultivation
Brigalow Research Station	24°50'	Ug5.16	8.1	14	15/02/90	Rough cultivation
Brian Pastures Research Station	25°39'	Ug5.32	6.5	60	9/11/87	Full cultivation

Table 5.10 Rainfall at Kapalee, Rangeview Kookaburra and Rolf Park, 1993/94, 1994/95 and 1995/96

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Yr
Kapalee													
1993/94				60	82	5	88	86	276	5	6	10	618
1994/95	2	0	11	66	12	88	113	45	60	12	48	19	476
1995/96	3	18	0	123	46	114	160	2	7	35			508
Average BRS (1924 - 1994)	31	22	23	55	77	99	102	106	63	42	42	36	698
Rangeview													
1993/94				84	34	6	103	161	147	19	3	15	572
1994/95	0	0	16	67	26	21	67	18	13	41	69	16	354
1995/96	0	13	12	95	65	108	145	11	0	57			506
Average Banana (1880-1990)	33	23	29	53	67	91	100	98	72	36	34	39	675
Kookaburra													
1993/94				54	14	32	2	68	110	3	18	17	318
1994/95	6	15	43	85	115	97	88	160	19	12	10	27	677
1995/96	6	13	0										19
Rolf Park													
1994/95				57	34	16	77	112	24	24	45	8	397
1995/96	0	56	73	70	70	16	154	0	1	21	30	30	521

Results and discussion

5.2.1 Kookaburra (Wandoan)

Legume populations (Table 5.11) and pasture yields (Table 5.12) as well as steer liveweight gains have been monitored.

Table 5.11 Legume density (plants/m^2) and frequency (%) in the *Desmanthus* paddock.

	15/02/94	25/05/94	31/10/94	26/05/95	27/11/95
Legume density (plants/m^2)	9.8	8.1	9.3	10.2	12.8
Frequency (%)	83	76	72	74	84

Table 5.12 Pasture yields of the buffel and buffel + *desmanthus* paddocks at Kookaburra

Treatment	Species	25/05/94	31/10/94	26/05/95	27/11/95	14/03/96
Buffel	Buffel	1690	1275	1814	2239	2654
	Other grass/weeds	582	255	55	251	35
Buffel + *Desmanthus*	Buffel	993	548	635	827	1563
	Desmanthus	991	502	323	279	443
	Other grass/weeds	441	84	143	184	nil

Total pasture yields were similar in both paddocks when grazing commenced in May 1994 (Table 5.12). Buffel grass contributed 75% of the yield in the grass paddock and 40% in the legume paddock with desmanthus also contributing 40% to yield. Yields have been measured on 4 sampling dates (one when grazing commenced and 3 subsequently). In the buffel paddock yield has ranged from 1300 to 2200 kg/ha, mainly due to seasonal and grazing effects, but has remained strong and the composition of buffel grass has increased to 90%. In contrast total pasture yields in the buffel/desmanthus paddock has declined to about half of that in the buffel paddock. The reasons for this are not clear. Paddocks sizes were recently checked and found to be correct. Buffel yields have ranged from 540 to 990 kg/ha but at the most recent sampling had recovered somewhat to 830 kg/ha. Desmanthus yield however has continued to decline from 990 to 280 kg/ha. Some preferential grazing of the legume exacerbated by dry conditions is apparently occurring but further measurements are needed before this can be substantiated.

There was little difference in liveweight gain of steers from the first draft between buffel and buffel + *desmanthus* (Table 5.13). The second draft started grazing on 30 August 1995 and again there has been little difference between treatments but liveweight gain has been high (0.9 kg/head/day).

Table 5.13 Liveweights and liveweight change of steers in the grass and grass + *Desmanthus* paddock.

Draft 1 1 steer/2 ha	L/wt 11/07/94	L/wt 27/06/95	Change (kg) (351 days)	kg/head/day
Grass + *Desmanthus*	259	457	198	0.56
Grass	261	476	215	0.61
Draft 2 1 steer/ 2 ha	L/wt 30/08/95	L/wt 19/07/96	Change (kg)(324 days)	kg/head/day
Grass + *Desmanthus*	257	460	203	0.64
Grass	256	462	206	0.63

5.2.2 Kapalee (Biloela)

One half of a 40 ha paddock of buffel grass pasture on a brigalow clay soil was oversown to *Desmanthus virgatus* using a bandseeder in January 1994 and again in January 1995 but legume density remains low (0.6 plants/m^2) (Table 5.14). However some desmanthus plants are well grown and some (mainly Marc) have set seed. Grass yields are similar for the 2 paddocks which are being used for grazing.

Table 5.14 Legume density and pasture yields at Kapalee

		02/06/94	24/05/95	29/11/95
Legume density (plants/m^2)		0.51	0.63	0.56
Frequency (%)		18	16	14
Pasture Yield (kg/ha)	Grass	2461	2413	n/a
	Grass + *desmanthus*	2273	2614	n/a

5.2.3 Rangeview (Theodore)

Paddocks at this site are of 15 hectares each and the desmanthus paddock was oversown using a bandseeder in January 1994. Soils are black earths with native pastures of *Astrebla, Bothriochloa, Dichanthium* and *Panicum* spp.

Desmanthus was oversown again in December 1994 but a roller drum seeder was used because grass yields were low in the desmanthus paddock and the band treated with glyphosate during bandseeding has not been recolonised. Some seedlings emerged but few have survived and density of seedlings remains low (Table 5.15).

Table 5.15 Legume density and pasture yields at Rangeview

	01/06/94	24/08/95	8/11/95
Legume density (plants/m^2)	0.75	0.70	0.35
Frequency (%)	24	17	9
Pasture Yield (kg/ha) Grass			
Grass + *desmanthus*	2992	2607	n/a
	1645	1668	n/a

5.2.4 Rolf Park (Middlemount)

This site has established well from a sowing in January 1995 (Table 5.16). Two paddocks of about 19 ha each have been fenced and supplied with stock water.

Table 5.16 Legume and grass density of Rolf Park.

	03/03/95	29/05/95	25/03/96
Legume density (plants/m^2)	12.6	12.6	9.3
Frequency (%)	88	84	82
Buffel density (plants/m^2)			
buffel	4.9	8.2	n/a
buffel + *desmanthus*	4.6	6.8	n/a

Although conditions were dry following establishment most legume seedlings have survived and growth of legumes and grass in the 1995/96 season has been good.

6. Comparison of advanced lines of legumes for grazing and ley pastures on clay soils in small swards

Background

A suite of elite legumes for the Northern-Australian grazing industry has been identified in the early phase evaluation studies, primarily the COPE project (Coordinated Plant Evaluation Program) (Pengelly and Staples 1996) and also small trials on clay soils evaluating legumes for sheep or cattle (Clem and Hall 1994, Conway *et al.* 1988, Jones and Rees 1997, Rees *et al.* 1995). The aim of the following trials was to evaluate a range of these advanced lines of legumes in small plots, for use in permanent pasture and ley phases in clay soils in Queensland.

6.1 Tropical legumes

Materials and Methods

One hundred and fifty-two legume accessions were planted over three years (1992-1995) on clay soils at three research stations in Central and South-East Queensland. These were CSIRO Narayen Research Station, Mundubbera (brown clay soil (Ug 3.13), Lat 25° 41's Long 150° 46'E), QDPI Brigalow Research Station, Theodore (Black earth (Ug5.16), Lat 24° 50'S long 149° 46'E) and QDPI Emerald Research Station (Black Earth (Ug5.12), Lat 23° 28'S long 148° 09'E). Long term climatic data and soil chemical data are presented in tables 6.1 and 6.2 respectively.

The legume accessions planted in any one year were generally the same at all sites. Accessions planted in the first year were predominantly of perennial introduced species while final year sowings contained a greater proportion of annuals and also more legumes that were native to Australia (refer to table 6.3).

Selected groups of legumes were sown with and without a sown grass, with the objective of testing legumes with strong and weak competition. The remainder were sown with a grass adapted to the local area: buffel grass (*Cenchrus ciliaris*) in 1992/93 and Queensland bluegrass (*Dichanthium sericeum)* in 1993/94 and 1994/95. Three replicates were used throughout. Plots in the 1992/93 and 1993/94 planting were arranged in a split-plot design with grass treatments as the main plots. Plots in the 1994/95 sowing were arranged in a randomised complete block design. The effect of grass treatment was determined by analysing data for the subset of species common to both treatments using analysis of variance for a split-plot design.

Seed was tested for germination, scarified to 60-80% germination and inoculated with appropriate *Rhizobium* or *Bradyrhizobium* prior to sowing. Sowing rate was generally 5-8 kg/ha for small or medium sized seed, but was increased for large seed - up to 20 kg/ha for *Lablab purpureus.* Companion grasses were sown at 4 kg/ha together with legumes onto plots 4m x 4 m in size. Following seeding, seed was buried just beneath the surface of the cultivated seed-bed using a roller or light set of harrows. Irrigation was not used except at Emerald for the 1992/93 planting to aid establishment.

Measurements of seedling density after emergence, annual plant density and yield were taken at each site, with observations of flowering, seed production and insect damage. Survival of marked plants was measured on some accessions. All plots at Mundubbera and Theodore were grazed at the end of the first year and then periodically in subsequent years as growth allowed, except during the 1-2 months prior to sampling. No grazing occurred at the Emerald Research Station, which being a cropping research station, had no grazing animals. Weed control using herbicides and mechanical methods occurred at Mundubbera and Theodore. A more detailed description of methodology is given in (Brandon et al, 1997).

Table 6.1 Long term climatic data at Narayen Research Station near Mundubbera, Brigalow Research Station near Theodore and Emerald Research Station in Queensland.

Climatic attribute	Mundubbera	Theodore	Emerald
Average annual rainfall (mm)	715	670	620
Average maximum temperature (Dec) (°C)	34.4	33.0	32.0
Average minimum temperature (Jul) (°C)	7.3	6.3	6.0

Table 6.2 Chemical properties of three soils used in small plot evaluations at Narayen Research Station near Mundubbera, Brigalow Research Station near Theodore and Emerald Research Station in Queensland.

Depth	Characteristic	Mundubbera	Theodore	Emerald
0-10cm	pH (1:5 H_2O)	6.5	8.1	7.3
	EC (1:5 H_2O) (ms/cm)	0.14	0.19	0.06
	Cl (1:5 H_2O) (mg/kg)	86.0	18.0	26.0
	Organic C (%)	3.3	1.5	1.2
	Total N (%)	0.30	0.10	0.05
	NO_3 (1:5 H_2O) (mg/kg)	17.0	2.0	2.0
	P (Bicarb) (mg/kg)	62.0	14.0	8.0
	P (Acid) (mg/kg)	149.0	26.0	27.0
	K[1] (meq/100g)	1.5	0.6	0.8
	SO_4 (MCP) (mg/kg)	10.0	3.0	2.0
	Ca[1] (meq/100g)	34.0	19.0	49.0
	Mg[1] (meq/100g)	9.0	9.0	18.0
	Na[1] (meq/100g)	0.5	0.9	0.5
	Cu[2] (mg/kg)	6.3	1.9	1.5
	Zn[2] (mg/kg)	4.1	0.7	0.5
	Mn[2] (mg/kg)	31.0	34.0	23.0
	Fe[2] (mg/kg)	21.0	20.0	14.0
	B[2] (mg/kg)	1.3	0.7	0.5
20-30 cm	pH (1:5 H_2O)	7.9	8.9	7.6
	EC (ms/cm)	0.25	0.30	0.10
	Cl (1:5 H_2O) (mg/kg)	10.0	47.0	15.0
40-50 cm	pH (1:5 H_2O)	8.1	8.4	7.7
	EC (ms/cm)	0.22	0.69	0.17
	Cl (1:5 H_2O) (mg/kg)	21.0	181.0	7.0
>80 cm	pH(1:5H_2O)		4.7	
	EC (ms/cm)		1.2	
	Cl (1:5 H_2O) (mg/kg)		264.0	

[1]Measured following extraction using aqueous NH_4Cl at pH 7
[2]Measured following extraction using 0.005M DTPA
All other nutrients were determined using standard DPI soil analysis methods

Table 6.3 Legumes planted at Narayen Research Station near Mundubbera (M), Brigalow Research Station near Theodore (T) and Emerald Research station (E) in 1992/93, 1993/94 and 1994/95 in small plots.

Genus	Species	Accession	Sites								
			1992/93			1993/94			1994/95		
Aeschynomene	*americana*	Lee[1]	M	T	E	M	T	E			
Aeschynomene	*americana*	91235[1]	M	T	E						
Aeschynomene	*americana*	93624[1]	M	T	E						
Aeschynomene	*villosa*	37235[1]	M	.	E						
Aeschynomene	*villosa*	91209[1]	M	.	E	M	T	E			
Alysicarpus	*longifolius*	94490							M	T	
Alysicarpus	*monilifera*	52343[1]	M	.	E	M	T	E			
Alysicarpus	*rugosus*	51655							M	T	E
Alysicarpus	*rugosus*	69487							M	T	E
Alysicarpus	*rugosus*	52351[2]	M		E						
Alysicarpus	*rugosus*	84470							M	T	
Alysicarpus	*rugosus*	94489[1]	M		E						
Arachis	*burkatii*	58109[1]	M		E						
Arachis	*paraguariensis*	91419[1]	M		E						
Arachis	*pusilla*	91423[1]	M								
Arachis	*spp.*	58121[1]	M		E						
Atylosia	*scarabaeoides*	52372							M	T	E
Cajanus	*cajan*	Jay[1]	M		E				M	T	E
Cajanus	*cajan*	Royes[1]	M		E						
Cajanus	*cajan*	Quest							M	T	E
Centrosema	*brasilianum*	55698							M	T	E
Centrosema	*schotii*	65967							M	T	E
Clitoria	*ternatea*	Milgarra[1]	M		E	M	T	E	M	T	E
Desmanthus	*illinoensis*	Sabine[1]				M	T	E			
Desmanthus	*sublobatus*	90857							M	T	E
Desmanthus	*virgatus*	Bayamo[2]	M		E	M	T	E	M	T	E
Desmanthus	*virgatus*	Marc[2]	M		E	M	T	E	M	T	E
Desmanthus	*virgatus*	Uman[1]	M		E	M	T	E	M	T	E
Desmanthus	*virgatus*	TQ90[1]				M	T	E			
Desmanthus	*virgatus*	40071[1]				M	T	E			
Desmanthus	*virgatus*	55719[1]				M	T	E	M	T	E
Desmanthus	*virgatus*	84972							M	T	E
Desmanthus	*virgatus*	85172							M	T	E
Desmanthus	*virgatus*	85177							M	T	E
Desmanthus	*virgatus*	85178[2]	M		E	M	T	E			
Desmanthus	*virgatus*	89197							M	T	E
Desmanthus	*virgatus*	90750							M	T	E
Desmodium	*dichotomum*	47186[1]	M		E	M	T	E	M	T	E
Desmodium	*scorpiurus*	89707							M		
Desmodium	*setigerum*	52431							M	T	E
Galactia	*spp.*	67646							M	T	E
Galactia	*spp.*	82294[1]				M	T	E			
Galactia	*striata*	49740							M	T	E
Glycine	*latifolia*	CQ3368[1]	M		E	M	T	E	M	T	E
Glycine	*latifolia*	line 6							M		E
Heylandia	*latebrosa*	31951							M		
Indigofera	*schimperi*	16055[1]				M	T	E	M	T	E
Indigofera	*schimperi*	52621[1]	M		E				M	T	E
Indigofera	*schimperi*	69495[2]	M		E	M	T	E	M	T	E
Indigofera	*schimperi*	73608[1]	M		E	M	T	E			
Lablab	*purpureus*	Highworth[2]	M		E	M	T	E	M	T	E
Lablab	*purpureus*	24973[1]			E	M	T	E			
Lablab	*purpureus*	28701[1]	M		E	M	T	E			
Lablab	*purpureus*	51564[1]	M		E	M	T	E			
Lablab	*purpureus*	52437[3]				M	T	E			
Macroptilium	*atropurpureum*	Aztec							M	T	E
Macroptilium	*atropurpureum*	Siratro[2]	M		E	M	T	E	M	T	E
Macroptilium	*atropurpureum*	84989[3]				M	T	E			
Macroptilium	*atropurpureum*	87506								T	E
Macroptilium	*atropurpureum*	90338[1]	M		E					T	E
Macroptilium	*atropurpureum*	90748							M	T	E
Macroptilium	*atropurpureum*	90776							M	T	E

Genus	Species	Accession	Sites							
			1992/93		1993/94			1994/95		
Macroptilium	*atropurpureum*	90844[1]	M	E	M	T	E			
Macroptilium	*atropurpureum*	90905						M	T	E
Macroptilium	*bracteatum*	27404[2]	M	E	M	T	E	M	T	E
Macroptilium	*bracteatum*	55755[3]			M	T	E			
Macroptilium	*bracteatum*	55758						M	T	E
Macroptilium	*bracteatum*	55769							T	
Macroptilium	*bracteatum*	81724							T	E
Macroptilium	*gracile*	93084[2]			M	T	E	M		
Macroptilium	*lathyroides*	Murray[3]			M	T	E	M	T	E
Macroptilium	*lathyroides*	49771[3]			M	T	E	M	T	E
Macroptilium	*martii*	49780						M	T	E
Macroptilium	*psammodes*	39098[1]	M	E						
Macrotyloma	*axillare*	52469[1]			M	T	E			
Macrotyloma	*daltonii*	60303[2]	M	E	M	T	E			
Macrotyloma	*uniflorum*	Leichardt[3]			M	T	E			
Medicago	*sativa*	Trifecta[1]	M	E	M	T	E	M	T	E
Neptunia	*dimorphantha*	CQ1839						M	T	E
Neptunia	*gracilis*	CQ1849						M	T	E
Neptunia	*gracilis*	CQ3226						M	T	E
Neptunia	*gracilis*	CQ3227						M	T	E
Neptunia	*monosperma*	CQ2082						M	T	E
Neptunia	*plena*	46380						M	T	
Neptunia	*sp.*	CQ1842						M	T	E
Psoralea	*spp.*	CQ2973[1]			M	T	E			
Psoralea	*tenax*	CN55[1]			M	T	E			
Rhynchosia	*minima*	52704						M	T	
Rhynchosia	*minima*	81386[1]	M	E	M	T	E			
Rhynchosia	*minima*	60335						M	T	E
Rhynchosia	*sublobata*	52727[1]			M	T	E	M	T	E
Rhynchosia	*verdicourtii*	34133							T	
Rhynchosia	*verdicourtii*	52724[1]			M	T	E			
Stylosanthes	*aff-scabra*	92828b						M	T	E
Stylosanthes	*aff-scabra*	104710[1]	M	E						
Stylosanthes	*aff-scabra*	105546b[1]	M	E						
Stylosanthes	*aff-scabra*	110343[1]	M	E						
Stylosanthes	*aff-scabra*	110361[1]	M	E	M	T	E	M	T	E
Stylosanthes	*aff-scabra*	110370b[1]	M	E						
Stylosanthes	*aff-scabra*	110370c[1]			M	T	E			
Stylosanthes	*aff-scabra*	110372[1]	M	E						
Stylosanthes	*aff-scabra*	115994[1]			M	T	E	M	T	E
Stylosanthes	*aff-scabra*	115995[1]	M	E				M	T	E
Stylosanthes	*scabra*	Seca[1]	M	E	M	T	E			
Stylosanthes	*sympodialis*	67704[1]			M	T	E			
Teramnus	*labialis*	60371[1]	M	E						
Vigna	*decipiens*	52839						M	T	E
Vigna	*decipiens*	73602						M	T	E
Vigna	*luteola*	Dalrymple[2]			M	T	E			
Vigna	*oblongifolia*	28763						M	T	E
Vigna	*oblongifolia*	43799						M	T	E
Vigna	*oblongifolia*	57524						M	T	E
Vigna	*oblongifolia*	60430[2]			M	T	E			
Vigna	*oblongifolia*	60433						M	T	E
Vigna	*trilobata*	13671[2]	M	E	M	T	E			
Vigna	*vexillata*	CQ3044						M	T	E
Vigna	*vexillata*	15463						M	T	E
Vigna	*vexillata*	43799						M	T	E
Vigna	*vexillata*	69030						M	T	E
Vigna	*unguiculata*	R.caloona[3]			M	T	E			

All accession numbers are CPI (commonwealth plant introduction) numbers unless otherwise indicated.

[1]grown in presence of companion grass species only

[2]grown in presence and absence of companion grass species

Results

Rainfall

Summer rainfall in most years was below calculated median values determined from long-term records, particularly for the 1992/93 and 1993/94 planting (Table 6.4). Near median rainfall occurred at Emerald and Theodore in 1994/95 at the time of the last planting.

Table 6.4 Seasonal rainfall data for summer (Dec, Jan, Feb), autumn (Mar Apr, May),winter (Jun Jul Aug) and spring (Sep, Oct, Nov) at three sites with corresponding long term median totals. **Bold** type indicates rainfall below the corresponding long-term median.

Site and Year		Summer	Autumn	Winter	Spring
Mundubbera					
1992					**126**
1993		**201**	**15**	**58**	**160**
1994		**230**	**108**	**21**	**83**
1995		**201**	**73**	**26**	377
1996		**188**	144		
	median	281	128	90	149
Theodore					
1992					136
1993		**173**	**10**	**47**	171
1994		**179**	218	**30**	152
1995		293	236	**31**	200
1996		473	139		
	median	288	122	77	136
Emerald					
1992					**49**
1993		**171**	**21**	103	167
1994		**113**	400	**1**	**43**
1995		260	**73**	**34**	120
1996		363	159		
	median	257	114	70	112

There have been no significant effect of grass treatment on establishment, yield or plant density in the 1992/93 or 1993/94 plantings. Results of the grass treatments therefore have been combined in the tables 6.6 to 6.13 which list the density, yield and ratings of seed production for each sowing

Establishment

The generally lower than average rainfall resulted in variable establishment across sites and years depending on timing of pre- and post-planting falls. However, despite low rainfall, very few legumes failed to establish at least at one of the sites, although the first planting at Theodore in 1992/93 failed. Good emergence at Emerald in 1992/93 occurred only in the first replication of the trial due to late planting of the second and third replications caused when rain interrupting sowing. Although irrigation was subsequently used, emergence in the second and third replications remained lower than that of the first replication. Emergence of over 7 legume seedlings/m^2 occurred at Mundubbera in all years and at Theodore in 1993/94 and at Emerald in 1994/95.

Best establishment in the 1992/93 planting at Mundubbera and Emerald tended to occur in legumes with small (e.g. *Desmanthus*) to medium sized seed (e.g. *Macroptilium spp*). This trend was repeated in later plantings, although emergence of some of the medium sized seed, such as the *Macroptilium* and *Vigna* species, often exceeded that of the smaller seeded species in the heavier soils at Theodore and Emerald.

The large-seeded forage peanut (*Arachis spp.*) failed to establish at all sites in 1992/93. Some *Arachis* seed at Mundubbera was found near the entrance to an ant nest suggesting that some seed may have been removed by harvesting from ants before establishment. However, emergence of other larger seeded legumes such as *Lablab purpureus* also tended to be low in all sowings, perhaps as a result of the planting method of broadcasting and harrowing which resulted in only shallow burial of seed.

Establishment of some other species appeared to extremely variable between sites. The *Stylosanthes* sp. aff. *S. scabra* for example frequently had densities in excess of 10-20 plants/m^2 at Mundubbera but generally less than 3 plants/m^2 at Theodore. Nonetheless, density was better than that of Seca stylo at all sites.

Establishment of the sown companion grass species was also variable, but generally higher in the second and third years following the planting of the native grass species *Dichanthium sericeum* (>5 plants/m^2) (all sites?). Best emergence of the introduced grass species in the 1992/93 planting occurred in plots of *Chloris gayana* at Mundubbera (up to 20 plants/m^2), and *Setaria incrassata* at Emerald but establishment of *Cenchrus ciliaris* was low at all sites (<1 plant/m^2). However despite the low germination of buffel grass, the main companion species at Mundubbera in the 1992/93 planting, naturalized urochloa (*Urochloa panicoides*), quickly established in all plots (approximately 14 plants/m^2)

Persistence

Accessions with consistently greater than 50% survival of original plants in the first two years after planting in the 1992/93 and 1993/94 sowings include most *Desmanthus virgatus* accessions, *Glycine latifolia, Indigofera schimperi* (CPI 69495 and 73608), and *S.* sp.aff. *S. scabra.* Results from the tagged plants at Mundubbera showed that indigofera was the most persistent, with survival of over 90%, 4 years after sowing (Table 6.5). Desmanthus cultivar Bayamo was less persistent, with 40% of original plants surviving 4 years after planting compared to only 7% in the earlier flowering cultivar Marc. *Glycine latifolia* had 60% of plants surviving (Table 6.5).

Table 6.5 Survival (%) of tagged plants and calculated half life of *Desmanthus virgatus* cv Marc and Bayamo, *Indigofera schimperi* CPI 52621 and 73608 and *Glycine latifolia* (Capella) in the 1992/93 sowing at the Narayen Research Station near Mundubbera

Date	Survival of original plants				
	Marc	Bayamo	CPI 52621	CPI 73608	Capella
			(%)		
11/6/93	100	100	100	100	100
5/10/93	100	100	100	100	97
2/11/94	90	100	93	93	83
28/9/95	50	90	93	83	63
12/3/96	13	70	93	81	60
4/10/96	7	40	93	62	60
Half life (months)	15	88	301	107	40

Although not included in tagged-plant studies, plant density figures (Tables 6.6-6.13) indicated that greater than 50% of lucerne (*Medicago sativa*) and siratro (*Macroptilium atropurpureum*) plants had died within 2 years after planting. Both these species were included as controls. Perennial legumes with very much poorer survival than the controls included all accessions of *Aeschynomene* and *Alysicarpus,* the lablab accessions CPI 24973, CPI 28701, CPI 51564 and CPI 52437 and single accessions of *Desmanthus illinioensis* and *Stylosanthes sympodialis.* Species previously considered annuals, which persisted into the second year included accessions of *Macroptilium lathyroides* (Murray and CPI 49771), *Vigna oblongifolia* CPI 60433 and *Vigna vexillata* CPI 15463.

Recruitment

The only perennial legumes to recruit appreciable numbers of seedlings were the *Stylosanthes* sp. aff. *S. scabra* lines at Mundubbera and Emerald. Up to 200 seedlings/m^2 were observed at Emerald in the first and second years after planting of the 1992/93 sowing (Table 6.7). Most of these seedlings died in the dry years and there was little net increase in plant numbers with time. Fewer seedlings have been observed under desmanthus and less under indigofera despite seed being set by both species, particularly in the mid and early flowering desmanthus accessions. This is probably due to a large proportion of seed set being hard. The presence of a few seedlings of Marc and Bayamo at Mundubbera following out-of-season rainfall in May 1996 suggest that some of this seed may now be softening, and higher levels of recruitment may occur in the near future. Seedlings were also observed in the annual legumes *Vigna trilobata, Macrotyloma daltonii* and *Macroptilium lathyroides,* but they did not compensate for death of original plants in the years since planting. Low numbers of indigofera and marc desmanthus seedlings (<5/m^2) were also observed at Emerald in the 1992/93 sowing in November 1996 (data not presented).

Yields - Legumes for permanent pastures

Highest yielding across sites and seasons of the permanent pasture legumes planted in 1992/93 was *Indigofera schimperi* (especially CPI 52621 and 69495) which often had yields in the post establishment years of 1-2 t/ha. Yield of *Stylosanthes spp.* aff. *S. scabra* accessions were also frequently up to 2 t/ha but more variable between sites, with low yields being recorded at the Theodore Research Station where it failed to establish well. Yields of Bayamo desmanthus were as high as 2.6 t/ha in the year after planting at Mundubbera, but declined in the second and third years after planting due mainly to a decline in plant vigour. Similar declines in productivity in cultivar Marc was mainly due to declining plant numbers.

Some accessions of desmanthus at Mundubbera appeared to hold more green leaf at the end of the first year after planting than either Marc or Bayamo (e.g. TQ90 and 40071), and TQ90 did not appear to suffer as large a decline in yield in the second year after planting. They were also earlier flowering than Bayamo and more productive than Marc.

Yields - legumes for ley pastures

Best yielding of the ley legumes in the 1992/93 planting was the annual Highworth *Lablab purpureus* which yielded 1240 kg/ ha at Mundubbera and 500 kg/ ha at Emerald. *Macroptilium bracteatum* also gave high yields at Mundubbera in the year of establishment (1320 kg/ ha) and persisted into subsequent years reaching a maximum yield of 2400 kg/ ha the second year after planting. The annual *Vigna trilobata* had similar yields to lablab at Emerald in the year of establishment but minimal yields in later years, despite some seedling recruitment.

The *Macroptilium atropurpureum* accessions although not high yielding in the first year, gave moderate but consistent yields in first few years following planting in the 1993/94 and 1994/95 sowings. Increased individual plant growth was able to compensate for declining plant numbers. *Macroptilium lathyroides* in these same plantings gave higher first year yields and persisted into the second year. At Mundubbera, in the 1993/94 sowing, second year yield of accession 49771 was over 1t/ha

Yield of lucerne (*Medicago sativa*) which was included as a control in all sowings, was generally near zero in the first or second year after planting. This was mainly due to plant mortality, but may also have been due to the sampling late in summer which would be expected to favour the more tropical species.

Grass yield

Rhodes grass, planted as a companion species at Mundubbera in the 1992/93 sowing had largely died out by the end of the first season due to drought. Yield of the other companion species, *Cenchrus ciliaris*, was also negligible due to poor establishment. Nonetheless, total grass yield in most plots was 1-2 t/ ha at the end of the first season due to colonisation of the area with the annual urochloa. By the end of the third year after planting, combined yield of *Cenchrus ciliaris* and urochloa was higher than that of urochloa alone (4800 and 4200 kg/ ha respectively). Yield of sown grasses were also initially low in the 1992/93 sowing at Emerald, and despite some invasion by Queensland bluegrass (*Dichanthium sericeum*), yields generally remained less than 1000 kg/ ha.

In the 1993/94 planting at Mundubbera, there was no difference in total grass yield of plots sown or unsown with *Dichanthium sericeum* due to invasion of all plots by naturalized urochloa (total yield varied from 50-2000 kg/ ha). However in the second year after sowing combined yield of urochloa and *Dicanthium sericeum* was 5-6 t/ ha in sown plots compared to 3.5-4.5 t/ ha urochloa in unsown plots.

In the 1994/95 there was good establishment of *Dichanthium sericeum* at Mundubbera (1750-5600 kg/ ha) and the other sites with minimal invasion by unsown grasses.

To date, there has been no significant effect of companion grass species on legume density or yield for any of the sites or sowings. The more adapted legumes have generally out-lived the less hardy *Chloris gayana* in the 1992/93 planting at Mundubbera. However other companion grasses such as Buffel and *Dichanthium sericeum* continue to increase in yield and it is anticipated that grass competition will be significant in the coming seasons.

Discussion

Effects of rainfall and grass competition

Despite generally lower than average rainfall, establishment of legumes at most sites was adequate for their evaluation. This was probably due to the accumulation of sub-soil moisture prior to sowing so that even quite moderate falls of rain were sufficient to ensure good emergence and early survival. Establishment failure however occurred where no rainfall fell after planting, such as in the 1992/93 planting at Theodore.

Lower than average rainfall after legume emergence resulted in death of less adapted legumes and at some sites to the poor survival of some of the companion grass species. Rhodes grass for example quickly died out in the 1992/93 planting at Mundubbera when the surface of the soil dried out before secondary roots developed. The objective of testing legumes with a strong and weakly competitive grass in this trial therefore have so far not been achieved.

Similar difficulties in achieving moderate competition by companion grasses were found in legume evaluation work on clay soils by Jones and Rees (1997). They found low competition early in the trial due to poor establishment, while excessive competition later in the trial was due to high soil fertility. At Mundubbera the naturalized grass *Urochloa panicoides* quickly became established and the other companion grass species, *Cenchrus ciliaris* has gradually increased. Therefore although there are currently no effects of companion grass species on legume growth, effects of buffel grass in the 1992/93 planting and of *Dichanthium sericeum* which established well in the later plantings should be possible.

Promising legumes for permanent pastures

Desmanthus virgatus cultivars Bayamo and Uman were generally higher yielding than cultivar Marc, particularly in the second year after planting. Lower yield in Marc was due to its earlier maturity with plants generally only reaching heights of 30-40 cm. By contrast Bayamo in the second year at Mundubbera reached a height of over 1m. Uman plants also grew into large plants but were generally more prostrate than Bayamo.

Yield of all cultivars decreased in the second year after planting as original plants began to die or decline in vigour. Tagged plant studies showed that Bayamo was generally longer lived (half life of 88 months) than Marc (15 months). The reasonably rapid decline in plant number increases the importance on recruitment particularly for Marc.

To date, seedling recruitment and survival has not compensated for plant death of desmanthus. This is in contrast to data of Clem and Hall (1994) who found up to 5-10 seedlings in the third year growing season in plots of Marc desmanthus. Clem and Hall (1994) also found that although the initial performance of desmanthus was variable, it improved in productivity in the fourth season due to its ability to recruit new plants. Similarly in a grazing trial at Narayen, yield and plant density of early seeding lines increased when recruitment began to occur 3-4 years after planting (authors unpublished data).

All three of the commercial cultivars (Marc, Bayamo and Uman) were able to set a little seed in the year of establishment and under intermittent grazing at Mundubbera and Theodore in the second year, although grazing at Mundubbera was deliberately delayed toward the end of the season to allow Bayamo seed to mature. Uman, although considered the latest of the three cultivars to flower, also seeded early in spring of the following year on stems that escaped frosting in the intervening winter.

The low levels of recruitment in the third year after planting therefore did not appear to be due to inadequate amounts of seed set, but to high levels of hard seed. Rate of hard seed breakdown in the field can be slow under conditions of high ground cover which reduces diurnal temperature fluctuations (Burrows and Porter 1993). The observation of some seedling recruitment in Autumn 1996 at Mundubbera suggest that some seed is now soft and it is expected that seedling recruitment should increase in the coming seasons provided rainfall is adequate.

Experience at Mundubbera and other sites has been that Bayamo and Uman seeding is often very low in comparison to Marc. The observation of cultivars of desmanthus CPI 40071 and TQ90 that were earlier flowering than Bayamo but higher yielding than Marc is therefore significant. It will be of interest to monitor the development of plant density and yield in these accessions in the coming years as these may provide useful substitutes for Bayamo or Uman if these cultivars are unable to set enough seed for long-term persistence in the majority of environments.

Attack by sap-sucking native psyllid insects was observed at various times on desmanthus, mainly affecting the young leaves and growing point. At Mundubbera, these attacks were very location specific, and were sometimes severe in one planting and not in another planting in plots nearby. The psyllid has been identified as belonging to the *Achizia* genus and is therefore different to that commonly attacking leucaena. It remains to be seen how important a problem it will become on desmanthus. However it did not appear to be a significant problem on grazing trials at Mundubbera.

Although there did appear to be differences in susceptibility of various desmanthus accessions to psyllids, these differences were not always consistent over time and may simply have been due to accessions being at different stages of phenological development at the time of attack. Accession CPI 85178, however, did appear to be more consistently attacked than other accessions. It is an extremely low growing variety that was selected from a region with a rainfall of only 200 mm.

Stylosanthes sp. aff. *S. scabra* yields were as high as 1-2t/ha where establishment was good. There were no consistent differences found between accessions of *Stylosanthes spp.* aff. *S. scabra* in terms of yield and all were better than Seca stylo which was usually only found in low numbers due to poorer establishment. Accession CPI 110361 however sometimes appeared greener and leafier than the others at Mundubbera and this accession has now been released as cultivar Unica. Another accession used in the 1994/95 sowing, CPI 92838b (Primar), has been released for use in cooler more southern regions. None, however, remained as green or leafy at the end of the growing season as Seca stylo.

However, poor establishment at Theodore and low and variable establishment at other sites in recent work coordinated by R.M. Jones suggests that *Stylosanthes spp.* aff. *S. scabra* may be more difficult to establish in some heavy clay soils than either desmanthus or indigofera which have slightly larger seed. Work by R.A Date found that surface sowing of the seed was not always successful even when followed by irrigation. Further work on the establishment of this species is needed.

Glycine latifolia cv. Capella persisted better than Marc desmanthus. Yield and seed set in some plots however appeared to be reduced in later years by competition from dense naturalized or introduced grass. Data over the next few years from each of the sowings will be useful in evaluating the ability of this legume to persist in competition with vigorous naturalized, native and introduced pasture grasses.

Stylosanthes sp. aff. *S. scabra* showed the greatest capacity to regenerate quickly from seed. This was due to its early indeterminate flowering habit, heavy seeding and its generally higher levels of soft seed (C. K. McDonald personal communication). Flowering and seed set was found to be much greater than in Seca stylo. But despite the observation of seedlings on a number of occasions at several sites, few seedlings have survived to maturity in the dry seasons experienced. Sufficient seedlings have survived at Mundubbera, however, to offset death of older plants.

Indigofera schimperi was consistently the highest yielding permanent pasture legume. Its ability to maintain high yields with time is due to a combination of high plant survival (>90% over 4 years at Mundubbera) and high individual plant production. High yield potential and persistence of indigofera are also recorded by Jones and Rees (1997) and Clem and Hall (1994). Half life of accession 52621 was calculated at over 300 months, which is more than double that of desmanthus or glycine.

To date indigofera has shown little ability to recruit from seed. However, some seedlings were observed in plots established in 1992 at Emerald following good early season rainfall. The generally poorer recruitment of indigofera compared to desmanthus and *Stylosanthes spp.* aff. *S. scabra* may be due to the longer time required for mature seed set. Nonetheless it seeded in most seasons. The seed is usually hard, and like desmanthus, takes a long time to soften (C.K. McDonald personal communication). It is also slower to germinate than desmanthus, particularly at temperatures below 24^{o} C (C. K. McDonald personal communication).

None of the accessions of *Indigofera schimperi* used to date in Queensland contain the toxic compound indospicine (Aylward *et al.* 1987). However, palatability of indigofera sometimes appears to be lower than for other legumes such as desmanthus. Concerns about the plants acceptability to cattle resulted in its removal from evaluation plots by Clem and Hall (1994). Accessions CPI 52621 and CPI 69495 appeared to be the leafiest and greenest of the accessions tested in the current trials and may be slightly earlier flowering and higher yielding than CPI 73608. The plants were eaten by animals when grazed irregularly over the growing season. Results of on-farm trials suggest that decreased acceptability occurs when the plants are allowed to become rank during the growing season. When this happens, the soft green foliage present early in the season becomes dry and purplish and there are unpalatable seed pods. In view of concerns about its palatability, the lower growing accession CPI 16055, which is later to mature, may offer better potential as a cultivar. The relative palatability of these accessions is being followed up in work initiated at the Brian Pastures Research Station.

Other species for permanent pastures

Macroptilium atropurpureum accessions (CPI 90338, CPI 84989) showed advantages over siratro in some sowings. Accession 90338 stayed remained much greener following dry and cold conditions at Emerald. No accession however consistently out-yielded siratro and long-term survival of these species is not expected to exceed that of siratro unless significant recruitment from seed occurs. None of the accessions, however, have appeared to produce large quantities of seed.

Clitoria ternatea, although mainly considered a ley legume, has persisted in competition with grasses for a number of years. It has also persisted for 2-3 years in on-farm trials in northern regions and was productive for 3-4 years in grass legume plots in work by Clem and Hall (1994). Although it was gradually replaced by grass, it showed some ability to regenerate from seed and it may be possible to keep it in permanent pastures by allowing regular seed set. Production of seed in grazed swards would probably require lenient grazing during the summer growing season, which also increases its persistence and productivity (Hall 1985).
Macrotyloma daltonii, an annual species is also probably more suited to short term ley phases in cropping. However it has persisted through regeneration from seed in an established grass pasture at Brian Pastures (R.L. Clem unpublished data). But, despite setting seed in the current small sward trials, it has generally not recruited large numbers of seedlings and these have grown poorly.

Neptunia spp. and other native legume species such as *Psoralea spp.* generally did not yield as well as the better introduced species. *Neptunia gracillis* CPI 3226 gave moderate first year yields at Mundubbera, but performed poorly the following year. *Psoralea* established well in 1993/94 plots at Mundubbera, but yields to date have been low. Nonetheless, plant density increased in accession CN55 in October 1996 as a result of seedling recruitment. *Glycine latifolia* has also been generally low yielding, but was reasonably persistent at Mundubbera (50% survival of original plants after 4 years) and produced green leaf at cooler times of the year when other tropical legumes had stopped growing. This ability to grow at cooler times of the year was also noted for *Psoralea* and may have some relevance to higher latitudes in the subtropics. *Glycine latifolia* for example performed particularly well on clay soils at Pittsworth in small plot trials conducted by Rees *et al.*(1995).

Legume species for ley pastures

Lablab purpureus cv. Highworth, where it established well, was the highest yielding of the annual species. Lablab will always be an attractive option when planting into cultivated cropping land either as a means of increasing soil nitrogen levels and/or as a source of animal feed. Nitrogen contributed by well grown commercial crops is in the order of 50 kg N/ha and live-weight gains of cattle fed lablab and grass were 0.8-0.9 kg/hd/day for the 3 month period over which lablab forage was on offer (John Agnew, personal communication). The main disadvantage of lablab is the need to replant if a ley phase of more than one year is required. The perennial accessions used in the current trial were not very productive. However more vigorous perennial accessions are being produced in a breeding program by CSIRO.

Macroptilium bracteatum although generally not as high yielding in the year of establishment as lablab out-yielded lablab in the second. It shows promise as a short term ley species and has an advantage over lablab in that it does not need to be replanted each year for a 2 or even 3 year ley.

The accession used most widely in the current trials was CPI 27404, primarily because of the large amounts of seed available from previous plant evaluation work many years ago by CSIRO. At that time *Macroptilium bracteatum* was passed over in favour of *Macroptilium atropurpureum* which was considered to have more potential as a permanent pasture plant. In early evaluation work it was usually described as *Phaseolus bracteatus* (Jones and Rees 1972). and was noted as vigorous, palatable and with a strongly developed tap-root.

In on-farm trials, it produced an average first year yield across 5 sites of 1.5 t/ha and remained productive at most sites for 2-3 years. A second year yield of 8 t/ha was recorded by Jones and Rees (1997) suggesting that it can take advantage of good conditions when they occur. It was also able to survive very dry periods such as occurred during the year of establishment in the Mundubbera 1992/93 sowing.

When grown in large pots it was tolerant of frequent and heavy defoliation (Dalzell *et al.* in press) and although smaller seeded than lablab, can emerge from depths of up to 5 cm under good soil conditions (unpublished data). It was not highly competitive with vigorous grass in the 1994/95 planting at Mundubbera or in other studies by Jones and Rees (in press) , so is more likely to be successful when grown as a pure legume ley. It was also not very tolerant of post emergent herbicides used to control weeds in the 1993/94 planting at Mundubbera, an observation confirmed by later work by Don Loch (personal communication). A wider range of accessions are being characterised and evaluated in further work funded by GRDC. This work may result in the release of a new cultivar.

Clitoria ternatea has generally not established well in the small plot trials at any of the sites, probably due to surface sowing of the large seed. Individual plants that did establish successfully however have often been productive, particularly at the more northern sites of Emerald and Theodore. Its adaption to northern regions is confirmed by early evaluation work by Reid and Sinclair (1980) who suggested that the plant may have a role as a forage plant and also as a grain legume due to its high oil and protein content.

Commercial use of this plant in regions near Emerald and Biloela is increasing (M. Conway personal communication). In on-farm sowings, stands have usually remained productive for 2-3 years.

Macroptilium lathyroides, although commonly regarded as an annual, perennated into the second and even third year at Mundubbera. The plant also showed some ability to regenerate from seed at the Brigalow Research Station. Yields of accession 49771 was generally higher than that of the cultivar Murray at Mundubbera. On the basis of the better than anticipated survival and yield, evaluation of a wider range of accessions may be warranted.

Other ley species. *Vigna trilobata* showed some promise at Emerald as a ground cover. Because it has a shallow root system it does not excessively deplete soil moisture particularly at depth, and may be useful in crop rotations where moisture is a major limitation (Leach *et al.* 1986). Some other vigna accessions such as *Vigna oblongifolia* 60433 and *Vigna decipiens* 52839 were able to persist into a second year and may be more productive in areas with higher rainfall.

Macrotyloma daltonii, an annual species, set reasonable quantities of seed in 1992/93 at Mundubbera despite extremely dry conditions. Although hard seeded, some seedling regeneration was observed following out of season rainfall in winter 1996. Pot trial work has shown that although leafy and fine stemmed, it was intolerant of severe and frequent defoliation (Dalzell *et al.* in press). *Desmodium dichotomum* also an annual, recruited from seed at Emerald in the year after planting of the 1992/93 trial. Yields and regeneration at the other sites however have been poor.

Medicago sativa included as a control, established better at Mundubbera than the more northern sites of Emerald and Theodore. However it did not persist well at any of the sites and low yields were recorded in the first and second years after planting. It continues to be used in commercial plantings in regions with deep alluvial soil due to its high fodder value. However even when grown in these soil types, it generally needs to be replanted every 3-5 years. Results of these trials suggest that on the majority of clay soils it would need to be replanted even more regularly.

Assessment of persistence of legumes in this experiment are based on results from 4 years (1992/93 sowings) or less. This is an inadequate time period to assess the ability of legumes to maintain plant density through seedling recruitment, especially where legumes are grown with a grass and regularly grazed. These are the key attributes to be followed in the 2 year extension of the project.

Table 6.6: Plant density, plant yield and seed production of legumes planted at the Narayen Research Station near Mundubbera in 1992/93

Accession	Plant density (pl/m2)						Plot yield (kg/ha)				Seed production		
	3/93	10/93	11/94	9/95	10/96		4/93[1]	4/94[1]	2/95[2]	2/96[2]	3/93	4/94	2/95
Aes. amer. (91235)	11.7	0.0	0.0	0.0	0.0		70	0	0	0	s	-	-
Aes. amer. (93624)	13.3	1.7	0.0	0.0	0.0		78	0	0	0	s	-	-
Aes. amer. (Lee)	2.0	0.0	0.0	0.0	0.0		36	0	0	0	s	-	-
Aes. vill. (37235)	12.3	1.7	0.0	0.0	0.0		198	0	0	0	s	-	-
Aes. vill. (91209)	3.3	0.0	0.0	0.0	0.0		61	0	0	0	s	-	-
Ali. moni. (52343)	3.0	1.0	0.0	0.0	0.0		41	0	0	0	s	-	-
Ali. rugo. (52351)	14.8	1.0	0.3	0.0	0.0		94	0	0	0	s	-	-
Ali. rugo. (94489)	27.0	0.0	0.0	0.0	0.0		64	0	0	0	s	-	-
Ara. burk. (58109)	0.0	0.0	0.0	0.0	0.0		0	0	0	0	-	-	-
Ara. para. (91419)	0.0	0.0	0.0	0.0	0.0		0	0	0	0	-	-	-
Ara. pusi. (91423)	0.0	0.0	0.0	0.0	0.0		0	0	0	0	-	-	-
Ara. spp. (58121)	0.0	0.0	0.0	0.0	0.0		0	0	0	0	-	-	-
Caj. caja. (Jay)	3.0	1.3	0.3	0.0	0.0		58	0	0	0	s	s	-
Caj. caja. (Royes)	0.3	0.3	0.0	0.0	0.0		15	0	0	0	s	s	-
Cli. tern. (Milg.)	0.7	1.0	0.0	0.0	0.0		0	2	0	0	s	-	-
Des. virg. (85178)	17.7	15.3	10.8	8.2	2.6		265	229	138	0	s	S	S
Des. virg. (Bayamo)	12.4	12.2	8.8	9.0*	7.8	**(0.2)**	316	2677	528	27	s	S	s
Des. virg. (Marc)	8.3	9.6	7.9	4.8	1.9		339	525	250	0	s	S	S
Des. virg. (Uman)	2.0	1.7	1.7	1.0	1.3		75	158	111	71	s	s	s
Desm. dic. (47186)	2.3	0.0	0.0	0.0	0.0		4	0	0	0	s	-	-
Gly. lati. (CQ3368)	2.0	2.0	1.0	2.0	0.0		17	5	18	0	s	s	-
Ind. schi. (52621)	8.0	3.7	5.0	8.0	4.7		78	302	559	1120	s?	s	s
Ind. schi. (69495)	12.8	12.4	8.4	11.0	10.1		227	1221	1689	1348	s?	s	s
Ind. schi. (73608)	10.3	18.7	9.3	9.7	4.3		187	319	773	160	s?	s	s
Lab. purp. (28701)	4.0	0.7	0.0	0.0	0.0		111	0	0	0	s	-	-
Lab. purp. (51564)	2.2	0.6	0.9	0.1	0.0		231	37	0	0	s	F	-
Lab. purp. (H'worth)	3.8	0.8	0.0	0.0	0.0		1238	227	0	0	s	s	-
Mac. atro. (90338)	12.3	9.3	4.7	3.3	1.7		638	632	150	155	s	s	-
Mac. atro. (90844)	5.0	3.7	3.0	2.3	1.7		212	481	225	273	s	s	-
Mac. atro. (Siratro)	13.7	6.4	4.1	1.2	1.7		529	501	287	355	s	s	-
Mac. brac. (27404)	18.0	13.9	5.0	2.6	1.2		1322	2384	201	234	s	s	-
Mac. psam. (39098)	7.0	1.0	0.3	0.0	0.0		109	19	0	0	s		-
Macr. dal. (60303)	3.4	0.7	0.0	0.0	0.0		313	0	0	0	s		-
Med. sati. (Trifecta)	23.0	24.7	4.3	0.7	0.0		54	390	0	0	F	F	-
Rhy. mini. (81386)	9.3	4.7	3.0	2.3	0.7		212	232	47	88	s	s	F
Sty. aff. (104710)	17.7	17.7	17.0	13.7*	17.3	**(2.0)**	222	680	357	377	s	S	S
Sty. aff. (105546b)	8.0	14.0	8.7	10.3	10.0	**(3.0)**	112	512	339	553	s	S	S
Sty. aff. (110343)	16.0	27.7	15.7	48.0*	15.0		275	621	306	265	s	S	S
Sty. aff. (110361)	42.3	42.3	31.0	35.0*	13.0	**(1.0)**	674	1219	476	235	s	S	S
Sty. aff. (110372)	11.3	17.3	9.3	7.7	4.7	**(0.7)**	249	739	160	172	s	S	S
Sty. aff. (11370b)	10.0	12.7	7.3	14.0*	7.7	**(1.7)**	268	/f651	134	97	s	S	S
Sty. aff. (115995)	11.7	13.0	7.7	7.0	2.7	**(0.3)**	222	969	243	133	s	S	S
Sty. scab. (Seca)	2.0	1.3	1.3	0.3	0.0		18	40	0	33	s	s	-
Ter. labi. (60371)	0.1	0.0	0.0	0.0	0.0		0	0	0	0	s	-	-
Vig. tril. (13671)	4.1	0.0	0.0	0.0	0.0		13	0	0	0	s	s	-

All accession numbers are CPI (Commonwealth Plant Introduction) numbers unless otherwise stated

F= flowered
s= set a "small" amount of seed
S= set a "large" amount of seed
[1]estimated using single plants and plant density

Numbers in bold are seedlings (ie emerged in current season)
All other numbers are mature plants
*mature plant number includes seedlings from last year
[2]estimated by harvesting single 1m*1m quadrats

Table 6.7 Plant density, plot yield and seed production of legumes planted at the Emerald Research Station in 1992/93. Numbers in brackets are seedlings that emerged in the current season.

Accession	Plant density (pl/m2)							Yield (kg/ha)				Seed set		
	4/93	7/94		3/95		2/96		6/93* 1	7/94[1]	6/95[1]	2/96[1]	6/93	7/94	6/95
Aes. amer. (91235)	0.3	0.0		0.0		0.0		0	0	0	0	F	-	-
Aes. amer. (93624)	2.3	0.7		0.0		0.0		16	26	0	0	F	s	-
Aes. amer. (Lee)	0.7	0.0		0.0		0.0		65	0	0	0	F	F	-
Aes. vill. (37235)	1.0	0.0		0.0		0.0		0	0	0	0	F	-	-
Aes. vill. (91209)	1.0	2.0		0.0		0.0		0	27	0	0	F	F	-
Ali. moni. (52343)	7.0	4.3		0.0		0.0		53	29	0	0	s	s	-
Ali. rugo. (52351)	1.3	0.9		0.0		0.0		3	06	0	0	-	s	-
Ali. rugo. (94489)	2.7	0.0		0.0		0.0		274	0	0	0	s	-	-
Ara. burk. (58109)	0.0	0.0		0.3		0.0		0	0	0	0	-	-	-
Ara. para. (91419)	0.0	1.0		4.0		0.3		40	10	7	15	F	-	-
Ara. spp. (58121)	0.0	0.0		0.0		0:0		0	0	0	0	-	-	-
Caj. caja. (Jay)	4.3	0.0		0.3		0.0		78	0	0	0	s	-	-
Caj. caja. (Royes)	1.3	0.0		0.0		0.0		343	0	0	0	s	-	-
Cli. tern. (Milg.)	2.0	4.3		5.7		1.0	(1)	25	320	235	430	-	s	s
Des. virg. (85178)	11.78	6.4		2.3		1.0		177	100	10	30	s	s	s
Des. virg. (Bayamo)	3.44	3.8		0.9		0.2		31	732	26	19	s	s	-
Des. virg. (Marc)	7.0	3.4		1.9		1.1	(0-5)	55	90	108	170	S	s	s
Des. virg. (Uman)	1.0	0.0		0.0		0.0		12	0	2	0	F	-	-
Desm. dich.(47186)	8.7	0.0	(26)	0.0	(19)	0.0		292	24	6	0	S	s	-
Gly. lati. (CQ3368)	5.0	10.7		8.3		4.7	(1.)	78-	514	70	260	s	s	s
Ind. schi. (52621)	0.7	3.3		2.0		3.0	(0-5)	118	1442	1229	2560	F	s	S
Ind. schi. (69495)	7.2	4.6		3.8		3.8	(0-5)	261	960	2221	4600		s	S
Ind. schi. (73608)	0.7	2.0		1.0		1.7		373	1330	567	2530	s	s	S
Lab. purp. (24973)	3.3	0.0		0.0		0.0		0	0	0	0	-	-	-
Lab. purp. (28701)	4.3	0.0		0.0		0.0		107	0	0	0	-	-	-
Lab. purp. (51564)	3.6	0.6		0.0		0.0		51	43	14	0	F	-	-
Lab. purp. (H'worth)	5.4	0.0		0.0		0.0		496	0	0	0	s	-	-
Mac. atro. (90338)	2.0	6.3		4.0		0.7		143	1711	803	40	-	-	s
Mac. atro. (90844)	3.7	3.3		3.3		1.7		47	116	26	440	-	-	F
Mac. atro. (Siratro)	8.0	6.9		2.6		0.7		99	744	232	180	F	-	s
Mac. brac. (27404)	5.8	2.4		1.0		0.0		211	65	9	0	F	-	-
Mac. psam. (39098)	0.67	0.0		0.0		0.0		04	0	0	0	-	-	F
Macr.dalt. (60303)	3.2	0.1		0.7		0.0		43	0	0	0	s	-	F
Med. sati. (Trifecta)	0.3	0.0		0.0		0.0		0	0	0	0	-	-	-
Rhy. mini. (81386)	1.0	3.0		25.7		0.0		04	38	0	0	F	s	-
Sty. aff. (104710)	3.3	8.3	(71)	7.0	(72)	2.7	(1-5)	327	973	868	590	S	S	S
Sty. aff. (105546b)	0.7	6.0	(105)	6.0	(185)	6.7	(1-5)	438	1257	795	1400	S	S	S
Sty. aff. (110343)	3.0	11.3	(25)	9.0	(35)	2.3	(1-5)	167	1456	620	710	S	S	S
Sty. aff. (110361)	7.7	19.7	(51)	10.3	(71)	7.3	(1-5)	89	2114	297	710	S	S	S
Sty. aff. (110372)	4.7	9.7	(58)	10.7	(35)	8.0	(1-5)	44	1560	391	1300	S	S	S
Sty. aff. (11370b)	2.7	2.7	(1)	2.0		2.7		0	204	12	1300	S	S	S
Sty. aff. (115995)	0.0	8.0	(2)	1.7	(5)	1.7	(1-5)	3.3	1027	177	810	S	S	S
Sty. scab. (Seca)	0.0	1.3		0.0		0.0		0	2	0	0	s	s	s
Ter. labi. (60371)	0.3	0.1		0.6		0.0		5	1	0	0	-	-	-
Vig. tril. (13671)	11.1	3.4		0.1		0.0		396	5	0	0	S	s	-

All accession numbers are CPI (Commonwealth Plant Introduction) unless otherwise stated
F= flowered
s= set a "small" amount of seed
S= set a "large" amount of seed
*1993 yield data presented for replication 1 only
[1]Yield estimated using plant density and plant wt

Table 6.8 Plant density and plot yield of legumes planted at Narayen Research Station near Mundubbera in 1993/94

Accession	Plant density (pl/m^2)					Plot yield (kg/ha)		
	2/94	11/94	10/95	10/96		4/94[1]	3/95[2]	2/96[2]
Aes. amer. (Lee)	15.0	6.3	0.0	0.0		218	0	0
Aes. vill. (91209)	42.0	17.7	0.0	0.0		353	0	0
Ali. mono. (52343)	22.3	5.0	1.3	0.0		167	0	0
Cli. tern. (Milgarra)	3.7	1.7	1.0	0.3		96	184	67
Des. illi. (Sabine)	8.3	3.7	0.0	0.0		64	0	0
Des. virg. (40071)	30.0	22.0	19.0	23.3		933	1882	597
Des. virg. (55719)	26.7	26.7	14.7	3.3		1333	1634	1007
Des. virg. (Marc)	22.7	23.0	17.7	16.7*		671	1406	223
Des. virg. (Bayamo)	16.3	17.8	17.3	6.2		568	1857	720
Des. virg. (85178)	26.3	39.0	26.0	1.0		260	888	53
Des. virg. (TQ90)	32.0	20.7	23.7	13.0		353	2352	1723
Des. virg. (Uman)	9.0	8.7	6.0	1.3		140	904	310
Desm. dic. (47186)	21.3	0.3	0.0	0.0		202	0	0.
Gal. spp. (82294)	1.3	0.7	0.3	0.0		66	0	0
Gly. lati. (CQ3368)	2.3	4.3	3.7	2.3		75	57	0
Ind. schi. (16055)	19.3	16.7	13.3	7.7		115	798	1227
Ind. schi. (69495)	20.3	28.7	21.5	15.3		209	1832	2027
Ind. schi. (73608)	56.3	52.7	11.3	5.3		335	1210	780
Lab. purp. (24973)	2.3	2.7	0.0	0.0		101	279	0
Lab. purp. (28701)	2.0	0.7	0.0	1.3		65	0	0
Lab. purp. (51564)	4.2	1.8	0.0	0.0		581	24	0
Lab. purp. (52437)	3.3	1.3	0.0	0.0		228	370	0
Lab. purp. (H'worth)	0.2	0.0	0.0	0.0		337	0	0
Mac. atro. (84989)	7.7	6.7	2.7	1.0		796	152	83
Mac. atro. (90844)	10.3	5.0	4.7	1.3		220	0	277
Mac. atro (Siratro)	25.7	21.2	13.8	8.0		657	1128	792
Mac. brac. (27404)	14.8	5.7	3.2	1.0		190	171	102
Mac. brac. (55755)	19.7	4.7	2.3	0.3		113	1532	137
Mac. grac. (93084)	25.0	18.8	5.2	0.3		995	1254	302
Mac. lath. (49771)	31.0	19.3	8.3	3.3*		1031	1492	757
Mac. lath. (Murray)	13.3	15.3	5.7	2.7*		1063	0	470
Macr. axi. (52469)	4.0	1.7	0.3	0.0		67	26	17
Macr. dal. (60303)	6.3	15.7	0.2	0.0		813	107	0
Macr. uni. (Leich.)	1.3	0.0	0.0	0.0		240	0	0
Med. sati. (Trifecta)	26.0	3.7	2.0	4.0		153	0	0
Pso. spp. (CQ2973)	35.0	33.0	37.7	11.3*		336	98	0
Pso. tena. (CN55)	15.3	14.0	8.7	17.7*		146	51	0
Rhy. mini. (81386)	8.0	10.3	4.0	0.0		220	444	43
Rhy. verd. (52724)	13.7	15.3	11.0	1.3		395	1535	150
Sty. scab. (110361)	66.3	60.3	33.3	46.0*	(1.7)	512	1555	1437
Sty. scab. (110370C)	55.7	49.3	27.7	33.3*	(1.0)	362	1220	910
Sty. scab. (115994)	65.7	58.0	46.0	35.3*	(0.7)	959	2052	1300
Sty. scab. (Seca)	29.7	15.0	11.0	11.0		52	470	197
Sty. symp. (67704)	44.3	27.0	0.7	0.0		281	161	20
Vig. lute. (P1469)	3.5	0.3	0.0	0.2		494	0	0
Vig. oblo. (60430)	17.7	2.2	0.0	0.0		711	0	0
Vig. tril. (13671)	15.0	2.0	0.0	0.0		359	0	0
Vig. ungu. (R. cal.)	3.0	0.0	0.0	0.0		874	0	0

All accession numbers are CPI (Commonwealth Plant Introduction) numbers unless otherwise stated.
*Mature plant count includes seedlings from the previous year

Table 6.9 Plant density and plot yield of legumes planted at Brigalow Research Station near Theodore in 1993/94

Accession	Plant density (pl/m^2)					Plot yield (kg/ha)		
	2/94	6/94	6/95	2/96		6/94[1]	6/95[1]	2/96[1]
Aes. amer. (Lee)	0.0	0.3	0.0	0.0		0	0	0
Aes. vill. (91209)	15.7	4.7	0.0	0.0		29	0	0
Ali. mono. (52343)	3.7	7.7	0.0	0.0		7	0	0
Cli. tern. (Milgarra)	5.3	4.0	3.7	3.8		40	221	0
Des. illi. (Sabine)	0.0	0.0	0.0	0.0		0	0	0
Des. virg. (40071)	3.3	3.7	1.7	1.8		23	216	0
Des. virg. (55719)	8.0	6.3	5.0	2.7		54	2483	73
Des. virg. (Marc)	2.3	1.7	1.7	2.0		104	375	0
Des. virg. (Bayamo)	1.7	1.5	1.2	0.9		16	274	0
Des. virg. (85178)	2.7	0.7	1.3	0.3		1	113	0
Des. virg. (TQ90)	1.3	0.7	1.3	2.3		1	832	0
Des. virg. (Uman)	0.7	1.3	1.3	1.2		9	449	0
Desm. dic. (47186)	6.0	6.3	0.0	0.0		519	0	0
Gal. spp. (82294)	0.0	0.0	0.0	0.0		0	0	0
Gly. lati. (CQ3368)	6.7	6.0	3.7	2.0		10	44	0
Ind. schi. (16055)	2.7	2.0	3.3	3.8		7	1066	863
Ind. schi. (69495)	6.5	5.7	6.0	4.7		20	1326	773
Ind. schi. (73608)	19.7	8.7	10.0	4.5		29	829	607
Lab. purp. (24973)	3.3	1.0	0.0	0.0		44	0	0
Lab. purp. (28701)	3.7	1.0	0.0	0.0		12	0	0
Lab. purp. (51564)	8.2	4.3	0.0	0.0		115	0	0
Lab. purp. (52437)	5.0	0.3	0.0	0.0		2	0	0
Lab. purp. (H'worth)	5.8	3.5	0.0	0.0		480	0	0
Mac. atro. (84989)	9.0	7.7	2.7	0.8		36	47	0
Mac. atro. (90844)	14.0	5.7	0.7	0.2		68	1	0
Mac. atro (Siratro)	32.2	14.3	0.7	0.2		250	9	0
Mac. brac. (27404)	10.5	5.8	0.2	0.0		194	6	0
Mac. brac. (55755)	8.3	4.7	0.0	0.0		49	0	0
Mac. grac. (93084)	14.7	5.0	0.0	0.0		128	0	0
Mac. lath. (49771)	23.0	14.3	5.3	2.2		452	291	0
Mac. lath. (Murray)	13.3	15.3	2.0	2.0		341	70	0
Macr. axi. (52469)	0.7	2.0	0.0	0.0		3	0	0
Macr. dal. (60303)	9.3	6.3	0.5	0.6		59	3	0
Macr. uni. (Leich.)	4.0	3.0	0.0	0.0		98	0	0
Med. sati. (Trifecta)	0.0	0.0	0.3	0.0		0	5	0
Pso. spp. (CQ2973)	2.3	0.0	0.3	0.0		0	2	0
Pso. tena. (CN55)	6.7	4.0	0.0	0.0		13	0	0
Rhy. mini. (81386)	15.3	10.7	7.7	0.7		270	175	0
Rhy. subl. (52727)	8.3	4.0	0.3	0.2		18	1	0
Rhy. verd. (52724)	7.7	4.7	5.0	0.7		55	365	0
Sty. scab. (110361)	0.3	2.0	2.3	1.8	**(6.0)**	1	200	440
Sty. scab. (110370C)	0.3	2.3	1.3	2.0	**(3.3)**	3	193	50
Sty. scab. (115994)	0.0	0.3	1.3	1.3		1	188	0
Sty. scab. (Seca)	0.0	0.0	0.0	0.0		0	0	0
Vig. lute. (P1469)	2.0	2.3	0.0	0.0		42	0	0
Vig. oblo. (60430)	21.2	4.8	0.0	0.0		60	0	0
Vig. tril. (13671)	12.8	10.8	2.0	0.0		301	46	0
Vig. ungu. (R. cal.)	21.0	6.0	0.0	0.0		310	0	0

All accession numbers are CPI (Commonwealth Plant Introduction) numbers unless otherwise stated
[1]Yield estimated from plant density and individual plant weight

Table 6.10 Plant density and plot yield of legumes at Emerald Research Station in the 1993/94 sowing.

Accession	Plant density (pl/m²)				Plot yield (kg/ha)	
	4/94	7/94	6/95	2/96	7/94[1]	6/95[1]
Aes. amer. (Lee)	1.7	0.7	0.0	0.0	0	0
Aes. vill. (91209)	27.0	8.7	0.0	0.0	4	0
Ali. mono. (52343)	12.3	5.0	0.0	0.0	1	0
Cli. tern. (Milgarra)	10.7	6.0	0.7	1.7	6	18
Des. illi. (Sabine)	1.7	2.3	0.0	0.0	1	0
Des. virg. (40071)	9.0	1.3	0.3	0.7	1	1
Des. virg. (55719)	13.7	8.3	0.7	1.0	6	4
Des. virg. (Marc)	9.2	5.2	0.5	2.8	5	6
Des. virg. (Bayamo)	5.8	2.3	0.0	0.0	1	0
Des. virg. (85178)	9.7	3.7	0.3	1.3	1	0
Des. virg. (TQ90)	10.0	5.7	0.0	0.3	1	0
Des. virg. (Uman)	2.7	2.3	1.3	3.3	1	73
Desm. dic. (47186)	4.0	2.0	0.0	0.0	6	0
Gal. spp. (82294)	0.0	0.0	0.0	0.0	0	0
Gly. lati. (CQ3368)	11.0	17.7	2.3	5.3	216	33
Ind. schi. (16055)	5.0	4.0	1.7	3.7	3	48
Ind. schi. (69495)	5.0	3.7	0.5	6.3	3	18
Ind. schi. (73608)	6.0	4.0	0.3	2.7	4	4
Lab. purp. (24973)	3.3	4.0	0.0	0.0	16	0
Lab. purp. (28701)	1.7	0.3	0.0	0.0	7	0
Lab. purp. (51564)	6.3	3.0	0.0	0.0	16	0
Lab. purp. (52437)	1.3	0.3	0.0	0.0	0	0
Lab. purp. (H'worth)	5.5	3.0	0.0	0.0	35	0
Mac. atro. (84989)	5.3	0.7	0.7	2.7	3	62
Mac. atro. (90844)	2.3	0.7	0.3	0.7	2	6
Mac. atro (Siratro)	14.3	10.0	0.8	2.3	48	72
Mac. brac. (27404)	0.8	0.0	0.0	0.0	0	0
Mac. brac. (55755)	2.3	2.7	0.0	0.0	2	0
Mac. grac. (93084)	17.8	8.8	0.3	0.2	20	7
Mac. lath. (49771)	42.7	11.3	0.0	0.0	11	0
Mac. lath. (Murray)	17.0	12.0	0.0	0.0	48	0
Macr. axi. (52469)	0.3	0.0	0.0	0.0	0	0
Macr. dal. (60303)	1.2	0.3	0.0	0.2	1	0
Macr. uni. (Leich.)	3.7	2.0	0.0	0.0	6	0
Med. sati. (Trifecta)	0	0.0	0.0	0.0	0	0
Pso. spp. (CQ2973)	2.7	0.7	0.0	0.0	0	0
Pso. tena. (CN55)	10.0	5.0	0.0	0.0	1	0
Rhy. mini. (81386)	19.0	11.3	0.0	0.0	71	0
Rhy. subl. (52727)	41.3	15.3	0.0	0.0	46	5
Sty. scab. (110361)	14.7	6.3	0.3	0.7	7	6
Sty. scab. (110370C)	11.0	6.3	0.3	1.0	3	9
Sty. scab. (115994)	17.7	6.3	0.3	3.0	3	0
Sty. scab. (Seca)	2.7	2.7	0.0	0.0	1	0
Sty. symp. (67704)	8.0	3.0	0.0	0.0	3	0
Vig. lute. (P1469)	9.2	2.8	0.0	0.0	9	0
Vig. oblo. (60430)	15.3	5.3	0.0	0.0	9	0
Vig. tril. (13671)	26.8	16.7	0.0	0.0	61	0
Vig. ungu. (R. cal.)	17.0	6.7	0.0	0.0	111	0

All plant accession numbers are CPI (Commonwealth Plant Introduction) numbers unless otherwise stated
[1]Yield estimated from plant density and individual plant weight

Table 6.11 Plant density and plot yield of legumes planted at Narayen Research Station near Mundubbera in 1994/95.

Accession	Plant density (pl/m²)				Plot yield (kg/ha)	
	2/95	5/95	9/95	10/96	5/95[1]	2/96[2]
Aly. long. (94490)	46.7	0.0	0.0	0.0	0	0
Aly. rugo. (51655)	8.3	8.0	0.0	0.0	169	0
Aly. rugo. (69487)	33.7	11.0	0.0	0.0	17	0
Aly. rugo. (84470)	20.7	26.3	0.0	0.0	51	0
Ara. spp.	33.7	19.0	4.3	0.0	72	0
Aty. scar. (52372)	11.0	5.0	1.0	0.0	11	0
Caj. caja. (Jay)	2.7	0.7	0.0	0.0	5	0
Caj. caja. (Quest)	0.3	0.0	0.0	0.0	0	0
Cen. bras. (55698)	3.7	2.0	0.0	0.0	0	0
Cen. scho. (95967)	1.0	0.7	0.3	0.0	17	7
Cli. tern. (Milgarra)	4.0	1.7	0.0	0.0	2	1
Des. virg. (55719)	22.7	13.0	13.0	0.3	346	43
Des. virg. (84972)	30.7	19.0	23.3	2.0	190	91
Des. virg. (85172)	30.0	17.7	10.0	3.3	203	78
Des. virg. (85177)	44.7	35.3	29.3	0.0	328	32
Des. virg. (89197)	18.3	15.3	8.0	1.3	255	93
Des. virg. (90750)	84.0	47.3	42.3	14.3	515	245
Des. virg. (90857)	15.0	19.7	6.0	3.7	259	114
Des. virg. (Bayamo)	32.3	32.0	24.0	13.7	136	274
Des. virg. (Marc)	60.0	46.0	53.0	17.7	128	138
Des. virg. (Uman)	25.3	24.3	14.0	2.3	149	246
Desm. dic. (47186)	20.7	3.3	0.0	0.0	0	0
Desm. sco. (89707)	91.3	3.3	0.0	0.0	0	0
Desm. set. (52431)	2.0	0.0	0.0	0.0	0	0
Gal. spp. (67646)	4.3	2.0	0.7	0.0	0	0
Gal. stri. (49740)	1.3	0.3	0.3	0.0	0	0
Gly. lati. (CQ3386)	5.0	0.7	1.3	1.3	0	15
Gly. lati. (Line 6)	7.0	2.7	2.3	1.0	0	0
Hey. late. (31951)	35.0	21.0	13.7	0.0	174	0
Ind. schi. (52621)	20.0	22.0	20.7	10.7	109	919
Ind. schi. (73608)	38.0	37.0	34.0	6.3	67	354
Ind. shim. (16055)	21.7	21.7	25.7	15.7	129	963
Lab. purp. (H'worth)	2.0	2.7	0.7	0.0	322	0
Mac. atro. (84989)	6.3	6.3	7.3	1.7	165	119
Mac. atro. (90748)	5.3	2.7	1.3	1.0	8	125
Mac. atro. (90776)	2.7	4.3	0.3	0.0	0	69
Mac. atro. (90905)	7.3	1.3	5.7	5.7	19	274
Mac. atro. (Aztec)	14.3	11.7	14.3	6.0	7	545
Mac. brac. (27404)	15.3	12.3	10.0	1.7	1776	168
Mac. brac. (55758)	7.7	4.0	1.3	0.0	27	27
Mac. brac. (55769)	19.3	13.0	14.3	0.7	352	354
Mac. grac. (93084)	21.3	7.3	1.0	0.0	214	0
Mac. lath. (49771)	17.0	7.3	10.7	6.0	120	498
Mac. lath. (Murray)	42.7	24.7	12.7	2.7	288	104
Mac. mart. (49780)	21.3	19.3	9.3	0.0	341	142
Med. sati. (Trifecta)	78.0	20.3	25.0	1.3	13	0
Nep. dimo. (CQ1839)	4.3	3.0	1.7	0.0	42	6
Nep. grac. (CQ1849)	9.3	11.0	5.3	2.3	65	92
Nep. grac. (CQ3226)	11.0	13.0	7.0	0.0	283	12
Nep. grac. (CQ3227)	7.3	5.7	6.0	0.7	41	51
Nep. mono. (CQ2082)	4.0	1.0	0.7	0.0	8	18
Nep. plen. (46380)	3.3	2.0	0.3	0.0	25	36

Nep. spp. (CQ1842)	13.3	6.7	1.7	0.0	99	6
Rhy. mini. (52704)	10.7	8.0	9.7	0.7	79	35
Rhy. mini. (60335)	23.0	20.0	9.3	5.3	249	369
Rhy. subl. (52727)	0.0	0.3	0.7	0.0	5	0
Sty. scab. (110361)	87.3	43.7	52.0	17.3	122	403
Sty. scab. (115994)	47.7	22.3	31.3	8.7	66	381
Sty. scab. (115995)	48.3	26.0	31.3	16.7	346	429
Sty. scab. (92838b)	157.0	114.7	95.7	39.0	100	836
Vig. deci. (52835b)	6.3	6.3	1.7	0.0	329	54
Vig. deci. (52839)	12.7	12.7	8.3	0.0	0	312
Vig. deci. (73602)	6.0	0.0	0.0	0.0	0	0
Vig. oblo. (28763)	6.3	0.0	0.0	0.0	0	0
Vig. oblo. (43799)	2.7	0.3	0.0	0.0	0	0
Vig. oblo. (57524)	10.0	0.3	2.0	0.0	0	0
Vig. oblo. (60433)	16.3	13.3	5.3	0.0	82	73
Vig. tril. (13671)	38.3	27.0	0.0	0.0	359	0
Vig. vexi. (15463)	8.0	0.0	0.0	0.0	0	0
Vig. vexi. (43799)	1.7	0.3	0.0	0.0	0	0
Vig. vexi. (69030)	3.7	6.7	0.0	0.0	30	0
Vig. vexi. (CQ3044)	10.3	2.7	2.3	0.0	0	0

All plant introduction numbers are CPI (Commonwealth Plant Introduction) numbers unless otherwise stated
[1]Yield estimated from plant density and individual plant weight
[2]Yield estimated from harvested single 1m*1m quadrat

Table 6.12 Plant density and plot yield of legumes planted at Brigalow Research Station near Theodore in 1994/95. Numbers in brackets are number of seedlings emerged in the current season.

Accession	Plant density (pl/m^2)					Plot yield (kg/ha)	
	3/95	6/95		2/96		6/95[1]	2/96[1]
Aly. long. (94490)	2.0	0.7		0.0		7	0
Aly. rugo. (51655)	2.3	9.7		0.8	**(0.3)**	82	0
Aly. rugo. (69487)	1.7	0.7		0.2		1	0
Aly. rugo. (84470)	0.7	0.3		0.0		11	0
Aty. scar. (52372)	1.7	4.3		1.2		919	0
Caj. caja. (Jay)	2.3	1.7		0.0		94	0
Caj. caja. (Quest)	0.0	0.0		0.0		0	0
Cen. bras. (55698)	0.0	3.7		0.0		20	0
Cen. scho. (95967)	0.3	1.7		0.2	**(0.2)**	260	0
Cli. tern. (Milgarra)	0.3	5.7		3.0	**(0.3)**	29	72
Des. virg. (55719)	0.0	0.3		0.3		130	0
Des. virg. (84972)	0.0	0.3		0.2		127	0
Des. virg. (85172)	0.7	0.7		0.4		410	0
Des. virg. (85177)	2.0	2.0		0.7		215	0
Des. virg. (89197)	0.7	1.0		2.3	**(1.3)**	78	30
Des. virg. (90750)	0.7	0.7		0.0	**(1.2)**	96	0
Des. virg. (90857)	0.7	0.7		0.2		64	0
Des. virg. (Bayamo)	0.0	0.3		0.5		24	0
Des. virg. (Marc)	0.3	0.3		0.3		17	1
Des. virg. (Uman)	0.0	0.0		0.0		0	0
Desm. dic. (47186)	0.7	2.3		0.0		20	0
Desm. set. (52431)	0.0	0		0.0		0	0
Gal. spp. (67646)	1.3	0.7		1.2		6	8
Gal. stri. (49740)	2.3	2.3		1.2		34	65
Gly. lati. (CQ3386)	4.3	4.3		5.8		314	317
Ind. schi. (52621)	3.0	2.0		0.8		660	987
Ind. schi. (73608)	1.7	0.7		1.5		184	641
Ind. shim. (16055)	0.3	0.7		0.5		265	219
Lab. purp. (H'worth)	0.7	0.7		0.0		358	0
Mac. atro. (84989)	1.0	6.3		3.0		2230	334
Mac. atro. (87506)	0.3	7.7		4.0		988	306
Mac. atro. (90338)	2	4.3		1.7		761	78
Mac. atro. (90748)	3.3	5.0		2.3		219	94
Mac. atro. (90776)	1.3	5.0		2.0		2327	119
Mac. atro. (90905)	5.0	6.0		3.7	**(0.3)**	849	359
Mac. atro. (Aztec)	8.7	7.3		3.7		1443	589
Mac. brac. (27404)	3.3	4.3		3.3		43	209
Mac. brac. (55758)	1.7	3.3		1.2		44	61
Mac. brac. (55769)	9.0	5.3		4.7		127	962
Mac. brac. (81724)	0.0	0		0.0		0	0
Mac. grac. (84999)	3.3	2.3		2.2	**(3.3)**	711	23
Mac. lath. (49771)	11.3	12.0	(11)	7.2	**(2.5)**	785	313
Mac. lath. (Murray)	10.3	27.3	(69)	8.8	**(4.3)**	2285	1355
Mac. mart. (49780)	3.0	4.3		0.3		424	0
Med. sati. (Trifecta)	0.0	0.0		0.0		0	0
Nep. dimo. (CQ1839)	1.7	0.7		0.3		72	0
Nep. grac. (CQ1849)	1.0	1.0		2.7		135	127
Nep. grac. (CQ3226)	5.0	5.3		2.8		849	97
Nep. grac. (CQ3227)	4.3	2.3		3.8		70	141
Nep. mono. (CQ2082)	1.3	1.7		1.7		53	75

Nep. plen. (46380)	2.0	1.0	0.3		438	0
Nep. spp. (CQ1842)	3.3	3.3	2.8		109	0
Rhy. mini. (52704)	4.0	7.0	1.0		85	14
Rhy. mini. (60335)	6.7	7.3	1.7		1255	13
Rhy. subl. (52727)	0.3	2.3	0.7		28	0
Rhy. verd. (34133)	4.7	9	2.7		2684	397
Sty. scab. (110361)	0.3	0.3	0.7	(0.2)	0	0
Sty. scab. (115994)	0.7	0.0	0.2		0	0
Sty. scab. (115995)	0.0	0.3	0.2		0	0
Sty. scab. (92838b)	1.0	0.3	1.0		37	0
Vig. deci. (52835b)	3.0	3.7	0.0		401	0
Vig. deci. (52839)	7.7	8.0	3.3		602	274
Vig. deci. (73602)	1.0	1.0	0.0		5	0
Vig. oblo. (28763)	1.0	0.0	0.0		0	0
Vig. oblo. (43799)	0.3	0.7	0.0		5	0
Vig. oblo. (57524)	0.0	0.3	0.0		1	0
Vig. oblo. (60433)	2.3	1.7	1.2		43	0
Vig. tril. (13671)	8.0	9.3	0.8	(0.2)	2682	12
Vig. vexi. (15463)	3.7	4.3	0.0		14	0
Vig. vexi. (43799)	0.0	2.0	0.0		5	0
Vig. vexi. (69030)	0.7	2.0	0.0		15	0
Vig. vexi. (CQ3044)	0.7	4.7	0.2		278	0

All accession numbers are CPI (Commonwealth Plant Introduction) numbers unless otherwise stated
[1]Yield estimated from plant density and individual plant weight

Table 6.13 Plant density and plant yield of legumes planted at Emerald Research Station in 1994/95

Accession	Plant density (pl/m^2)			Plot yield (kg/ha)	
	3/95	6/95	2.96	6/95[1]	2/96[1]
Aly. rugo. (51655)	20.3	18.0	0.0	191	0
Aly. rugo. (69487)	21.0	8.7	0.0	23	0
Aty. scar. (52372)	4.3	3.7	0.3	61	0
Caj. caja. (Jay)	1.0	2.7	0.3	94	0
Caj. caja. (Quest)	1.7	1.3	0.0	20	0
Cen. bras. (55698)	3.7	3.7	0.0	24	0
Cen. scho. (65967)	1.3	0.7	0.2	9	0
Cli. tern. (Milgarra)	3.0	2.0	3.7	6	92
Des. virg. (55719)	2.0	2.0	0.8	5	35
Des. virg. (84972)	13.0	6.0	4.3	43	360
Des. virg. (85172)	18.0	5.7	8.0	30	340
Des. virg. (85177)	35.7	8.7	8.8	103	410
Des. virg. (89197)	4.7	3.0	3.0	17	184
Des. virg. (90750)	10.7	6.0	2.3	22	79
Des. virg. (90857)	9.3	4.0	6.7	11	541
Des. virg. (Bayamo)	1.0	0.3	0.2	0	6
Des. virg. (Marc)	13.3	9.0	5.0	49	310
Des. virg. (Uman)	3.0	2.3	0.5	6	6
Desm. dic. (47186)	16.7	13.3	0.0	307	0
Desm. set. (52431)	0.0	0	0.0	0	0
Gal. spp. (67646)	4.3	3.0	0.0	31	0
Gal. stri. (49740)	2.0	1.0	0.2	27	0
Gly. lati. (CQ3386)	4.3	4.0	3.2	28	34
Gly. lati. (Line 6)	2.7	5.7	0.8	25	8
Ind. schi. (52621)	11.7	11.0	10.3	16	645
Ind. schi. (73608)	19.7	4.7	3.8	6	378
Ind. shim. (16055)	6.3	1.3	2.3	1	120
Lab. purp. (H'worth)	1.0	2.3	0.3	266	0
Mac. atro. (84989)	10.0	5.7	4.0	95	282
Mac. atro. (87506)	0.3	0.7	0.7	10	9
Mac. atro. (90338)	3.3	3	0.8	29	15
Mac. atro. (90748)	4.3	3.3	1.8	43	153
Mac. atro. (90776)	2.7	1.7	1.2	20	52
Mac. atro. (90905)	8.0	3.7	2.5	37	174
Mac. atro. (Aztec)	6.0	7.7	2.2	117	126
Mac. brac. (27404)	15.3	14.3	4.5	157	198
Mac. brac. (55758)	2.3	3.3	3.2	35	250
Mac. brac. (55769)	25.0	17.7	1.5	382	0
Mac. grac. (84999)	6	1.0	0.2	5	0
Mac. lath. (49771)	8.3	4.7	1.7	89	35
Mac. lath. (Murray)	36.0	23.3	3.8	679	179
Mac. mart. (49780)	18.3	16.0	2.2	338	130
Med. sati. (Trifecta)	0.0	0.0	0.0	0	0
Nep. dimo. (CQ1839)	7.7	4.3	3.5	56	101
Nep. grac. (CQ1849)	4.7	2.0	4.0	19	213
Nep. grac. (CQ3226)	10.0	6.7	3.7	35	96
Nep. grac. (CQ3227)	6.7	2.3	3.0	5	78
Nep. Mono. (CQ2082)	3.7	1.3	0.7	2	3
Nep. plen. (46380)	2.0	2.3	0.8	8	69
Nep. spp. (CQ1842)	10.7	2.7	4.2	3	32

Rhy. mini. (60335)	6.0	4.0	0.3	38	2
Rhy. subl. (52727)	1.7	0.3	0.3	1	0
Sty. scab. (110361)	3.7	2.7	0.7	9	15
Sty. scab. (115994)	5.7	2.0	1.3	3	25
Sty. scab. (115995)	5.0	2.3	2.8	6	80
Sty. scab. (92838b)	7.3	8.0	4.2	33	95
Vig. deci. (52835b)	3.7	0.7	0.0	19	0
Vig. deci. (52839)	12.3	10.7	0.2	83	0
Vig. deci. (73602)	2.0	0.0	0.0	0	0
Vig. oblo. (28763)	2.0	0.0	0.0	0	0
Vig. oblo. (43799)	1.3	0.3	0.0	1	0
Vig. oblo. (57524)	5.7	0.7	0.0	0	0
Vig. oblo. (60433)	2.0	0.0	0.0	0	0
Vig. tril. (13671)	22.3	24.7	0.2	138	0
Vig. vexi. (15463)	6.7	0.0	0.0	0	0
Vig. vexi. (43799)	0.0	0.3	0.0	1	0
Vig. vexi. (69030)	3.3	0.0	0.0	0	0
Vig. vexi. (CQ3044)	2.0	0.0	0.0	0	0

All accession numbers are CPI (Commonwealth Plant Introduction) numbers unless otherwise stated
[1]Yield estimated

6.2 Medics

Growth and persistence of 17 annual medic (*Medicago* spp.) accessions on clay soils in Central Queensland

Adapted legumes are being sought for clay soils in this zone for both cropping and grazing systems as a means of restoring soil fertility and maintaining productivity. With the success of annual medics (*Medicago* spp.) in southern Queensland (Lloyd et al 1991), there is interest in finding medic germplasm that is suited to central Queensland farming systems.

The first medic germplasm commercialised in the sub-tropics was selected in southern Australia from naturalized and introduced material. The main cultivars used before 1977 were Jemalong and Cyprus barrel medics (*M. truncatula*) and Robinson snail medic (*M. scutellata*). With the arrival of aphids in 1977, and the subsequent damage to growth, germplasm was selected for resistance to aphids leading to use of cultivars such as Paraggio barrel medic. The effect of aphids has since declined and germplasm evaluation programs are now focussing on material that is suited to climatically marginal environments. Medics have been grown in Central Queensland (defined here as north of the Condamine river catchment) but problems of poor persistence have been experienced (Clarkson 1986). The aim of the current trial was to evaluate germplasm that may have the potential to persist in these areas.

Materials and Methods

Site Descriptions and Climate

Four sites were selected in Central Queensland (latitude 23°28' to 25°41'S) to cover the geographic area and soil types on which medics are likely to be grown. The sites were at Emerald (Emerald Research Station), Jambin ("Roann"), Theodore (Brigalow Research Station) and west of Mundubbera (Narayen Research Station) (Table 6.14). Emerald has the lowest annual rainfall at 637 mm (13% in winter), followed by Theodore 677 mm (14%), Jambin 696 mm (14%) and Narayen Research Station 707 mm (15%). Three sites were located in areas previously cleared of Brigalow, while the Emerald site was an area of naturally treeless open plains. All soils were neutral to alkaline and were moderately to highly fertile. All sites except Emerald Research Station had a soil depth of at least 1.5 metres.

Table 6.14 Location, rainfall vegetation and soil characteristics of 4 sites in central Queensland used in the evaluation of 17 medic accessions

Site	Jambin	Theodore	Mundubbera	Emerald
Latitude	24.10S	24.50S	25.41S	23.28S
Longitude	150.23E	149.46E	150.51E	148.09E
Nearest Town	Jambin	Theodore	Mundubbera	Emerald
Great Soil Group	Black earth	Black earth	Black earth	Black earth
Principal Profile Form	Ug 5.15	Ug 5.16	Dr 4.13	Ug 5.12
pH (0-30 cm)	6.5 - 7.0	7.0 - 9.0	6.5 - 7.5	7.0 - 8.5
Soil Depth (m)	>1.50	>1.50	1.50	0.70
Native Vegetation and Current Use	Cleared brigalow used for sown pasture	Cleared brigalow used for cropping and sown pasture	Brigalow / softwood scrub used for cropping and sown pasture	*Dichanthium* grassland
Annual Rainfall (mm)	696	677	707	637
Winter Rainfall (% of Annual Rainfall)	14	14	15	13
Total Nitrogen (%)	0.20	0.10	0.24	0.05
Phosphorous (mg/kg)	84	14	47	8
Zinc (mg/kg)	1.2	0.7	2.6	0.5
Sulphur (mg/kg)	8	3	11	2

Accessions

The seventeen accessions of medic sown at each site (Tables 6.14 - 6.17) were selected from a previous Wool Research and Development Corporation funded project (DAQ 51). This material primarily included accessions that had shown early maturity and the ability to set large quantities of seed under moisture limiting conditions in southern Queensland.

Site Establishment and Management

The 17 medic accessions were sown into cultivated soil at Theodore on 6 May 1993, Emerald on 17 June 1993, Jambin on 15 June 1993 and Mundubbera on 9 June 1993. Seed was inoculated with Group A *Rhizobium* and hand broadcast onto the soil surface at a rate of 10 kg/ ha. The surface of the soil was then harrowed or rolled to cover the seed with a thin layer of soil. All sites except Theodore were irrigated to assist establishment. Due to a lack of irrigation at Theodore, the sowing at this site failed to establish in 1993 and was replanted on 22 April 1994. The control species *Medicago sativa* cv. Trifecta was planted at all sites except Theodore where *Vicia benghalensis* cv. Popany was planted.

No fertiliser was applied to any of the sites in 1993. However, soil tests undertaken at each site in 1994 suggested that levels of S at Emerald and Theodore were lower than critical levels suggested by Baker and Eldershaw (1993). Phosphorus at Emerald was also moderately low at 8 mg bicarbonate extractable P/kg (Table 6.14). Plot size was 16 m^2 at Emerald and Theodore, 9 m^2 at Mundubbera and 4 m^2 at Jambin. Plots were replicated three times and each site was arranged in a randomised block design.

Data collection and analysis

Plant density was measured at all sites following emergence in the establishment year. This was done by counting all plants in 4 randomly placed 0.25 m^2 quadrats in each plot at all sites. However, when plant numbers were high, a 0.09 m^2 quadrant was used. Seedling regeneration in subsequent years was measured in a similar manner.

First year yield was measured by harvesting all above ground material in 0.25 m^2 quadrats that were considered to be representative of the whole plot. Herbage yield in subsequent years was rated visually on a subjective scale (1-5). Following senescence of plant tops at the end of the first season, pod number was counted in quadrats of 0.25m^2 or 0.09m^2 depending on pod density. Seed was removed from a random sample of 30 pods from each plot, counted and weighed so that seed number and seed weight/ha could be calculated. The percentage of seed that emerged as seedlings in the second year was calculated from seed number produced in the first year and seedling establishment in the second year.

Results

Rainfall

Rainfall was below average at all sites in all years particularly in 1994 and 1995. Winter rainfall at Emerald, Jambin and Mundubbera was highest in the year of establishment (1993), when plots were also irrigated to enable medic growth and seed set. Winter rainfall in the year of establishment at Theodore in the 1994 sowing was only 30 mm, but was sufficient to allow establishment following a wetter than normal autumn (217 mm).

Seedling emergence

Emerald. In 1993 there were six accessions which established with more than 200 seedlings / m^2 including 5 barrel medic accessions (Caliph, Cyprus, Parabinga, T116 and Z914) and 1 accession each of *M. aculeata* (SA8944) and *M. polymorpha* (Circle valley) (Table 6.15). There was no seedling emergence observed in 1994 and 1995. Only 4 medic accessions established in 1996; button medic (SA 8460) and 3 barrel medic cultivars (Caliph, Parabinga and Cyprus).

Theodore. Seedling emergence in 1994 occurred after rain in early winter with most accessions establishing. Circle Valley and Santiago had the high establishment with seedling number being more than double that of other accessions (Table 6.16). Rainfall in 1994 and 1995 enabled regeneration of most accessions with the exception of *M.aculeata* SA 8944, *M.scutellata* SA 3110 and Popany vetch. Sava barrel medic and SA 1868 snail medic had the highest regeneration.

Jambin. All accessions established well in 1993 with *M. orbicularis* SA 8460, *M. polymorpha* Circle Valley, and Trifecta lucerne having the highest seedling numbers (Table 6.17). In 1994 seedlings emerged after good falls of rain in autumn, with Parabinga barrel medic and Sava and SA 1868 snail medic producing the highest number of regenerating plants. Good rainfall in summer and early autumn in 1995, produced similar seedling numbers for all accessions to the previous years with Santiago, Parabinga Caliph and Cyprus barrel medics Sava and SA 1868 snail medics having over 100 seedlings / m^2. Germinating rains in mid Autumn of 1996 allowed emergence of all accessions with Cyprus, Caliph, Parabinga and T116 barrel medics, *M.orbicularis* SA8460 and *M. polymorpha* Santiago producing over 400 plants / m^2.

Table 6.15 Seedling emergence (1993, 1996), seed yield (1993) seed numbers (1993) and dry matter yield (1993) of 17 medic accessions at Emerald.

Species	Accession	1993 PD (m^2)	1996 PD (m^2)	1993 Seed Yield (kg/ha)	1993 Seed number (m^2)	1993 Dry Matter (kg/ha)
M. aculeata	SA 8944	114	0	0	0	528
M. orbicularis	SA 8460	275	29	314	8,790	1288
M. polymorpha	CIRCLE VALLEY	214	0	5	328	292
M. polymorpha	SANTIAGO	125	0	38	1,790	424
M. sativa	TRIFECTA	45	0	0	0	312
M. scutellata	KELSON	51	0	5	27	920
M. scutellata	SAVA	54	0	214	1,310	1450
M. scutellata	SA 1868	49	0	5	56	580
M. scutellata	SA 3110	49	0	0	0	552
M. truncatula	CALIPH	236	5	74	2,070	1460
M. truncatula	CYPRUS	200	1	25	584	752
M. truncatula	JEMALONG	154	0	0	53	888
M. truncatula	PARABINGA	223	3	17	361	788
M. truncatula	PARAGGIO	127	0	0	0	1050
M. truncatula	SEPHI	169	0	0	8	652
M. truncatula	SA 11292	31	0	0	0	220
M. truncatula	T 116	261	0	7	237	612
M. truncatula	Z 914	217	0	0	16	828
Mean		144	2	39	868	756

PD = plant density

Table 6.16 Seedling emergence (1994, 1995, 1996), seed yield (1994), seed number (1994, 1995) and yield rating (1995) of 17 medic accessions at Theodore

Species	Accession	1994 PD (m^2)	1995 PD (m^2)	1996 PD (m^2)	1994 Seed Yield (kg/ha)	1995 Seed Yield (kg/ha)	1994 seed numbers (m^2)	1995 seed numbers (m^2)	1995 DM Yield Rating (1-9)
M. aculeata	SA 8944	13	1	0	0	0	5	0	2
M. orbicularis	SA 8460	23	7	9	0	1	57	133	4
M. polymorpha	CIRCLE VALLEY	46	49	9	3	0	348	1	2
M. polymorpha	SANTIAGO	44	23	11	5	0	542	6	4
V. banghalensis	POPANY	16	0	0	0	0	0	0	0
M. scutellata	KELSON	12	2	3	1	0	17	12	3
M. scutellata	SAVA	12	21	51	2	7	60	214	8
M. scutellata	SA 1868	4	16	23	2	3	54	89	7
M. scutellata	SA 3110	11	1	0	0	1	12	13	3
M. truncatula	CALIPH	1	1	2	0	0	3	0	2
M. truncatula	CYPRUS	15	2	10	0	0	84	0	3
M. truncatula	JEMALONG	18	1	1	0	0	12	0	2
M. truncatula	PARABINGA	19	4	9	1	0	186	5	3
M. truncatula	PARAGGIO	20	1	2	0	0	0	2	2
M. truncatula	SEPHI	23	10	8	0	0	13	0	2
M. truncatula	SA 11292	21	20	1	0	0	0	0	2
M. truncatula	T 116	10	0	2	0	0	4	0	1
M. truncatula	Z 914	5	7	2	0	0	9	0	1
Mean		**17**	**9**	**8**	**1**	**1**	**78**	**26**	**3**

PD = plant density

Table 6.17 Seedling emergence (1993, 1994, 1995 and 1996), seed number (1993 and 1995) and dry matter yield (1993) of 17 medic accessions at Jambin.

Species	Accession	1993 PD (m^2)	1994 PD (m^2)	1995 PD (m^2)	1996 PD (m^2)	1993 Seed Yield (kg/ha)	1995 Seed Yield (kg/ha)	1993 Seed (m^2)	1995 Seed (m^2)	1993 Dry Matter (kg/ha)	1995 DM Yield Rating (1-9)
M aculeata	SA8944	138	6	11	39	17	0	393	0	3527	2
M orbicularis	SA8460	313	18	28	439	640	1	18,591	504	2405	2
M polymorpha	CIRCLE VALLEY	205	27	94	323	266	0	11,511	0	1773	3
M polymorpha	SANTIAGO	89	55	205	417	426	0	18,083	0	1547	3
M sativa	TRIFECTA	201	17	13	0	0	0	0	0	625	0
M scutellata	KELSON	79	5	8	21	32	2	227	69	4275	3
M scutellata	SAVA	79	137	136	45	756	12	5,027	372	3319	8
M scutellata	SA1868	37	107	120	23	604	4	4,004	125	3144	7
M scutellata	SA3110	66	27	53	26	201	0	1,297	0	2473	5
M truncatula	CALIPH	99	48	117	682	458	0	12,316	27	3797	4
M truncatula	CYPRUS	160	73	129	780	276	0	8,492	15	2583	4
M truncatula	JEMALONG	56	25	48	241	58	0	1,965	0	2107	4
M truncatula	PARABINGA	71	132	186	596	648	0	19,525	0	2947	4
M truncatula	PARAGGIO	93	12	17	19	33	0	1,156	9	2391	2
M truncatula	SEPHI	135	45	47	233	81	0	2,609	0	3528	3
M truncatula	SA11292	67	5	7	26	2	0	63	7	1900	2
M truncatula	T116	159	59	58	517	468	1	14,800	149	3509	4
M truncatula	Z914	29	20	38	201	18	0	1,304	0	1155	2
Mean		**115**	**45**	**73**	**257**	**277**	**1**	**6,742**	**71**	**2,611**	**3**

PD = plant density

Table 6.18: Seedling density (1993, 1994, 1995 and 1996), seed number (1993) and dry matter yield (1993) of 17 medic accessions at Mundubbera

Species	Accession	1993 PD (m^2)	1994 PD (m^2)	1995 PD (m^2)	1996 PD (m^2)	1993 Seed Yield (kg/ha)	1993 Seed (m^2)	1993 Dry Matter (kg/ha)
M. aculeata	SA 8944	22	13	25	23	41	758	1910
M. orbicularis	SA 8460	24	7	31	73	702	17,700	1760
M. polymorpha	CIRCLE VALLEY	70	953	92	533	778	21,917	680
M. polymorpha	SANTIAGO	20	143	27	88	219	6,500	4170
M. sativa	TRIFECTA	48	0	0	0	0	0	2670
M. scutellata	KELSON	10	7	11	0	9	125	1370
M. scutellata	SAVA	14	47	0	0	88	700	1290
M. scutellata	SA 1868	12	22	17	2	18	167	1640
M. scutellata	SA 3110	13	33	1	7	85	558	2090
M. truncatula	CALIPH	54	62	253	185	494	12,283	2800
M. truncatula	CYPRUS	77	152	550	1,117	445	20,092	2990
M. truncatula	JEMALONG	71	98	101	308	281	9,450	4630
M. truncatula	PARABINGA	57	280	225	467	615	15,400	3160
M. truncatula	PARAGGIO	49	44	41	46	64	1,717	3360
M. truncatula	SEPHI	37	60	100	177	146	4,875	1910
M. truncatula	SA 11292	10	5	1	21	1	83	2800
M. truncatula	T 116	147	177	392	744	492	12,917	270
M. truncatula	Z 914	46	60	108	138	102	3,417	1530
Mean		**43**	**120**	**110**	**218**	**254**	**7,148**	**2279**

PD = Plant density

Mundubbera. There was good establishment of medics at Mundubbera in 1993 although this was a result of irrigation and not rainfall. In 1994 the site received good falls of rain up to early autumn which allowed some plants to regenerate but they died due to lack of follow-up rain. Following rainfall in mid-spring and continued cool weather there was a late emergence of medic seedlings. Emergence ranged from 5 (barrel medic SA 11292) to 953 seedlings /m^2 (*M. polymorpha* Circle Valley) with an average of 120 seedlings /m^2 across all accessions (Table 6.18). In 1995, there was sufficient rainfall for regeneration, but these plants again died during winter before seeding. The accessions with the highest plant establishments were Cyprus, T 116, Caliph, Parabinga, Jemalong and Sephi barrel medic. In 1996 there was good rain in late autumn. Cyprus and T116 barrel medics had the highest emergence followed by *M. polymorpha* Circle Valley.

Herbage Yield

Emerald. In 1993 4 early maturing accessions (Caliph and Parragio barrel medic, Sava snail medic and *M. orbicularis* SA8460) produced over 1000 kg/ha of dry matter (Table 6.15). All of the annual medic accessions except the barrel medic SA 11292 and *M. polymorpha* Circle Valley were able produce greater amounts of dry matter than lucerne (312 kg /ha). Later maturing annual accession and some of the early maturing lines (eg Cyprus) did not give greater than 1000 kg/ha.

Theodore. Dry matter production in 1994 was extremely low. The two early maturing snail medic accessions (Sava and SA 1868) produced the highest yields (Table 6.16).

Jambin. All accessions except Trifecta lucerne produced over 1000 kg/ha (Table 6.17) and 5 accessions (Caliph, Sephi and T116 barrel medics, Kelson snail medic and *M. aculeata* SA8944) produced between 3500 - 4300 kg/ha of dry matter. All these accessions except Caliph were late maturing. Due to severe moisture stress in 1994 yields were very low and not recorded. In 1995, Sava, SA 1868 and SA 3110 snail medics rated highest in yield.

Mundubbera In 1993 all accessions except T 116 barrel medic and *M. polymorpha* Circle Valley produced over 1000 kg/ha of dry matter (Table 6.18). The four highest yielding accessions (Jemalong, Paraggio and Parabinga barrel medic and *M. polymorpha* Santiago) produced between 3000 - 4700 kg/ha. Trifecta lucerne produced the highest dry matter production of any of the sites with 2670 kg/ha although all plants died over the following summer. Yields were negligible in 1994 and 1995.

Seed Production

Seed production is usually reported as a quantity of seed set per unit area. However, as each of the accessions had different single seed weights, data on seed numbers/m^2 will also be presented. As can be seen from Tables 6.15 - 6.18, an accession that yields a high quantity (weight) of seed may not necessarily yield a high number of individual seeds. Seed numbers per unit area is a more important attribute for selecting persistent cultivars than seed weight per unit area.

Emerald. In 1993 only 13 accessions set seed (Table 6.15). Of these, only 4 accessions yielded more than 1000 seeds/m^2; Caliph barrel medic (2070 seeds/m^2), Sava snail medic (1310 seeds/m^2), *M .polymorpha* cultivar Santiago (1790 seeds/m^2) and *M. orbicularis* accession SA8460 (8790 seeds/m^2). There was no seed set in 1994 or 1995.

Theodore. In 1994 *M. polymorpha* cultivars Santiago and Circle Valley and Parabinga barrel medic were the only accessions able to set over 100 seeds/m^2 (Table 6.16).

Popany vetch established well but failed to set seed.. The 1995 rainfall pattern enabled the early flowering Sava and SA 1868 snail medic and *M. orbicularis* SA8460 to set between 89 - 215 seeds/m^2.

Jambin. All medic accessions set seed in 1993 (Table 6.17). Parabinga and T116 barrel medic, *M. orbicularis* (SA 8460), and *M. polymorpha* (Santiago) were the highest seed yielding accessions producing between 14,800 - 19,600 seeds/m^2. There was no seed set in 1994 because of severe moisture limiting conditions. The early flowering T116 barrel medic, Sava and SA1868 snail medic and *M. orbicularis* SA 8460, were the only accessions to seed in 1995.

Mundubbera. The top seed yielding accessions in 1993 were Cyprus, Parabinga, T 116 and Caliph barrel medic, *M. aculeata* (SA8944) and *M. polymorpha* (Circle Valley) producing between 12,300 - 22,000 seeds/m^2. The accessions that set seed represented all maturity types as there was sufficient moisture from irrigation. There was no seed set in 1994 or 1995 as there was insufficient moisture.

Seedling emergence from seed banks

From measurements of seed set in the first year and seedling emergence in the second year it was possible to calculate the percentage of first year seed set which emerged as seedlings in the second year. The results are listed in Table 6.19. There was much higher % emergence of seedlings at Theodore (mean 24 %), than at Mundubbera (2 %) or Jambin (2 %). There has been negligible emergence of seed at Emerald Research Station.

Some accessions, such as Sava snail medic, had a high percentage emergence of seed at Mundubbera, Jambin and Theodore. Other accessions, such as button medic SA 8944 tended to have a low percentage emergence at all three sites, whereas others, such as Sephi barrel, were inconsistent between sites.

Table 6.19 Percentage first year seed that emerged in the second year at Theodore, Jambin and Mundubbera.

Species	Accession	Theodore % Germinable Seed 94-95	Jambin % Germinable Seed 93-94	Mundubbera % Germinable Seed 93-94
M. aculeata	SA 8944	20.0	2.5	
M. orbicularis	SA 8460	12.3	0.2	0.0
M. polymorpha	Circle Valley	14.1	0.2	4.4
M. polymorpha	Santiago	4.2	0.2	2.2
M. scutellata	Kelson	11.8	4.4	5.6
M. scutellata	Sava	35.0	6.2	6.7
M. scutellata	SA 1868	29.6	4.7	
M. scutellata	SA 3110	8.3	3.6	5.9
M. truncatula	Caliph	33.3	0.2	0.5
M. truncatula	Cyprus	2.4	0.6	0.8
M. truncatula	Jemalong	8.3	0.5	1.0
M. truncatula	Parabinga	2.2	0.7	1.8
M. truncatula	Paraggio		1.3	2.6
M. truncatula	Sephi	76.9	1.5	1.2
M. truncatula	SA 11292		7.6	
M. truncatula	T 116		0.3	
M. truncatula	Z 914	77.8	1.0	1.8

Discussion

Annual medics that are to persist in as a component of permanent pastures in regions north of the Condamine river will need to develop adequate soil seed reserves to ensure long term survival. Winter rainfall is unreliable and seed needs to persist in the soil to provide the potential for regeneration in more favourable years.

The use of establishment irrigation at Theodore, Mundubbera and Jambin artificially increased first year yields and allowed both late and early maturing accessions produce large amounts of seed. The number of seeds set in the barrel medics was usually higher than that of the snail medics, but due to the small seed size of the barrel medics, yield on a kg/ha basis was sometimes similar. Seed production at Theodore, where irrigation was not used, was lower than at the other sites.

Despite the zero or very low levels of seed set in subsequent years at all sites, some lines have continued to regenerate in 1994, 1995 and 1996 at Narayen and Jambin. These plants have emerged from seed reserves set in the year of establishment. Calculations of seedlings as a proportion of seed set in the first year has shown that a larger proportion of seed has emerged at Theodore (24%) than at either Jambin (2%) or Mundubbera (2%). This suggests that the Theodore site may be more vulnerable to failure if dry conditions continue.

The lack of regeneration at Emerald, despite high levels of seed produced in the first year appeared to be due to the high level of grass competition that occurred at this site. Summer grasses were more vigorous than at the other sites, and although slashed before winter, seedlings may not have been able to emerge through the thick layer of litter that resulted. Competition to medics was less severe at Theodore where summer growing species were absent and at Mundubbera where *Rhagodia spp.* was the main species.

Trifecta lucerne and Popany vetch (*Vicia benghalensis*) failed to persist at any of the sites. The poor survival of lucerne is attributed to the prolonged dry periods in the warmer months and in Popany to its failure to seed. The failure of these species highlights the ability of the medics to persist through dry years by virtue of soil seed reserves. This ability to build up soils seed reserves is illustrated by the seed bank of 14, 000 Jemalong barrel medic seeds/m^2 beneath a 10 year old pasture at Narayen Research Station (Heida and Jones 1988).

To date, the promising accessions common to at least two sites include SA 8460 button medic, Cyprus, Parabinga, Caliph and T 116 barrel medics, *M. polymorpha* cultivars Santiago and Circle Valley and Sava snail medic. These accessions have usually produced the highest herbage and seed yields.

From this project and other industry funded work, the two most likely accessions to be released are SA 8460 button medic and T116 barrel medic. These results suggest that Essex snail medic and SA1868 snail medic, currently on pre-release, are not as well adapted to this region as Sava snail medic.

It is highly desirable that this study be continued for another two years. The dry winters experienced to date have provided a unique opportunity to assess the ability of seed reserves to persist through unfavourable periods. This ability will be confirmed by continued measurements of emergence and seed set and some selected measurements of soil seed reserves.

7. Comparison of advanced lines of legumes for grazing and ley pastures on clay soils in "on farm" demonstration plots

Introduction

There is increasing need for legumes on the clay soil areas of tropical and sub-tropical Queensland to maintain pasture quality and to prevent further nitrogen rundown in cropping areas. Although the range of well adapted legumes suited to these areas of clay soils is limited some have recently become available and others have been under test for some time. Very few of these legumes have been widely tested. The aim of this series of experiments was to demonstrate to producers the value of these commercial and near-commercial legumes for grazing and ley pastures on a range of clay soils in the central Queensland region. To do this large plots were established on producers' properties, forage production and legume persistence were measured and regular activities such as field days were held to interact with producers.

Methodology

Sites and legume species

Sites were chosen to represent the geographical range of clay soils on open downs and brigalow country. Soil types are black earths with principle profile form Ug or Uf but with some variation in the surface self-mulching and chemical and physical characteristics (Table 7.1 and 7.2).

Table 7.1 Site information for legumes for clay soils 'on farm' sowings in 1994

Site	Lat/ Long	Great Soil Group	Principal Profile Form	pH Surface	Soil Depth (m)	SO_4-S	Bicarb P	Max. EC (ds/cm)	Depth of Max. EC (cm)
Mutation Clermont	22° 27' 147° 29'	black earth	Ug 5.15	8.0	1.48	2	7	0.17	60
Goonderoo Springsure	23° 49' 148° 07'	black earth	Ug 5.12	7.0	0.65	3	55	0.11	0-10
Birrong Rolleston	24° 14' 148° 18'	black earth	Ug 5.12	7.0	0.48	4	47	0.35	30
Rangeview Theodore	24° 43' 150° 02'	black earth	Ug 5.12	7.5	0.94	3	7	0.44	110
Kapalee Biloela	24° 24' 150° 25	black earth	Ug 5.16	8.5	1.5+	6	15	1.30	100
Kookaburra Wandoan	25° 55' 149° 47'	black earth	Ug 5.16	8.0	1.5+	7	6	2.04	60

Table 7.2 Site information for legumes for clay soils 'on farm' sowings in 1995

Site	Lat/ Long	Great Soil Group	Principal Profile Form	pH Surface	Soil Depth (m)	Max. EC (ds/cm)	Depth of Max. EC (cm)
Rolf Park Middlemount		black earth	Ug 5.15	7.5			
Carramah Capella	22° 52' 147° 54'	black earth	Ug 5.12	8.5	0.6	0.07	60
Mungabunda	24° 40' 149° 20'	black earth	Ug 5.15	8.0	1.55	0.33	150
Kiamanna	24° 31' 148° 50'	black earth	Ug 5.15	8.5	1.5	0.56	150
Bindaroo Roma	26° 40' 149° 2'	black earth	Ug 5.15	7.5	1.5	1.69	120
Ellenvale Chinchilla	26° 44' 144° 21'	black earth	Ug 5.24	7.0	1.5+	0.75	110

In 1994 16 legumes including known annual short term and perennial cultivars and accessions (Table 7.3) were sown on commercial properties at 8 sites. In 1995 the range of legumes was expanded to 23 (Table 7.4) and a further 8 sites were sown. Of the sites sown 6 sites from the 1994 sowing and a further 6 sites from the 1995 sowing successfully established but 2 sites, Goonderoo (Springsure) and Mungabunga (Bauhinia Downs) subsequently failed and few measurements have been recorded at these sites. Mungabunga was resown in 1996.

Table 7.3 Legumes sown and details of seed and *Rhizobium* strain used for the 1994 sowings.

Species	Planting rate (kg/ha)	Seeds/kg	Germination (%)	Seed treatment/ scarification	Rhizobium
Aeschynomene americana cv. Lee/Glenn	5	200 000	30	Heat	CB 2312
Clitoria ternatea cv. Milgarra	10	23 000	50	Mechanical	CB 756
Desmanthus virgatus cv. Marc	5	410 000	72	Acid	CB 1397
Desmanthus virgatus cv. Bayamo	5	320 000	62	Acid	CB 1397
Desmanthus virgatus cv. Uman	5	310 000	38	Acid	CB 1397
Glycine latifolia CQ 3368	5	95 000	40	Mechanical	CB 1024
Indigofera schimperi CPI 69495	5	400 000	50	Mechanical	CB 1024/1015
Lablab purpureus cv. Highworth	30	5 000	82	None	CB 1024
Leucaena leucocephala cv. Cunningham	10	22 000	55	Hot water	CB 3060
Macroptilium atropurpureum cv. Siratro	6	75 000	66	None	CB 756/1024
Macroptilium bracteatum CPI 27404	6	n/a	60	None	CB 756/1024
Medicago sativa cv Trifecta	5	400 000	88	None	CB 3061
Stylosanthes hamata cv. Amiga	5	450 000	54	Heat	CB 1650
Stylosanthes scabra cv. Seca	5	800 000	76	Heat	CB 82
Stylosanthes spp aff scabra) CPI 110361	5	n/a	74	Mechanical	CB 2126
Vigna trilobata CPI 13671	6	110 000	93	None	CB 1015

Table 7.4 Legumes sown and details of seed and *Rhizobium* strain used for the 1995 sowings

Species	Planting rate (kg/ha)	Seeds/kg	Germination (%)	Seed treatment/ scarification	Rhizobium
Aeschynomene villosa CPI 37235	5	n/a	32	Heat	
Centrosema pascuorum cv. Cavalcade	6	48 000	48	None	
Clitoria ternatea cv. Milgarra	10	23 000	58	Mechanical	CB 756
Desmanthus virgatus cv. Marc	5	410 000	87	Acid	CB 3126
Desmanthus virgatus cv. Bayamo	5	320 000	64	Acid	CB 3126
Desmanthus virgatus cv. Uman	5	310 000	57	Acid	CB 3126
Desmodium dichotomum CPI 47186	5	n/a	47	Mechanical	CB 627
Glycine latifolia CQ 3368	5	95 000	68	Acid	CB 1024
Indigofera schimperi CPI 52621	5	400 000	50	Mechanical	CB 1024/1015
Lablab purpureus cv. Highworth	30	5 000	83	none	CB 1024
Leucaena leucocephala cv. Cunningham	5	22 000	92	Hot water	CB 3060
Macroptilium atropurpureum cv. Aztec	5	75 000	66	None	CB 756/1024
Macroptilium bracteatum CPI 27404	6	n/a	73	None	CB 756/1024
Macroptilium lathyroides cv. Murray	5	119 000	79	Mechanical	CB 756/1024
Macroptilium uniflorum cv. Leichhardt	8	33 000	96	None	CB 1024
Medicago sativa cv Trifecta	5	400 000	93	None	CB 3061
Stylosanthes hamata cv. Amiga	5	450 000	47	Heat	CB 1650
Stylosanthes scabra cv. Seca	5	800 000	74	Heat	CB 82
Stylosanthes spp aff *scabra* numerous acc..	5	n/a	70	Mechanical	
Vigna luteola cv. Dalrymple	8	n/a	52	None	CB 1015
Vigna oblongifolia CPI 28763	8	a	83	None	CB 1015
Vigna trilobata CPI 13671	6	110 000	90	None	CB 1015
Vigna vexillata CQ 3044	8	n/a	40	None	CB 1015

Sowing techniques

Prior to sowing legume seed was treated using mechanical scarification, hot water or acid to reduce the percentage of hardseed and tested for germination percentage. All seed was inoculated with the appropriate *Rhizobium* strain (Table 7.3 and 7.4).

Legumes were sown onto cultivated seedbeds on land used for grain or forage cropping except for 2 of the sites sown in 1994. One of these was bladeploughed and one was sown on a downs soil without cultivation. Both failed to establish.

At the other sites seed was sown onto the surface and rolled using press wheels. Depending on rainfall and condition of seedbed prior to sowing sub-soil moisture varied from good to poor. Some details of sowing for each site are shown for 1994 sowings (Table 7.5) and 1995 sowings (Table 7.6). At each site 2 replicates were sown into large plots of 20m x 12m in a randomised block design except at Kookaburra where plot size was smaller (20m x 5m) and 2 replicates were sown with grass and 2 were sown without grass. Seed of Queensland bluegrass *(Dichanthium sericeum)* was oversown across all the legume plots at 1 kg/ha at all sites except Kookaburra where bambatsi panic *(Panicum coloratum)* was used.

Measurements

Legume density has been measured by counting seedlings in a number of quadrats in each plot. For most sowing, counts have been made shortly after emergence and again at the end of the growing season each year. Also at Kapalee (Biloela), Kookaburra (Wandoan) and Carramah (Capella) selected legume plots have been sampled for soil seed reserves by taking 12 cores from each plot on a grid pattern. Core size was 41mm and sampling depth was 50mm. Sampling was done following rain in spring.

Forage production has been measured by either cutting a number of quadrats in each plot or by using rating techniques. When ratings have been used calibrations are also made so that all yields can be expressed in kg/ha and compared across sites.

Other measurements have been made at some sites. These include measurements of %N, %P and acid detergent fibre (ADF), on leaf and stem of selected legumes to provide an estimate of pasture quality. Samples were taken at Kapalee, Kiamanna (Acadia Valley) and Kookaburra in February 1995 and also at Narayen Research Station. At the same time the relative yield of leaf stem and pods was made by cutting and separating the components.

Frost tolerance was determined using a scale that appropriately described frost damage to the legumes at the time of observations at Kapalee (Biloela) and Kiamanna (Acadia Valley) in June 1995.

All sites have been grazed, generally at the end of summer growing season, but the intensity and length of grazing has varied because the areas are situated in paddocks used for cropping. At Kapalee an assessment of grazing preference was made in February-March 1995.

Table 7.5 Planting and harvesting information for legumes for clay soils 'on farm' sowings in 1994

Site	Sowing Date	Planting Technique	Success of Establ.	Rainfall 01/10/94 to planting (mm)	Rainfall planting to 30/6/95 (mm)	Harvest Date	Ann. Rainfall (nearest station) (mm)
Mutation Clermont	07/02/94	crop planter & presswheels into cultivated seedbed	very successful	171	151	08/06/94	637 (Clermont)
Goonderoo Springsure	08/02/94	crop planter and presswheels into blue grass (*D. sericeum*) pasture	successful	228	322	27/04/94	684 (Springsure)
Birrong Rolleston	09/02/94	crop planter & presswheels into cultivated seedbed	very successful	274	294	08/06/94	684 (Springsure)
Rangeview Theodore	24/01/94	crop planter & presswheels into cultivated seedbed	very successful	219	354	26/05/94	674 (Banana)
Kapalee Biloela	17/01/94	crop planter & presswheels into cultivated seedbed	very successful	213	406	27/05/94	697 (Biloela)
Kookaburra Wandoan	21/12/93	crop planter & presswheels into cultivated seedbed	very successful			25/05/94	679 (Taroom)

Table 7.6 Planting and harvesting information for legumes for clay soils 'on farm' sowings in 1995

Site	Sowing Date	Planting Technique	Success of Establ.	Rainfall 01/10/94 to planting (mm)	Rainfall planting to 30/6/95 (mm)	Harvest Date	Ann. Rainfall (nearest station) (mm)
Rolf Park Middlemount	31/01/95	harrowed, hand broadcast and large seeded plots harrowed	successful	183	213	29/5/95	646 (Bombandy)
Carramah Capella	10/01/95	crop planter & press wheels into cultivated seedbed	very successful	181	312	31/05/95	591 (Capella)
Mungabunda Bauhinia Downs	09/01/95 Resown 19/01/96	crop planter & press wheels into cultivated seed bed	poor	135	223	20/06/95	674 (Bauhinia Downs)
Kiamanna Arcadia Valley	31/01/95	crop planter & press wheels into cultivated seed bed	successful	297	298	24/05/95	679 (Taroom)
Bindaroo Roma	03/02/95	crop planter & presswheels into cultivated seedbed	successful	176	286	25/05/95	597 (Roma)
Ellenvale Chinchilla	31/01/95	crop planter & presswheels into cultivated seedbed	successful	192	186	25/05/95	672 (Chinchilla)

Results and discussion

Legume establishment and persistence

1994 Sowings

Initial legume populations were highest for *Vigna trilobata* CPI 13671, Siratro and *Aeschynomene* americana (Lee/Glenn) (Table 7.7) with some variations between sites (e.g. the range for *Vigna trilobata* CPI 13671 was 18 at Kookaburra, Wandoan to 43 seedlings/m^2 at Rangeview, Theodore). Lowest populations were for leucaena, trifecta lucerne and Seca stylo.

Survival of original plants into the second summer has been highest for *Stylosanthes spp* aff *S.scabra,* Marc desmanthus and Milgarra. For other perennials over 20% of the original population survived with the exception of Amiga and Seca stylo.

Seedling recruitment has been strongest at Kapalee (Table 7.7) with *S.spp* aff *S.scabra* being highest followed by Marc desmanthus. At other sites only *S.spp* aff *S.scabra* (all sites), Milgarra (Kookaburra, Birrong and Mutation) and Marc desmanthus (Kookaburra) have recruited. There was a regeneration of *Vigna trilobata* at Kapalee, Birrong and Mutation in 1995.

Table 7.7 Mean legume density (plants/m^2) for sites sown in 1994 and seedling recruitment at Kapalee in 1995 and 1996.

Species	1994	1995	1996	% of 1994 density	Seedlings at Kapalee 1995	Seedlings at Kapalee 1996
Aeschynomene americana cv Lee/Glenn	28	2	0	0	0	0
Clitoria ternatea cv. Milgarra	14	13	8	59	14	5
Desmanthus virgatus cv. Marc	12	8	7	59	50	29
Desmanthus virgatus cv. Bayamo	13	6	5	43	0	1
Desmanthus virgatus cv. Uman	7	3	2	29	27	1
Glycine latifolia CQ 3368	17	10	6	35	4	0
Indigofera schimperi CPI 69495	21	12	10	46	0	0
Lablab purpureus cv. Highworth	10	3	0	2	2	0
Leucaena leucocephala cv. Cunningham	12	5	4	32	0	0
Macroptilium atropurpureum cv. Siratro	29	12	7	23	11	0
Macroptilium bracteatum CPI 27404	23	8	4	19	7	0
Medicago sativa cv Trifecta	-	-	-	-	-	-
Stylosanthes hamata cv. Amiga	7	.3	1	9	13	1
Stylosanthes scabra cv. Seca	10	1	0	4	1	0
Stylosanthes scabra (aff.) CPI 110361	15	10	9	62	465	143
Vigna trilobata CPI 13671	33	106	1	2	82	0

1995 Sowings

Legume density at establishment was highest for *Vigna trilobata,* Murray phasey bean, *Desmodium dichotomum, Macroptilium bracteatum,* Siratro and lucerne (Table 7.8). Mungabunga had the poorest establishment.

Survival, into the second summer, of desmanthus, glycine, leucaena and lucerne was better than other legumes. Some annual legumes did regenerate but the populations were low. There was a seedling recruitment of 21 seedlings/m^2 for *Desmodium dichotomum* at Carramah but regeneration from seed was limited for all other legumes and at all other sites.

Comments on establishment and persistence

Despite generally below average rainfall, establishment of all but a few of the legumes at 10 sites was satisfactory. Establishment was better in cultivated seedbeds where sound farming practises were used to control weeds in the fallow, prior to planting to maximise subsoil moisture and, following planting to reduce competition from weeds. Of the 1994 plantings Oxford Downs (Nebo)and Goondooroo (Springsure) has good seedbeds and legumes emerged but failed because of weeds in marginal rainfall conditions while at Huntly (Acadia Valley) legumes were sown onto a rough (blade ploughed) seedbed. In 1995 establishment was good at 5 of 6 sites sown on well prepared seedbeds. The sowing at Mungabunga was poor but this site had the least rain. The northern sites at Charters Towers and Mt Douglas were sown late with little follow up rain and failed.

Establishment differences between species were evident at most sites but the most variation occurred with some of the smaller seeded legumes such as desmanthus and stylosanthes. While there are possibly many reasons for this, the depth of sowing is implicated. Under conditions where the seedbed is anything but fine or where there is a strong surface mulch seed, even when sown onto the surface is likely to be covered with soil. This is especially so for small slippery seed such as desmanthus and dehulled stylo or when rainfall occurs following sowing and soil was washed over the seed.

Establishment of annual legumes was more consistent across sites and over the 2 years of sowings. These generally have larger seeds and are less affected by sowing depth but some other characteristics such as early seedling vigour could also aid establishment under the range of conditions experienced. Regeneration of these annuals from seed in the second and subsequent years despite seed being set was very limited. Only *Vigna trilobata* regenerated with a high number of plants at some sites but these failed to develop and produce a useful yield under dry conditions.

Table 7.8 Mean legume density (plants/m^2) for sites sown in 1995

Species	Mean of Sites		% Survival
	1995	1996	
Aeschynomene villosa CPI 37235	9	0	0
Centrosema pascuorum cv. Cavalcade	8	1	7
Clitoria ternatea cv. Milgarra	12	5	42
Desmanthus virgatus cv. Marc	9	7	70
Desmanthus virgatus cv. Bayamo	7	6	84
Desmanthus virgatus cv. Uman	5	4	71
Desmodium dichotomum CPI 47186	19	2	11
Glycine latifolia CQ 3368	12	9	75
Indigofera schimperi CPI 52621	10	6	56
Lablab purpureus cv. Highworth	6	1	8
Leucaena leucocephala cv. Cunningham	5	4	72
Macroptilium atropurpureum cv. Aztec	17	8	46
Macroptilium bracteatum CPI 27404	19	6	29
Macroptilium lathyroides cv. Murray	23	6	27
Macroptilium uniflorum cv. Leichhardt	10	4	41
Medicago sativa cv Trifecta	16	15	92
Stylosanthes hamata cv. Amiga	4	1	28
Stylosanthes scabra cv. Seca	6	1	9
Stylosanthes scabra (aff.)	5	2	29
Vigna luteola cv. Dalrymple	8	0	0
Vigna oblongifolia CPI 28763	11	0	0
Vigna trilobata CPI 13671	23	4	17
Vigna vexillata CQ 3044	8	3	33

Desmanthus, *Stylosanthes spp* aff *S.scabra,* Milgarra butterfly pea and *Indigofera schimperi* have been the most persistent legumes with a high percentage of the original plants living for the two summers following establishment. However only Marc desmanthus and *S.spp* aff *S.scabra* and to a lesser extent at some sites Milgarra have re-established from seed in the sown sward. Seedling recruitment in aff scabra has been very high (up to 400 seedlings/m^2) although the amount of seed recovered from the soil is much lower than for Marc (Table 7.9). This suggests a high proportion of the stylo seed is soft or at least softens very quickly in contrast to desmanthus which has a high proportion of hard seed.

Table 7.9 Soil seed recovered from 3 on farm sites.

	Kapalee Seeds/m²			Carramah Seeds/m²			Kookaburra Seeds/m²	
	1994	1995	1996	1994	1995	1996	1994	1995
Marc	32755	8624	24851		3456	2344	56704	15265
Bayamo	1743	571	751		60	0	60	571
Uman	451	270	240		0	0	30	180
Indigofera	0	180	1983		30	4057	30	571
Aff.scabra	6220	1713	511		391	240	481	270
Macroptilium bracteatum	90	0	150		751	481	30	0
Vigna trilobata	1983	0	30		1683	30	60	0
Milgarra	0	0	60		361	60	0	0
Cavalcade	0	0	0		1292	90	0	0
Desmodium dichotomum	0	0	0		14845	3185	0	0
Glycine	0	0	180		691	0	0	481
Aztec	0	0	180		90	60		

Marc desmanthus and aff scabra despite the differences in seed and seedling recruitment characteristics are those legumes most likely to persist in sown pasture systems. They flower and seed over extended periods and can produce high seed yields. The high soil seed levels and good seedling recruitment that have been measured in this series of experiments suggests there is little doubt that they can maintain and improve legume density in commercially grazed pastures.

On the other hand Bayamo and Uman desmanthus, which have not seeded to the same extent and have shown little evidence of seed increase in the soil or seedling recruitment, are yet to confirm if legume density can be maintained. Of the other legumes Milgarra has re-established from seed but this has been restricted to sites on downs soil and where competition with strong perennial grasses is minimal. Soil seed of Indigofera schimperi is increasing but seedling recruitment has been minimal to date.

On all the cultivated sites the grass establishment was good. Queensland bluegrass was evenly distributed across the legume plots and successfully met the original objective of helping to suppress weeds and being present to take up any nitrogen made available in the better legume plots in later years, as well as being less competitive than other grasses, such as buffel and pigeon grass, in the establishment year.

Legume yield

Forage production although limited by inadequate rainfall and soil moisture in both seasons at most sites, has been adequate to allow comparisons between legumes.

1994 Sowings

First year yields (meaned for 5 sites) from the 1994 sowings were highest for Highworth lablab. *Vigna trilobata* CPI 13671 (a legume on pre release) was ranked second and *Desmanthus virgatus* cv. Uman, *Macroptilium bracteatum* CPI 27404 and *Stylosanthes* (aff.) *scabra* CPI 110361 were equal to or better than siratro. As expected the perennial legumes have yielded highest in the second year. *Indigofera schimperi* had the highest yield followed by siratro, Cunningham leucaena, *M. bracteatum, Clitoria ternatea,* desmanthus and *S.spp* aff. *S.scabra.* In the third year best yields were Indigofera > Milgarra > *S.spp* aff.*S.scabra* > desmanthus. (Table 7.10).

Table 7.10 Mean yield (kg/ha) and rankings of legumes sown in 1994

Species	Mean Yield (kg/ha) and rank							
	1994	Rank	1995	Rank	1996	Rank	3 year YI	Rank
Indigofera schimperi CPI 69495	520	14	1940	1	3560	1	6020	1
Lablab purpureus cv. Highworth	3500	1	280	11	0	14	3780	2
Macroptilium atropurpureum cv. Siratro	1190	5	1160	2	760	6	3110	3
Clitoria ternatea cv. Milgarra	1030	8	760	5	1260	2	3050	4
Stylosanthes scabra (aff.) CPI 110361	1140	6	560	7	1130	3	2830	5
Macroptilium bracteatum CPI 27404	1490	4	800	3	500	8	2790	6
Desmanthus virgatus cv. Bayamo	870	9	690	6	840	4	2400	7
Desmanthus virgatus cv. Uman	1550	3	480	9	340	10	2370	8
Leucaena leucocephala cv. Cunningham	730	11	800	3	820	5	2350	9
Vigna trilobata CPI 13671	1920	2	230	12	10	13	2160	10
Glycine latifolia CQ 3368	1060	7	400	10	560	7	2020	11
Desmanthus virgatus cv. Marc	870	9	540	8	450	9	1860	12
Stylosanthes hamata cv. Amiga	630	12	120	14	70	11	820	13
Aeschynomene americana cv. Lee/Glenn	630	12	40	16	0	14	670	14
Medicago sativa cv Trifecta	150	15	200	13	0	14	350	15
Stylosanthes scabra cv. Seca	60	16	80	15	45	12	185	16

Variation in legume yield between sites was marked and to some extent related to rainfall, although yields at the two brigalow sites were higher than at the three sites on open downs country (Figure 7.1). In the establishment year this was probably due to higher subsoil moisture in the two brigalow soils. Nonetheless there is likely to be some subtle and as yet unexplained reasons why legumes perform differently when grown in different soils and in different locations and circumstances.

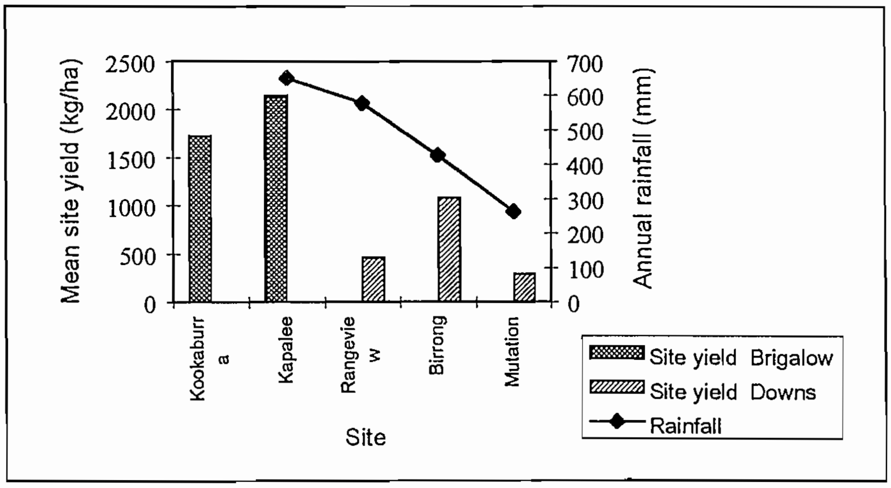

Figure 7.1 Mean site yield of legumes sown at 5 sites in 1994

There was a marked tendency for some legumes, e.g. Marc desmanthus to produce higher forage yields on the brigalow soils (Figure 7.2) while growth of Milgarra was much improved on open downs soils (Figure 7.3). Also growth of lucerne was generally poor except at Ellenvale (Chinchilla) where it was one of the most productive. Legume growth was most often restricted by extended periods of dry conditions and generally below Mean Annual Rainfall. In the case of Marc desmanthus there was some concern at the very low proportion of leaf in comparison with other legumes.

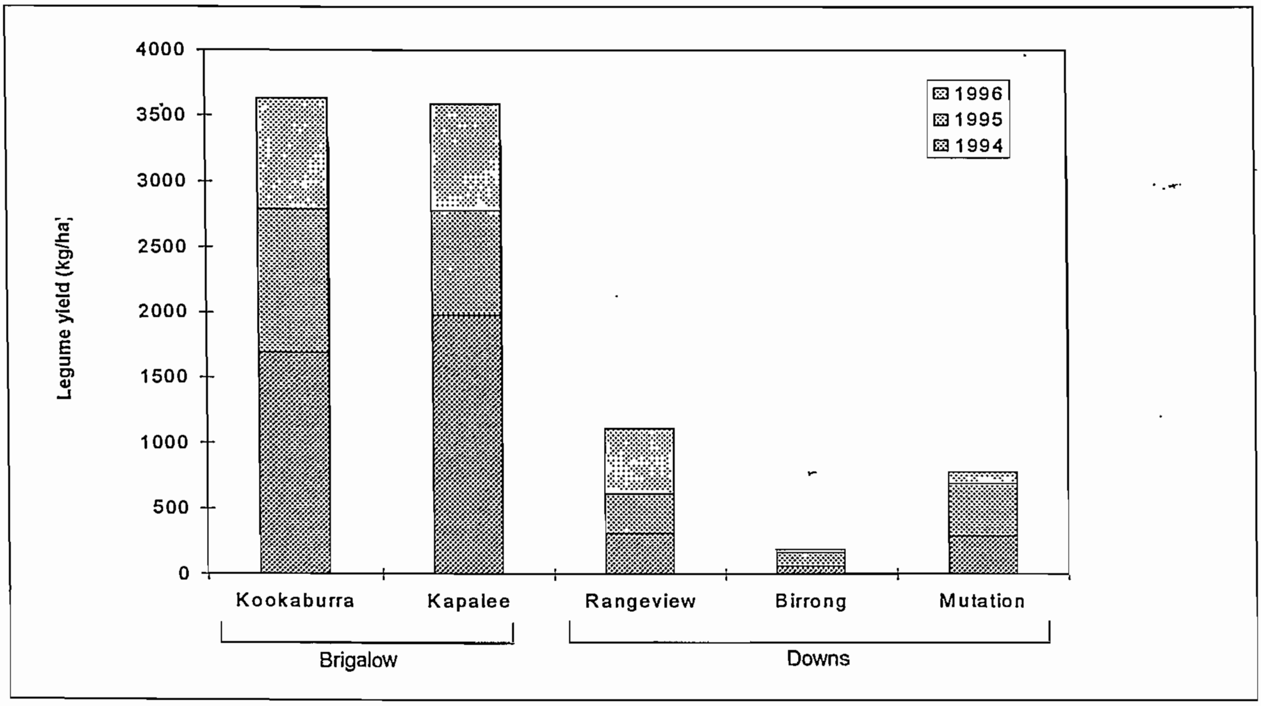

Figure 7.2 Yield of Marc desmanthus over 3 seasons at 5 sites sown in 1994

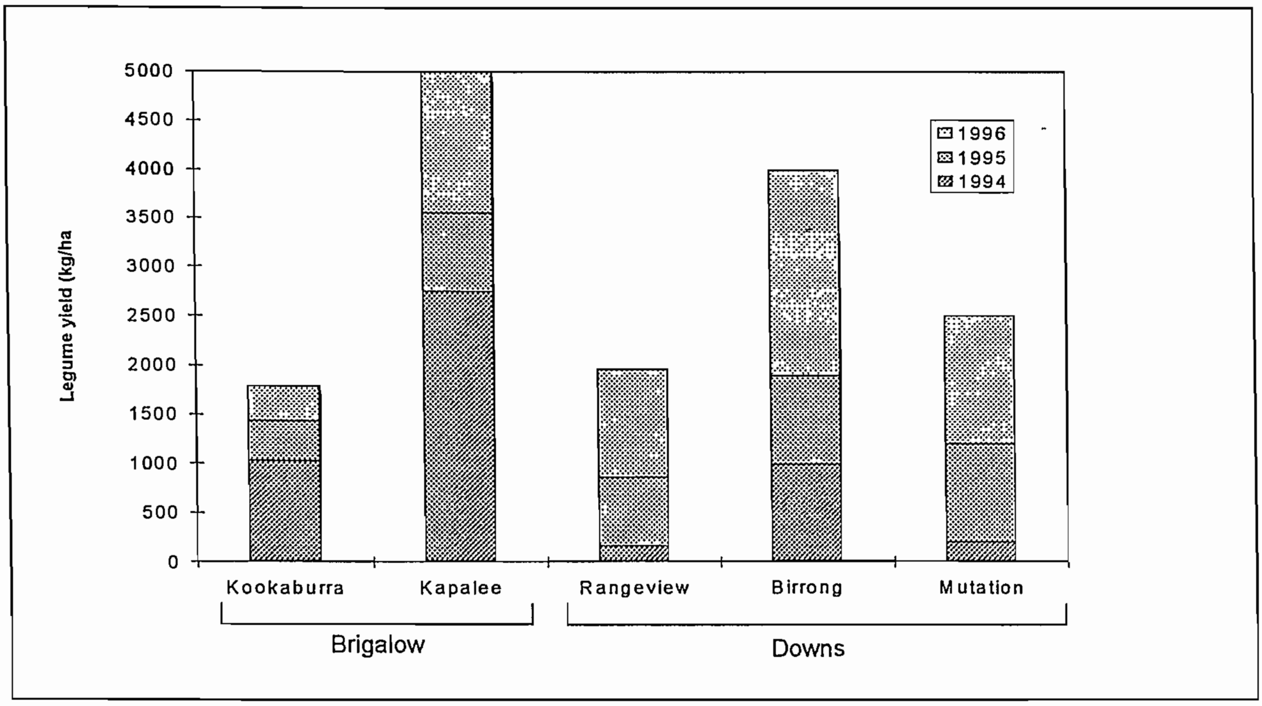

Figure 7.3 Yield of Milgarra butterfly pea over 3 seasons at 5 sites in 1994

This was confirmed from one sampling made in February 1995 (Table 7.11) when the percentage of the yield made up by pods (both green and dry) was also relatively high. These characteristics of Marc to shed leaf and produce seed in response to dry or deteriorating moisture conditions are perhaps characteristics that ensure survival through drought and are why Marc is so well adapted to clay soils in drier areas. Whether legumes with these forage characteristics are able to improve animal production is yet to be shown.

Table 7.11 Percentage yield of leaf, stem and pod of 9 legumes at Kapalee in Feb 1995

		% leaf	% stem	% pod
M. bracteatum	CPI 27404	62	38	0
M. atropurpureum	Siratro	62	38	0
L. leucucephala	Cunningham	56	44	0
G. latifolia	CQ 3368	56	39	5
L. purpureus	Highworth	50	50	0
I. schimperi	CPI 69495	49	43	8
D. virgatus	Bayamo	48	52	0
D. virgatus	Uman	39	60	1
D. virgatus	Marc	13	50	37

1995 Sowings

Although the 1995 sowings were geographically more widely distributed (from Roma to Middlemount) and also covered greater variation in soil type than the 1994 sowings the relative forage yields and rankings between the legumes were similar (Table 7.12) Highworth lablab was again the highest yielding with *V.trilobata, Macrotyloma uniflorum* cv. Leichhardt (a legume not sown in 1994) and *M. bracteatum* again better than siratro. Second year yields were highest for Indigofera, *M.bracteatum*, Cunningham leucaena and Milgarra.

Table 7.12 Mean yield (kg/ha) and rankings of legumes sown in 1995

Species	Mean Yield (kg/ha) and Rank					
	1995	Rank	1996	Rank	1995-96 Yld	Rank
Macroptilium bracteatum CPI 27404	1060	4	1720	2	2780	1
Indigofera schimperi CPI 52621	610	11	2000	1	2610	2
Lablab purpureus cv. Highworth	2050	1	480	12	2530	3
Macroptilium atropurpureum cv. Aztec	990	5	1270	5	2260	4
Desmanthus virgatus cv. Bayamo	820	7	1160	6	1980	5
Macroptilium lathyroides cv. Murray	740	8	1080	7	1820	6
Leucaena leucocephala cv. Cunningham	300	19	1510	3	1810	7
Clitoria ternatea cv. Milgarra	420	15	1340	4	1760	8
Desmanthus virgatus cv. Uman	580	12	880	8	1460	9
Vigna trilobata CPI 13671	1130	2	220	16	1350	10
Glycine latifolia CQ 3368	570	13	680	9	1250	11
Macroptilium uniflorum cv. Leichhardt	1110	3	140	19	1250	11
Desmanthus virgatus cv. Marc	640	10	530	11	1170	13
Centrosema pascuorum cv. Cavalcade	890	6	260	15	1150	14
Medicago sativa cv Trifecta	270	20	610	10	880	15
Vigna oblongifolia CPI 28763	730	9	0	23	730	16
Desmodium dichotomum CPI 47186	560	14	50	21	610	17
Stylosanthes spp aff. *S. scabra*	250	21	351	13	601	18
Stylosanthes hamata cv. Amiga	370	17	175	18	545	19
Vigna luteola cv. Dalrymple	400	16	80	20	480	20
Vigna vexillata CQ 3044	220	22	220	16	440	21
Stylosanthes scabra cv. Seca	100	23	290	14	390	22
Aeschynomene villosa CPI 37235	340	18	30	23	370	23

Frost tolerance/susceptibility

An assessment of frost damage was made on legumes in 1995 at 2 sites (Table 7.13). At Kapalee (Biloela) where assessments were made 3 times over a period of six weeks *L.purpureus* cv Highworth, *M. atropurpureum* cv Siratro, *A. americana* cv Lee/Glenn, *M. bracteatum* CPI 27404 and *V. trilobata* CPI 13671, were susceptible to even light frost. While the upper leaves of *C. ternatea* cv Milgarra were frosted by light frost, they were retained for some time and protected the lower leaves which remained green. Subsequent moderate frost killed all leaves and small branches.

Table 7.13. Ratings# for frost damage at Kapalee (Biloela) in 1995 and at Kiamanna (Acadia Valley) following frost on 12 June 1995

Genus/species	Kapalee				Kiamanna	Frost
	24/07/95	14/08/95	08/09/95	Total	12/06/95	tolerance ##
Medicago sativa cv Trifecta					4.0	****
Glycine latifolia CQ 3368	4.0	4.0	4.0	12.0	4.0	****
Leucaena leucocephala cv Cunningham	4.0	2.0	3.0	9.0	3.5	***
Desmanthus virgatus cv Marc	4.0	2.5	2.0	8.5	4.0	***
Desmanthus virgatus cv Uman	3.5	2.5	2.0	8.0	2.5	***
Indigofera schimperi CPI 69495/5266621	4.0	1.0	2.0	7.0		***
Stylosanthes hamata cv Amiga	2.0	3.0	2.0	7.0	2.5	**
Stylosanthes scabra cv Seca	2.5	1.0	2.0	5.5	4.0	**
Clitoria ternatea cv Milgarra	2.5	1.0	1.5	5.5	3.5	**
Desmanthus virgatus cv Bayamo	2.0	1.0	2.0	5.0	3.0	**
Macrotyloma uniflorum cv Leichhardt					2.0	**
Stylosanthes (aff) scabra CPI 110361	1.5	1.0	2.0	4.5	2.0	*
Vigna trilobata CPI 13671	2.0	1.0	1.0	4.0	2.0	*
Macroptilium lathyroides cv Murray					2.0	*
Macroptilium bracteatum CPI 27404	1.0	1.0	2.0	4.0	1.5	*
Macroptilium atropurpureum cv Siratro/Aztec	1.0	1.0	2.0	4.0	1.5	*
Aeschynomene americana cv Lee/Glenn	1.0	1.0	1.0	3.0		*
Lablab purpureus cv Highworth	1.0	1.0	1.0	3.0	1.5	*
Desmodium dichotomum CPI 47186					1.5	*
Centrosema pascuorum cv Cavalcade					1.5	*
Aeschynomene villosa CPI 37235					1.5	*
Vigna luteola cv Dalrymple					1.5	*
Vigna vexillata CQ 3044					1.0	*
Vigna oblongifolia CPI 28763					1.0	*

# Ratings were: 1 = severe (all leaves and above ground parts frosted)
2 = moderate (50-70% of leaves frosted)
3 = slight (up to 25% of leaves frosted)
4 = no visual damage

**** most tolerant to * susceptible

Stylosanthes spp aff. *S. scabra* CPI 110361 was more susceptible *than S. hamata* cv Amiga which was more susceptible the *S. scabra* cv Seča to light frost. Seca retained frosted leaf better than Amiga or S.spp aff S. scabra. *I. schimperi* CPI 69495 was not greatly affected by early light frost but all leaf was killed and shed following later moderate frosting. *Indigofera* did not regenerate with warm weather between frost.

Bayamo desmanthus was more susceptible than Uman which was more susceptible than cultivar Marc. Although new growth of Marc was frosted a significant proportion of its leaf had already been shed.

L. leucocephala cv Cunningham leaves were not killed by light frost and upper leaves avoided subsequent severe frost. *G. latifolia* CQ 3368 showed no visual effect to frost.

Assessments made at Kiamanna (Acadia Valley) a site sown in 1995 with a larger range of legumes showed a similar order of frost tolerance. One exception was Seca stylo which was not affected at this site to the same extent as at Biloela. Of the legumes not sown at the Biloela site the temperate legume Trifecta lucerne was not affected by frost but the tropicals which included *Macrotyloma, Desmodium, Centrosema, Aeschynomene* and *Vigna* accessions were moderately to severely affected.

While any assessment of frost is likely to change under different conditions (e.g. location, severity and number of frosts, stage of growth of plants) the relative tolerance shown in Table 7.13 is provided as a guide. Frosts can be an issue in pastures in central Queensland as this is a time when grasses are of lowest quality. Often however low rainfall (especially in autumn and winter) limits the growth and leaf retention of legumes. Under these conditions legumes that have some tolerance to frost can only increase the quality of feed available to grazing stock in years of favourable rainfall or if plants have exceptional tolerance to drought.

Legume Nutritive Quality

Results of analyses of samples from 10 legumes growing at 4 sites (Narayen, Wandoan, Acadia Valley and Biloela) show clearly that the main differences are between leaf and stem. The percentage nitrogen in leaf tips which is perhaps the best measure of quality varied markedly between legume species, and was up to twice that of the value in legume stems (Figure 7.4) Similarly acid detergent fibre (ADF) percent (Figure 7.5) was higher in stems than in leaves for all legumes. Milgarra and to a lesser extent all three cultivars of desmanthus had higher N% in the leaves and lower ADF% in stems than the other legumes. Seca had the lowest leaf N% and a higher ADF%. Milgarra had high leaf P% but variation in other P% was minimal (Figure 7.6).

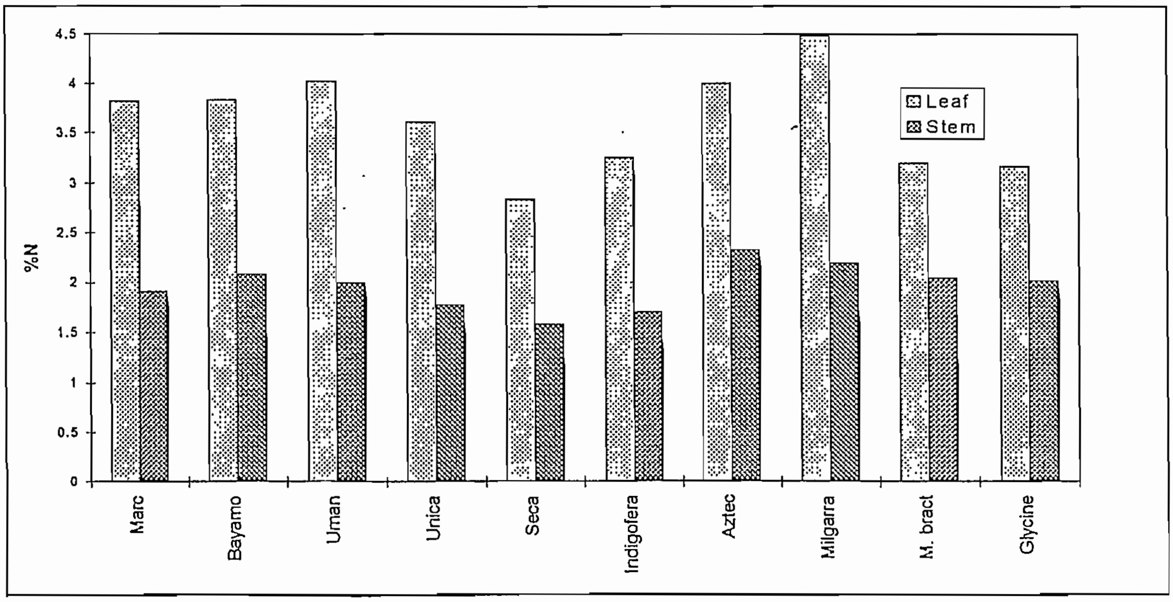

Figure 7.4 Percent nitrogen in leaf and stem of a range of legumes

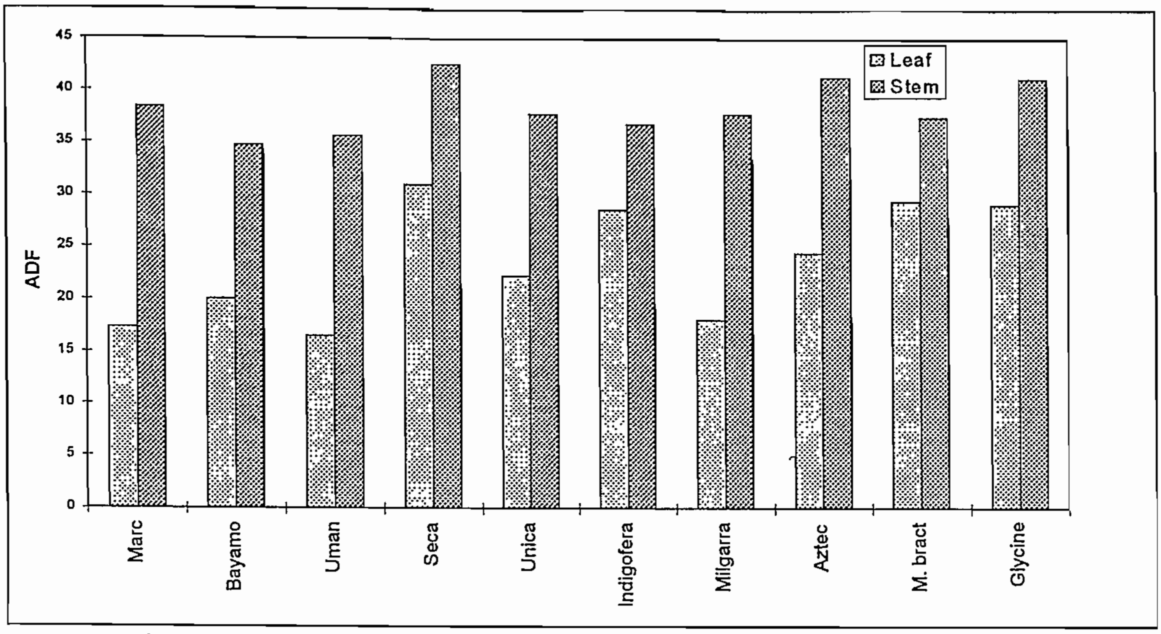

Figure 7.5 ADF in leaf and stem of a range of legumes

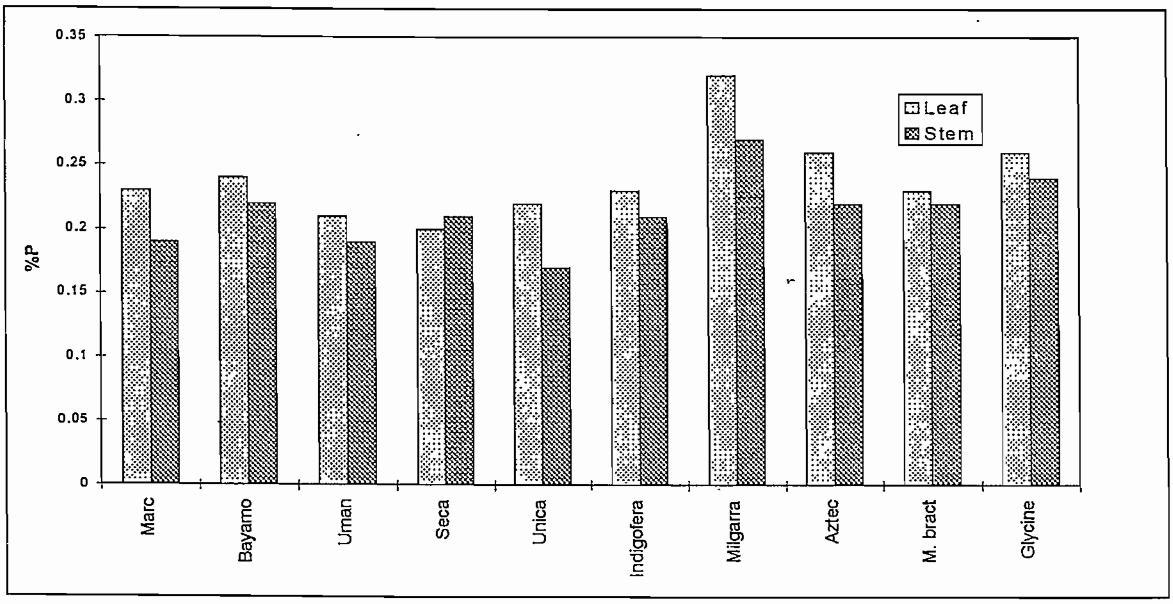

Figure 7.6 Percent P in leaf and stem of a range of legumes

Seca stylo has substantially improved liveweight gains of stock grazing stylo based pastures in central Queensland (Middleton et. al 1993). These results show that the range of legumes tested are of higher quality than Seca and have potential for similar or better improvement in animal liveweight gain, provided of course they can grow and provide similar amounts of leaf to the grazing stock. In this study only *S.spp* aff *S.scabra* had lower leaf percentages than Seca but Marc desmanthus can also have low leaf percentages for substantial times during the year when it has shed leaf under dry conditions.

Grazing preference/Palatability

An estimate of how well plants were eaten on a scale of 1 to 3 was made at Kapalee (Biloela) in February 1995 and at Kookaburra (Wandoan) in February 1996. (Table 7.14). Prior to assessment plants were actively growing although at Kookaburra conditions dried quickly. Over the grazing period animals had access to the plots and other area of grazing. At Kapalee it was sorghum stubble and at Kookaburra it was a small area of *Panicum coloratum* cv Bambatsi.

Leaf of Highworth lablab and leucaena was readily eaten from the day stock were introduced. A range of leafy legumes and also Bayamo and Uman desmanthus were eaten to some extent and more readily as the amount as more palatable species declined. There were some differences between sites in that desmanthus and aff scabra were preferred over Capella glycine and Aztec at Kookaburra. Marc desmanthus, Seca stylo and Indigofera were the least eaten other legumes but all were grazed to some extent before stock were removed. At Kookaburra Indigofera was preferred to Marc desmanthus and Seca stylo. This assessment can only be regarded as a guide to acceptance of the legumes and provides some comparison between the legumes being tested. Longer term grazing at more sites under a wider range of conditions is needed and is being done for some of the legumes to better understand how well they will be utilized and what management will be necessary to maintain a balance of species in the pastures.

Table 7.14 Palatability Ratings at Kapalee (Biloela) and Kookaburra (Wandoan)

	Kapalee 23/02/95	3/03/95	10/3/95	Total	Rank	Kookaburra 16/02/96	20/02/96	30/02/96	Rank	Palatability Rating
Lablab purpureus cv Highworth	3a	3	3	9	1					*****b
Leucaena leucocephala cv Cunningham	3	3	3	9	2	3	3	gone	1	*****
Vigna trilobata CPI 13671	2	3	3	8	3					****
Macroptilium bracteatum CPI 27404	2	3	3	8	4	2	2	dried off	5	****
Glycine latifolia cv Capella	2	3	3	8	5	1	1	dried off	9	****
Clitoria ternatea cv Milgarra	2	2	3	7	6	2	2	dried off	4	****
Macroptilium atropurpureum cv Aztec	2	2	3	7	7	1	2	dried off	6	****
Desmanthus virgatus cv Uman	2	2	3	7	8	2	2	3	3	****
Desmanthus virgatus cv Bayamo	2	2	2	6	9	2.5	2.5	3	2	****
Aeschynomene americana cv Lee/Glenn	2	2	2	6	10					***
Stylosanthes spp aff S scabra CPI 11036	2	2	2	6	11	1.5	1.5	3	7	**
Desmanthus virgatus cv Marc	2	2	2	6	12	1	1	3	10	**
Stylosanthes hamata cv Amiga	2	2	2	6	13					**
Stylosanthes scabra cv Seca	1	2	2	5	14	1	1	2	11	*
Indigofera schimperi CPI 52621	1	2	2	5	15	1	2	3	8	*

Note (a) 3=>50% eaten, 2=<50% eaten, 1=not eaten
(b) Most palatable ***** to least palatable *

8. Supporting Research

Research has been undertaken on practical aspects of establishment and management of legumes by CSIRO and QDPI staff in conjunction with students from The University of Queensland. Research findings are presented as abstracts or short summaries as follows:

8.1. Nutrition

8.1.1. *Nutritional limitations of Desmanthus virgatus. I. Is chlorosis of desmanthus grown in a black earth soil from Gayndah due to nutritional deficiencies?*

Nutrient omission and addition trials using *Rhizobium* inoculated and nitrogen fertilized *Desmanthus virgatus* plants were used to determine if element deficiencies were responsible for stunting and chlorosis in stands of the pasture legume growing in a black earth soil at Gayndah in southeast Queensland.

Omission of S or Mo relative to an all treatment reduced yield by 55% and 42%, respectively, in inoculated plants and 92% and 14% respectively in nitrogen supplied plants in the second of 2 harvests. Omission of Mn, P or Cu reduced plant growth by 8-24% in inoculated plants but had no significant effect on yield of nitrogen fertilised plants.

The combined addition of P, S, Mo, Mg, K, Ca, Cu, Zn, B, Mn to inoculated plants almost doubled yield of plant tops after 11 weeks growth, but there was no significant effect when either S, Mo, or P were applied alone.

The results suggest that S, Mo and possibly P, Mn and Cu may contribute to the development of chlorosis and low yield of inoculated desmanthus at Gayndah. A tentative critical concentration in leaf tissue of 0.20% was determined in a sulphur rate trial.

8.1.2. *Nutrient limitations of clay soils for Desmanthus virgatus. II. Potential nutrient deficiencies in 7 soils from southern, central and northern Queensland.*

The potential for the nutrients P, S, Zn and Mo to limit growth of *Desmanthus virgatus* in clay soils from Queensland was investigated using nutrient omission experiments in glasshouses located at Gatton (5 soils) and St. Lucia (2 soils). Six of the soils were black earths and were neutral to alkaline (pH 7 to 8). The seventh soil, was a euchrozem and was slightly acid (pH 6). Effect of nutrient deficiencies were determined by measuring top growth 47 and 103 days after planting in the Gatton trial and 73 days after planting in the St. Lucia trial as well as by observation of deficiency symptoms.

In the first harvest of the Gatton trial, omission of P or Zn significantly ($P<0.05$) reduced top dry weight of plants in 3 of the soils by 50-60% relative to plants fertilised with all nutrients. Responses to these nutrients decreased and were generally not significant at the second harvest. This was in contrast to the effect of S omission, which increased with time and was significant in 4 of the 5 soils in the second harvest, reducing top growth by 24-75% and drastically reducing pod production in 3 of the soils. A small reduction in growth in one soil also occurred due to the omission of Mo.

In the St. Lucia trial, omission of Mo and Zn, as well as S and P caused significant reductions in plant growth in a slightly acid euchrozem soil. Low pH appeared to reduce the availability of some nutrients in these soils and the application of lime increased growth in the presence and absence of added nutrients by 20 and 210% respectively.

8.2. Inoculation and rhizobial requirements

8.2.1. *Growth response of Desmanthus virgatus to inoculation with CB3126 I. A pot trial using 8 clay soils from central and southern Queensland*

The need to inoculate *Desmanthus virgatus* cv. Marc in 8 clay soils from central and southern Queensland was investigated in a glasshouse experiment, by comparing growth of uninoculated plants with that of plants inoculated with effective *Rhizobium* strain CB3126 or fertilised with N. The success of the inoculum in forming nodules in competition with indigenous strains was tested using a serological method. The N-fixation effectiveness of indigenous strains of *Rhizobium* compared to CB3126 was evaluated in a second experiment.

Significant ($P<0.05$) plant growth responses to inoculation with *Rhizobium* strain CB3126 were recorded in 2 soils 56 days after planting and in 4 soils 100 days after planting. Leaf production was increased relative to the uninoculated controls by up to 96%, 56 days after planting, and by up to 90%, 100 days after planting. The strain CB3126 accounted for 35 to 96% of nodules 56 days after planting and 23 to 98% 100 days after planting. Uninoculated plants in 6 of the 8 soils formed nodules. Indigenous strains of *Rhizobium* isolated from 5 of these soils were at least 60 as effective as CB3126.

This study demonstrates that *Desmanthus virgatus* responds to inoculation with *Rhizobium* strain CB3126 when sown into soils with few or no native *Rhizobium.* Although no response to inoculation occurred in 4 of the 8 clay soils used in the trial, inoculation with the commercially available strain CB3126 is recommended for all soils as a normal part of the sowing procedure.

8.2.2. *Growth responses of Desmanthus virgatus to inoculation with Rhizobium strain CB3126. II. A field trial at 4 sites in southeast Queensland.*

Growth of *Desmanthus virgatus* cultivars Marc, Bayamo and Uman inoculated with *Rhizobium* strain CB3126 was compared to that of uninoculated and nitrogen fertilised plants at 4 sites in Southeast Queensland over a 2 year period. The proportion of nodules due to the inoculum strain was determined using serological methods and the proportion of total plant nitrogen arising from biological fixation in the second and third year was estimated using the natural abundance method.

Top growth was significantly increased by inoculation at 3 sites in the first year and at 1 site in the second year. Growth increases relative to uninoculated plants varied from 34 to 310% and appeared to depend on the prevalence of indigenous strains and soil nitrogen level. The inoculum accounted for few (<3%), some (0-65%), or most (>94%) of the nodules formed in soils in which nodulation of uninoculated plants was high, medium and low, respectively. The proportion of total nitrogen due to biological nitrogen fixation in the second and third years ranged from 0% in a highly fertile soils to between 38 and 98% in 3 infertile to moderate fertile soils.

The ability of strain CB3126 to increase growth of desmanthus in some soils was confirmed in these field trials. Inoculation of desmanthus seed with an effective strain of *Rhizobium* such as CB3126 is recommended.

8.2.3. *Survival of Rhizobia on seed of Desmanthus virgatus stored at different temperatures.*

The survival of *Rhizobium* strain CB3126 on inoculated seed of *Desmanthus virgatus* cv. Bayamo was determined after 3, 7, 14, 28 and 39 days storage at 25, 35, 45 and 55°C.

Survival was assessed by observing the presence or absence of nodules on aseptically growing desmanthus inoculated with material washed from the stored seed. Plant colour, height and dry weight were compared with plants grown from seed freshly inoculated with CB3126 and plants grown with fertiliser N.

Temperatures above 45°C significantly reduced bacterial survival after only 3 to 7 days of storage. At 35°C nodulation was significantly reduced when the inoculated seed was stored for 14 days or longer. There was no effect of storage time on final nodulation when seed was stored at 25°C. However, early chlorosis of plants indicated that nodulation was delayed by the longer storage times, even at 25 and 35°C. The dry weight of desmanthus inoculated with freshly prepared peat was significantly higher than that following storage in all but the 25°C 3 day storage treatment. The implications of these observations for field sowings of inoculated seed of *Desmanthus virgatus* are discussed in relation to seedling nodulation and establishment.

The implications of these observations for field sowings are that longevity of *Rhizobium* inoculated onto desmanthus seed is often less than 2 weeks under temperature conditions similar to that occurring in the field in summer. *Rhizobium* on seed are highly vulnerable under hot dry conditions. Because desmanthus is summer growing and small seeded, it must be sown shallow, usually into dry soil, where temperatures above 50°C have been recorded (Marshall 1963); Brockwell and Phillips 1970; Hacker 1989). Although, tropical and sub-tropical Queensland receives predominantly summer rainfall, high rainfall variability means that seed will usually have at least a week and usually a longer period when daily soil temperature maxima are >50°C. The development of new methods of sowing, new inoculation techniques using bacterial protective agents, and the selection of rhizobial strains more tolerant of high temperatures are major challenges for future research.

8.3. Legume Establishment

8.3.1. *The effect of sowing depth on legume emergence.*

The rate and final % emergence of 7 tropical legume species was examined at a range of sowing depths from 0-5 cm in trays of clay soil in a germination cabinet set to day/night temperatures of 30/20°C. The species included had current or potential use either as ley legumes (*Lablab purpureus* cv. Highworth, *Macroptilium atropurpureum* cv. Siratro, *Macroptilium bracteatum* CPI 27404 and *Macrotyloma daltonii* CPI 60303) or permanent pastures (*Desmanthus virgatus* cv. Marc, Bayamo and Uman, *Indigofera schimperi* accessions *CPI 52621 and* CPI 73608 and *Glycine latifolia* cv. Capella). The ability of soft seed of *Indigofera schimperi* and *Desmanthus virgatus* to either emerge as seedlings or to retain viability during brief periods (1-4 days) of watering were also examined.

The small-seeded *Desmanthus virgatus* and *Indigofera schimperi* emerged only from depths of less than 3 cm. The remaining larger seeded legumes all emerged from the maximum depth of 5 cm. *Indigofera schimperi* was much slower to emerge than *Desmanthus virgatus* and required 4 days of good soil moisture to reach 50% emergence of viable seed compared to 1-2 days for the same level of emergence in desmanthus.

This resulted in greater emergence of desmanthus than indigofera given only 1-2 days watering. In some cases, soft ungerminated seed of *Indigofera schimperi* remained viable even following frying of the soil, and germinated on a subsequent watering cycle. Possible implications of sowing depth and rate of emergence are discussed in relation to establishment in the field.

8.4 Legume management

8.4.1 *Response of* Lablab purpureus *cv. Highworth,* Macroptilium bracteatum *and* Macrotyloma daltonii *to different intensities and frequencies of cutting*

The response to defoliation of three herbaceous forage legume species *Lablab purpureus* cv. Highworth, *Macroptilium bracteatum* CPI 27404 and *Macrotyloma daltonii* CPI 60303 was studied in a cutting trial at the University of Queensland, St. Lucia, between December, 1993 and April, 1994. The plants were grown for 5 weeks prior to the imposition of defoliation treatments which continued for a 12 week period. These treatments were combinations of two defoliation intensities (7 and 15 cm cutting heights) and three cutting frequencies (2, 4 and 6 weeks) with an additional uncut control treatment. The objective of the experiment was to study the persistence and productivity of these potential ley forage legumes under various defoliation regimes.

Macroptilium bracteatum was the most persistent and productive legume under severe defoliation, producing large numbers of growing points beneath both cutting heights. This perennial species developed a substantial well nodulated root system under all clipping regimes and flowered and set seed when cut less frequently.

The annual *Macrotyloma daltonii* persisted poorly under severe defoliation intensity, failing to survive cutting at 7 cm. This species was lower yielding than both *L. purpureus* and *M. bracteatum* and accumulated less root biomass. *M. daltonii* flowered and set seed under lenient less frequent cutting regimes.

Uncut *L. purpureus* control plants were high yielding, however productivity declined with defoliation to less than that of *M. bracteatum. L. purpureus* persisted poorly under frequent, intense defoliation (7 cm). Mortality of *M. daltonii* and *L. purpureus* plants was associated with the failure of these species to initiate growing points below the cutting height.

The results of this preliminary experiment identified *Macroptilium bracteatum* as a hardy productive perennial legume tolerant of severe defoliation. Further evaluation of this potential ley species in grazed field trials is now required.

9. Technology transfer

Every effort has been made to ensure that practical recommendations from the project are adequately and effectively made available to producers. Industry has been informed of the benefits of legumes and the need for more specialised management strategies through:

Farm walks and bus tours of on-farm demonstrations:

1993
- Northern Australia Pasture Plant Evaluation Committee visited LCS sites at Brian Pastures, Narayen, Theodore and Wandoan

1994
- planting of the Wandoan *Desmanthus* grazing development site
- Nebo Landcare group visited plots at Oxford Downs

1995
- "Rolf Park", Middlemount
- "Kiamanna", Arcadia Valley
- "Mutation", Clermont
- "Kookaburra", Wandoan
- "Rangeview", Theodore
- "Kapalee", Biloela
- "Carramah", Capella
- "Birrong", Rolleston
- "Ellenvale", Chinchilla

1996
- Northern Australia Pasture Plant Evaluation Committee visited LCS sites at Brian Pastures
- Baralaba Landcare group bus tour
- "Ellenvale", Chinchilla- March and October
- "Kapalee", Biloela
- "Rangeview", Theodore
- "Carramah", Capella

Linking with Producer Groups:

Through such activities close contact has been maintained with Landcare groups, in particular the Brigalow Floodplains Landcare Group, Baralaba District Landcare Committee, Taroom Landcare group and the Chinchilla Landcare Committee.

Interactive Displays at Agricultural Shows:

Displays of potted, posters and handout material manned by advisory staff were developed for:
- Ag show, Toowoomba in 1994, 1995 and 1996,
- Agro 2000, Emerald in 1996
- AgroTrend, Bundaberg in 1996
- Meat for Profit Day, Chinchilla in 1996
- Biloela and Gayndah agricultural shows

Legume Fact Sheets:

Fact sheets on the agronomy and management of desmanthus and butterfly pea were produced in consultation with industry (Appendix 1):

- "Desmanthus: a promising summer pasture legume for clay soils"
- "Milgarra Butterfly Pea"

Media Coverage:

- Radio interviews were given on 16 June on Radio 4HI, on "The value of legumes in pastures" and on the "Legumes for Clay Soils" project broadcasted on 4CC "Country Mile" on 23 June, 1995.

- Newspaper articles (Appendix 2):
    - ◊ "Summer Legumes for Clay Soils, QDPI Dawson Gazette, 1992
    - ◊ "Legumes for Clay Soils", DPI Brigaletter, 1994
    - ◊ "Agshow legumes draw crowd", Capricornucopia - Newsletter of CSIRO, Division of Tropical Crops and Pastures, 1994
    - ◊ "Difficult to better dolichos", "Springsure legume field day highlights dolichos research", Queensland Country Life, 1994
    - ◊ "DPI encourage legume use with farmwalk tours", "New summer legume for Qld", Queensland Country Life, 1995
    - ◊ "New stylo offers boost to industry", "Research focus on pasture leys", Queensland Country Life, 1996
    - ◊ "Milgarra butterfly pea - producers experiences", Tropical Grassland Society of Australia Newsletter, 1996

Quarterly Newsletter (Appendix 3):

A newsletter produced quarterly under the editorship of Neil Brandon has informed over 200 producers, and producer groups throughout Central Queensland, and research and extension staff of various organisations of project findings and activities.

10. Industry implications, recommendations and conclusions

Producers and Beef and Grain Industry bodies have a greater recognition of the potential for legumes that can be used in both grazing and cropping enterprises on clay soils now, than at the start of this project. There has been a positive response from producers who have expressed strong support for this project and the need for continuation of work in this area.

Legumes are seen as a viable option to assist in the maintenance of soil nitrogen levels. This is of critical importance in cropping lands where grain yields and quality is declining and the benefits of adding fertilizer nitrogen are unpredictable under highly variable rainfall. Outputs from this project have been invaluable to the GRDC funded "Sustainable Farming Systems for Central Queensland" project. They have provided:

- a strong stimulus for the further development of crop/pasture based farming systems
- guidance on those legumes most likely to be successful in the region and those worthy of further evaluation
- insights into likely benefits and establishment and management needs of legumes on these soils.

In particular the Legumes for Clay Soils project has highlighted the potential for Milgarra butterfly pea (Appendix 4: Research Impact Assessment). The potential for this legume has been recognised for some time (Hall, 1985) and seed has been commercially available. It has impressed many producers as a legume for leys and some producers are now planting larger areas. Demands for seed have increased and these demands have largely been met as seed production presents no major problems. There is potential for economic benefits from the use of Milgarra to flow through more quickly to producers than is the case with desmanthus, where there will be a greater time lag.

The potential for commercial development of better adapted cultivars of Centurian centro, Vigna and Macrotyloma and for cultivars of completely new species such as *Macroptilium bracteatum* has been recognised. Also the performance of lablab has reinforced the value of this legume and given stimulation to the CSIRO/MRC program to develop lablabs that are more perennial or at least biennial.

It is likely that legumes which have already been identified but are unsuited to current management will be recognised as having a useful role in farming systems, for example Milgarra Butterfly Pea. This is particularly so as more specialised production systems are developed and producers begin to manage for a range of outcomes.

The existing on-farm and small plot studies will be continued to document persistence of the more promising accessions. These sowings were only made 2-4 years ago, and this time-span is inadequate to evaluate persistence. This is especially so where legumes are grown with a grass. Companion grasses can have a major impact on seedling recruitment, which is essential for long-term persistence in legumes.

For the successful integration of legumes and legume leys into cropping systems there is a need for the development of grazing management practices for ley legumes. There is also a need for a better understanding of the legume hardseed component both for management in the crop phase and for the possible re-establishment of the legumes.

In the beef industry as premium beef markets are developed, producers are seeking higher quality forage so that high animal growth rates can be obtained and age at turnoff can be reduced. Legumes in grass pastures and grown in rotation with crops on cropping land can provide higher quality feed. However these systems are complex and will take considerable time to develop in industry. The Legumes for Clay Soils project is an important early step in detemining:

- which legumes are adapted to the range of soil, climate and cultural practices of the of industry
- what are the limitations and what are the likely benefits to soil nitrogen and grazing animal performance.
-

Findings to date, on a range of topics including establishment, the need for inoculation, nutrition and management have given a much better base for the successful use of desmanthus. This basic agronomic information is needed to ensure effective use of new cultivars.

There will be increased emphasis on the agronomy of *S. sp.* aff. *sp. scabra.* This legume will be commercially available in summer 1997/98 and has aroused great industry interest. Three demonstration sites will provide the base for work on animal production and pasture yield and composition. These sites also offer the opportunity to take measurements of the percentage of legume in the diet and the proportion of nitrogen in the legume that is derived from the atmosphere - similar to the measurements planned for desmanthus.

Desmanthus has not yet increased liveweight gains, although this is not unexpected in view of the:

- low rainfall experienced during the previous four years
- the mineralisation of nitrogen from sowing into cultivated seedbeds and
- the high animal growth rates recorded on the grass only pastures.

The existing grazing trials and on-farm grazing studies will be continued to document the effect of desmanthus on animal production as the effect of mineralisation of nitrogen from sowing decreases and, hopefully, rainfall improves (Appendix 4: Research Impact Assessments on desmanthus). We also plan to use these existing sites to check on nitrogen fixation by desmanthus - as studies reported here show that there may be some sites where desmanthus will not nodulate with native rhizobia. The existing trials will also be used to check on the extent of sulphur deficiency, which has been identified as a potential problem. Where possible, we will use carbon isotope measurements of faeces to determine the proportion of desmanthus in the diet throughout the year to assist in interpretation of pasture and animal production.

In the longer term, there is potential for commercial development of better adapted cultivars of desmanthus. Management strategies will be developed that will:

- allow the legume to make a significant contribution to the diet of grazing stock and
- maintain the productive perennial grasses which are vital to the longer term sustainability of these valuable grazing resources.

11. Data Information and Storage

An efficient and user-friendly information management system is paramount to managing the large data bank generated within the 'Legumes for Clay Soils' project. All information is currently stored in Microsoft Excel spreadsheets held with the project leaders. However databases are being developed in Microsoft Access for more powerful file management capability, while maintaining ready availability of information for use in spreadsheet and word processor programs. Every effort is being made to protect the integrity of the primary data and to provide for efficient exchange of information.

At each sampling occasion, a set of minimum descriptors was selected for recording across all sites. Data was collected on field recording sheets or on portable computerised data capture devices and transferred immediately to computer file. In most cases field recording sheets held with the project leaders are the original source of data and provide an important back-up to computer files.

Data will be progressively incorporated into QPASTURES (Queensland Pasture Species Evaluation Database) (Silcock, 1991). Through this statewide database, all information on individual accessions evaluated and developed through the 'Legumes for Clay Soils' project will be available for further use.

12. Project publications

12.1 Conference and Symposia Papers

Cook, B.G., Graham, T.W.G., Clem, R.L., Hall, T.J. and Quirk, M.F. (1993) Evaluation and development of *Desmanthus virgatus* on medium- to heavy- textured soils in Queensland. *Proceedings of the XVII international grasslands congress, p.2148-2149.*

Brandon, N.J. and Dalzell, S.A. (1996) *Macroptilium bracteatum*: a promising legume for leys. *Proceedings of the eight Australian Agronomy Conference, p.625.*

Clem, R.L. *et al.* (1995) Legumes for clay soils - an integrated research project. *Tropical Grasslands*, 30, 136.

Conway, M.J., Esdale, C.R., Clem, R.L. and Brandon, N.J. (1995)Legumes for clay soils - demonstrating establishment, persistence and production. *Tropical Grasslands,* **30**, 137.

Jones, R.M., Brandon, N.J. and Conway, M.J. (1995) *Indigofera schimperi* - a promising legume for clay soils. *Tropical Grasslands*, **30**,

Clem, R.L. and Conway, M.J. (1994) Use of pasture legumes in farming systems in central Queensland: Some future options. *Proceedings Australian Institute of Agricultural Science, Central Queensland Branch, Occasional Publication No 76,* Biloela 1994.

12.2 Papers submitted

Dalzell, S.A., Brandon, N.J. and Jones, R.M. (1997) Response of *Lablab purpureus* cv. Highworth, *Macroptilium bracteatum* and *Macrotyloma daltonii* to different intensities and frequencies of cutting. (accepted for publication in Tropical Grasslands).

Jones, R.M. and Clem, R.L. (1996) The role of genetic resources in developing improved pastures in semi-arid and subhumid northern Australia. (Workshop paper)

12.3 Papers in preparation

Bahnisch, G.A., Date, R.A., Brandon, N.J., and Pittaway, P. Growth responses of *Desmanthus virgatus* to inoculation with *Rhizobium* strain CB3126. I. A pot trial using 8 clay soils from central and southern Queensland.

Brandon, N.J., Date, R.A., Clem, R.L., Robertson, B.A., and Graham, T.W.G. Growth responses of *Desmanthus virgatus* to inoculation with *Rhizobium* strain CB3126. II. A field trial at 4 sites in southeast Queensland.

Agustin, C., Becerra Stiefel, Date, R.A., and Brandon, N.J. Survival of Rhizobia on Seed of *Desmanthus Virgatus* stored at different temperatures.

Brandon, N.J., and Date, R.A. Nutritional limitations of *Desmanthus virgatus*. I. Is chlorosis of desmanthus grown in a black soil from Gayndah due to nutritional deficiencies?

Spies, P.R., Brandon, N.J., Date, R.A., Bahnisch, L.M., and George, D. Nutrient limitations of clay soils for *Desmanthus virgatus*. II. Potential nutrient deficiencies in 7 soils from southern, central and northern Queensland.

Brandon, N.J., and Jones, R.M. The effect of sowing depth and duration of watering on emergence of tropical legumes in clay soils under controlled temperature.

12.4 Proposed publications

Brandon, N.J., Clem, R.L., Conway, M.J., Jones, R.M., and Willcocks, J.R. The evaluation of tropical legumes on clay soils at three sites in Queensland.

Clem, R.L. *et.al.* paper on management and grazing of *Desmanthus virgatus.*

Conway, M.J. *et.al.* On farm evaluation of tropical legumes for permanent and ley pastures on clay soils.

12.5 Reports

Collins, R., Adult learning and the adoption of the pasture legume. *Desmanthus virgatus. Cope reports,* Brigalow Research Station, DPI Biloela.

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14. Acknowledgments

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We are also very grateful to the co-operating producers who have provided land and stock for the on-farm and grazing demonstration sites, and to these and other producers for the support and encouragement to continue this project.

15. Appendices

Appendix 1: Legume fact sheets

Appendix 2: Media coverage

Appendix 3: Quarterly newsletters

Appendix 4: Research Impact Assessments

Appendix 1: Legume Fact Sheets

CSIRO
AUSTRALIA

DPI QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES

Wrightson Seeds

DESMANTHUS: A PROMISING SUMMER PASTURE LEGUME FOR CLAY SOILS

Desmanthus virgatus is a perennial summer growing legume suitable for growing on clay soils in tropical and sub-tropical Queensland. It is native to central and southern America where it grows on neutral to alkaline soils in areas of low rainfall. Unlike other tropical legumes currently available to livestock producers for sowing in heavy soils, desmanthus is well suited for use in extensive grazing areas of native and sown grasses.

WHERE WILL IT GROW?

Desmanthus has been grown experimentally from the NSW border in the south to Collinsville/Townsville in the north and west as far as Roma, Emerald and Julia Creek.

(i) *Soils* Desmanthus is suited to medium and heavy textured clay soils with neutral to alkaline soil pH (Ph > 6.5). It has been grown successfully on brigalow clay soils, open downs and alluvial country. Most of these soils are high in phosphorus and soil P will be adequate for high plant and animal growth, but some soils will have inadequate levels of P and may benefit from adding fertilizer. Also, desmanthus may respond to added sulphur on soils that are known to be deficient.

(ii) *Rainfall* Desmanthus is adapted to areas with annual rainfall of 550 to 750 mm.

(iii) *Temperature* Desmanthus is a tropical legume but has some frost tolerance. It is defoliated by heavy frosts but regrows from crowns in the spring once there is sufficient soil moisture.

PLANTING

Desmanthus can either be planted into cultivation or by oversowing existing grass pastures, either using the bandseeder or during pasture renovation. When oversowing, establishment will be more successful if competition from the existing native or sown grasses is reduced. For example, if using the bandseeder planting should be delayed until after rainfall. This allows grass to regrow and be killed by spraying and also provides subsoil moisture for seedling growth. Plant in early to mid-summer (October/November or January/February) in mixtures with summer grasses.

Desmanthus is relatively small seeded (300000 - 320000 seeds/kg) and so depth of sowing and seedbed condition can have a large effect on establishment. Seed should be sown at depths no greater than 10-15 mm and rolling could be a benefit particularly on fluffy seedbeds. Sowing rates should be at least 2 kg/ha.

(i) *Seed treatment* Freshly harvested seed has a high percentage of hard seed and seed treatment is necessary to increase the proportion of soft, readily germinable seed. Seed purchased from merchants will have been treated. A level of 50-70% soft seed is best as it allows for good germination on the first rain after sowing - but leaves some seed in reserve in case the first emergence dies due to lack of follow-up rain.

Hard seed can be treated by mechanical scarification (usually done by the seed merchant) or hot water treatment by immersing seed in boiling water for 4 seconds, quickly draining and spreading to cool. Seed should be re-tested for germination after treatment to ensure that there is adequate soft seed.

(ii) *Seed inoculation* To promote nodulation and nitrogen fixation, a specific inoculum, which can be bought from seed merchants, should be used. The inoculum is stuck to the seed with a dilute sticking agent such as Methofas (1%), milk, or a weak sugar solution. While continuously stirring or mixing the seed, apply enough sticker to the seed so that seeds are sticky but not adhering to each other. Then add the required amount of inoculum as described on the inoculum package and mix thoroughly. Dry the inoculated seed in the shade and plant as soon as possible.

(iii) *Cultivars* Three cultivars each with different flowering times, are available and seed merchants will provide a seed mix to suit local planting requirements. The three cultivars vary in growth and maturity. The combination of the three will provide genetic variation and wide adaptability. The cultivars are:

Wrightson Seeds (Australia) Pty. Ltd. A.C.N. 004 227 927
Unit 5/17 Stanton Road, P.O. Box 357, Seven Hills, NSW 2147, Australia. Telephone (02) 674-6666 Facsimile (02) 674-6257 Telex AA 121570

ARMIDALE
Cnr Bundarra Road & Miller Street
P.O. Box 218, Armidale, NSW 2350
Telephone (067) 728-599 Facsimile (067) 712-030

BRISBANE
22B Reginald Street, Rocklea
P.O. Box 124, Brisbane Markets, Qld 4106
Telephone (07) 274-3477 Facsimile (07) 274-3023

MELBOURNE
11 Export Drive, Brooklyn
P.O. Box 472, Altona North, Vic 3025
Telephone (03) 315-1755 Facsimile (03) 315-2932

Marc - an early flowering cultivar which can grow to a height of 30 to 60 cm and spreads to a diameter of 120 to 230 cm. This cultivar is originally from Argentina.

Bayamo - a mid season flowering cultivar which can grow to a height of 95 to 135 cm and spreads to a diameter of 120 to 200 cm. Bayamo originates from Cuba.

Uman - a late flowering cultivar can grow to a height of 40 cm to 100 cm and spreads to a diameter of 230 to 280 cm. Uman is originally from Mexico.

These Cultivars are protected by Plant Variety Rights and are marketed exclusively by Wrightson Seeds.

PRODUCTION AND PERSISTENCE

Desmanthus is a productive, persistent, drought tolerant legume that is well eaten by livestock.

Desmanthus, especially cultivar Marc, can seed heavily under grazing. This means that stands can thicken up through seedling recruitment following good rainfall. It is important to ensure a good seed set in the first and second year after planting - and periodically thereafter - to build up a soil seed reserve. This seed reserve is needed for the seedling recruitment required to compensate for the death of plants in older stands.

Frost, short growing seasons, low rainfall and heavy grazing can limit seed production, particularly of the later maturing Bayamo and Uman cultivars. Also, seedling recruitment can be delayed until the second year after seed set because the hard seed requires some period of field weathering to soften and germinate.

In combination with perennial grasses, such as buffel and Bambatsi panic, Desmanthus has yielded 1 to 2 tonnes of dry matter per hectare and up to 3 tonnes in pure swards.

It does not cause bloat and digestibility and protein content are high although less thanfor leucaena. Established plants of desmanthus can survive for a long time (>4 years) in pastures that are grazed throughout the year. Even under drought conditions and where plants have been heavily grazed to small crowns, survival has been good and there had been rapid regrowth from the crowns following rain.

PESTS AND DISEASES

A native psyllid (small aphid like insect) can attack desmanthus stands causing some leaf yellowing and even death. It has been more prevalent in the coastal areas and late in the growing season.

Desmanthus virgatus **- flowering branch** and seed pod

Acknowledgment

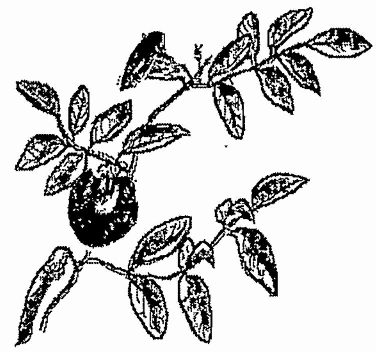
The Meat Research Corporation and the Wool Research and Development Corporation have supported the research and development of desmanthus.

Drawing is from "Plant Resources of South East Asia, Vol 4, Forages" published by Pvdoc.

MILGARRA

Butterfly Pea

Clitoria ternatea cv. Milgarra



- **vigorous, summer growing, perennial legume**
- **persists and regenerates from seed on clay soils**
- **palatable and nutritious**
- **large seeded - easy to sow and establish**
- **alternative to lablab where annual planting is not possible or desirable**

Why plant Milgarra?

Milgarra is a palatable and nutritious legume for fertile soils. It is a vigorous, twining, summer growing perennial featuring large blue, but sometimes white flowers. Milgarra is persisting and regenerating from seed on a range of soils (clays to loams) in northern Australia and central Queensland. It is particularly well suited to open downs country and in pastures that are grazed in late summer and autumn.

Milgarra continues to yield well in the 2nd and 3rd year after planting at experimental sites in central Queensland, and can be regarded an alternative to lablab in crop rotations where more than one year of forage crop is desirable. In permanent pastures it will contribute most when not grazed heavily over the growing season.

Suitable soils and climate

Butterfly pea is best suited to medium to heavy textured clay soils of high fertility, but will grow and persist on loamy and red basaltic soils. It will not persist on sandy infertile soils or where regular waterlogging occurs.

Milgarra has established and persisted in northern Australia and in central Queensland in areas with a mean annual rainfall of 650 mm to 1250 mm. Milgarra usually survives dry conditions and frosting, but has not been widely tested in southern areas. Leaf fall occurs in dry conditions, but rapid regrowth occurs following rainfall in spring.

Establishment

Seed treatment: It is recommended that seed be tested prior to sowing and scarified if necessary. Quality of Milgarra seed and germination percentage can vary widely depending on the extent of damage to the seedcoat during harvesting and the length of storage. Often seed stored for a short term (6 months or so) has adequate germination without further treatment.

Inoculation: For successful establishment *Rhizobium* (Tropical group M) should be added to the seed, although effective nodulation has occurred in many soils without inoculation.

Sowing: Milgarra has a large seed (23000 seeds/kg) which is an advantage in handling and establishment. For establishment, seed needs to be buried. This can be achieved by sowing into cultivated seedbeds or surface sowing onto strongly self mulching clay soils. Best emergence and establishment has occurred when sown at a depth of 20 to 50 mm into well prepared seedbeds with stored subsoil moisture.

Seeding rates can vary depending on the proposed use of the pasture. High seeding rates of 4 to 8 kg/ha will provide very thick stands of legume, and would be best used where Milgarra is sown for a forage crop or as a ley - a short-term pasture between crops. Lower seeding rates (< 1kg/ha) have been used successfully when sown with other pasture species. However, success with such low seeding rates depends on strong seedling recruitment to increase the population, favourable seasons and low levels of competition with weeds and strong perennial grasses such as buffel grass.

Production

Forage production of 0.5 to 4 tonnes/ha has been reported from a range of growing conditions on clay soils. Highest yields have been measured from pure stands of legume growing on soils with a high water holding capacity (eg deeper black earths on open downs country and better brigalow soils). While Milgarra can persist in competition with vigorous growing grasses, yields are lower.

Seed production is best in seasonally dry frost-free tropical areas when growing on fertile, well-drained soils under irrigation. Irregular pod maturity affects the time and success of seed harvesting. In seed crops diseases such as powdery mildew, leafspot and anthracnose can occur and insect pests such as leaf sucking insects, caterpillars and grasshoppers can cause damage.

Management

Production and persistence of Milgarra is reduced under frequent grazing or mowing during the growing season. This may be because most growth occurs from the main stems and large branches and not from the crowns. Management should therefore aim to restrict grazing during the growing season and graze heavily in late summer and autumn. Late grazing will also maximise the amount of seed that is dropped to the soil which could enhance seedling recruitment. Although there are no data on animal production from Milgarra, it is a palatable and highly digestible tropical forage with high nutrient concentrations.

Future

Because it is easily established, productive and persistent, Milgarra is being more widely recognised as a useful legume in ley and permanent pastures. While it's use as a permanent pasture legume is likely to increase, it has an even greater potential as a ley legume - to provide quality feed and to reduce the rate of nitrogen rundown in cropping soils, particularly in central Queensland. There is a need to quantify the contribution that Milgarra can make to soil nitrogen and to animal production and to define what are the best grazing strategies for this legume.

PRODUCED BY:

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Appendix 2: Media coverage

SUMMER LEGUMES FOR CLAY SOILS

Bob Clem (Pasture Agronomist)

Legumes have been shown to improve animal performance on lighter textured soils particularly during the Autumn/Winter months. Previously, pastures of mainly summer growing grasses on brigalow and open down soils provided high animal production, but this is now declining. At present there is a strong incentive to maintain high annual levels of beef production to meet fastidious market specifications for grass fed steers.

However there are few legumes currently available that are well adapted to clay soils.

This also applies to cropping land where there is a requirement for legumes for pasture leys to improve declining soil fertility and restore grain yields and protein content.

These problems will be addressed by a new project, Legumes for Clay Soils, which will be conducted by the Queensland Department of Primary Industries and CSIRO with funding support from the MRC.

The project will examine the use of a range of legumes and has the following broad objectives:

(a) To give sound guidelines on the establishment and management of *Desmanthus*/grass pastures in different areas of Queensland and on their likely impact on animal production.

(b) To give preliminary guidelines on the establishment, management and likely impact on animal production of *Indigofera schimperi* and *Glycine latifolia*.

(c) To draw up a short list of legumes that may be suitable for annual or short term leys with guidelines about their potential area of adaptation, management and yield.

(d) To make firm recommendations about legumes for permanent pastures (other than *Desmanthus*, *Indigofera* and *Glycine*) that warrant further evaluation and to identify, and prepare a case for release of, new cultivars.

Desmanthus will be evaluated under experimental grazing, using a range of stocking rates, at Narayen Research Station (CSIRO) and in three commercial type grazing development sites at Taroom, Banana and Clermont.

Advanced lines of legumes including the recently released Lee Joint Vetch, Milgarra Butterfly pea, the three cultivars of Desmanthus and a range of new material will be compared with Lablab and Siratro for grazing and ley pastures on clay soils.

The project will be a cooperative effort involving personnel from throughout the state. Principal investiagors are stationed at Biloela, Emerald, Roma and Brisbane. Field sites for comparison and evaluation will be set up in the following areas: Taroom, Burnett, Bauhinia, Banana, Duaringa, Emerald, Clermont, Nebo, Charters Towers and Normanton and also on Narayen, Brian Pastures, Brigalow and Biloela Research Stations. Many cooperators from the above centres will also be involved in the project.

The careful monitoring and assessment of these legumes will involve small sward and larger on-farm testing with information and recommendations being made available to producers during the next three to four years.

LEGUMES FOR CLAY SOILS

Harry Bishop, Senior Pasture Agronomist, Mackay

Next year, there will be on farm demonstration areas of the following legumes on clay soils:- *Desmanthus virgatus* cv Marc, Bayano and Uman; *Clitoria ternata* cv Milgarra, Blue Butterfly pea.

These legumes have been released in recent years. Seca stylo is the "miracle" legume of the subcoastal and drier hinterland areas but Seca stylo will not grow on heavy clay soils. Les Edye of CSIRO, Davies Lab at Townsville, is currently looking for and testing stylos for clay soils.

Butterfly pea cv Milgara has been growing on heavy clay soils at "Connors Junction" for the last four years. It is commercially available from Joe Tomerina, Tolga Seeds, Tolga (070-954263), for around $12 per kg. The recommended sowing rate is 2-3 kg/ha. It may be tried planting behind a blade plough.

Butterfly pea has a large seed (bigger than Leucaena seed) and is best drilled into a prepared seedbed. It does not need inoculation.

Desmanthus has a small seed. It needs a special inoculum to be effective in producing nitrogen and is best sown into a firm, moist, cultivated seedbed using a seed drill with presswheels. However, successful establishment has occurred by surface sowing onto a "rough" seedbed but establishment is much slower and less reliable. Desmanthus does not like to be buried deeper than 10 to 15 mm deep.

Therefore the ideal situation for these two legumes is drilling into old cultivation areas which are being converted back into pastures. Drilling strips into existing grass pasture using a band seeder or sowing into sprayed or cultivated strips is an acceptable alternative. Sowing onto the surface of existing grass pasture or following a burn as with Seca stylo is not recommended at this stage.

Sowing demonstration areas is a good way of getting to know new legumes. Not every property has the soil type, situation, or time to sow a demonstration area of pastures and follow its performance.

The Meat Research Corporation is a strong supporter of producer group pasture demonstration sites and

money is available to establish them. Simply, these groups are neighbours willing to pool ideas, resources, etc., in planning, planting and managing (with help from DPI if you need it).

Several individuals and groups have already indicated they are interested in legumes for their clay soils and some have asked about Desmanthus and Butterfly pea. We will be following up these current requests so we can jointly develop plans to set up "Producer Demonstration Sites".

If you are interested, talk it over with your neighbours or with an existing producer group in your area and contact myself, George Lambert, Ross Dodt or any of the DPI team. Any proposal for MRC funding needs to be submitted by the end of December 1994 and if successful the funding commences in 1995/96.

September 1994 - No 149

CAPRICORNUCOPIA

CSIRO AUSTRALIA

NEWSLETTER OF CSIRO, DIVISION OF TROPICAL CROPS & PASTURES

AgShow legumes draw crowd

The Division's AgShow exhibit enjoyed popular support at this year's event, with the CSIRO-DPI 'Legumes for Clay Soils' display drawing large crowds.

DTCP Chief, Bob Clements, said it was the best legumes exhibit he had been involved with, adding that he had never fielded so many questions at an event of this nature.

Dick Jones and his team had plenty to smile about at this year's event which proved the value of displaying good looking plants to an enthusiastic audience of graziers and mixed farmers.

But there were plenty of other reasons to smile, with a good level of cross-Divisional support for the event coming from Tropical Animal Production, the Tropical Beef Centre, Australian Animal Health Laboratory, CSIRO Education Programs to name a few.

DTCP's Bruce Pengelly (l) and QDPI's Bob Clem (r) proudly display the Desmanthus legume, a star attraction on the Legumes for Clay Soils stand at AgShow

Although the location for the CSIRO marquee seemed to be at a 'dead end', the rear of the marquee was kept buzzing for the three day event, with AgShow visitors seeking out the latest in DTCP research.

Thanks to all those who helped out at this year's AgShow. Like all successful ventures of this nature, it takes team work to make sure that each post is a winning one, and the effort at AgShow 94 made sure of that.

And if you weren't involved this time around, it looks like you will have a chance in 1995.

Planning for next year's AgShow 95 has already begun with plans to extend the Clay Soils exhibit to incorporate other land class types, and an even greater range of live plants.

PASTURE RESEARCH

Difficult to better dolichos

By ANNE LLOYD

DPI and CSIRO researchers examining "new" species for possible inclusion in ley or permanent pasture systems have already concluded that the legume, dolichos lablab, is going to be "pretty hard to beat".

Addressing a recent Central Queensland field day, Legumes for Clay Soils project leader, Bob Clem, said lablab had easily out yielded other cultivars in on-farm trials during the 1993/4 season.

"The only trouble with lablab is that you have to plant it every year," Mr Clem told grain and cattle producers.

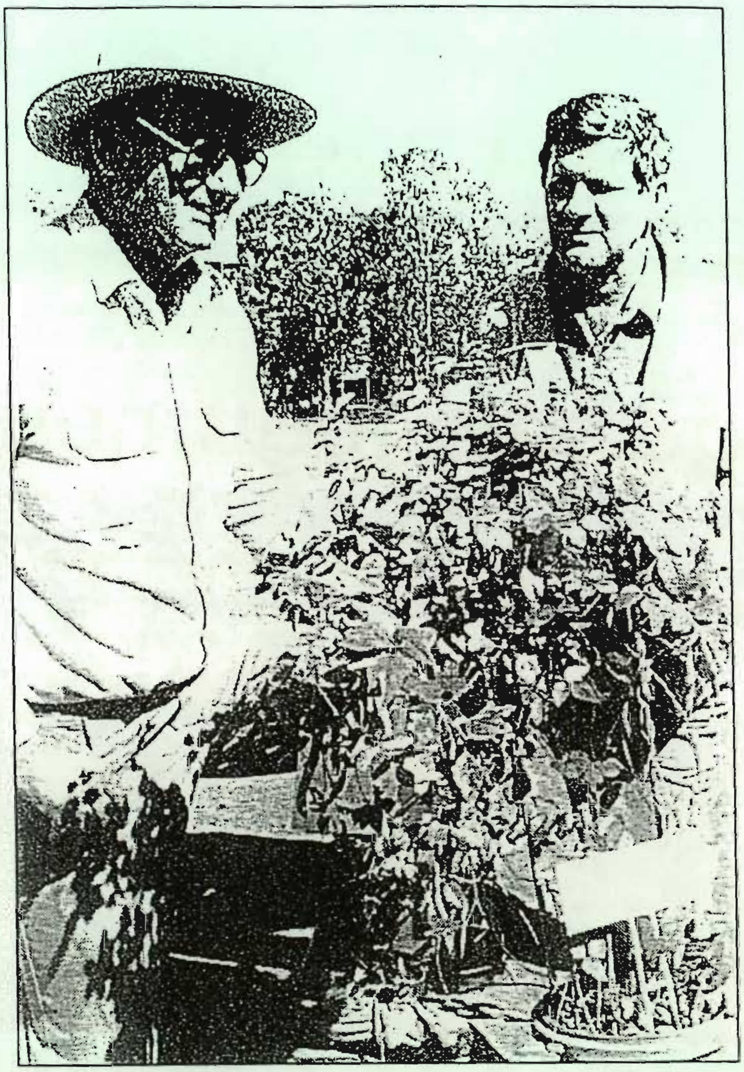
"There are lablab varieties which are perennial, but they don't have the same productivity. Research is currently focussing on crossing the annual and perennial lablabs, in a bid to develop a perennial variety with better productivity."

Mr Clem said another legume, Clitoria ternatea, also known as butterfly pea, offered potential in that it was strongly perennial.

But Clitoria grew better under higher rainfall conditions, did not like frost, and had not yielded as well as lablab.

A third legume, Desmanthus virgatus, was under investigation at Narayen, Brian Pastures and Brigalow Research Stations, and was also being trialled on properties at Taroom, Theodore, Biloela and Clermont.

Mr Clem said the Legumes for Clay Soils project was also investigating the potential of medics.



Grain and cattle producer, John Mayne, Wealwandangie, and Legumes for Clay Soils project leader, Bob Clem, inspect a promising alternative legume - Clitoria ternatea, also known as butterfly pea.

DPI encourages legume use with farmwalk tours

QDPI beef husbandry officer, Col Esdale (pictured), flicks through the latest release from the Department bookshop — Phosphorous Nutrition of Beef Cattle in Northern Australia.

Mr Esdale is fresh from hosting a series of farmwalks at Theodore and Biloela intended to familarise graziers with the most suitable legumes for Central Queensland.

The walks were part of a DPI and MRC funded project with three main objectives:

- To develop methods of establishment and management of Desmanthus, Indigofera and Glycine.
- To quantify liveweight gain from these pastures and encourage their use by industry.
- To identify new legumes for use in ley and permanent pasture systems on clay soils.

The project is directed mainly at the central and northern brigalow belt where clay soils occupy over six million hectares.

Mr Esdale said producers had identified the need after being informed of statistics stating that it had been 30-40 years since the majority of the land had been cleared.

□□□

ALSO hot off the press is the DPI's latest beef publication — Live Cattle Export Opportunities for Northern Australia.

This booklet is a valuable source of information for cattle producers and personnel involved in the live cattle export trade.

The publication, compiled by Cloncurry stock inspector, Rick Dunn, has been approved by AQIS and live export companies.

The booklet is available for $10 from the Townsville DPI.

For further information contact: Rick Dunn (077) 421 311, Ray Nicholls (077) 222 688.

□□□

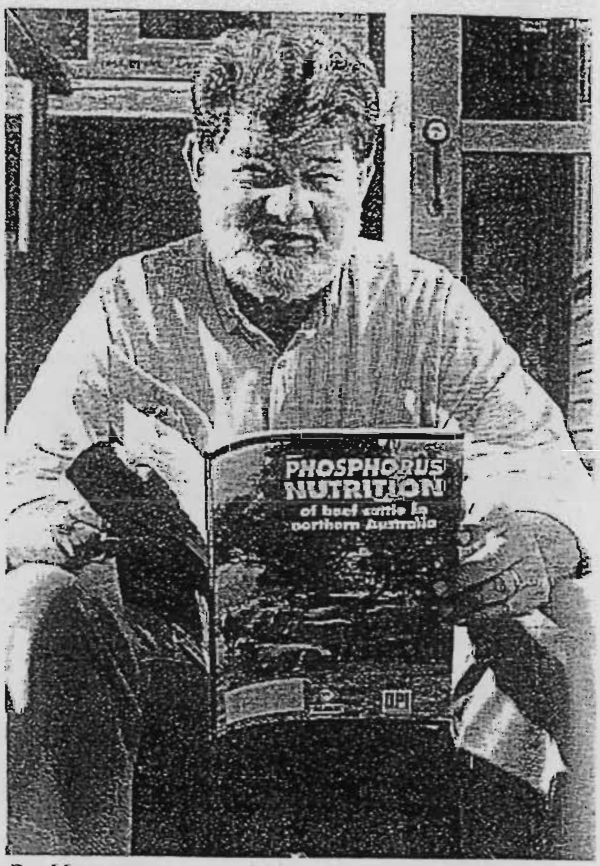
YOUNG farmers will have their opportunity to carve their mark in the the sugar industry when nine more farms in the Burdekin River Irrigation area are auctioned on June 29 in Ayr.

Sales in the district over the past 12 months have seen a swag of young faces accept the challenge of developing near virgin properties, into highly productive irrigation farms.

The total pre-bid price of the blocks, including land, water allocation and improvements range from around $300,000 to $580,000.

□□□

ON TO property and six out of the seven portions of Birrahlee, Ridgelands, via



Rockhampton, comprising 860ha sold for an average price of $1455 on May 6.

The agent responsible, Leo Gately informed me that only portion 29 remains unsold, featuring double frontage to Ridgelands Creek, and several kilometres of ponded pasture.

□□□

PHILLIP Wilson of Longreach was awarded the Apprentice of the Year for 1993 for Civil Aviation Engineering.

He has worked most of his apprenticeship with Curley Air Maintenance at Longreach Airport, where he also gained his "pilot's wings" with instructor Eli Thieboom.

Phillip has also won the 1992 Achiever of the Year award, and is presently stationed at Archerfield, attending TAFE and preparing for his final exams.

The award was donated by the Federal Airports Corporation.

Springsure legume field day highlights dolichos research

QIDC regional manager, Vern Ezzy, Emerald, met up with Knox Jamieson, Marla Downs, and Arnold Kajewski, Orion Downs, at the Inderi field day.

John Brown, Valencia, Capella, agricultural consultant Graham Spackman, Emerald, and Alan Uebergang, Horsham, Victoria, took advantage of the field day on Gerald and Faye Mayne's Springsure property to learn about recent developments in legume research.

Scott Huf, DPI, Emerald, takes a break from field day proceedings with Capella primary producers, Lindsay Vagg, Welmby Downs, and Don Sampson, The Glen.

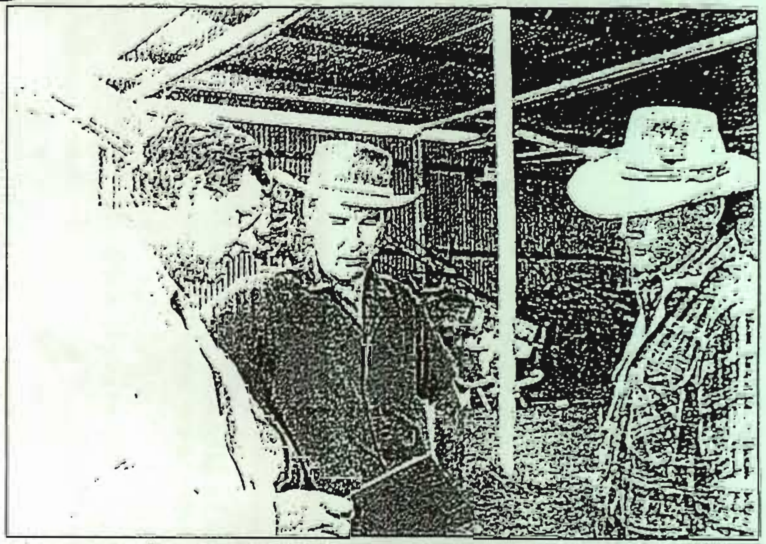
A LEGUME field day held earlier in the month on Gerald and Faye Mayne's Inderi property, Springsure, attracted strong support from both Central Highlands and Dawson Valley producers.

Organised by DPI extension agronomist, John Agnew, the field day highlighted the results of a three-year, on-property, dolichos trial, conducted with Meat Research Corporation funding assistance.

The trial demonstrated the summer forage legume's ability to finish cattle during the autumn/early winter period while simultaneously contributing to soil nitrogen.

Other topics discussed on the day included progress from the Legumes for Clay Soils project led by Bob Clem (Brian Pastures Research Station) and from Roger Armstrong and Kevin McCosker's (DPI Emerald) Role of Ley Pasture in Farming Systems trial.

Field day participants also seized the opportunity to inspect Mr Mayne's leucaena planter, as well as his newly built leucaena seed harvester.



▲ Legumes for Clay Soils project leader, Bob Clem, was happy to share research results with Geoff and Steve Kajewski, Orion Downs.

▲ Lindsay Nott, Selected Seeds, and DPI staff member, Col Esdale, both travelled from Biloela to attend the dolichos lablab field day.

◄ Andrew Mactaggart, Bears Lagoon, Moura, and David Brimblecombe, Dalkeith, Capella, were particularly interested in the establishment of leucaena on the Maynes' Inderi property.

Research focus on pasture leys

A LEGUME similar to siratro and a highly palatable grazing pea are among legumes targetted by researchers looking at the potential of pasture leys to reverse fertility and organic matter problems in exhausted cropping soils.

Growers will support the research through the Grains Research and Development Corporation, which has a firm policy of promoting greater use of legumes — particularly pasture leys — as the key to development of sustainable farming pasture systems.

While fertility improvement options available to farmers also include nitrogen fertiliser application, zero tillage and grain legumes, Queensland Wheat Research Institute research suggests only the use of legume based pastures will deliver:

- Soil nutrients in excess of crop removal;
- Minimum disruption to soil aggregates, and;
- Optimum aeration and soil water relations.

However, while grain growers in southern Australia can turn to a range of legumes which are proven as pasture leys, and for which the growing technology is readily available, their counterparts in the north are not so fortunate yet.

Jacqui Willcocks, pasture agronomist with Queensland's Department of Primary Industries at Emerald, says any successful pasture ley legume in Central Queensland will have to be suitable for areas of open downs and brigalow clay soils and be able to tolerate the local climate.

"Central Queensland is a region characterised by highly variable rainfall — 470mm to 800mm being normal — high summer temperatures of 30 to 38 degrees Celsius and high rates of evaporation, averaging 8mm a day in December," Ms Willcocks said.

"In January Maurie Conway, from QDPI Biloela, and I will plant 30 tropical legumes on three cooperating private properties to determine which of them are suitable to use as pasture leys.

"We will see how well these legumes grow and how well they set seed."

Ms Willcocks said the three trial sites would be on:

- John and Marion Brown's open downs property Valencia, south-east of Clermont, on black, cracking clay farmed for 21 years;
- Another open downs site, on the property Juanita, north of Springsure, owned by Ron Schwartz, and;
- On Bruce Ballentine's Namgoori, at Banana, a brigalow clay which had grown mostly sorghum for 25 years.

Ms Willcocks said the three trial sites were chosen because of their long cropping histories, which led to conditions of limited nitrogen.

The dryland plantings on them would be made in January, when the certainty of rainfall was a lot higher.

One hectare would be planted to the trial on each property, with the owners grazing them to researchers' directions.

Ms Willcocks said in associated research Emerald DPI weeds agronomist Vicki Osten was looking at weed control in ley pasture systems by evaluating the best use of herbicides and other practices.

"Vicki will also identify effective and safe methods of terminating a ley pasture when it is time to go back into a cropping phase — a choice that often needs to be made quickly in Central Queensland," Ms Willcocks said.

"She will also assess whether the ley phase acts as a weed management tool in the overall cropping/ley pasture system.

"Her work involves three trials, all at the Emerald Research station, where the six of our most promising legumes were planted under irrigation to simulate a planting rain at the beginning of November and where other promising legumes from our work will be included in future years."

Ms Willcocks said these six legumes were the annual lablab, vigna trilobata, Aztec rust resistant siratro, Mactoptillium bracteatum, butterfly pea and lucerne.

"We are including lucerne because people are planting it, even though we are really on the limit of its climatic range," Ms Willcocks said.

"Good results with lucerne are coming out of the Orion area, but paddocks north of Springsure are not as productive.

"We think lablab is better suited to the clay soils and we also have Stylothantes aff Scabra — "aff" meaning "like" Scabra — that is more suited to clay soils than seca stylo.

"Butterfly pea is a perennial that does best with more than 600mm of rain, doesn't like frost and grows on any fertile soil, especially heavy black soil in North Queensland."

New summer legume for Qld

A NEW summer-growing perennial legume, developed jointly by the Queensland Department of Primary Industries and CSIRO has recently been released for commercial use.

The legume is Desmanthus virgatus, known commercially as Jabiru Desmanthus. It is a summer-growing legume suited to clay soils in tropical and sub tropical regions of Australia.

Paul Kenny, northern manager for the commercial licensee Wrightson Seeds, says Jabiru Desmanthus will have a significant impact on beef production in northern Australia as it is readily accepted by stock, has a high protein content and is very persistent.

"Unlike other tropical legumes, Jabiru Desmanthus is suited to heavy soils," Mr Kenny said. 'It is well suited for use in the extensive grazing areas of native pastures and can be combined with grasses such as buffel."

Jabiru Desmanthus is a blend of three Desmanthus varieties, Marc, Bayamo and Uman and has been adapted for northern, central and southern areas of Queensland and northern areas of NSW.

During its development Jabiru Desmanthus has been growing successfully from the NSW border in the south to Collinsville and Townsville in the north and as far west as Roma, Emerald and Julia Creek.

New stylo offers boost to industry

AFTER a long wait, cattlemen in the brigalow and the basalt, may have access to a stylo suited to the their properties' heavier soils.

Soon to be released, aff Scabra, has shown better frost resistance, survival, seeding regeneration and dry matter yields than existing stylos growing on such soils.

Chief research scientist at the CSIRO, Townsville, Dr Les Edye, has been working on the release of aff Scabra, a Brazilian legume suited to the heavier soils of Southern, Central and Northern Queensland.

"The industry has been looking for a new stylo, superior to Seca, for use on fertile, heavier textured soils," Dr Edye said.

To date, most of the stylo research programs in this country have concentrated on improving the less fertile, native spear grass regions of northern Australia.

According to Dr Edye, the release of aff Scabra could increase the area suitable for stylo pastures in Queensland by 50 percent, giving cattlemen an increase in beef production of up to $10 million per annum.

Funded by the Meat Research Corporation, under the 'Legumes for Clay Soils' program, the new stylo is performing very well in trials, involving a wide range of soil types, across the state.

In plots at Wandoan, Theodore, Biloela, Rolleston and Clermont, aff Scabra has out-yielded Seca by nearly 20 times, and produced double the quantity of Amiga, based on the mean yields.

Northern plots of aff Scabra on Hillgrove and Cardigan Stations, Charters Towers and Yarramulla, near Mt Suprise, appear promising after surviving a run of very poor seasons.

The anthracnose-resistant legume has potential as a forage plant for tropical and sub-tropical regions of northern Australia, with clay soils, cool winters and distinct wet/dry seasonal conditions.

Aff Scabra flowers earlier than Seca, and with water, will continue to flower all year round. The seeds also ripen more quickly, improving its chances of survival during harsh seasons.

□ Callide Valley district cattleman Ben McAuiffe discusses the promising performance of shrubby stylo on heavy clay brigalow soils with DPI pasture experimentalist Maurie Conway.

Search is on for legumes

Department of Primary Industry pasture experimentalist at DPI Biloela Research Station, Maurie Conway, says a Meat Research Corporation-funded three year project will enable individual livestock producers to make their own plant performance assessments.

Trial areas had been established in the Dawson Callide region and on the Central Highlands in the on-going quest to find suitable pasture legumes.

Mr Conway said that while it was still early days to draw any conclusions from this year's mid-January plantings, three selections of Desmanthus were showing increasing promise and three selections of shrubby stylo had performed well.

The Dawson Callide legume demonstration sites inspected by 60 beef producers on May 18 had been planted on the Biloela district property, Kapalee, owned by Lindsay and Dorothy Sharpe and Ben McAuliffe and on the Durkin family's Theodore holding, Rangeview.

Mr Conway said research had indicated there were some concerns with nodulation relating to the nitrogen-fixing ability of these legumes. This poor nodulation inhibited the plants' performance on the heavy clay soils.

Two CSIRO pasture scientists, Les Edye and Dick Date, will travel to South America this year to look for suitable nodule material which will enable Desmanthus and shrubby stylo to perform on heavy clay soils.

"We believe the industry will have access to a high performance stylo within two years to be utilised across six million hectares of our central and northern brigalow regions," Mr Conway said.

Mr Conway said there was also a vital role for legumes in ley pasture management programs. About 1 million hectares of brigalow soil was being cash cropped and the subsequent run-down in fertility had been reflected in reduced yield and protein content of harvested grain.

The Kapalee and Rangeview producer demonstration sites also included commercial plantings of Desmanthus into buffel grass and native pasture. A three-row bandseeder was used to sow the Desmanthus directly into the pasture. A 50cm band of Roundup herbicide spray was applied at planting over each row to reduce grass competition.

DPI beef cattle husbandry officer, Col Esdale, Biloela, said cattle live weight gain performance would be recorded from the legume-augmented areas in comparison with adjoining grass pasture stands.

Milgarra butterfly pea

Maurie Conway, DPI Biloela

Interest in Milgarra butterfly pea (*Clitoria ternatea* cv. Milgarra) is increasing in central Queensland, particularly from producers on the open downs of the Central Highlands. Butterfly pea can be established easily on these cracking clay soils, and its productivity and persistence makes it useful as a ley pasture for restoring soil fertility but also in longer-term pastures.

Milgarra grows best on fertile medium to heavy clays with 650-1250 mm rainfall. It is normally sown at 4-8 kg/ha for rapid and dense growth in leys, but can also be planted at less than 1 kg/ha in mixtures.

Being a trailing legume, Milgarra cannot stand heavy grazing during the growing season and is best managed by restricting grazing during summer, then grazing heavily in late summer and autumn. This may also allow some seed to drop.

Producers' experiences

Stuart Coaker of 'Lindley Downs' Orion (south of Springsure) planted Milgarra butterfly pea three and half years ago when he was unable to buy desmanthus. He planted 15 kg/ha of seed with an air seeder into moisture at about 4-6 cm on 14 ha in December 1993. In January 1995 he planted another 66 ha at 20 kg/ha using his own seed.

Drought hardy

David Day, the manager at 'Lindley Downs' was impressed with the way Milgarra butterfly pea has survived in the run of dry summers experienced since planting. It has certainly proved itself drought hardy.

David said they have planted butterfly pea as deep as 7.5 cm and, while it took a long time to come up, it established well. They also once planted shallow into dry soil and waited for rain. It established but success was dependant on follow-up rain. Butterfly pea planted into a stand of purple pigeon grass also established, and is surviving despite a very dry summer.

Wheat was zero-tilled into butterfly pea, but the mixture is being grazed because there was insufficient rain for a crop.

Butterfly pea is readily eaten by cattle, but David does not consider that it would be easily grazed out.

Recovers after rain

Mike Wells 'Yandina' Orion planted 20 ha of butterfly pea at 10 kg/ha in 43 cm rows in January 1995. He got an excellent strike despite dry conditions after planting. Mike was impressed by the well developed tap root of butterfly pea; cattle grazed it hard but it came back after rain.

Rain in January 1996 produced a seed crop which was harvested in March 1996 producing about 2 tonne of seed from 20 ha. A conventional harvester was used with no adjustments after harvesting sorghum.

In with the blade-plough

John Howard of 'Mountain View', Biloela, has planted about half a tonne of butterfly pea. In September 1995, he blade-ploughed some country, and planting a mixture of buffel, Silk sorghum and Milgarra butterfly pea, getting good germination of the pea from rain in October. The butterfly pea almost died during the very hot conditions of last summer before the good rain fell in January 1996, but then so did the buffel grass seedlings. John has grazed it fairly heavily since March 1996, and the butterfly pea has survived well. He was particularly impressed with the establishment and growth of Milgarra butterfly pea in his heavy clay soils especially in hard clay pan.

Seed crops can produce up 700 kg/ha with direct heading; germination has averaged 42% with 45% hard seed. Although stored seed should not need treatment, germination should be checked before sowing.

Milgarra butterfly pea has a branched root system with 5-6 major roots; it can survive drought and still become productive again when it rains.

For more information, ask Maurie at Biloela DPI or Bob Clem at DPI Brian Pastures, Gayndah for their leaflet.

NEW PASTURE LEGUMES GENERATE ENTHUSIASM

Beef producers in Central Queensland have welcomed a range of new tropical legumes that are suited to the region's brigalow clay soils and the open downs clay soils.

The legumes have been developed though the Department of Primary Industries and CSIRO Legumes for Clay Soils Project partly funded by the Meat Research Corporation.

DPI pasture research technician at Biloela Research Station, Maurie Conway, assisted by Bob Clem and Benita Darrow from Brian Pastures Research Station, Gayndah, put the legumes on display at the July 11-13 Ag Grow 2000 field days at Emerald.

Mr Conway said legumes were tested in on-farm demonstration plots from Middlemount to Roma and a number of species were now established under commercial grazing on a cooperators' properties.

At the Ag Grow field days, legumes were displayed in pots supported by posters detailing their characteristics.

"Central Highlands cattle producers were most interested in Milgarra butterfly pea which was persistent and productive on self-mulching downs soils", said Mr Conway. "Pasture productivity on extension areas of the Central Highlands downs grazing country has been reduced by drought and parthenium invasion. Butterfly pea has shown it can be easily established. Its persistence and productivity suggests it could play a vital role in the reestablishment of pastures on these cracking clay soils.

"Three to four years after sowing butterfly pea is surviving and producing seed. At some sites it is regenerating from seed and competing with a range of weeds including parthenium," said Mr Conway.

Milgarra butterfly pea was previously tested by DPI in North Queensland, particularly in the Gulf country. It was released as a public variety in 1991 and seed produced in North Queensland was readily available from seed merchants.

Mr Conway also focussed industry attention on Desmanthus virgatus, a legume being sold commercially as Jaribu desmanthus.

"Jaribu desmanthus is well suited to brigalow clay soils and can survive with very competitive grasses including buffel grass.

"Our demonstration trials indicate once Jaribu desmanthus is established, it can survive drought and remain productive in brigalow pastures. It is readily eaten by stock, provides a high protein feed source and should help prevent further rundown in brigalow soil nitrogen reserves," said Mr Conway.

Producers were also pleased to see a display of the new clay soil stylos, Stylosanthes (aff) scabra. These stylos had proven to be better adapted to clay soils, than the previous cultivars - Seca, Siran, Verano and Amiga. The new releases were perennials which could survive for at

BARALABA LANDCARE INSPECTS LEGUMES

Pasture legumes adapted to clay soils were a major focus for a recent Baralaba Landcare group bus tour. On June 5th forth producers inspected a range of legumes at "on farm" sites on a number of producers properties. These were established as part of the Legumes for clay soils project (MRC funded) and the Development of ley legumes project (GRDC funded).

The enthusiasm shown by this group reflects the positive results being achieved in these projects and the strong producer support for further legume research. The group had previously voiced a real concern with the decline in pasture productivity and the need to establish adapted legumes in their pastures as a means of arresting this decline so that cattle liveweight gains can be maintained and soil nitrogen levels for future pastures and crops can be improved.

The tour was organised by Gavin Graham, senior extension officer, Tropical Beef Centre, Rockhampton and Col Esdale, beef extension officer, Biloela. Maurie Conway, pasture experimentalist at Biloela Research Station who supervises the sites spoke of the progress being made with legume development at each stop.

At Lindsay and Dorothy Sharpe's "Kapalee" near Biloela, legumes that caught the eye of many of the producers were Unica, a stylo (*Stylosanthes* (aff) *scabra*) that is better suited to clay soil and Milgarra butterfly pea (*Clitoria ternatea*). Other legumes that attracted the producers attention were desmanthus, leucaena and Peak Downs clover (*Glycine latifolia*).

At the desmanthus grazing demonstration site, also on "Kapalee" one producer commented that he was pleased to see desmanthus growing with buffel and being grazed. While the desmanthus population is still low this provided a practical demonstration of how the legume can be established and how it can contribute to the pasture system.

Lunch was enjoyed at "Namgoori", the property of Bruce and Kaye Ballantine, Banana before inspecting a ley legume site planted this year on their property. Legumes that may play a role in ley farming systems generated interest especially among producers with mixed farming enterprises.

Milgarra butterfly pea sown at the Durkin's family property "Rangeview", Theodore had recently been grazed. Its good palatability and the extent of regrowth caught producers attention.

This interest in pasture legumes by the Baralaba Landcare group has been maintained and since extended to include a visit to Warren and Peter Oates property "Wongadoo", Baralaba, to inspect stylos and butterfly pea.

least three years. Because they were heavy seed producers which could recruit strongly from seed, legume density could increase even from poor establishments and after the death of older plants.

Mr Conway said the two varieties registered for release were Unica and Primar. Both were protected by Plant Breeder Rights although seed was not yet commercially available.

Mr Conway said Unica was being recommended for the northern brigalow country including the Callide-Dawson while Primar was better suited to the Burnett and Maranoa regions.

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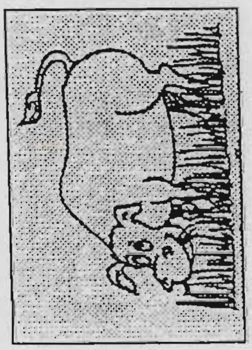
TO THE PROGRESSIVE BEEF PRODUCER

You are invited to be involved in a two part activity on 'Pastures to Processing'

'Pastures to Processing'



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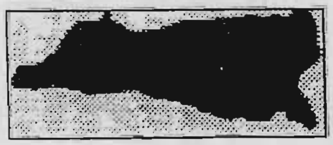


Taroom Shire Beef Marketing Group

DPI Queensland Department of Primary Industries South Region

An Invitation

to participate in a

Field Day and Bus Trip

on

Pasture legumes

Cattle performance

Live Animal Assessment

and

Processing technology

DAY 1
8th June 1995
Pasture & Live Animal Assessment Field Day

Venue: 'Kookaburra' Wandoan
Time: 9:30am - 3:30pm

Topics:

- Small plots of potential pasture legumes
- Desmanthus performance, adaptation and establishment
- Grazing trial with desmanthus
- Targeting markets
- Comparing marketing options
- Hands-on live animal assessment (including ultrasound fat depth scanner)
- Assessment of trial steers prior to slaughter

Speakers:
Bob Clem - QDPI Pasture Agronomist, Brian Pastures Research Station
Bryan Robertson - QDPI Pasture Agronomist, Roma Research Station
Scott Cawley - QDPI Extension Agronomist, Miles
Kay Taylor - QDPI Beef Cattle Extension Officer, Miles
Richard Handley - Primac Manager, Dalby
Daryl Baker - Livestock Marketing Consultant, Wandoan

BYO Lunch
RSVP - important
(see details on other page)

DAY 2
29th June 1995
Visit to South Burnett Meatworks Murgon

The 'Kookaburra' trial cattle will be killed at South Burnett on the 29th of June. In addition to following these animals through to the hook, a number of other aspects will be covered.

- The South Burnett Co-operative
- Inspection of kill floor and facilities
- Offal plant
- Video Image Analysis
- Electronic identification
- Hide damage and blue hide tanning plant
- Strategic alliance with Sizzlers
- Smithfield Feedlot
- Rumentech

RSVP - essential
(or you'll miss the bus)

BOOKING INFORMATION
for
'Pastures to Processing'

Prior booking for each of these days is preferred (or essential in the case of the meatworks visit).

For further information and bookings contact:

Kay Taylor or Scott Cawley
DPI, Miles
Ph: 076-271599
Fax: 076-271775
or
Mick Alexander
Taroom Shire Landcare Office, Wandoan
Ph: 076-274481
Fax: 076-274336

RSVP Dates:
Field Day - 5th June
Meatworks Visit - 22nd June

Don't miss these two opportunities of a lifetime.

DPI QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES SOUTH REGION

Taroom Shire Beef Marketing Group

QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES CENTRAL REGION

Central Queensland
Producer Demonstration Site

FARMWALK

WHEN: 9am Tuesday 12 July 1994

WHERE: "Inderi": Gerald & Fay Mayne's property situated 25km North West of Rolleston on the Dawson Highway.

WHAT:

1. A producer demonstration trial (funded by Meat Research Corporation) was set up in 1992 to **promote** the **benefits** of **Dolichos Lab Lab.**

   Cattle live weight gain during autumn/early winter and the legumes contribution to soil nitrogen and subsequent grain sorghum crops are being monitored over 3 years.

   John Agnew (DPI, Emerald) will summarise the results of the first two years and discuss the implications of the 1994 findings..

2. **Bob Clem** (DPI, Biloela/Gayndah) will talk about the progress from the **Legumes** for **Clay Soils** project (MRC funded) which includes an evaluation of potential legumes suitable for short term ley pastures and for permanent pastures.

3. Kevin McCosker (DPI, Emerald) will outline a new GRDC funded project examing the **role** of **ley pasture farming** systems in Central Queensland.

FINISHING TIME: approximately 11.30am

Appendix 3: Quarterly newsletters

Dec 1992

LEGUMES FOR CLAY SOILS - Newsletter No. 1

The following newsletter is designed to inform people about early developments in the legumes for clay soils project. This issue simply outlines the project and some of its objectives. However as soon as you have some results or noteworthy news please forward it to Neil Brandon for future newsletters. As there are many people involved in this project from a wide geographical area, we hope that newsletters will help us to keep in contact with each other.

SUMMER LEGUMES FOR CLAY SOILS

by Bob Clem, Project Leader.

Grazing and cropping enterprises in the central and northern brigalow region could benefit from the introduction of summer growing legumes that are adapted to clay soils. Currently few legumes are available although three cultivars of *Desmanthus virgatus* have recently been released. The "Legumes for Clay Soils" project funded by the Meat Research Corporation under the NAP(2) programme aims:

(i) to develop management guidelines for *Desmanthus* and also for *Indigofera schimperi* and *Glycine latifolia*;

(ii) to extend the technology to industry in Desmanthus development/demonstration sites, and

(iii) to identify further legumes for both grazing and short term pastures by testing a range of promising lines in sward trials and in "on farm" demonstration sites.

The project complements another project "Evaluation of species for sown pastures and ley farming in the sub-tropics" which is funded by the AWC/WRDC and being undertaken in the southern brigalow region.

The project has been developed in recent months and because of the large geographical area targeted, the range of experiments to be undertaken and the need to embrace skills in research, development and extension, a large group of QDPI and CSIRO personnel is involved. To ensure that the project can successfully achieve its objective and, in particular, that the benefits to primary producers can be maximized over the relatively short term of the project a high degree of cooperation and support will be necessary. I thank you all for the contributions you have already made and look forward to a busy and rewarding 4 years for all members of the LCS (Legumes for Clay Soils) team.

Special thanks are extended to those who took time out to welcome Neil Brandon into the project. He spent the first couple of weeks in August travelling areas of central Queensland to meet other members of the Legumes for Clay Soils team and gaining an appreciation of the major objectives of the project. He will be based in Brisbane (CSIRO cunningham laboratory).

Perceptions of the Project:

by Neil Brandon.

Comments made by graziers and scientific staff in areas travelled in central and southern Queensland, indicated strong support for the project. Legumes grown either alone, or as part of a grass legume mix are seen as vital to increasing production in cropping lands and boosting animal production in grazing areas. Classic comment probably was "If you could successfully introduce a legume into these soils, whether it be into newly cleared land or into established pasture, you would have to beat graziers back at the door for the interest it would create" (someone from Emerald?)

WHAT IS THE LEGUMES FOR CLAY SOILS PROJECT AND WHO IS INVOLVED?

By Dick Jones - CSIRO project leader.

There are four main components of the "Legumes for Clay Soils" project. They are briefly summarized here and more details will be given over time in reports and following newsletters.

(1) Grazing development sites. These are modelled on the earlier stylo demonstration sites. These sites will have paired paddocks of grass and grass plus *Desmanthus.* Animal weight gains will be measured seasonally and pasture measurements will be taken once a year (yield and composition in Autumn, density in spring and soil seed reserves at the end of Winter). One site (Taroom) will be sown this year and sites at Bauhinia and Clermont next year. Gavin Graham will take the responsibility of the Taroom site, assisted by Carla Schefe and Scott Cawley. Bob Clem, Maurie Conway and Col Esdale will be looking after a site around Banana/Bauhinia and Jackie Wilcox and John Chamberlain after the Clermont site. Neil Brandon will be measuring the soil seed reserves at the three sites and assisting in some pasture measurements at the two southern sites.

(2) Detailed investigation of *Desmanthus* and *Indigofera schimperi* at Research Stations. This component includes a new grazing trial at Narayen and three existing experiments at Brian Pastures, Brigalow and Narayen.

The new experiment at Narayen will be focussing on the persistence and productivity of *Desmanthus* (cv. Marc and cv. Bayamo) and *Indigofera* (52621 and 73608) at a range of grazing pressures. We hope to get one or two paddocks of *Glycine latifolia* CQ3368 (which is on pre-release) incorporated in the trial. Enough measurements will be taken to enable us to interpret any differences in persistence between accessions and grazing pressures. Neil Brandon, Dick Jones and Geoff Bunch are involved in this as well as with the continuation of an existing experiment in which commonly grazed plots of 8 lines of *Desmanthus* are being subjected to 5 grazing pressures. The existing comparisons of pastures with and without *Desmanthus* at Brigalow (Bob Clem, Maurie Conway) and Brian Pastures (David Burrows) will be continued.

(3) The third component of the project looks at promising material coming out of the early phase evaluation studies, primarily the COPE project. This year a range of species will be sown at Brigalow (Bob and Maurie), Narayen (Neil, Geoff and Dick) and Brian Pastures (David). The emphasis will be on tropicals but a restricted range of annual medics, selected by the experts from Toowoomba and Roma, will be included. It is anticipated that these sowing will be continued for a further two years.

A restricted range of the promising lines (including the three *Desmanthus* cultivars, Lee joint vetch and Milgarra butterfly pea) and some appropriate commercially available species will be sown on farms at 7 widely separated sites. Some of these sites will be sown in 1992/93 and the remainder in 1993/94. These trials will be very useful in extending the "research station" results. Additional people engaged in this will be Harry Bishop, and Terry Hilder at Nebo, Scott Huff at Emerald and Bob Walker at Normanton. "Measurements" will be based on rating rather than spending a lot of time counting or cutting and sorting.

(4) The fourth component of the project relates to establishment. There are many types of experiment that could be done here, but at this stage we plan to keep an open mind until the key problems or questions are better defined from field experience. It would be appreciated if you could give any ideas about the priority of establishment research that you have gained or will gain from your experiences to Bob Clem or Neil Brandon.

Also there is a lot of work in seed increase associated with the program. The bulk of this will be carried out by John Hopkinson and Bernie English at Walkamin, some will be done at Gympie by Don Loch, at Lawes by Bob Greenfield and some also at Biloela.

Feb 1993

LEGUMES FOR CLAY SOILS - Newsletter No. 2

Welcome to the second edition of the "Legumes for Clay Soils" newsletter. In this edition we bring you up to date with the experiments that have been planted, as well as reporting on important work on the population dynamics of *Desmanthus*, conducted at Brian Pastures over the last 4 years.

What has been done to date

Experiments planted, localities and dates are given below:-

Desmanthus development site (20 ha):-
planted at Wandoan 25-28 January.

Small sward testing:-
Theodore - 15 January
Emerald - 20 January
Narayen - 20 January

On farm demonstration sites:-
Wandoan - 28 January
Kilcummin - 20 January

Grazing trial:-
Narayen - 12 February

Generally, the season has not been kind to us with some sites yet to receive germinating rain and with rainfall generally being too low to give desirable sub-soil moisture.

A high level of interest in *Desmanthus* continues to be shown amongst graziers at a number of locations. Many turned up to watch the planting of the development site at Wandoan following invitation by Scott Cawley and Lew Markey (QDPI) and David Brown (Landcare). Cattle from pastures with and without *Desmanthus* will be weighed regularly with help from Kay Taylor (QDPI Miles) and will add to animal production data collected at Narayen, Brian Pastures (with help from Vickie Hansen and Brigalow (Tom James).

Small sward trials have now been planted at Theodore, Emerald and Narayen (not at Brian Pastures as stated in the last newsletter - Sorry Jacqui!). A further suite of promising medic species arising out of work by the Wool Research and Development Corporation will be added in April/May.

The grazing trial at Narayen has been planted using the band seeder. *Desmanthus* (Marc and Bayamo) and *Indigofera schimperi* (52621, 73608) will be grazed at five stocking rates. *Glycine latifolia* will be grazed at two stocking rates. Although soil moisture conditions were good at planting, there has been no subsequent germinating rain. Special thanks are extended to Geoff Bunch, Keith Gould and John Coote who undertook planting while others were away at the International Grasslands Congress in N.Z.

Some other news

A literature review on *Desmanthus*, based primarily on a CAB literature search (1980-1992) is available for those interested. Twenty-eight papers were found. Most were fairly general, although there were two dealing with nutritional status of *Desmanthus*. A copy of this review is available on request (N. Brandon).

It has also been brought to my attention that Donald Njarui, a student from Kenya has been working on emergence of *Indigofera*, *Desmanthus* and *Glycine* at Gatton (supervisor Len Bahnisch). Although this has not yet been written up, it was found that *Indigofera* is more sensitive to temperature/ soil depth/ soil strength than *Desmanthus* or *Glycine*. These differences may impact on emergence under field conditions.

Desmanthus studies at Brian Pastures

Although *Desmanthus* is a prolific seeder, it's hard seededness may make it vulnerable during the first years after establishment when original plants are dying out but soil seed is not yet germinating. David Burrows has contributed the following summary of a paper submitted to Tropical Grasslands reporting work on the hard-seededness of *Desmanthus* and the population dynamics in grazed and ungrazed pastures.

The experiments were conducted at Brian Pastures between 1988 and 1992 to determine plant longevity, seedling recruitment, soil seed reserves, and hard seed breakdown of *Desmanthus virgatus* C.P.I. 78382. The experiments were located within two 2.7 ha paddocks sown with *Desmanthus* and purple pigeon grass which were part of a grazing trial to assess productivity of *Desmanthus*. Exclosures were set up in each paddock to give grazed and ungrazed areas.

In the first experiment, individual plants were monitored within permanent quadrats located in grazed and ungrazed areas. In experiment 2, soil seed reserves were measured by taking soil cores from both areas once a year. Hard seed breakdown (Experiment 3), was measured by putting 100 scarified (hot water), or non-scarified seeds in nylon bags and locating the bags on the soil surface or 2 cm below the soil surface. The grazing treatment in this experiment was simulated by brush-cutting grass from the plots containing the seed bags.

Results from experiment 1 showed that although some individual plants lived for up to four years, more than 50% of plants from any grazed cohort had died 6 months after establishment. Plants in the ungrazed quadrats had slightly higher survival rates. Seedling and adult plant populations were higher in the grazed quadrats.

Soil seed reserves (Experiment 2) at planting were 180 seeds/m^2 in both areas. Four years later, there were 460 seeds/m^2 in the grazed areas and 180 seeds/m^2 in the ungrazed areas.

From Experiment 3, an 18% decrease in hard-seededness over 3.5 years was measured in seed lots placed in the field. Scarified seed and buried seed had significantly lower hard-seededness than unscarified and surface sown seed.

The conclusion from this work is that heavy grazing promotes seedling recruitment and consequently higher populations of *Desmanthus*. Reduced shading from grass exposes the seed to greater diurnal temperature fluctuations, which has been shown to soften legumes seed. CPI 78382, along with some other *Desmanthus virgatus* accessions were collected from heavily grazed pastures in Argentina. CPI 78382 is very similar to CPI 78373 (cv. Marc).

What happened at the IGC?

There was a display section by Wright Stephenson on *Desmanthus virgatus* at the International Grasslands Congress and it is expected that seed of the three cultivars will be commercially available next season.

A poster by Cook, Graham, Clem, Hall and Quirk outlining the *Desmanthus* evaluation and development work in Queensland since 1978 was well received.

Martin Adjei presented a poster on his work testing *Desmanthus* cultivars in the Virgin Islands. Although there were significant differences in yield and seasonal growth pattern between cultivars, no significant differences were observed in leaf digestibility or protein contents. Leaf as a percent of dry forage ranged from 34 to 43%. Average crude protein level in leaves and stems was 19 and 7% respectively. *In vitro* organic matter digestibility was 83 and 49%.

May 1993

LEGUMES FOR CLAY SOILS - Newsletter No. 3

Welcome to another edition of the "Legumes for Clay Soils" newsletter. In this edition we bring you up to date with what has been happening in initial experiments in the project, as well as include a number of background articles on some of the key legume species of the project. Hope you find it interesting. If you have any contributions for further editions, please forward them to Neil Brandon CSIRO Cunningham Lab St. Lucia.

What has been happening?

Small sward trials are nearing the end of their first season. Interesting comparisons of drought tolerance have been possible at Narayen, with many accessions surviving despite only a single fall of rain (75 mm) falling since planting. Brigalow research station has received no significant rainfall since planting. Irrigation was used at Emerald to ensure emergence and this may be continued over the coming weeks to ensure their survival. A range of 17 medic species is currently being planted at all three sites. (Irrigated for emergence at Narayen and Emerald, not at Brigalow). The lines include cultivars of snail and barrel medic and some experimental lines. Thanks to Bryan Robertson and others in the Wool and Research Development Corporation legume project for supplying the seed.

Grazing trials (Narayen) and on farm demonstration sites have been sown but there has been little or no emergence. Some may require replanting next season, others may germinate from seed planted this season but lying dormant in the soil.

New releases of *Desmanthus* in South Africa
by Bruce Pengelly CSIRO St. Lucia

It appears that *Desmanthus* is taking off as a forage legume in other parts of the world. Dr. Kruger of the Roodeplaat Grassland Institute in South Africa is hoping to release two cultivars of *D. virgatus* and one of *D. fruticosus* in the near future.

All three accessions to be released are from the ATFGRC collection. CPI 55719 was collected by Bob Burt in 1971 near Maracaibo in Venezuela, a region with an annual rainfall of only 600mm. This accession has shown enough promise here in Queensland to be included in several evaluation studies.

CPI 85177 was collected by Bob Reid from the Mexican state of Coahuila where it was growing with Buffel grass on a clay loam. Mean annual rainfall at this site was only 350mm. This accession is almost identical to CPI 85178 which has been sown at several sites in Queensland and is included in the small sward trials LCS project. These two accessions are easily distinguished by their grey-green leaves, a character which might be important in distinguishing any future cultivars.

By far the most interesting development is the proposed release of *D.fruticosus* CPI 84972. This accession was also collected by Bob Reid, this time in southern Baja California, Mexico, where mean annual rainfall is only 160mm (if mean annual rainfall means anything in such regions). Once again the plant was growing with Buffel grass. For those that don't know *D. fruticosus* it is a large shrub with coarser foliage and less branchy than *D. virgatus* with larger inflorescences, pods and seeds.

One final point of interest. There is to be a revision of the genus *Desmanthus* published later this year by Melissa Luckow of Cornell University. From the specimens I saw in the US herbaria last year, I believe our current concept of *D. virgatus* will be put on its ear. *D. virgatus* may be split into a number of species. More of this when we see the review.

Yellowing of *Glycine latifolia*

Glycine latifolia CQ3368 (Peak Downs clover) is a native legume which has yielded, persisted and spread well at Pittsworth, sown in 1987, and at Toobeah (west of Goondiwindi) sown in 1988. At times however it shows a marked yellowing of its leaves. Christine Horlock (student) and David Teakle in the Microbiology Dept at the University of Queensland believe this may be due to infection by Alfalfa Mosaic Virus. Christine is extending these studies in 1993 as an honours project.

As this accession has been sown in the "legumes for clay soils" small plots and in the farm sowings, we would appreciate information about whether the disease is site specific or whether it occurs across all sites. If the disease is found at all sites this might suggest that the virus is seed borne. (All seed sent out from Brisbane has been collected from stands at Pittsworth or Gatton where the yellowing has been observed). If it is site specific, this might suggest the virus is insect transmitted (Alfalfa Mosaic Virus is widespread in Southeast Queensland).

This information will help us understand the virus and will also help the honours student. If you have glycine growing would you please let Dick Jones know if it has yellow patches on the leaves. If you observe these could you collect and forward us some leaf samples? Suggested method of sampling is given in the box below.

> Take infected sections of shoot and leaf (about 30cm in length) from at least 5 plants and bulk in a plastic bag. If there are plants that show no yellowing, take similar samples from these and bulk in another plastic bag. (Even if there is no yellowing, could you take a sample of the green plants?) Seal the bag, giving details of date of collection, site and an estimate of % leaves on the plant that show yellowing and send ASAP to Dick Jones at the Cunningham laboratory. Don't add water to the bag as this may promote moulding. However if there is a delay between sampling and posting, please store in an esky or refrigerator.

By the way, the virus does not appear to severely effect yield as it has been present for years at the Pittsworth site where the accession has done well. Some other accessions grown at Gatton to date show no symptoms at all. (The CQ3368 remains one of the highest yielding lines at Gatton).

I. schimperi - does it contain toxins?

It has been known since 1988 that indospicine, an amino acid present in a limited number of *Indigofera* species accumulates in the tissues of livestock that eat these plants, sometimes causing hepatotoxic effects in dogs that eat the meat from such animals. The question likely to be asked about any species of *Indigofera* for use as a forage is: does it contain indospicine?

Merv Hegarty reports that in initial and subsequent evaluations of *I. schimperi*, no traces of indospicine or 3- nitropropanoic acid (another toxin of *Indigofera* sp.) have been found.

The method of analysis used for measuring indospicine is specific for the compound and has high sensitivity. It is capable of detecting indospicine in dry forage at a concentration as low as 0.001% w/w (10 ppm). By way of comparison, the concentration of indospicine in the forage of *I. linnaei* that was used in forage trials with horses in Alice Springs was in the range 0.05-0.09%.

Feeding trials in rats showed that animals fed diets containing *I. schimperi* grew as well as control animals, and showed no histological abnormalities of their vital organs. Similarly in later studies, feeding of 5 accessions of *I. schimperi* to young merino rams, resulted in no adverse effects on production or reproduction and the vital organs of all animals were normal.

The investigations briefly summarized above were well designed and well executed, and demonstrate that *I. schimperi* has not produced any signs of toxicity in various test animals. It can therefore be considered a useful pasture legume for wider use on clay soils. However a new method of detecting indospicine to levels as low as 0.5 ppm have recently been developed and will be used to further test *Indigofera schimperi*. A more detailed report of work conducted to date by Merv Hegarty is available from Neil Brandon CSIRO Cunningham Laboratory St. Lucia.

Sep 1993

LEGUMES FOR CLAY SOILS Newsletter No. 4

Welcome to another edition of the "Legumes for Clay Soils" newsletter. Final planning of next seasons sowings will not be completed until a meeting of major collaborators in early October. However in this edition we aim to fill you in on the general direction of the project by way of an assortment of small articles and some information coming from work commenced prior to the LCS project.

What did we achieve last year?

Evaluation of new legumes.

Forty-five tropical legumes for ley and permanent pastures were evaluated at 3 sites last summer. Rainfall at all sites was low, with no emergence occurring at one site (Theodore). Good establishment occurred at another site (Narayen) following 3" rainfall but plants then relied on minimal stored soil moisture for the remainder of the season, with negligible follow up rain occurring. Legumes at the third site (Emerald) were planted immediately prior to good establishment rain in one replication, but only after rainfall in the other two replications. Although subsequently irrigated, emergence in Reps 2 and 3 remained poor.

Best yields (based on plant density and individual plant weight) occurred in the commercial lablab cultivar Highworth and *Macroptilium bracteatum* at Narayen. Best performers in Rep 1 at the Emerald site were lablab followed by *Vigna trilobata* and *Desmodium dichotomum*. Permanent pasture plants that persisted well at both sites were *Desmanthus virgatus* (Marc and Bayamo) *Indigofera schimperi* (52621, 73608 and 69495) and 7 accessions of aff-scabra (kindly provided by Townsville CSIRO). Of these only Marc desmanthus and the aff-scabras were able to flower and set seed at Narayen.

Observations on these sowings will be continued and species for next seasons sowings will be selected in the October meeting.

Do medics have a role in central Qld.

Medics, increasingly recognized as being useful in the southern Darling Downs, may have a place in more northern areas extending up to the central highlands. The major limitation is low and unreliable winter rainfall preventing seed set so necessary for survival of these annual species. Earlier flowering varieties may set seed under less ideal conditions and thereby extend the area of adaption of medics further north. A new suite of early maturing barrel, snail and burr medic lines are currently being evaluated at Mundubbera, Biloela, Theodore and Emerald in the LCS project. The lines were selected by DPI colleagues and the results are being forwarded to Bryan Robinson (Roma) who is examining a much wider range of medics in a project funded by the Wool Research and Development Corporation. Three of the sites have been irrigated to allow seed set in the first season, but will not be irrigated in subsequent seasons to allow testing of persistence under natural rainfall conditions. No yield data is available yet, however large variation has been observed in early vigour and flowering time between lines.

Yield and first season pod production will be estimated in a few weeks time, so we will keep you posted on results.

Comparison of desmanthus lines

Work has been continuing on experiments at Narayen, Brigalow and Brian Pastures comparing performance of a number of desmanthus lines under grazing. Eight lines have been included at Narayen, 4 at Brigalow and 2 at Brian Pastures. All trials have now been going for a number of years and were planted prior to the commencement of the LCS project. Despite generally poor growing conditions experienced since planting, the density of early flowering lines such as 78382 and 78373 (Marc) is much better than that of later flowering lines such as 92803 (Uman). This is attributed to their ability to set seed quickly after rain, resulting in greater seed reserves and recruitment of new plants.

Grazing of desmanthus and indigofera

Areas of desmanthus and indigofera (16ha total) were planted last February at Narayen research station with the aim of evaluating effect of different grazing pressures on persistence. No significant rain fell in the months following planting. There have been light falls in July (separated falls of 14 and 10mm) and also in August. It is unlikely that these will have greatly reduced the viable seed level. However success of establishment this year may depend on adequate early rainfall to wet the now very dry profile. The need for re-sowing will be determined in spring. Sufficient seed of both species will be available should re-sowing prove necessary.

On-farm sowings

A number of legume species including glen joint vetch, desmanthus (Marc Bayamo and Uman) indigofera, *Glycine latifolia*, seca stylo, siratro, lablab and leucaena were to be demonstrated on a grazier's properties as examples of useful ley and permanent pasture plants. Although three such sites were planted, establishment has been poor and they will be replanted later this year, along with some other sites.

Grazing demonstration sites

The aim of this component of the project is to demonstrate the development of desmanthus under commercial grazing. One site has been planted but has not been successful due to the exceptionally dry conditions since planting. The area has since been cultivated for a winter wheat crop, but may be replanted this summer along with one or two other sites (depending on seasonal conditions and availability of seed).

Establishment of legumes

Optimum depth of sowing of desmanthus in the field by Gavin Graham and in the glasshouse (Neil Brandon) has indicated that shallow planting is best. Under ideal conditions emergence is reduced from depths greater than 2cm. Surface sowing of seed in the bottom of shallow furrows was successful in heavy soils near Roma. Further information on emergence of desmanthus in the field and of a variety of legumes in controlled cabinet work will form the feature of a future LCS newsletter.

Other news

Ag-show and release of Desmanthus

Continued interest was shown by primary producers in desmanthus and other legumes for clay soils at the Ag-show held recently in Toowoomba. Seed increase and marketing is being undertaken by Wright Stephenson. Excellent yields of Bayamo and Uman have been recorded (300- 400 kg seed/ha). However, it has been decided to withhold marketing of all three cultivars until seed of the earliest flowering cultivar (Marc) becomes available (late this season or early next season).

Rhizobium strains for desmanthus

Incompatible *Rhizobium* is frequently cited as a reason for poor performance of legumes on clay soils. Continued concern about the suitability of *Rhizobium* strain CB1397 for desmanthus, has led to the initiation of an experiment examining the persistence of an alternative strain (CB3161) at three sites in Central Queensland commencing this year. Dick Date of the CSIRO Division of Tropical Crops and Pastures will help coordinate the experiment which will involve regular sampling of nodules followed by serological testing to see if nodules formed are a result of the introduced or indigenous strains of *Rhizobium*.

Cooperation with University of Qld.

A small experiment in co-operation with the University of Queensland will be conducted to examine the clipping tolerance of *Macrotyloma daltonii*, *Macroptilium bracteatum* compared to *Lablab purpureus*. Both species hold promise as ley species. However to offer any advantage over the already available lablab, *Macroptilium bracteatum* needs to be able to perenniate, while the annual species *Macrotyloma daltonii* needs to produce new plants in the second season from seed set in the first year.

Do ley legumes increase crop yield?

Yield increase in wheat following a number of crop rotation systems with medic (winter annual), lucerne (winter perennial), lablab (summer annual) and desmanthus (summer perennial) will be measured in work commencing this year by Roger Armstrong at Emerald.

Dec 1993

LEGUMES FOR CLAY SOILS Newsletter No. 5

Welcome to another edition of the "Legumes for Clay Soils" newsletter. In a recent meeting of major collaborators, a number of issues were discussed including that of establishment of desmanthus and other small seeded legumes in clay soils. The objective of this issue is to report the main decisions of the meeting regarding future directions of the LCS project and summarize work to date on establishment.

First annual meeting of the LCS project

Results from trials conducted to date have been summarized in the previous edition of the Legumes For Clay Soils Newsletter and were reported on at the meeting. Due to the very dry conditions, many of the trials need to be replanted. Other trials will be extended. New sowings this year include:-

Grazing development sites (with and without desmanthus in two 10 ha paddocks). Gavin Graham will be replanting his site at Wandoan. Additional sites will be planted at "Ballaroo" and "Rostock" in cooperation with Peter Knight's producer demonstration sites in the Maranoa and at "Silverton" (Theodore), "Kapalee" (Biloela) and "Innisfree" (Clermont).

On farm sowings (to test promising ley and pasture species) will be planted at six sites (Wandoan, Clermont, Nebo, Theodore, Emerald and Arcadia Valley) with the possibility of others (up to 10)

Grazing trial (Indigofera and desmanthus at 5 stocking rates) will be replanted at Narayen.

Small sward trial A number of aff-*scabras* will continue to be evaluated along with desmanthus and indigofera. Promising ley species, including *Macrotyloma daltonii*, *Macroptilium bracteatum* and *Vigna trilobata* will be evaluated along with commercially available *Lablab purpureus*. Evaluation of *Aeschynomene* species will be continued for possible use in gilgai country. Some accessions from *Macroptilium*, *Vigna* and other genera will be sown for the first time.

Rhizobium trial

Experiments testing the new *Rhizobium* strain CB3126 for desmanthus will be planted at three sites (Brian Pastures, Narayen and Roma).

Establishment of desmanthus and other small seeded legumes in clay soils

Results are summarized for trials conducted in (i) controlled temperature cabinets (ii) glasshouse and (iii) the field.

Controlled temperature cabinets

The effect of sowing a number of ley and permanent pasture legumes at different depths in clay soil was examined in temperature controlled cabinets set at 20°C night temperature and 32°C day temperature. Larger seeded legume species including Lablab, *Macrotyloma daltonii* and *Macroptilium bracteatum* emerged from depths of up to 5 cm (Table 1). Emergence of the smaller seeded legumes *Indigofera schimperi* and *Desmanthus virgatus* was best at shallow depths (0.5 and 1 cm) and decreased at depths greater than 2 cm. None of the species established well from seed placed on the soil surface.

Glasshouse experiments

Germination of the permanent pasture plants, desmanthus, indigofera and glycine was equally good from depths 0.5, 1.0 and 1.5 cm in experiments conducted in the glasshouse. Survival of seed sown on the soil surface was again poor.

Field experiments

Surface sowing of desmanthus in the bottom of shallow furrows was more successful than drilling seed at a depth of 2 cm in a heavy cracking clay soil in experiments by Gavin Graham and Carla Schefe in the Roma region (Table 2). Establishment of Trifecta lucerne on the other hand was unaffected by soil type or planting technique. Good establishment of desmanthus was also achieved using the band seeder at Narayen.

Table 1: Total emergence (% of germinable seed) of *Desmanthus virgatus* (78373), *Indigofera schimperi* (52621), *Glycine latifolia*, (CQ3368) *Macrotyloma daltonii* (60303), *Macroptilium bracteatum* (27404), *Macroptilium atropurpureum* (siratro) and *Lablab purpureus* (Highworth) in clay soil in controlled temperature cabinet at 20/32°C.

Depth (cm)	78373	52621	CQ3368	60303	27404	Siratro	Highworth
0	7	3	0	8	21	20	0
0.5	97	56	86	82	97	94	97
1	95	64	86	90	100	99	90
2	73	38	100	82	95	85	93
3	4	30	80	90	100	79	86
4	0	8	94	98	82	90	75
5	0	0	80	94	82	100	90

Table 2: Effect of two planting techniques, drilling at 2 cm depth and sowing at the base of shallow furrows, on establishment of three *D. virgatus* accessions and Trifecta lucerne sown on two soil types at Wyoming in April 1990

	Establishment (% of germinable seed sown)			
	Red soil		Black soil	
Accession	Buried	Furrow-base	Buried	Furrow-base
Marc (78373)	15	19	5	16
Uman (92803)	10	10	4	10
78382	6	10	4	11
Trifecta	6	6	6	8

In all trials, maximum emergence was achieved where desmanthus was planted shallow. Planting depths greater than 1.5-2 cm should be avoided. Reasonable emergence has occurred in small plot work where seed was sown on the soil surface and rolled with a rubber tyred roller. However, planting machines designed to place seed in a shallow groove are ideal. In this case, shallow coverage of seed is achieved by soil wash following storm rain.

Unlike larger seeded legumes which can be planted in moist soil at a moderate depth (2-5 cm), the small seeded legumes planted shallow into dry surface soil rely on subsequent rainfall for germination. Sowing of seed without adequate sub-soil moisture however is not recommended as survival of young seedlings may depend on plants being able to tap sub-soil moisture following emergence.

Scarified desmanthus seed germinates rapidly and this may be important for successful emergence under conditions of soil drying. Desmanthus seed can reach 50% germination in 1-2 days. The top 1 cm of the soil however can dry to less than wilting point in as little as a day after rainfall. Planting seed in shallow grooves or furrows has the advantage of temporarily ponding water around the seed to slow the soil drying process.

Mar 1994

LEGUMES FOR CLAY SOILS Newsletter No. 6

Welcome to another edition of the "Legumes for Clay Soils" newsletter. In this edition we aim to bring you up to date with which experiments have been planted so far this season as well as report on trials conducted with medics commenced last winter. Further information on tropical legumes of interest are reported from work conducted prior to the LCS project by Bob Clem. Hope you find it interesting. Please keep me up to date on your experiments, so that I can include information in future newsletters. (Neil Brandon, CSIRO Cunningham Lab, St. Lucia 4067).

What has been done to date?

Desmanthus development sites were sown in January on co-operator's properties at "Kapalee" (Biloela) and "Rangeview" (Theodore). About 20 ha of buffel pasture (Kapalee) and 15 ha of native grass pasture (Rangeview) was oversown with a mixture (1/3, 1/3, 1/3) of the three desmanthus cultivars using the bandseeder from CSIRO Narayen. An adjoining grass only paddock has also been fenced at both sites. The site at "Kookaburra" (Wandoan) was resown in December

Small sward trials examining a wide range of permanent and ley pasture legumes have been planted at Narayen (December), Brigalow Research station (January) and Emerald (February).

On farm sites examining a smaller range of potential ley and permanent pasture plants were planted at "Huntly" (Arcadia Valley), "Birrong" (Rolleston), "Gunderoo" (Springsure) "Mutation" (Kilcummen), "Kapalee" (Biloela), "Rangeview" (Theodore) and "Kookaburra" (Wandoan).

A grazing trial (16 ha) examining response of desmanthus and indigofera under 5 grazing pressures was replanted in January at Narayen following poor establishment last year.

Rhizobium experiments examining the performance of new *Rhizobium* strain CB3126 on desmanthus have been established at Brian Pastures, Narayen and Roma in January.

Good rainfall across much of the state should aid survival of early plantings (eg. Narayen and Wandoan) and allow successful late establishment at others (eg. Emerald).

Medic report

Work is being done in cooperation with Bryan Robertson (Roma DPI) looking at the potential of a small range of annual medic species for areas of sub-tropical Queensland. Poor and unreliable rainfall in winter normally limits the use of medics in these more northern areas. Very rapidly maturing varieties may have some potential.

Eighteen commercial and experimental lines were planted in Autumn 1993 at Narayen, Brigalow research station, Emerald and Biloela (Table 1). Establishment was fair at all sites where irrigation was applied to supplement rainfall. No emergence occurred at Brigalow where irrigation could not be used and where rainfall was low.

Although it is too early to predict persistence of the lines, first season growth was good at Narayen, Emerald and Jambin, with all lines setting some seed prior to the end of the first season (Table 1). Large differences in yield, time-to-flowering and seed set were found between lines. Successful establishment in subsequent seasons will depend on amount of seed set, and the cool season rainfall (no more irrigation will be applied).

However it is hoped that presence of medic in pastures may allow useful growth on out-of-season winter rainfall. Despite being predominantly summer dominated, many northern areas still experience some useful falls in winter. Some of the fastest maturing varieties may be able to grow and set seed on one good fall of rain.

Longevity of seed in the soil is also of interest. Some lines may have higher hard seed content, possibly giving them greater regeneration following dry seasons than others.

Table 1: First year yield (kg/ha) of 18 medic accessions grown under irrigation at Narayen, Jambin and Emerald along with pod number (meaned across all sites).

Accession	Narayen	Jambin	Emerald	Mean Pod number/m^2
M. aculeata (SA 8944)	1920	3530	530	180
M. orbiclaris (SA 8460)	1760	2410	1290	1500
M. polymorpha (Circle valley)	4160	1770	290	2810
M. polymorpha (Santiago)	680	1550	430	2580
M. sativa (Trifecta)	1520	630	310	-
M. scutellata (Kelson)	1320	4280	920	30
M. scutellata (Sava)	2680	3320	1450	530
M. scutellata (SA 1868)	1360	3140	580	370
M. scutellata (SA 3310)	1640	2470	550	150
M. truncatula (Caliph)	2800	3800	1460	1910
M. truncatula (Cyprus)	3360	2580	750	1660
M. truncatula (Jemalong)	3160	2110	840	580
M. truncatula (Parabinga)	4640	2950	790	1600
M. truncatula (Parragio)	2080	2390	1050	210
M. truncatula (Sephi)	2800	3530	650	530
M. truncatula (SA 11292)	280	1900	220	20
M. truncatula (T116)	3120	3510	610	1810
M. truncatula (Z914)	1920	1160	830	300

Persistence and productivity of a range of legumes sown on cracking clays in north-east Queensland

Fifty-six legume accessions were grown on 3 clay soils in north-east Queensland (2 near Collinsville and 1 north of Charters Towers) for 4 years (1980-1984) and evaluated for persistence, regeneration and production.

The most promising for permanent pastures were 2 lines of Clitoria ternatea (one of the lines is a component of cv. Milgarra), Desmanthus virgatus (cv. Marc), Leucaena leucocephala (Cunningham and especially CPI 61227) and Indigofera schimperi (69495). Desmanthus improved in productivity and density when grown with buffel grass whereas the other legumes tended to decline. Persistence of clitoria (not tolerant of heavy grazing) was better than expected perhaps due to the fact that the trials were not grazed during the wet season.

The promising annuals were Centrosema pascuorum, Desmodium dichotomum and Vigna trilobata. They all regenerated from seed to some extent in the second and later years, but not in the presence of a vigorous grass - hence they only show promise for leys and not for permanent pastures.

Results will appear in a paper by authors Bob Clem and Trevor Hall in the Australian Journal of Experimental Agriculture.

Promising accessions are included in the evaluation component of the "legumes for clay soils" project.

Jul 1994

LEGUMES FOR CLAY SOILS Newsletter No. 7

Welcome to another edition of the "Legumes for Clay Soils" newsletter. In this edition we bring you up to date with the farm demonstration sites and the small sward studies and also present some information from the Wool Research and Development Corporation funded project that Dick Jones is involved in. The next edition will provide information on the desmanthus grazing trials.

Farm demonstration sites

On farm sites were sown on 7 properties. Of these 5 established successfully, one established poorly and one sown by hand onto blade ploughed country in the Acadia Valley failed to establish. Apart from this site, the other 6 were sown with conventional crop planting equipment. Legume yields measured at 5 sites are presented below.

Highest yielding of the ley species was the commercial *Lablab purpureus* cultivar (mean 3500 kg/ha). *Macroptilium bracteatum* and *Vigna trilobata* were lower yielding, (mean 1500 and 1900 kg/ha), but may have a very useful role in ley pastures if they are able to perenniate (*bracteatum*) or come back from seed (*trilobata*). Lindsay Sharpe (cooperator at Biloela) is keen to replant a larger area of *Vigna trilobata. Macroptilium bracteatum* is undergoing seed increase for further evaluation by Richard Armstrong's GRDC funded project at Emerald.

Of the permanent pasture plants, good yields were measured in *Desmanthus virgatus*. In fact at Biloela, where seasonal conditions had been reasonably good, yield of the long season variety (Uman) was second only to Lablab. Unlike the earlier maturing varieties, however, it failed to set before winter. Aff. *scabra* plants out-yielded the commercial cultivars Seca (nearly 20 times based on the mean yields) and Amiga (double), while also flowering and setting a lot of seed. Aff *scabra* is showing a great deal of promise across a wide range of soil types as a useful permanent pasture plant. A number of lines are now on pre-release. *Indigofera schimperi* had lower yields than aff. *scabra* or desmanthus but is showing a strong ability to perennate at other sites where it has been planted.

Table 1: First year yields (kg/ha) of a variety of ley and permanent pasture legumes at five on-farm sites in central Queensland.

Species	Accession	Wandoan	Theodore	Biloela	Rolleston	Clermont	Mean (Rank)
Aeschynomene americana	Lee/Glenn	350	570	810	1130	280	630 (12)
Clitoria ternatea	Milgarra	1030	160	2750	990	200	1030 (8)
Desmanthus virgatus	Marc	1690	310	1980	60	290	870 (9)
Desmanthus virgatus	Bayamo	1820	250	2020	110	130	870 (9)
Desmanthus virgatus	Uman	2440	240	4710	140	240	1550 (3)
Glycine latifolia	CQ 3368	540	-	1850	1560	270	1060 (7)
Indigofera schimperi	CPI 69495	480	220	830	660	390	520 (14)
Lablab purpureus	Highworth	4970	2320	5310	3860	1030	3500 (1)
Leucaena leucocephala	Cunningham	140	170	2280	860	190	730 (11)
Macroptilium atropurp.	Siratro	2070	420	1880	1260	320	1190 (5)
Macroptilium bracteatum	CPI 27404	3200	480	2530	1080	140	1490 (4)
Stylosanthes hamata	Amiga	1780	260	610	440	40	630 (13)
Stylosanthes scabra	Seca	50	20	30	180	10	60 (15)
Stylosanthes aff-*scabra*	CPI 115995	2850	230	1630	860	110	1140 (6)
Vigna trilobata	CPI 13671	2390	730	2800	2990	700	1920 (2)
Site mean		1720	460	2140	1080	290	
Rainfall (mm)							
- prior to planting			220	220	270	170	
- since planting			350	410	300	150	

Small plots

Plant evaluation work in small plots has been conducted at three research stations (Narayen, Brigalow and Emerald) to examine a range of legumes for use in ley or permanent pastures on clay soils. Two plantings of thirty to forty accessions have occurred in each of the years 1992/93 and 93/94. Most accessions are experimental lines, although a few commercial cultivars have been included as controls.

Seasonal conditions at Narayen were reasonable this year and yields were higher than in 1992/93. Best yields occurred in *Macroptilium gracile* (800 kg/ha) and *Macroptilium lathyroides* (900-1000 kg/ha) and in *Vigna oblongifolia* (700 kg/ha). Reasonable first year yields were also measured in a number of the desmanthus (200-800 kg/ha) and aff. *scabra* (300-600 kg/ha).

Of the accessions planted in 1992/93 at Narayen, high yields were observed in the mid-flowering desmanthus cultivar Bayamo. This cultivar, being later flowering than Marc, took advantage of the better conditions. Marc however was able to set seed in poorer seasons. Good persistence and yields were also observed in *Indigofera schimperi* and aff. *scabra*. Yield of some of the ley species such as *Macroptilium bracteatum* out-yielded lablab, which had largely died out following the high yields in the first season. *Macrotyloma daltonii* and other species failed to regenerate from seed despite good rains early in the season (75 mm in early February).

At Emerald, dry weather delayed planting of the 1993/94 planting until very late in the season. Already established plants of *Indigofera* and *Desmanthus* from the 92/93 sowing however responded to the isolated falls and Marc desmanthus set some seed.

At Brigalow Research Station, where legumes failed to establish in 1992/93 establishment and growth, in competition with dense Sesbania, has been poor again this year. Legumes with the highest plant populations were accessions of *Macroptilium*, *Rhynchosia*, *Vigna* and *Alysicarpus* while lablab and *Desmodium dichotomum* were the largest plants.

Wool funded work

In wool funded work conducted at Pittsworth and Toobeah, several legume accessions showed promise for use in leys. They did not yield any more than lablab in the first year, but yielded much better in the second year. In some cases the second year yield was from plants that perenniated (*Macroptilium bracteatum*), while other times it was from seedling recruitment (*Macrotyloma daltonii*) and sometimes it was from a mix of perenniating plants and seedlings (phasey bean). The same species have shown some promise in more recent plantings at Tara and Wandoan, although actual yields have been limited due to dry conditions.

Of the permanent pasture legumes, *Desmanthus virgatus* and *Indigofera schimperi* have done well at all sites (Pittsworth, Toobeah and Kindon) and *Glycine latifolia* at Pittsworth and Toobeah. One accession of desmanthus, CPI 78382 (which is very similar to Marc), has built up seed banks of several thousand seeds per square metre at Pittsworth and Toobeah since it was sown in 1986-1988.

Promising ley and permanent pasture plants have been carried into the LCS project. The results of wool funded work at Pittsworth, Kindon and Toobeah are being written up and anyone interested should contact Dick Jones (Ph 07 377 0351). Results of the medic studies in this project will be reported by Brian Robertson in a later newsletter.

Farm walks

Farm walks were held at Rolleston, Clermont, Theodore, Biloela, and Wandoan and were well attended (20-40 people at each site). Maurie Conway and Col Esdale and John Chamberlain at the Northern sites and all those involved at Wandoan were happy with the level of interest shown.

Annual meeting

An annual meeting is planned for 31 Aug and 1 Sep. It will be held at Wandoan, Theodore and Brigalow Research Station. Details will be forwarded soon but if you require more details contact Bob Clem.

Feb 1995

LEGUMES FOR CLAY SOILS

Newsletter No. 8

Desmanthus seed went on sale in mid-January this year. This issue of the Legumes for Clay Soils newsletter reviews our research into desmanthus to date and provides some guidelines for sowing and management.

Progress of grazing demonstration sites:

Paddocks of grass with and without desmanthus are being compared on properties for legume yield, development, and animal live-weight gains. Establishment differed between locations depending on previous land use, sowing method and rainfall.

Kookaburra (Wandoan)

Planted in December 1993 into old cultivation, establishment and early growth of buffel and desmanthus have been excellent. Greater than 9 desmanthus plants/m^2 were recorded in October 1994 when desmanthus contributed 40% of the total pasture yield of 2400 kg/ha. Steers were introduced in July 1994 and at January 1995 had gained 132 kg in the buffel paddock and 117 kg in the desmanthus/buffel paddock. The higher than expected weight gains on the buffel paddock were due to higher grass density relative to the desmanthus paddock and the good summer grass growth. It will be interesting to see the results from the late summer, autumn and winter period when an advantage to the higher quality legume might be expected.

Kapalee (Biloela)

Planted in January 1994 into buffel grass pasture using the band seeder, establishment was marginal (1 plant/2 m of sown row) following only light falls of rain which favoured regrowth of buffel. Despite continued dry conditions, many of the desmanthus have survived and some have set seed. However the area was over-sown again this year in January with application of glyphosate in the old inter-row areas to reduce grass competition, while retaining surviving original plants.

Rangeview (Theodore)

Sown into native bluegrass/mitchell grass pasture with the band-seeder, establishment was only marginally better than at Kapalee with 3 plants establishing in every 4 m of sown row. The area was therefore over-sown in January this year.

Brigalow Research Station

In one of the older plantings of desmanthus (1990), initial establishment was poor, requiring over-sowing using the bandseeder in 1992. Grazing commenced in May 1991, and plants have set seed despite the dry seasons. Seedling recruitment has been observed on a number of occasions but few have survived due lack of follow up rain.

Grazing trial at Narayen

After successful establishment in February last year (>5 pl/m of row) plant numbers have decreased owing to dry conditions and high competition from Urochloa. Desmanthus numbers in most paddocks however are still greater than 2 plants/m^2 and so stocking could commence next year (Marc and Bayamo at 5 stocking rates and Uman at two stocking rates). Desmanthus cultivar Marc has set seed despite only limited rainfall. Companion grass species, (buffel and Rhodes grass) however have died out and have been replanted this summer, with no emergence to date.

Other sites:-

A site at Glenlea, north of Clermont, was sown by John Chamberlain using a crocodile seeder in 1994 but rainfall has been inadequate for establishment. Also, Peter Knights has sown desmanthus at two sites, (Rostock via Yuleba and Ballaroo via Roma), as part of the Producer Demonstration Sites project.

What about *Rhizobium*?

Inoculation with the new *Rhizobium* strain CB3126 resulted in a positive growth response at 2 out of 4 irrigated sites. However, in dry sowings, survival of inoculum on the seed prior to germination may be critical. Results of work conducted by Agustin Becerra, in a joint University of Queensland/ Division of Tropical Crops and Pastures project, have shown survival of *Rhizobium* strain CB3126 of only 7 days at 45°C and 3 days at 55°C. This is cause for concern as soil temperatures in summer often exceed 45°C. This has led to work being conducted by Geoff Bahnisch, a student from University of Queensland Gatton campus, looking at the prevalence of native strains able to infect desmanthus in a cross section of clay soils. Results of this work will be made available as soon as possible.

What about establishment?

Establishment of desmanthus has become a critical issue given the run of poor seasons in recent years. Best establishment in a variable climate such as in Queensland can be expected with complete cultivation and with adequate storage of sub-soil moisture. The seed is then introduced in rows (at planting depth not more than 2 cm) or by lightly harrowing/rolling following broadcasting on a cultivated soil surface.

Establishment using over-sowing techniques such as the bandseeder can be successful, but rely on adequate control of existing pasture (eg herbicides sprayed onto the row at planting) and to sufficient moisture being available to meet the needs of the germinating seed along with the competing grass. Under these conditions it is critical that a "good kill" is achieved in a band at least 50 cm wide to provide adequate moisture for germination and emergence of the legume.

Desmanthus being a small seed must be planted in the top 1-2 cm. Planting at depths greater than 2-3 cm has been singularly unsuccessful. Shallow planting in summer means that seed will usually be sown into dry soil. For this reason it is recommended that planting be delayed until more reliable rain in December and January. Work by Kendrick Cox (Ph.D student working with Wrightsons) has shown that small falls of rain immediately following planting, can be detrimental to seed survival. Planting when chances of good rain are highest will reduce risk of poor germination.

What about fertilizers?

Although desmanthus is generally well adapted to a wide range of clay soils, deficiencies of sulphur and molybdenum have been identified in a soil from Brian Pastures near Gayndah. Peter Spies, a student from the University of Queensland Gatton Campus, is testing responses to a range of nutrients in a number of downs and brigalow soils.

Seed sale

Seed is being marketed by Wrightsons. The early, mid and late maturing cultivars (Marc, Bayamo and Uman) will be mixed in equal quantities and sold at $19.50/kg under the trade name "Jaribu". Special thanks to John Hopkinson and the team from Walkamin who helped with seed production.

How do I manage desmanthus?

Although desmanthus is a perennial plant it relies on seedling regeneration from seed for its long term survival. It is important therefore to let desmanthus plants set seed soon after establishment. This might mean decreasing stocking rate toward the end of the first season. Once good seed reserves are present in the soil, stocking rates are less critical. However as a general rule, lighter stocking towards the end of the season will promote flowering and seed production, moderate to heavy grazing early in the season will reduce grass competition and allow seedling recruitment.

Experience with Desmanthus elsewhere

Three desmanthus cultivars are up for release in S. Africa (one originally labelled *D. fruticosa* was later found to be a *D. virgatus* accession). At. Kruger envisages the more erect cultivars of desmanthus being grown in hedgerows either as a fodder bank for cut and carry or for animal grazing, somewhat like we use leucaena here.

Bill Occumpagh from Texas USA reports that some experimental lines of desmanthus showed greater winter survival than others. Temperatures fell to 18/8°C in winter with 11 days when the screen temperature was below zero. This highlights the possibility of selecting more winter tolerant desmanthus cultivars from experimental lines.

Legumes for Clay Soils at Ag-show Sept. 1994

A joint CSIRO/DPI display on legumes for clay soils was presented at Ag-show. There was a display of plants which are either commercially available or are in an advanced stage of evaluation for use on clay soils and a display on establishment principles of desmanthus. John Coote got the tropical plants in good shape and David Lloyd and Bryan Robertson provided the medics.

There were two radio interviews resulting from the display and a Queensland Country life interview. The desmanthus brochure, a copy of which is enclosed with the newsletter, is an updated version of one prepared previously by Gavin Graham. Photographs and boards prepared by CSIRO communications unit are available for other displays. Please contact Bob Clem, Neil Brandon or Dick Jones if you want to use these. Thankyou to all those who helped at the display.

July 1995

LEGUMES FOR CLAY SOILS Newsletter No. 9

Welcome to another issue of the Legumes for Clay.Soils Newsletter. In this edition we review some projects that have relevance to our work:- (1) A ley cropping project being funded by the Grains Research Development Corporation (GRDC), (2) Desmanthus seed production funded by Wrightsons seed company and (3) various other projects of interest.

(1) Ley Cropping- GRDC

The potential of a number of species for use as ley legumes in rotation with winter and summer cereal crops is being tested in this project. The project is centred at Emerald DPI, supervised by Roger Armstrong, but has many government, private and University collaborators. The project has a number of phases but basically aims to measure establishment, yield, nitrogen fixation and water use efficiency of iegumes and yield increase in subsequent cereal crops. Yield increase in subsequent cereal crops is compared to that obtained using various rates of nitrogen fertilizer. Species tested in detail include: mungbean, desmanthus, lablab, siratro and lucerne.

The main trial commenced in July of 1993 and results last summer have indicated a benefit of legumes on sorghum yield. Maximum benefit was obtained using mungbean and lablab (Table 1). Yield increases after desmanthus, lucerne and siratro were lower. Yield increases in some cases were greater than that achieved using the highest rate of nitrogen fertilizer. This, however, may have been due to the particular seasonal conditions, whereby nitrogen fertilizer applied in the surface of the soil at planting did not move down the profile, and remained unavailable in the dry surface soil.

The higher than expected benefit from the grain legume mungbean, compared to the forage species lablab, may have been due to its earlier maturity, allowing some break-down of leaf and stem residue prior to the planting of the subsequent crop. It must be recognised that this is the result of one years work and involved the use of some supplementary irrigation. It may not apply accross all seasonal conditions and it will be interesting to see the effects of these legumes on subsequent cereal plantings.

Smaller experiments in the program look in more detail at the nitrogen fixing ability of a wider range of potential ley species using the natural abundance method in the field and gas exchange methodology in the glasshouse. Results are not yet available, but some measurements taken on the main trial are given in Table 1.

Lablab and mungbean fixed 32 and 85 kg N/ha compared to only 1 kg N/ha by desmanthus. However the desmanthus had been inoculated with a strain of *Rhizobium* now recognized as ineffective compared to the now recommended strain CB3126. Other experiments aim to measure the efficiency of water use for crop grain and pasture dry matter production and examine in detail the fate of nitrogen supplied by fertilizer and legumes using labelled N.

Table 1: Nitrogen fixation by legumes in the field at Emerald in 1994 and yield of sorghum grown in 1995

Legume Species	Sorghum grain (kg/ha)	Legume Yield (kg/ha)	Legume Total N (kg N/ha)	Legume Fixed N (kg N/ha)
Highworth lablab	1870	6640	142	85
Siratro	1400	4420	77	45
Regur mungbean	1970	4140	66	32
Trifecta lucerne	1450	920	26	7
Bayamo desmanthus	1210	4190	40	1

*lucerne was planted later than the other legumes
*yield of sorghum followed by sorghum was 910 kg/ha without N fertilizer

(2) Seed production of Desmanthus

Work in this project is centred at Gympie and is being conducted by Kendrick Cox, who is doing his Ph.D under the supervision of Don Loch from Gympie DPI. The project is funded by Wrightsons and looks at seed production technology with the aim of producing desmanthus seed efficiently while ensuring maximum quality. Experiments investigate a number of aspects of seed production including use of nitrogen, herbicides and time of flowering.

Nitrogen fixation

Although legumes can usually fix their own nitrogen, where high yields of seed are required, it is sometimes worthwhile to add fertilizer nitrogen to promote growth prior to nodulation and to guard against nodulation failure. Nitrogen rate trials therefore have been conducted on desmanthus inoculated with the new *Rhizobium* strain CB3126. However it was found that plants were effectively nodulated when sown in conditions conducive to establishment (35^{0}C with good follow up rainfall), but not when seed was sown during irrigated but hot dry weather (>45^{0}C) for seven days. This points to the "cooking" of CB3126 under these conditions either by heat or exposure to UV radiation and agrees well with work conducted by Agustin Becerra (LCS newsletter No. 8).

Herbicides

Weed control is critical in seed crops where slow establishment may reduce yields and where weed seeds can contaminate harvest of the legume seed. Sixty herbicides (25 pre- and 35 post emergence) have been screened in pot trials. Seventeen of these have been selected for further field evaluation. Best pre-emergence control of weeds (Johnson grass, Bellvine, Sida, Bladder Ketmia) with minimal damage to desmanthus was achieved with triflualin and pendimethalin. Good post-emergence broadleaf control was achieved using bentazone and bromoxynil, while grass weeds were controlled by haloxyfop. Of special note was that desmanthus does not generally tolerate the "hormone" based herbicides.

Insect pests

During late summer young leaves and tips of desmanthus were attacked by an Acacia Psyllid (Acizzia sp.) which removed young leaves and potential flower sites closest to the tip of the plant. This pest is expected to be more of a problem in seed production than under grazing due to the high concentration of plants.

(3) Other projects

* A new species of stylosanthes, useful as a pasture legume for clay soils in Queensland, has been identified by Les Edye and others. The species can be considered to be morphologically between that of *Stylosanthes hamata* and *Stylosanthes scabra*, has tentatively been called aff- *scabra*. Two accessions will be submitted to the QHPLC for release this year. Dick Date has identified a *Rhizobium* strain that is effective in the glasshouse and testing of the strain in the field is in progress. Aff-*scabra* is a perennial species with some cool tolerance and is adapted to clay soils. It should not be thought of as a replacement for the currently available Seca stylo which is well suited to lighter country.

* Bill Ocumpaugh from Texas University reports on a number of more frost tolerant lines of desmanthus Some lines have been selected for further testing against Marc, Bayamo and Uman at 4-6 sites across southern Texas.

* Funding has been received for a joint QDPI/CSIRO project on legumes for ley pastures with particular emphasis on Central Queensland. The project will include the growing out of the *Macroptilium bracteatum* collection and on-farm testing of a range of tropical legumes and annual medics. The project will be led by Bruce Pengelly and others involved will include Jacqui Willcocks (DPI Emerald) and Bryan Robertson (DPI Roma).

* Tom Cowan from DPI Mutdapilly research station has been working on legumes for use for dairy cows, with the particular aim of providing high quality feed during late summer/autumn. Although results are not complete, early results suggest cowpea to be the most promising legume due to its high digestibilty, reliable establishment and moderate yield. The project will continue in 95/96.

* There have been a number of farm walks held recently in the LCS project. The largest of these was at Wandoan on Leo Bahnisch's property in which desmanthus under grazing and a number of promising ley and permanant pasture legume plots were viewed. Smaller farm walks were conducted at Clermont, Capella, Springsure, Arcadia Valley, Biloela and Theodore. There were posters on the LCS project and a display by Wrightsons at the Tropical Pastures Conference at Atherton and the Ag-grow 2000 display at Emerald.

Nov 1995
Newsletter No. 10

LEGUMES FOR CLAY SOILS

Welcome to another issue of the Legumes for Clay Soils Newsletter. In this edition we bring you up to date with recent work on nodulation and nitrogen fixation of desmanthus and summarize work evaluating a range of legumes on producers' properties and Research Stations. We are also pleased to inform you of some work being done in other projects on burr medic and new accessions of leucaena.

Ability of desmanthus to fix nitrogen

Early work on desmanthus at Emerald showed an annual nitrogen fixation rate of only 1 kg N/ha (LCS newsletter 9). Although the inoculum used (CB1397) was later found to be defective, it raises two important questions: (i) how much nitrogen can we expect desmanthus to fix and (ii) how many soils have native *Rhizobium* strains that are able to nodulate desmanthus. The ability of native strains of *Rhizobium* to nodulate desmanthus is particularly important given that inoculum applied to the seed may not survive for more than 2 weeks at the high soil temperatures associated with summer plantings (LCS newsletter 8).

Stephen Johnson (Central Queensland University student) has been measuring the nitrogen fixation of a range of legumes in field and glasshouse plantings. Although not all the information is available yet, desmanthus at Emerald inoculated with CB3126 appeared to fix 5-25 kg N/ha/year. Even higher fixation rates have been found overseas (>100 kg N/ha). These high fixation rates however have been associated with plant yields of 5-9 t/ha which are higher than those likely to be achieved under normal conditions in the field. The results however suggest that desmanthus will contribute significantly to the nitrogen status of the soil, even if it is only in the longer term. Where more rapid accumulation of nitrogen is desired, faster growing but shorter-lived ley species may be more suitable (see results by Roger Armstrong LCS newsletter 9).

Geoff Bahnisch, (University of Queensland student) has looked at the prevalence of native strains able to nodulate desmanthus in eight clay soils. Six of the 8 soils had native *Rhizobium* able to nodulate desmanthus, but there was a positive response to inoculation in four soils, apparently due to low native *Rhizobium* numbers. Our current recommendation therefore, is that desmanthus be inoculated with strain CB3126. It is available commercially from all seed merchants. Work is continuing on methods of introducing the inoculum that may increase its survival in clay soils. This work is being done by Dick Date (aff-*scabra*) and Wrightsons seed company (Desmanthus).

Results from "On-Farm" Sowings

Maurie Conway and his team involved in the "on-farm" sowings had a busy year in 1994/95 as they continued measurements on trials planted in 1994 and successfully established 5 new sites.

Rainfall was very variable over the 1994/95 growing season. Only 2 of the 13 sites received more than their average rainfall from October 1994 to March 1995, whereas 3 sites had less than half their average rainfall.

1993/94 sowings

Of the five sites successfully established in 1994, there are still high plant densities (>8 plants/m^2) of well adapted lines at four sites.

Legumes yields at these sites in autumn 1994 were given in newsletter number 7. The major changes in the following 12 months were as follows:

- The annuals Highworth lablab and *Vigna trilobata* which, averaged over all sites, ranked 1 and 2 out of 15 accessions in 1994, have now dropped to 10 and 12.
- In contrast, *Indigofera schimperi* increased from ranking 14 in 1994 to rank 1 in 1995.
- Siratro increased from rank 5 to rank 2 and Milgarra butterfly pea from rank 8 to rank 5.
- *Macroptilium bracteatum* and Uman were closely ranked (4 and 6) in 1995.
- Cunningham leucaena varied widely between individual sites, from rank 1 at Birrong (Rolleston) to ranking 11 at the poorest site.

The lower ranking of the annuals and the higher ranking of the potential ley legumes such as Milgarra, siratro and *M. bracteatum* was expected. However, it was not anticipated that indigofera would be the most productive accession in the second year. Several accessions set seed, notably Marc, *Stylosanthes* aff. *scabra* and Capella glycine.

1994/95 sowings

Eight sowings were made in 1994/95 and five of these established well.

Twenty four legumes were sown and the ten highest yielding, ranked over all sites, were:- Highworth (1), *Vigna trilobata* (2), *Macroptilium uniflorum* [Leichardt] (3), *M. bracteatum* (4), Aztec siratro (5), *Centrosema pascuorum* [Cavalcade] (6), Bayamo desmanthus (7), Murray phasey bean (8), *Vigna oblongifolia* (9) and Marc desmanthus (10). As expected the highest yielding legumes were annuals or short term perennials like siratro.

Seed set was heaviest on the annuals *Desmodium dichotomum*, *Vigna trilobata* and Leichardt (*Macroptilium uniflorum*), the weakly perennial Murray phasey bean and the perennials *Stylosanthes* aff-*scabra*, Aztec siratro and Capella glycine.

General comments

Successful farm walks were held at 7 sites this year. A summary poster was presented at the June 1995 Tropical Pasture Conference in Atherton.

While the productivity of *Indigofera schimperi* was outstanding in the 1993/94 sowings, there have been varying reports on its acceptability to cattle. Its acceptance has generally been lower than that of other legumes but has ranged from well eaten to not eaten. Grazing has usually been for short periods at the end of the season. We are yet to test indigofera under larger scale grazing, but this might soon be possible at Narayen and Brian Pastures. In the meantime it has been removed from some sites, but has been kept at others where there is good control of grazing, so that we can continue responsible evaluation of the species.

Capella glycine is the most frost tolerant of the tropical legumes.

Small sward trials

Over a three year period 150 accessions have been planted at each of three sites (Narayen, Brigalow Research station and Emerald Research Stations). Some observations to date are:

- 90% survival of original *Indigofera* plants sown in 1993 (Narayen). High seedling recruitment of aff-*scabra* (Narayen, Emerald and Brigalow Research Stations) and in Marc desmanthus this summer (Narayen).

- *Macroptilium bracteatum* yield was 2000 kg/ha in 1993/94 at Narayen (1993 planting) compared to 200 kg/ha under the lower rainfall conditions in 1994/95. Similarly *Vigna trilobata* regenerated at Brigalow in 1993/94 but not in 1994/95.

Work on *Macroptilium bracteatum* is continuing in a GRDC funded project run jointly by DPI and CSIRO under the leadership of Bruce Pengelly.

Medics/Burr medic research

As part of the LCS project 17 barrel, snail, burr and keg medics were planted in small plots in winter 1993 at four sites in Central Queensland. Although most set seed in the first year (in some cases with the aid of irrigation), there has been little or no seed set at any of the sites since. This has provided an opportunity to look at the ability of the various lines to regenerate from an established soil seed-bank, a characteristic important to the persistence of medics in the more northern areas. So far, soil seed reserves of most barrel and burr medics have been sufficient to allow good recruitment. Bryan Robertson (Roma) will keep us up to date on future developments.

David Lloyd and others from Toowoomba DPI have also commenced a program looking at the agronomic potential of some naturalized burr medics collected from both NSW and Queensland. Elite lines (approx 120) have been selected on the basis of seed yield and plant vigour. These are currently being compared to lines obtained from collections from the Mediterranean and Middle-East. This evaluation will continue in the field this year at Emerald, Roma, Coonamble and Warwick.

Leucaena work

New leucaena accessions with potential psyllid resistance and cool tolerance are being evaluated at a number of sites in Australia and overseas in a project funded by ACIAR and coordinated by Max Shelton of the University of Queensland. Some of the varieties are hybrids, and many have higher levels of condensed tannins than Cunningham leucaena. The effect of increased tannin on feed quality is currently being investigated. Their agronomic performance is being tested at a number of sites including Brian Pastures Research Station, Gayndah and Brigalow Research Station, Theodore.

News on the progress of this work is published in a newsletter called "Leucnet news" available from Max Shelton, Department of Agriculture, University of Qld.

In the most recent issue Col Middleton and Ray Jones report that leucaena has generally survived the extended drought of Central Queensland well. Many of these leucaena stands have now been productive for 15 - 20 years and, under rotational grazing, have produced good liveweight gains in cattle. Ray warns against the old system of grazing whereby leucaena was allowed to grow above grazing height. He says this results in large amounts of seed being set which in the long term may result in the formation of thickets. It may also increase infestation by psyllids (comment by Bob Clem).

Mar 1996

LEGUMES FOR CLAY SOILS

Newsletter No. 11

Welcome to another issue of the Legumes for Clay Soils Newsletter. In the last edition we presented an article on the *Rhizobium* requirements of desmanthus. In this edition we will report on response of desmanthus to fertilizers as well as presenting articles on the early adoption of desmanthus by graziers and farmers.

Response of desmanthus to fertilizers

Glasshouse trials have indicated potential nutrient deficiencies in a number of clay soils. However pot trials, where plants are grown under ideal moisture and temperature conditions in small volumes of soil may overestimate nutrient requirements by plants. So what are the chances of getting similar responses in the field? Can we identify soils in which responses are likely? Can we correct nutrients responses with small additions of chemical fertilizers? These are some of the questions addressed in this article.

Pot trials

Sulphur was identified as a potential nutrient deficiency in clay soils from Gayndah (Brian Pastures), Emerald, Theodore, Clermont and Walkamin in an omission trial by Peter Spies of the University of Queensland Gatton campus (Table 1). The reduction in plant top growth over a 14 week growth period compared to plants that were supplied with sulphur ranged from 30 to 50%. Molybdenum was identified as a limitation in soils from Theodore, Clermont and Walkamin (>20% reduction in plant growth) and phosphorus in soils from Theodore, Clermont and Walkamin (>20% reduction in growth). In other trials at CSIRO St. Lucia, smaller but significant responses to the addition of copper and manganese were found.

Responses in the field?

In previous work on lucerne, Dick Jones of CSIRO found that a response to sulphur in clay surface soils in pots did not always translate to a response in the field, particularly if sulphur concentrations increased in the sub-soil. In the current trial, omission of sulphur reduced top growth of desmanthus by 50% when grown in a soil collected from Brian Pastures Research Station at Gayndah (Table 1). At this same site, Bob Clem reports that application of sulphur and molybdenum to parts of an old stand of desmanthus resulted in a greening up of plants compared to areas where the fertilizer was not applied. Concentrations of these nutrients in the leaves of these plants are being analysed, but this observation suggests that field responses to fertilizer are possible at least in some soils.

Can we predict responsive soils?

Sulphur concentrations in soil as measured by the KCl extraction method ranged from 2 to 15 mg/kg. Five of the 7 soils had extractable sulphur levels below 5 mg/kg. These soils showed significant yield reductions with the omission of sulphur in the pot trial (Table 1). Previous work by Derek Cooksley and John Prinsen at Brian Pastures Research Station has shown that unlike many soils, concentration of sulphur in the Brian Pastures soil decreases with soil depth. John Prinsen found that there was a positive response to sulphur in old stands of leucaena at this site.

Soils with concentrations of extractable sulphur of less than 5 mg/kg and which decrease with depth may be the most likely to respond to applications of sulphur fertilizer in the field. The response to phosphorus appears less easy to predict on the basis of chemical analysis, as two soils which both had a bicarbonate extractable phosphorus level of 7 mg/kg responded to phosphorus application, but a soil with 6 mg P/kg and another soil with 8 mg P/kg did not. Molybdenum is difficult to measure in the soil, and chemical analysis is usually not a good predictor or yield response. Leaf concentrations of molybdenum are being analysed in plants grown in responsive and non-responsive soils to see if tissue analysis can provide an indicator of the need to apply molybdenum.

A slightly acid soil from Walkamin also responded to the application of phosphorus despite having a bicarb extractable level of 40 mg P/kg. This was because the soil is able to fix phosphorus in forms unavailable to plants. Plants in this soil also responded to liming, and to application of sulphur, molybdenum and zinc. John Hopkinson of Walkamin Research Station has found that liming and application of molybdenum has been successful in preventing yellowing of desmanthus in areas of desmanthus grown for seed production.

What rates should be applied?

Marc desmanthus has responded when grown in pots of Emerald and Gayndah soil to rates of sulphur as high as 60 kg S/ha. Ninety percent maximum growth however occurred at the rate of 30 kg S/ha. In the field trial at Brian Pasture Research Station the rate used was 20 kg/ha.

Table 1: Soil chemical characteristics and growth effects of various nutrients on desmanthus

Site	Soil chemical characteristics			% reduction in plant growth		
	P (Bicarb)	S (KCl)	S (MCP)	-S	-P	-Mo
	(mg/kg)	(mg/kg)	(mg/kg)			
Gayndah	84	3	1	50	3	7
Emerald	8	2	2	36	18	23
Clermont	7	3	1	30	60	23
Theodore	7	3	1	31	47	14
Wandoan	6	8	82	5	15	0
Bauhinia	35	15	13	9	4	7
Walkamin	40	2	1	51	27	51

Sulphur extractions and analysis kindly done by INCITEC without charge.

Experience at Walkamin Research Station is that pre-planting application of 20 kg S/ha, 30 Kg P/ha and 2 t/ha of dolomite plus 0.5 kg/ha of sodium molybdate applied in solution through the boom-spray, ensures vigorous seed production.

Adoption of desmanthus

Rodney Collins of DPI at Biloela has recently completed a study on the way primary producers access and use information in making decisions about the adoption of desmanthus. Data collection involved interviewing graziers currently growing desmanthus and surveying DPI and CSIRO staff currently researching the plant.

One of his main findings was that DPI and CSIRO remain a major source of information regarding desmanthus. This is not surprising, given that most producers interviewed were already actively participating in on-farm demonstration sites and there has been insufficient time since the release of desmanthus, for farmers and the grazing community at large to gain first hand experience of the plant. It highlights however, the responsibility we have at DPI/CSIRO to ensure that up-to-date information about the plant is disseminated well. Another source of information that was regarded highly by graziers was that provided by the seed companies.

To date, our emphasis has been on conducting farm walks at on-farm demonstration sites, and mounting displays at various shows eg. Toowoomba Agshow. A one page leaflet is currently available from Wrightsons to all those buying desmanthus seed. This leaflet contains some of the information already gained by research in desmanthus. Results of more recent work has been summarized in this newsletter, which are circulated not only to those in the project, but extension officers and interested producers. Copies of all newsletters are available on request.

Seed sales

Paul Kenny from Wrightsons seed company reports that demand for desmanthus has been steady, with recent rainfall in many areas being ideal for planting. Good seed yields of all three cultivars were obtained in seed production areas last year, and there are reasonable supplies of "Jaribu" desmanthus available. He says that most seed so far has been sold through their Brisbane warehouse to areas of the Northern Darling Downs and Central Highlands, although some seed has also gone out of their Rockhampton warehouse.

Congratulations

Congratulations are extended to Geoff Bahnisch of the University of Queensland Gatton College, who won the Brian Medal for the best final year project. His contribution to work on nodulation of desmanthus is gratefully acknowledged. Also to Peter Spies another student who contributed to the Legumes for Clay Soils project in the area of plant nutrition and who has recently accepted a job in the DPI working on pastures in the Charters Towers area.

Aug 1996

LEGUMES FOR CLAY SOILS

Newsletter No. 12

The first phase of the Legumes for Clay Soils project funded by Meat Research Corporation is due to finish in August this year. This newsletter summarizes some of the main findings of the project.

Highlights

The project "Legumes for Clay soils" has aimed to develop better legumes for permanent and ley pasture on clay soils. A range of sites over the clay soil region of Queensland (16 established from Roma (27°S) to Middlemount (23°S)) have been established and many organisations (QDPI, CSIRO, UQ, MRC, Landcare groups, GRDC) have been involved. Through grazing studies and demonstrations of desmanthus, on-farm testing of new cultivars and elite lines, small plot evaluation, supporting research and regular communication activities, the project has:

- demonstrated the grazing value of desmanthus and provided information on *Stylosanthes* (aff.) *scabra, Indigofera schimperi, Clitoria ternatea* cv. Milgarra, *Macroptilium bracteatum* and a range of other legumes
- provided information on establishment, production and persistence, rhizobial and nutritional needs, seed production and management of a range of commercial and experimental legumes
- informed producers and other stakeholders of results and increased awareness of a range of legumes that could be used in short and longer term pastures on clay soils

Grazing demonstrations

Desmanthus has been established in paddocks of 10 - 20 ha at Gayndah, Taroom, Theodore, Biloela and Middlemount to demonstrate its value under extensive grazing ie grazed thoughout the year at a stocking rate of about 1 steer/2ha. Although establishment has been variable, desmanthus has survived dry conditions and set seed. It has been readily eaten by stock but to date there has been no improvement in animal liveweight gain, probably because growth of cattle grazing buffel grass as a comparison has also been high. These sites will continue to be monitored, and it is planned to measure the amount of desmanthus being eaten as pastures develop further.

On-farm sowings

Valuable information on the establishment, persistence and production of commercial and pre-release legumes for leys and permanent pastures on clay soils has been obtained from on-farm sowings. On-farm demonstrations have been established at 11 sites over 2 years. Of the annuals, the self-regenerating *Vigna trilobata* (pre-release) rated second in yield to the forage legume lablab, indicating the potential for a role in ley farming systems. *Clitoria ternatea* cv. Milgarra and *Macroptilium bracteatum* have shown promise for use in rotations with crops where annual planting is not possible or desirable. Both perenniated and produced moderate to high yields in the second and third years.

A better understanding has been obtained of the performance of the perennial pasture legumes *Desmanthus virgatus* cv. Jaribu, *Stylosanthes* (aff.) *scabra* and *Indigofera schimperi.* The yield of *Indigofera schimperi* has generally increased at all sites due mainly to good survival and productivity of original plants. Early yields of *Desmanthus virgatus* and *Stylosanthes* (aff.) *scabra* have been variable, with some indication that desmanthus may be less suited to the shallow open downs soils near Emerald and Clermont, than the Brigalow soils elsewhere in central Queensland.

The success of many of the sites owes much to the good planning and coordination and the cooperation of the many land-holders.

Small sward trials

Measurements of the establishment, productivity and persistence and other more detailed observations were made for 150 legume accessions in small plots at three research stations in three plantings. Of the perennial legumes for permanent pastures, indigofera again proved extremely persistent and productive. From a wider range of desmanthus tested, there appears to be promise for selecting accessions that are earlier flowering than Bayamo but higher yielding than Marc. There may also be scope for selecting frost tolerant lines from some recently collected material from Paraguay. Aff-*scabra* is also showing promise, and has the ability to recruit from seedlings.

Of the ley legumes, *Macroptilium bracteatum* is being further evaluated in work funded by GRDC. Some accessions of *Vigna*, have perenniated in the more recent plantings but have not yielded well so far. *Macroptilium lathyroides* has been able to perenniate and regenerate from seed, resulting in moderate yields in recent plantings.
It is still too early to determine the long-term success of medics in the more northern regions. However at Narayen, some lines continue to emerge each year despite no seed being produced since the year of

establishment (1993) when plots were irrigated. Seed reserves in the soil will be measured prior to completion of the experiment.

Supporting Research

Research has been undertaken on practical aspects of establishment and management of legumes by CSIRO and DPI staff in conjunction with students from the University of Queensland.

Legume establishment

Cam McDonald of CSIRO in his work with hard seed breakdown of legumes at a range of diurnal temperatures has found that the initial rate of breakdown of desmanthus seed was slow compared to aff-scabra. Only about 20% of hard seed of desmanthus was soft after 4 months compared to over 50% in aff-*scabra*. Rate of breakdown of desmanthus seed increased after 4 months and was faster at higher temperatures. This concurs with work by David Burrows (QDPI) who found recruitment of desmanthus was limited in the first 2-3 years, despite significant seed production. Aff-*scabra* however has been found to recruit in large numbers, but few seedlings have survived at LCS sites due to dry weather.

Work on planting depth showed the importance of planting small seeded legumes such as desmanthus at depths of less than 2 cm. Don Loch (DPI Gympie) has screened desmanthus against a variety of herbicides and found that it is not resistant to many of the hormonal herbicides, but is tolerant to some other pre and post-emergent herbicides. Kendrick Cox, as part of his pHD studies on seed production of desmanthus has recently found that pre-emergence herbicides are more effective than post-emergence herbicides in increasing seed yield.

Inoculation and rhizobial requirements

Field work confirmed the suitability of the strain CB3126 as a commercial inoculum for desmanthus. However work by Agustin Becerra (visiting scientist from Argentina) showed that longevity of *Rhizobium* inoculated onto desmanthus seed is often less than 2 weeks under temperature conditions similar to that occurring in the field in summer.

Nutrition

Preliminary work on nutrient availability suggest that growth of desmanthus may be affected at least in some soils. Results of glasshouse work showed a >50% growth reduction due to omission of S in 2 of 7 clay soils tested in pots. Phosphorus was a potential limitation in another clay soil and Mo in a slightly acidic krasnozem soil. Concentration of sulphur in leaves of desmanthus growing at Brian Pastures was found to be low and when sulphur was added, S and N concentrations in desmanthus leaves increased and yellowing in the field was reduced.

Management

Defoliation studies with a range of ley legumes by Scott Dalzell (UQ student) highlighted *M. bracteatum*'s tolerance of severe defoliation and supported the initiative to further evaluate this species.

Technology transfer

Extension of information on legumes for clay soils has generated a very positive response from producers who have expressed strong support for the project and the need for continuation of work in this area. Several farm walks, field days and bus tours of on-farm legume demonstrations have been well attended, while displays of plants, posters and handout material at Agro 2000 Emerald, Agshow Toowoomba and local shows have aroused considerable interest. Through such activities we have maintained close contact with Landcare groups, in particular The Brigalow Floodplains Landcare Group, the Baralaba District Landcare Committee and the Chinchilla Landcare Committee. This newsletter is currently received by producers and producer groups throughout Central Queensland, and research and extension staff of various organisations, with the list of interested readers continuing to expand.

Where to from here?

Progress towards the original objectives has been good, despite summers with below average rainfall that restricted legume establishment and growth. Further measurements of legume performance at the established project sites is needed to continue to build on the progress that has been made. The grazing demonstration sites are at various stages of development, however all except for two are now being grazed. Monitoring pasture and animal production in them will help confirm the value of desmanthus, define grazing management requirements and quantify animal liveweight gain.

Performance of other legumes such as *S.* (aff.) *scabra*, Clitoria, *M. bracteatum*,, Macrotyloma and Vigna will continue to be monitored in the on-farm plots and in small swards on research stations to determine their usefulness as ley and permanent pasture legumes and to demonstrate their value to producers.

Additional measurements are also proposed to increase our knowledge, especially in the following areas: (i) nitrogen fixation levels in desmanthus under grazing (ii) the occurrence and magnitude of sulphur deficiency in desmanthus and (iii) the amount of desmanthus eaten by cattle in grass/legume pastures. We are keen to retain a close level of communication with producers and producer groups and to continue to report findings through the LCS newsletter.

Dec 1996

LEGUMES FOR CLAY SOILS

Newsletter No. 13

The first phase of the Legumes for Clay Soils project ended in August of this year. Most of the field experiments are being continued in the second phase of the project with additional measurements being taken on some trials. A summary of the proposed activities is outlined below, along with some recent results from current and related trials.

Phase 2 of LCS

The existing 10-20 ha grazing demonstrations of desmanthus will be continued at Wandoan (Kookaburra), Middlemount (Rolf Park) Brian Pastures and Brigalow Research Station.

Measurements of persistence and yield of promising ley and pasture legumes will be continued in the 11 on-farm trials and in the small plot studies at Narayen, Brigalow and Emerald Research stations.

Additional measurements in the on-farm trials will aim to quantify the amount of nitrogen fixed by desmanthus and possible limitations of S and Mo. The proportion of desmanthus in the diet of cattle will be measured in the grazing demonstrations at Wandoan, Brigalow Research Station and Middlemount.

Feed quality of tropical legumes

Quality of tropical legumes has been measured in a range of legumes grown at 4 on-farm sites. The terminal 15 cm, (approximating that grazed by animals) was cut from a number of plants and the % leaf calculated (Table 1).

Both stem and leaf material were analysed for acid digestable fibre (ADF), N% and P% with the objective of comparing the quality of the 2 fractions across sites.

Stem material had higher ADF content than leaf material with little difference occurring between legumes (35-43%) (Table 1). This suggests that leaf% and ADF of leaves are the more important quality attributes measured. Highest in leaf% were the *Macroptilium* and desmanthus accessions. Lowest were Seca and *Stylosanthes* sp. aff. *S. scabra*.

Although indigofera was intermediate in leafiness and had similar ADF of leaves to other legumes, more work needs to be done on its palatability. Observations following grazing at the farm sites would suggest that it is often eaten less than other legumes, particularly when allowed to grow rank. More work has been initiated on a wider range of indigofera accessions at Brian Pastures Research Station to evaluate their acceptability under grazing.

Table 1: Leaf%, acid digestable fibre content of leaf and stem, and N and P concentration in leaves of terminal 15 cm of 10 legumes grown at 4 sites.

	%leaf	Leaf quality			Stem quality	
Legume		ADF	%N	%P	ADF	%N
Bayamo desmanthus	77	20	3.8	0.24	38	2.1
Siratro	73	17	3.8	0.23	38	1.9
Marc desmanthus	73	17	3.8	0.23	38	1.9
Macroptilium bracteatum	72	29	3.2	0.23	37	2.0
Indigofera schimperi	71	29	3.3	0.23	37	1.7
Uman desmanthus	70	17	4.0	0.21	36	2.0
Capella glycine	69	29	3.2	0.26	41	2.0
Milgarra butterfly pea	68	18	4.5	0.32	38	2.2
Seca stylo	61	31	2.8	0.20	43	1.6
Stylosanthes sp. aff. *S. scabra*	54	22	3.6	0.22	38	1.8

Evaluation of Tropical legumes - Wool funded work.

Small plot work at Pittsworth and Toobeah has confirmed the good persistence and high production of indigofera and desmanthus CPI 78382 (similar to Marc). Capella glycine, sown in 1986, is persisting at Pittsworth but has died out at Toobeah.

Yellowing of uninoculated desmanthus grown in pots containing soil collected from Tara was due to poor nodulation and not sulphur deficiency. This confirms the need to inoculate desmanthus with the recommended commercial strain CB3126.

Evaluation of tropical legumes - LCS

Recent observations of on-farm trials and small sward trials has indicated variable peristence of desmanthus. Poorest survival of original plants has occurred in shallow downs country where butterfly pea and to a lesser extent *Stylosanthes* sp. aff. *S. scabra* have performed better. Recruitment from seed is being observed in *Stylosanthes* sp. aff. *S. scabra*, and in butterfly pea where more lenient grazing has allowed seed set. Recruitment of desmanthus has so far been low, but is now occurring in small swards at Narayen, and in on-farm trials at Wandoan (Kookaburra) and Biloela (Kapalee).

Evaluation of medics - LCS project

Medics regenerated again this winter at Narayen Research Station and Jambin near Biloela. These trials were planted in 1993 using irrigation but with the dry winters in 1994 and 1995 there has been little or no subsequent seed set. Seedling regeneration therefore has come from seed set in the first winter. The ability of medics to maintain good soil seed reserves is important in regions with low and unreliable winter rainfall. To test this, soil seed reserves are being measured in 6 of the 17 lines. Seedling regeneration and yield will continue to be monitored in all plots.

Perennial lablabs

A breeding program at CSIRO has looked at the possibility of combining the vigour of annual lablabs with the 2-3 year growing duration of some of the perennial forms.

Early crosses of annual cultivars (Highworth and Rongai) with perennial accessions were successful. Evaluation trials of these crosses are now into their third season at Gatton, Emerald, Biloela and Narayen. Two of the most promising lines will be further evaluated at 6 sites in Central Queensland in cooperation with a larger trial evaluating ley species being funded by the Grain Research and Development Corporation.

Collection and use of desmanthus overseas

Sixty new accessions of desmanthus were collected on a recent trip to Argentina by Bruce Pengelly of CSIRO and Bruce Cook of DPI. This region has many similarities with southern and central Queensland. CSIRO are characterizing the collection using molecular biology. This should give a clearer basis for the selection of representative lines for further field testing.

Bill Occumpagh reports that lines CPI 81337, 84508, 90857 and 90906 have shown promise in Texas. Three of these lines, grown in previous trials by DPI and CSIRO, have not been as promising in Queensland.

Technology transfer

Details of the LCS project were displayed at Toowoomba Agshow, Agrow 2000 at Emerald and at the MRC Chinchilla "Meat-For-Profit" day. These displays of plants, posters and information sheets attracted a high level of interest and enquiry from project staff who were on hand to talk to clients. Farm walks, held at many sites this year, are again planned for 1997.

Changes in personell

Neil Brandon of CSIRO is leaving the project in mid-December but John Ogden of Narayen Research Station will provide some technical support to the project. In DPI, Jacqui Willcocks has left Emerald and Bryan Robertson has left Roma. Tim Neal has recently been appointed at Miles to replace Scott Cawley who is now at Roma.

Future newsletters

With Neil Brandon's departure only two newsletters are planed for 1996/97.

Appendix 4: Research Impact Assessments

DAQ 086 Legumes for Clay Soils

Research Impact Assessment

Outputs from four assessments are included:

1. Long-term large area assessment based on the use of a number of legumes (desmanthus, stylo, butterfly pea, and other ley legumes) over a large area and using long-term rather than current buying and selling prices (LCS).

2. Assessment as for 1 but using current buying and selling prices (LCS2).

3. A more targeted assessment based on the augmentation of perennial grass pastures with desmanthus (LCSDES).

4. Assessment using butterfly pea as alternative to annual lablab in cropping systems (LCSLEY).

Explanation and comments on assessments and how they were developed

Assessments 1 - 3 use gross margins as shown which are based on those of Ryan (1992) but are updated for costs. The comparisons are between liveweight gains of steers grazing either established grass pastures (without technology) and these same pastures augmented with legumes (with technology).

Grass pastures growing on the higher fertility soils of the brigalow region currently support beef cattle finishing enterprises that rely on annual steer liveweight gain of about 180 kg/head. These pastures are highly valued by industry and are widely used to finish steers from 380-400 kg to Japanese ox (carcass 300kg) in their final year of grazing. The rationale is that legumes can maintain, or marginally improve on this high growth rate while the established pastures will further decline in productivity as available soil nitrogen declines. On pastures in good condition current stocking rates are about 2ha/steer although this is high in comparison with whole of shire and whole of pasture community figures. Nonetheless it is consistent with those being used both in experimental and in commercial areas of this type of pasture where annual liveweight gains of 180 to 200+ kg/head are being recorded.

The details are:

Assessment 1 (LCS)

The prediction in this assessment (LCS) is that growth rate will be 180kg/head for both grass and legume systems in years 1-5. Establishment costs of $90/ha for the legume pasture in year 1 are amortised over 20 years at 10%. Gross margin for the legume is therefore reduced by $10/ha/yr for cost of establishment. At year 5 growth rate on grass has declined to 160 and on legume has increased to 200kg/head/yr. There is no change in stocking rate of 1 beast/2ha. The legume pasture is predicted to continue at the same liveweight gain/head and the same stocking rate. However it is predicted that on the grass pasture the stocking rate will be reduced to 2.5ha/steer at year 10 and to 3ha/steer at year 15 to maintain a growth rate of 160kg/head/yr.

In the longer term this scenario is possible, but is very dependent on continuous development and refinement of the technology to ensure application to a wide range of soil/climate associations, and to ensure adoption is both significant and rapid. There is a need to define more accurately which parts of the native pasture communities are suited to the technology but this has not been possible with the current package.

Assessment 2 (LCS2)

This assessment is the same as in 1 except that buying and selling prices that reflect current prices are used. It demonstrates the sensitivity to changes in beef prices and in particular a change in the price differential between buying and selling. These are a buying price of $1.00/kg and selling price of $0.90/kg instead of $1.00 and $1.10 as in LCS.

Assessment 3 (LCSDES)

This assessment uses the same animal production parameters as 1 and 2 but targets a smaller area that is considered well suited to growing desmanthus. These areas are the better clay soils in the brigalow region and some of the open downs of central Queensland. The RIA has been restricted to these areas receiving between 500 and 1000 mm rainfall, where soil phosphorus is >9 ppm and frosting is less the 50 frosts/year. The analysis is also restricted to those pastures where <25% are in class A. The resultant area is 1.5 m ha, which is probably an overestimation of areas in which the application will be most successful. This overestimation is because a large proportion of land is in the 500 to 700 mm rainfall zone. Desmanthus is growing in areas down to 600 mm but reliability of establishment and production at 500 mm will be reduced. There is no option to exclude the 500 to 600 mm rainfall zone but perhaps a better estimate is 1 million ha.

There are good prospects for relatively high adoption rates in these areas. Producers recognise that productivity has declined and have a strong incentive to resow or oversow these areas to provide higher quality forage for finishing systems. Most of the soils are of high fertility which improves the chances of success. The predicted 20% over 10 years is realistic and would amount to 300,000 ha. If sown at 2kg/ha this would require 600 tonnes of seed to be sown over the 10 to 15 years, or some 60 tonnes/year. This outcome is achievable given that 10 tonnes of desmanthus has been sold in 2 years since commercialisation and a further 20 tonnes is available for sale. Demand for seed has been effected by dry summer seasons and now a reduction in cattle prices although producer interest remains high. Seed price has been reduced from $20 to $15.00/kg for the current season and there are prospects for further reductions as seed production technology improves.

Assessment 4 (LCSLEY)

Ley farming practices have been used to only a very limited extent in central Queensland but their value is now being more widely recognised by producers and interest is high because of declining grain yields and protein percentages. The best option at present is to use the annual forage legume lablab as a ley as demonstrated by Agnew (1994). However for longer leys (3 to 4 years) the disadvantage of lablab is in the high cost of seed and land preparation for annual sowing. Two perennial legumes evaluated in the Legumes for Clay Soils project that promise to be well suited to a long term rotation are Milgarra butterfly pea, which is available and *Macroptilium bracteatum,* which is still being developed.

The calculation of a gross margin for these systems is very complex because it involves benefits and costs derived from grazing of the ley pasture and also to the following crop through a range of factors including how much nitrogen is supplied and how it is utilised, soil physical improvement and weed control. Producers attitude to risk and the sequence of seasonal conditions will also affect the outcome so any detailed analysis will not be attempted here. A simple case is presented. That is that there will be no differences either in the costs of managing the 2 pasture types or in the amount and form of nitrogen available for the crop following the ley phase. It is assumed that lablab will provide grazing for 90 days with a liveweight gain of 0.9 kg/day at a stocking rate of 1 steer/0.65ha (data from Agnew) and that Milgarra will provide 160 days grazing with a gain of 0.6 kg/day at a stocking rate of 1 steer/ha (predicted). Beef prices are the same as used in assessment 1 and 3 (LCS and LCSDES).

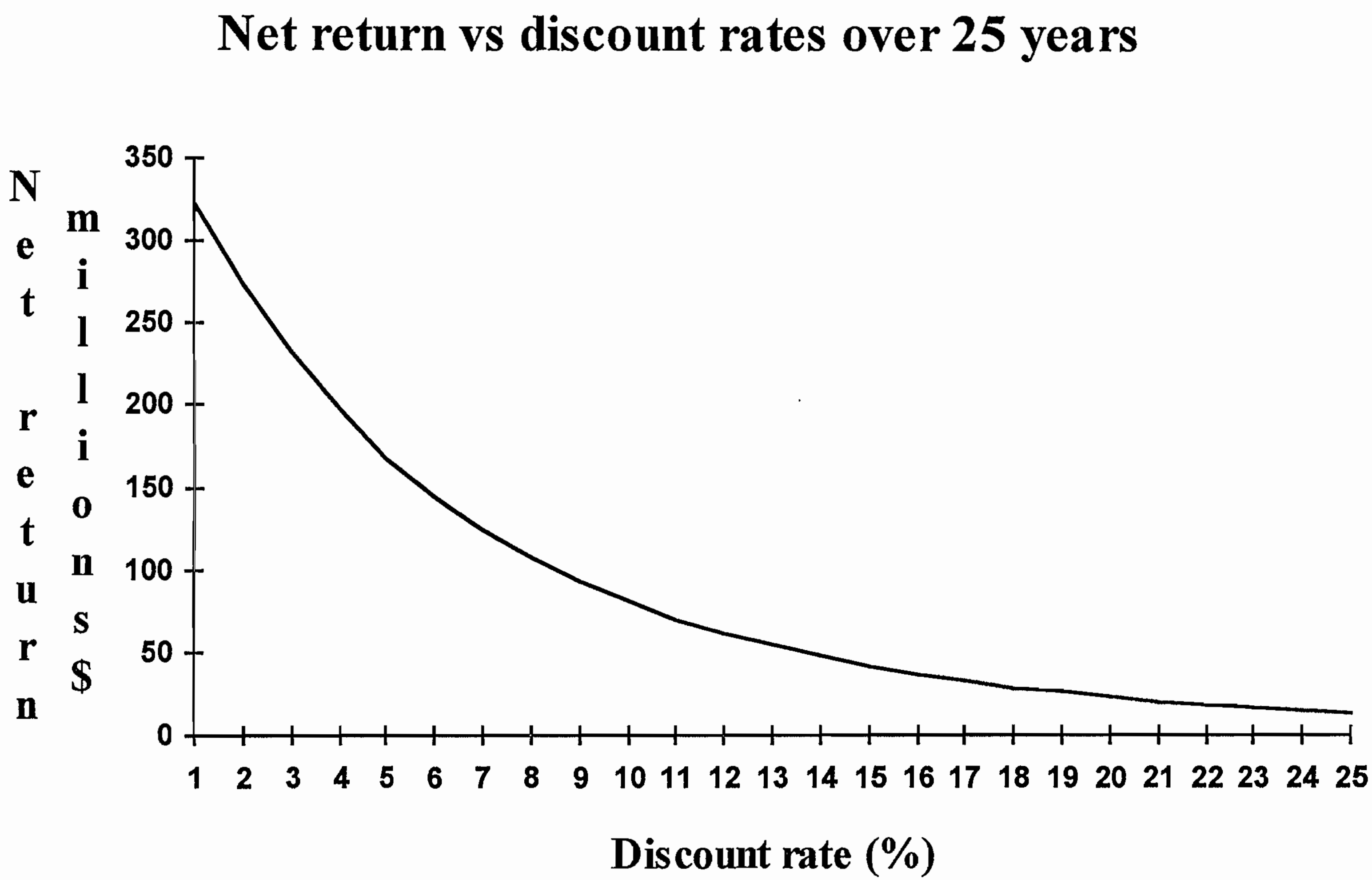
R.L.Clem (Pasture Agronomist)

20 September 1996

References:

Agnew, John (1994) "INDERI" Producer demonstration site: the dual benefits of dolichos in CQ. Field Day notes.

Ryan, Tim (1992) Cattle costs and returns, central Queensland, 1992. Queensland Department of Primary Industries, Emerald.



NapR&D Version: 2.1a

Financial assumptions

All Native Pasture Communities
All Pasture Land Types

Units of analysis: ha	Years					
	1	5	10	15	20	25
Adoption rate (%):	0	5	15	15	20	20
Gross margin without the research:	72.00	61.00	48.00	40.00	40.00	40.00
Gross margin with research:	62.00	73.00	73.00	73.00	73.00	73.00

Project: DAQ.086 Legumes for clay soils - Gross margin analysis
Grass only - year 1: long term average prices

Enterprise: Fattening steers on grass pastures

Enterprise unit: 100 steers

INCOME

Cattle	Age (y)	No	Weight(kg)	$/kg	Total
	3.5	99	560	1.10	60984

VARIABLE COSTS

Livestock purchase

Cattle	Age (y)	No	Weight(kg)	$/kg	Total
	2.5	100	380	1.00	38000

Livestock husbandry

	No.	$/head	Total
Drench	100	1.20	120
Buffalo fly and ticks	100		
Growth promotant	100	3.60	360

Freight and marketing

	$/km	km	$/head	Total
In				
D/deck X2	2.90	300		1740
Out				
D/deck X2	2.90	300		1740
S/deck X1	2.40	300		720
Transaction levy		99	3.50	347

Interest on purchase

	%	$	Total
Interest on capital	10	38000	3800
Total Variable Costs			46827
Gross Margin			14158
Gross Margin/steer			143.01
		ha/steer	
Gross Margin/ha		2	71.50
		2.5	57.20

Project: DAQ.086 Legumes for clay soils - Gross margin analysis
Grass only - year 5: long term average prices

Enterprise: Fattening steers on grass pastures

Enterprise unit: 100 steers

INCOME

Cattle	Age (y)	No	Weight(kg)	$/kg	Total
	3.5	99	540	1.10	58806

VARIABLE COSTS

Livestock purchase

Cattle	Age (y)	No	Weight(kg)	$/kg	Total
	2.5	100	380	1.00	38000

Livestock husbandry

	No.	$/head	Total
Drench	100	1.20	120
Buffalo fly and ticks	100		
Growth promotant	100	3.60	360

Freight and marketing

	$/km	km	$/head	Total
In				
D/deck X2	2.90	300		1740
Out				
D/deck X2	2.90	300		1740
S/deck X1	2.40	300		720
Transaction levy		99	3.50	347

Interest on purchase

	%	$	Total
Interest on capital	10	38000	3800

Total Variable Costs		46827
Gross Margin		11980
Gross Margin/steer		121.01
	ha/steer	
Gross Margin/ha	2.0	60.50
	2.5	48.40
	3.0	40.34

Project: DAQ.086 Legumes for clay soils - Gross margin analysis
Legume - year 5: long term average prices

Enterprise: Fattening steers on grass pastures

Enterprise unit: 100 steers

INCOME

Cattle	Age (y)	No	Weight(kg)	$/kg	Total
	3.5	99	580	1.10	63162

VARIABLE COSTS
Livestock purchase

Cattle	Age (y)	No	Weight(kg)	$/kg	Total
	2.5	100	380	1.00	38000

Livestock husbandry

	No.	$/head	Total
Drench	100	1.20	120
Buffalo fly and ticks	100		
Growth promotant	100	3.60	360

Freight and marketing

	$/km	km	$/head	Total
In				
D/deck X2	2.90	300		1740
Out				
D/deck X2	2.90	300		1740
S/deck X1	2.40	300		720
Transaction levy		99	3.50	347

Interest on purchase

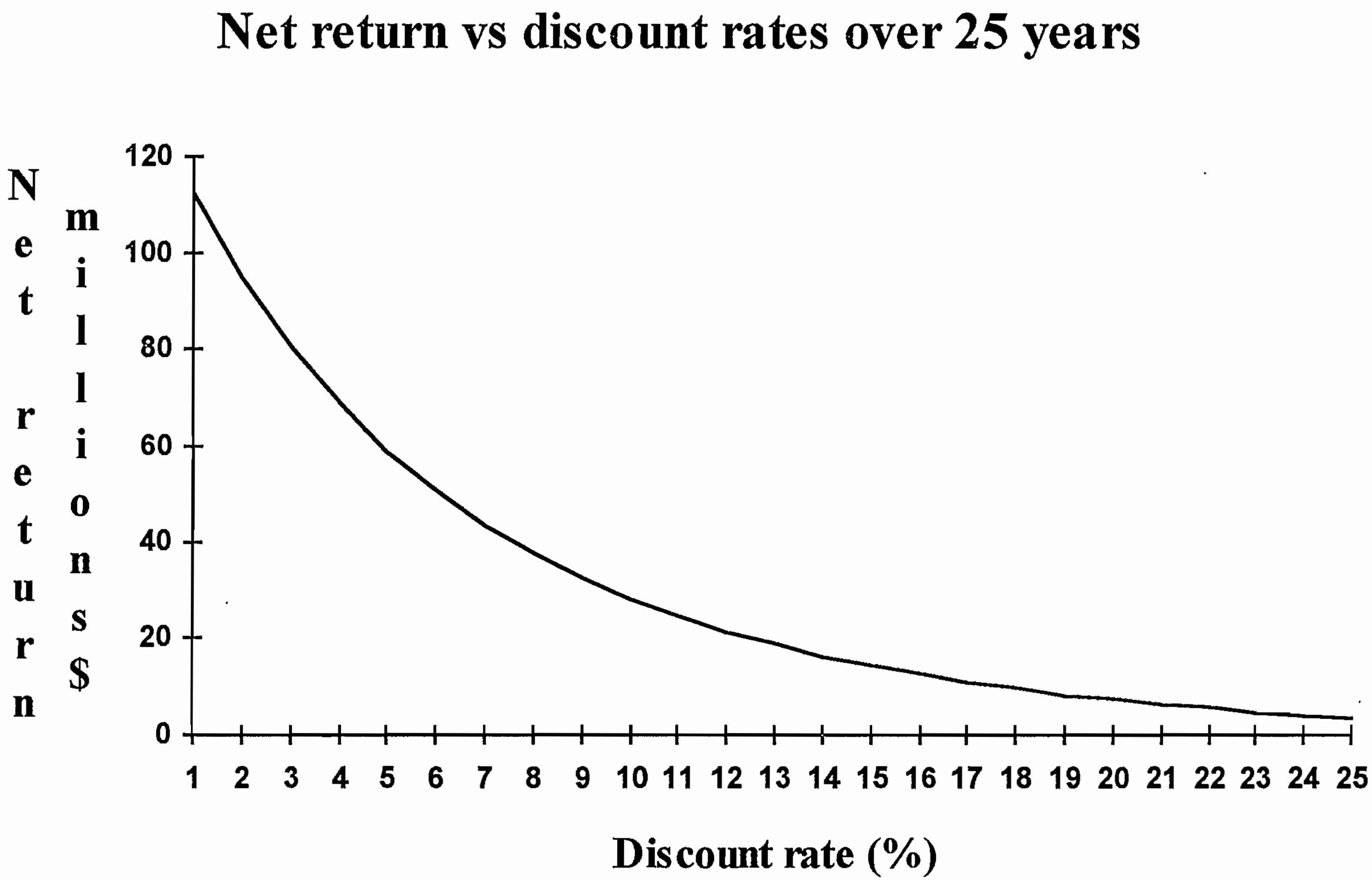
	%	$	Total
Interest on capital	10	38000	3800

Total Variable Costs		46827
Gross Margin		16336
Gross Margin/steer		165.01
	ha/steer	
Gross Margin/ha	2	82.50
	2.5	66.00

Summary of scores

Native pasture land types	Total Live Stock Units	Impact area (ha)
Score: >90%		
Aristida-Bothriochloa pastures Basalt Highlands	240	7,292
Aristida-Bothriochloa pastures Flood Plains	8,802	166,113
Black speargrass pastures Basalt Uplands and Plains with clay soils	23,487	466,302
Black speargrass pastures Other Highlands with shallow clays	3,213	23,715
Brigalow pastures Basalt Highlands with shallow structured loams, clays and earths	1,829	13,902
Brigalow pastures Basalt Uplands and Plains with clay soils	953	9,185
Brigalow pastures Basalt Uplands and Plains with structured earths	294	2,749
Brigalow pastures Flood Plains	44,747	398,588
Brigalow pastures Lowlands and Old alluvial plains with clay soils	62,947	597,423
Brigalow pastures Lowlands with duplex soils	1,709	16,314
Brigalow pastures Lowlands with massive earths	870	8,226
Brigalow pastures Other Highlands with structured earths	271	1,988
Brigalow pastures Other Uplands and Plains with clay soils	32,029	302,692
Brigalow pastures Other Uplands and Plains with duplex soils	50,182	498,188
Brigalow pastures Other Uplands and Plains with earths	4,801	49,946
Gidgee pastures Lowlands with clay soils	15,278	254,389
Gidgee pastures Other Uplands and Plains with clay soils	10,870	180,339
Queensland bluegrass pastures Basalt Uplands and Plains with clay soils	81,044	663,019
Queensland bluegrass pastures Flood Plains	20,811	178,889
Queensland bluegrass pastures Lowlands with clay soils	10,080	87,346
Queensland bluegrass pastures Other Uplands and Plains with clay soils	10,888	71,794
Total:	**385,345**	**3,998,399**

Analysis...LCS2



NapR&D Version: 2.1a

Financial assumptions

All Native Pasture Communities
All Pasture Land Types

Units of analysis: ha

	Years					
	1	5	10	15	20	25
Adoption rate (%):	0	5	15	15	20	20
Gross margin without the research:	16.00	7.00	5.00	4.00	4.00	4.00
Gross margin with research:	6.00	15.00	15.00	15.00	15.00	15.00

Project: DAQ.086 Legumes for clay soils - Gross margin analysis
Grass only - year 1: current buying and selling

Enterprise: Fattening steers on grass pastures

Enterprise unit: 100 steers

INCOME

Cattle	Age (y)	No	Weight(kg)	$/kg	Total
	3.5	99	560	0.90	49896

VARIABLE COSTS
Livestock purchase

Cattle	Age (y)	No	Weight(kg)	$/kg	Total
	2.5	100	380	1.00	38000

Livestock husbandry

		No.		$/head	Total
Drench		100		1.20	120
Buffalo fly and ticks		100			
Growth promotant		100		3.60	360

Freight and marketing

	$/km	km		$/head	Total
In					
D/deck X2	2.90	300			1740
Out					
D/deck X2	2.90	300			1740
S/deck X1	2.40	300			720
Transaction levy		99		3.50	347

Interest on purchase

	%	$			Total
Interest on capital	10	38000			3800
Total Variable Costs					46827
Gross Margin					3070
Gross Margin/steer					31.01
		ha/steer			
Gross Margin/ha		2.0			15.50
		2.5			12.40
		3.0			10.34

Project: DAQ.086 Legumes for clay soils - Gross margin analysis
Grass only - year 5: current buying and selling

Enterprise: Fattening steers on grass pastures

Enterprise unit: 100 steers

INCOME

Cattle	Age (y)	No	Weight(kg)	$/kg	Total
	3.5	99	540	0.90	48114

VARIABLE COSTS

Livestock purchase

Cattle	Age (y)	No	Weight(kg)	$/kg	Total
	2.5	100	380	1.00	38000

Livestock husbandry

	No.	$/head	Total
Drench	100	1.20	120
Buffalo fly and ticks	100		
Growth promotant	100	3.60	360

Freight and marketing

	$/km	km	$/head	Total
In				
D/deck X2	2.90	300		1740
Out				
D/deck X2	2.90	300		1740
S/deck X1	2.40	300		720
Transaction levy		99	3.50	347

Interest on purchase

	%	$	Total
Interest on capital	10	38000	3800

Total Variable Costs		46827
Gross Margin		1288
Gross Margin/steer		13.01
	ha/steer	
Gross Margin/ha	2.0	6.50
	2.5	5.20
	3.0	4.34

Project: DAQ.086 Legumes for clay soils - Gross margin analysis
Legume - year 5: current buying and selling

Enterprise: Fattening steers on grass pastures

Enterprise unit: 100 steers

INCOME

Cattle	Age (y)	No	Weight(kg)	$/kg	Total
	3.5	99	580	0.90	51678

VARIABLE COSTS
Livestock purchase

Cattle	Age (y)	No	Weight(kg)	$/kg	Total
	2.5	100	380	1.00	38000

Livestock husbandry

	No.	$/head	Total
Drench	100	1.20	120
Buffalo fly and ticks	100		
Growth promotant	100	3.60	360

Freight and marketing

	$/km	km	$/head	Total
In				
D/deck X2	2.90	300		1740
Out				
D/deck X2	2.90	300		1740
S/deck X1	2.40	300		720
Transaction levy		99	3.50	347

Interest on purchase

	%	$	Total
Interest on capital	10	38000	3800

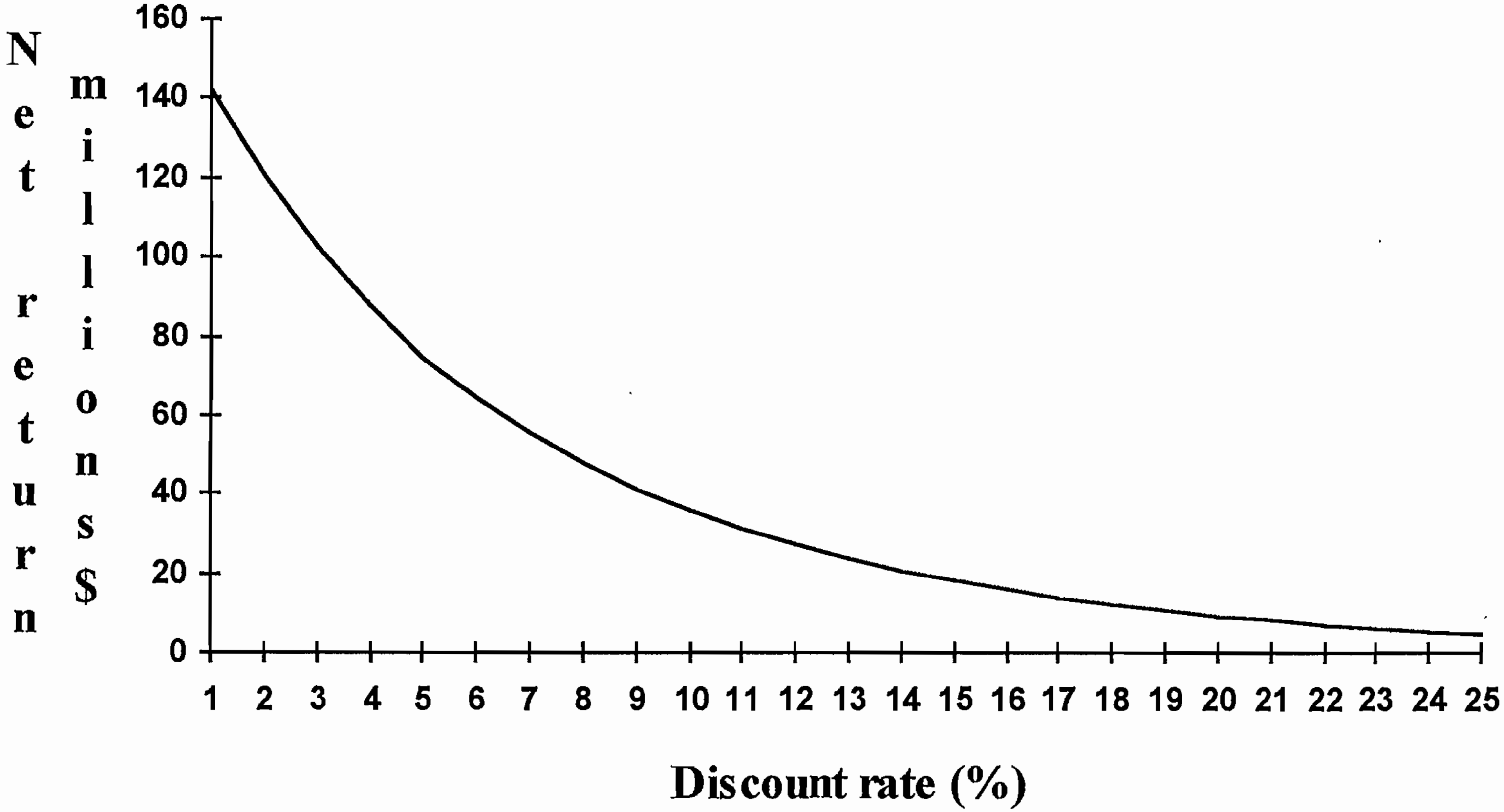
Total Variable Costs		46827
Gross Margin		4852
Gross Margin/steer		49.01
	ha/steer	
Gross Margin/ha	2.0	24.50
	2.5	19.60
	3.0	16.34

Summary of scores

Native pasture land types	Total Live Stock Units	Impact area (ha)
Score: >90%		
Aristida-Bothriochloa pastures Basalt Highlands	240	7,292
Aristida-Bothriochloa pastures Flood Plains	8,802	166,113
Black speargrass pastures Basalt Uplands and Plains with clay soils	23,487	466,302
Black speargrass pastures Other Highlands with shallow clays	3,213	23,715
Brigalow pastures Basalt Highlands with shallow structured loams, clays and earths	1,829	13,902
Brigalow pastures Basalt Uplands and Plains with clay soils	953	9,185
Brigalow pastures Basalt Uplands and Plains with structured earths	294	2,749
Brigalow pastures Flood Plains	44,747	398,588
Brigalow pastures Lowlands and Old alluvial plains with clay soils	62,947	597,423
Brigalow pastures Lowlands with duplex soils	1,709	16,314
Brigalow pastures Lowlands with massive earths	870	8,226
Brigalow pastures Other Highlands with structured earths	271	1,988
Brigalow pastures Other Uplands and Plains with clay soils	32,029	302,692
Brigalow pastures Other Uplands and Plains with duplex soils	50,182	498,188
Brigalow pastures Other Uplands and Plains with earths	4,801	49,946
Gidgee pastures Lowlands with clay soils	15,278	254,389
Gidgee pastures Other Uplands and Plains with clay soils	10,870	180,339
Queensland bluegrass pastures Basalt Uplands and Plains with clay soils	81,044	663,019
Queensland bluegrass pastures Flood Plains	20,811	178,889
Queensland bluegrass pastures Lowlands with clay soils	10,080	87,346
Queensland bluegrass pastures Other Uplands and Plains with clay soils	10,888	71,794
Total:	**385,345**	**3,998,399**

Analysis...LCSDES

Net return vs discount rates over 25 years



NapR&D Version: 2.1a

Financial assumptions

All Native Pasture Communities
All Pasture Land Types

Units of analysis: ha	Years					
	1	5	10	15	20	25
Adoption rate (%):	0	5	20	20	20	20
Gross margin without the research:	72.00	61.00	48.00	40.00	40.00	40.00
Gross margin with research:	62.00	73.00	73.00	73.00	73.00	73.00

Project: DAQ.086 Legumes for clay soils - Gross margin analysis
Grass only - year 1: long term average prices

Enterprise: Fattening steers on grass pastures

Enterprise unit: 100 steers

INCOME

Cattle	Age (y)	No	Weight(kg)	$/kg	Total
	3.5	99	560	1.10	60984

VARIABLE COSTS
Livestock purchase

Cattle	Age (y)	No	Weight(kg)	$/kg	Total
	2.5	100	380	1.00	38000

Livestock husbandry

	No.	$/head	Total
Drench	100	1.20	120
Buffalo fly and ticks	100		
Growth promotant	100	3.60	360

Freight and marketing

	$/km	km	$/head	Total
In				
D/deck X2	2.90	300		1740
Out				
D/deck X2	2.90	300		1740
S/deck X1	2.40	300		720
Transaction levy		99	3.50	347

Interest on purchase

	%	$	Total
Interest on capital	10	38000	3800

Total Variable Costs		46827
Gross Margin		14158
Gross Margin/steer		143.01
	ha/steer	
Gross Margin/ha	2	71.50
	2.5	57.20

Project: DAQ.086 Legumes for clay soils - Gross margin analysis
Grass only - year 5: long term average prices

Enterprise: Fattening steers on grass pastures

Enterprise unit: 100 steers

INCOME

Cattle	Age (y)	No	Weight(kg)	$/kg	Total
	3.5	99	540	1.10	58806

VARIABLE COSTS
Livestock purchase

Cattle	Age (y)	No	Weight(kg)	$/kg	Total
	2.5	100	380	1.00	38000

Livestock husbandry

	No.	$/head	Total
Drench	100	1.20	120
Buffalo fly and ticks	100		
Growth promotant	100	3.60	360

Freight and marketing

	$/km	km	$/head	Total
In				
D/deck X2	2.90	300		1740
Out				
D/deck X2	2.90	300		1740
S/deck X1	2.40	300		720
Transaction levy		99	3.50	347

Interest on purchase

	%	$	Total
Interest on capital	10	38000	3800

Total Variable Costs		46827
Gross Margin		11980
Gross Margin/steer		121.01
	ha/steer	
Gross Margin/ha	2.0	60.50
	2.5	48.40
	3.0	40.34

Project: DAQ.086 Legumes for clay soils - Gross margin analysis
Legume - year 5: long term average prices

Enterprise: Fattening steers on grass pastures

Enterprise unit: 100 steers

INCOME

Cattle	Age (y)	No	Weight(kg)	$/kg	Total
	3.5	99	580	1.10	63162

VARIABLE COSTS
Livestock purchase

Cattle	Age (y)	No	Weight(kg)	$/kg	Total
	2.5	100	380	1.00	38000

Livestock husbandry

	No.	$/head	Total
Drench	100	1.20	120
Buffalo fly and ticks	100		
Growth promotant	100	3.60	360

Freight and marketing

	$/km	km	$/head	Total
In				
D/deck X2	2.90	300		1740
Out				
D/deck X2	2.90	300		1740
S/deck X1	2.40	300		720
Transaction levy		99	3.50	347

Interest on purchase

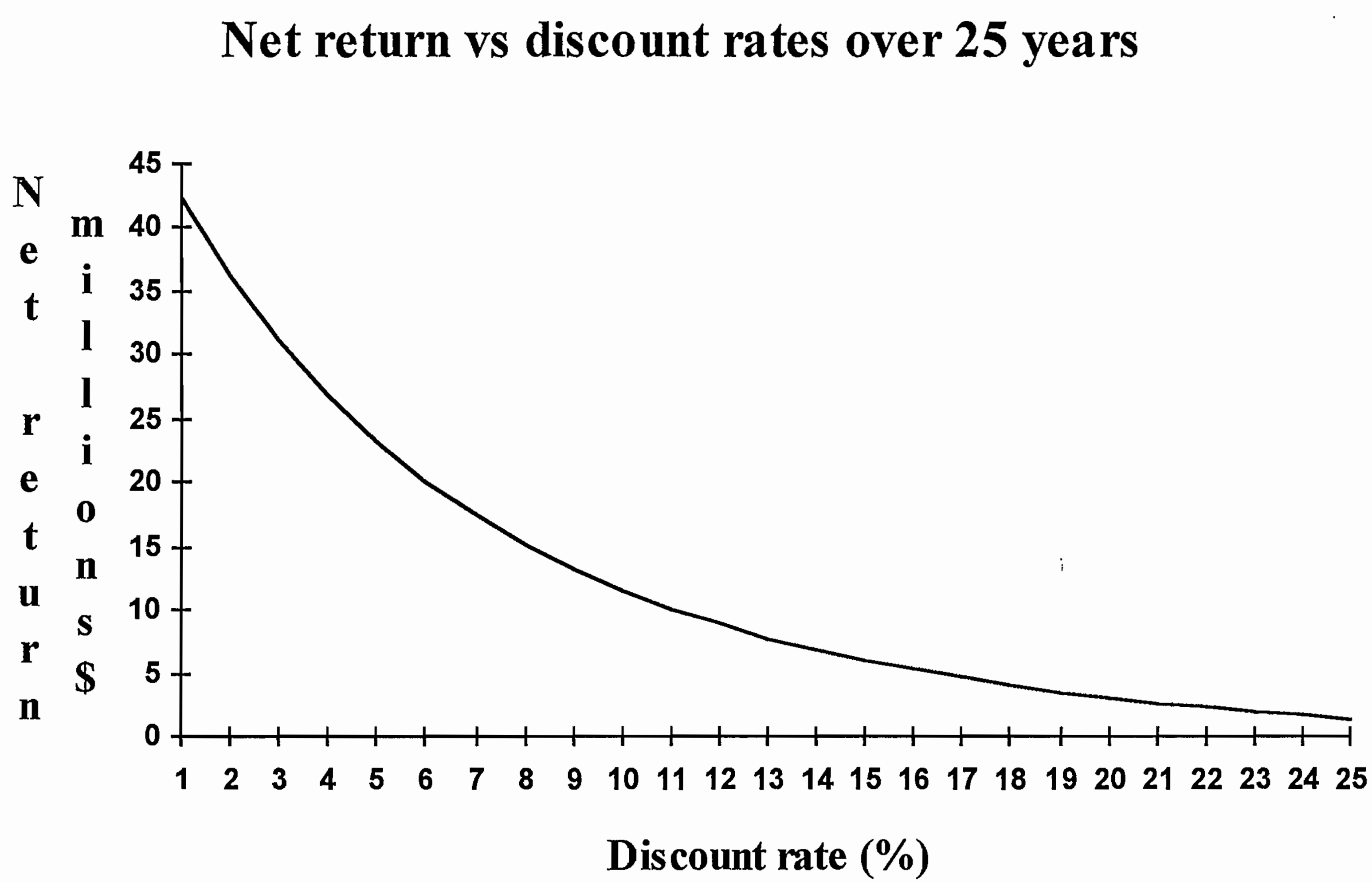
	%	$	Total
Interest on capital	10	38000	3800

Total Variable Costs		46827
Gross Margin		16336
Gross Margin/steer		165.01
	ha/steer	
Gross Margin/ha	2	82.50
	2.5	66.00

Summary of scores

Native pasture land types	Total Live Stock Units	Impact area (ha)
Score: 80-90%		
Brigalow pastures Flood Plains	34,552	311,789
Brigalow pastures Lowlands and Old alluvial plains with clay soils	19,939	226,366
Brigalow pastures Other Uplands and Plains with clay soils	8,712	101,174
Queensland bluegrass pastures Basalt Uplands and Plains with clay soils	81,044	663,019
Queensland bluegrass pastures Flood Plains	20,811	178,889
Queensland bluegrass pastures Other Uplands and Plains with clay soils	10,888	71,794
Total:	175,946	1,553,031

Analysis...LCSLEY



NapR&D Version: 2.1a

Financial assumptions

All Native Pasture Communities
All Pasture Land Types

Units of analysis: ha	Years 1	5	10	15	20	25
Adoption rate (%):	1	10	20	20	20	20
Gross margin without the research:	55.00	55.00	55.00	55.00	55.00	55.00
Gross margin with research:	73.00	73.00	73.00	73.00	73.00	73.00

Project DAQ.086 Legumes for Clay Soils - Gross margin analysis

Using Perennial legumes (Milgarra) in leys instead of annual Lablab

			Lablab		Milgarra	
Costs for 4 year ley						
seed	kg/ha		40		8	
	$/kg		1.20		12.00	
		$/ha		48		96
land preparation		$/ha		34		34
no of plantings			4		1	
Total		$/ha		328		130
Cost/ha/year				**82**		**33**
Predicted return						
grazing	days		90		160	
liveweight gain	kg/head/day		0.9		0.6	
stocking rate	ha/head		0.65		1	
beef price	$/kg		1.10		1.10	
Return/ha/year				**137**		**106**
Gross margin/ha/year				**55**		**73**

Summary of scores

Native pasture land types	Total Live Stock Units	Impact area (ha)
Score: >90%		
Queensland bluegrass pastures Basalt Uplands and Plains with clay soils	81,044	663,019
Queensland bluegrass pastures Other Uplands and Plains with clay soils	10,888	71,794
Total:	91,932	734,813