National Annual Pasture Legume Improvement Program

PROJECT DETAILS

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<td>PROJECT TITLE:</td>
<td>NATIONAL ANNUAL PASTURE LEGUME IMPROVEMENT PROGRAM</td>
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Summary

The National Annual Pasture Legume Improvement Program II (NAPLIP II) (2000-2005) continued the research from NAPLIP I in the evaluation and development of temperate and tropical legumes for the northern grains region. Four tropical and six temperate legume species were evaluated and improved varieties are now available for grain and mixed enterprise growers. The impacts of legumes on soil nitrogen (N) have also been researched.

The major achievement was the release of burgundy bean - a tropical legume for clay soils in the subtropics. Its inclusion in this region's systems should complement management decisions to develop sustainable and productive farming systems. New varieties of subclover, spineless burr medics and a button medic have also been or are being commercialised.

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Conclusions
New tropical and temperate pasture legume varieties for the northern grain belt, summer dominant rainfall (SDR) zone were developed according to project aims and methodologies. Within the zone, the evaluation and commercialisation were carried out by the collaborative efforts of three agencies; CSIRO Sustainable Ecosystems (contract holder), Department of Primary Industries and Fisheries (DPI&F) Queensland (QLD) and New South Wales (NSW) Department of Primary Industries ( DPI), and through national collaboration in the development of temperate legumes, particularly the South Australian Research and Development Institute (SARDI).

New varieties released or in the commercialisation pipeline are as follows:

Two varieties of the new summer growing legume, burgundy bean, Cadarga (CPI 55769) and Juanita (CPI 68892) have been released and substantial quantities (six tonnes in 2003/04 and 20 tonnes in 2004/05) have been produced by the commercial partner, Heritage Seeds. The seed is being provided to growers as a blend of the two varieties.

The desmanthus accession Q9153 has shown better field performance than the commercial variety Jaribu over four years of continuous evaluation and will be commercialised during the next three years.

There are now a large number of temperate legume options available for producers that have resulted from inter-agency collaboration. Sulla is a very promising, highly productive legume. Two varieties, Wilpena and Moonbi, have been commercialised and seed will be available in 2007. Coolamon, Izmir, Urana and Mintaro are new hardseeded subclover varieties suited to the acid, pastoral soils of the granite belt and traprock in QLD and the north-west slopes in NSW. Urana is the most productive and persistent early-mid season variety that has been developed for these lands. Cavalier and Scimitar spineless burr medicas have been very promising in evaluation trials and demonstrations. In addition, the button medic line South Australia 8460 is in the commercialisation pipeline as Bindaroo and a first variety of Lotus ornithopodioides will be released through AgWA.

Promotion through on-farm demonstrations has been enhanced through the EC 300 NAPLIP support project. Agnotes and Fact Sheets have been developed and media releases distributed. The NAPLIP product booklet has been developed and placed on the DPI&F website.

The objectives have been achieved despite the very dry conditions experienced in the northern grain belt. The national, collaborative process with well targeted goals within each project contract, with project coordination and annual collaborators' meetings to review progress and to set strategic and operational objectives for the following year and beyond, is a successful model to emulate in future research, development and extension (RD&E) supported by external funds. Annual spring tours that have demonstrated the performance of new, targeted germplasm in the various environments around Australia has been a successful innovation. The NAPLIP process has developed a national camaraderie that has contributed
strongly to the success of the project. In addition, there has been equally strong collaboration and support within the zone between the three collaborating agencies.

The project has also been instrumental in enabling a significant growth in capacity in systems research to occur, which has added to the research capacity in Grain and Graze projects and the GRDC funded farming systems projects in the region. This outcome was not a milestone but has been a very significant one as evidenced by the breadth of research reported in the publications section.

**Recommendations**

1. That the next phase of research in pastures (under Pastures Australia) will have a far greater systems approach. While NAPLIP has focused on variety development, producers need to better understand their management and the best options to deliver animal production and soil N and carbon benefits to producers. Some of this may be delivered through Grain and Graze but there needs to be considerably more research to test new and novel options using thorough, rigorous methodologies outside the participatory methodology of Grain and Graze.

2. That appropriate research and development corporations whose industry members gain from improved pasture varieties and their systems applications continue to contribute to on-going funding for pasture research into the northern cropping zone through the Pastures Australia initiative.

3. That a pasture plant improvement component be included in the Pastures Australia agenda to focus on overcoming identified deficiencies in key varieties through pasture breeding. As an example, powdery mildew has become a serious problem with barrel, strand and burr medics. Varieties resistant to powdery mildew would have immediate adoption and a very high level of adoption.

4. That the collaborative processes implemented through the NAPLIP model be maintained in future national funding initiatives.

**Outcomes**

**Economic:** This project will deliver more sustainable and profitable grain-based farming systems across the northern cropping zone. This will be achieved by evaluating and developing, and eventually commercialising new pasture legume varieties that are significantly better than the existing varieties. They will provide mixed grain/livestock producers with alternative pasture rotations that significantly improve the performance in soil N and livestock production in their grain-based farming systems. The program also identified pasture legume genotypes that might deliver further advances in legume productivity post 2005.

These new legumes are adapted to the four million hectares of cropping soils in the northern cropping zone. Their use will deliver an increase in cereal yields of up to 50% from soils which are severely N depleted. Higher N nutrition from these legumes also has the potential to raise protein levels from 8-10% to 12-14% protein with significant income from higher quality. These legumes will also enable producers to provide higher quality feed and hence faster growth rates in livestock. For instance, growth rates from some tropical legumes can deliver liveweight gains in excess of 0.7-0.9kg/hd/day for periods of 200 days per year. Even at a stocking rate of four animals per hectare, this equates to production rates of 3.2kg ha/day. An increasingly important economic benefit from the use of these legumes in cropping systems is as a source of N in an economic environment which has seen very rapid international oil prices, and hence N fertiliser price rises, in the past 12 months.

**Environmental:** These legumes have the potential to overcome soil fertility decline, which, with declining carbon levels, is one of the major environmental issues in landscapes which have a long cropping history. The legumes also have the potential to be used in association with grasses which have potential to raise soil carbon levels. Grass/legume and perennial legume pastures will benefit soil structure, enhance infiltration and reduce runoff and erosion, and as perennial components in farming systems, will restrict soil water leakage that occurs during wetter summer seasons.

**Social:** The project team comprised scientists from CSIRO Sustainable Ecosystems, QLD DPI&F and NSW DPI. These researchers are also Partners in Grain & Graze initiatives and outcomes from the NAPLIP project form a key part of the Grain & Graze research agenda which has a strong on-farm research focus. This connection between the projects builds significant
growth in knowledge and capacity about the role and options in pastures-in-cropping systems for producers and extension specialists and delivers into GRDC’s strategy to identify and overcome factors constraining adoption of better conservation and farming systems practices to protect industry investment, production, capability and community’s land use options.

**Achievements/Benefits**

The objective of the project has been to identify, evaluate and release new pasture legume varieties that enhance the environmental and financial performance of grain-based farming systems in QLD and northern NSW, and collect, package and market information that will promote their use upon release. Adoption of these new varieties into cropping systems on 480,000ha of fertility depleted soils of the northern grain belt will have an estimated economic impact of $80/ha/yr based on current prices of N fertiliser and the value of crops and animal products. Adoption is expected to be slow unless immediate support is provided for agronomic studies of the implementation of new varieties into farming systems. Growers need to know how to use new legumes such as burgundy bean and sulla in farming systems. Further pasture legume improvement should be restricted to addressing the limitations of existing varieties. Powdery mildew resistance of medics should be overcome in the near future with breeding following work initiated in this project.

This component of the NAPLIP project in the northern grain belt, the SDR zone has been successfully carried out by effective within-zone collaboration between the agency contract holder CSIRO SE (tropical legume development), NSW DPI (temperate and tropical legume development) and DPI&F QLD (temperate legume development). In turn, the temperate legume development has been carried out with strong collaboration with interstate agencies, particularly SARDI. This is associated with the occurrence of alkaline soils in both areas.

The objectives have been achieved despite the very dry conditions experienced. This success is a testimony to the national, collaborative process with well targeted goals within each project contract, coordinated by annual collaborators’ meetings to review progress and to set strategic and operational objectives for the following year and beyond. This has been supported by annual spring tours that have demonstrated the performance of the new, targeted germplasm in the various environments around Australia. The NAPLIP process has developed a national camaraderie that has contributed strongly to the success of NAPLIP. In addition, there has been equally strong collaboration and support within the SDR zone between the three collaborating agencies.

The success of the past five years of the project is embodied in the new varieties released or in the commercialisation pipeline as follows:

Two varieties of the new summer growing legume, burgundy bean, Cadarga (CPI 55769) and Juanita (CPI 68892) have been released and substantial quantities (six tonnes in 2003/04, 20 tonnes in 2004/05 and 100 tonnes in 2005/6) have been produced by the commercial partner, Heritage Seeds. The seed is being provided to growers as a blend of the two varieties. Burgundy bean meets the grower’s need for a short term summer legume for cropping soils in the subtropics.

The desmanthus accession Q9153 has shown better field performance than the commercial variety Jaribu over four years of continuous evaluation and its release is being considered by a commercial partner with a target date of approx. 2-3 years with seed increase currently underway in north QLD. Desmanthus is a summer growing perennial legume for long term legume grass based pastures. This replacement for Jaribu would be expected to create a productive presence in the pasture more quickly than its predecessor (Marc). It has excellent seedling regeneration and production but its use will be limited to longer term pastures because of its lower dry matter production in its first year. A potential outcome may be its release as a blend between Marc and Q9153.

There are now a large number of temperate legume options available for producers that have resulted from inter-agency collaboration. Sulla is a very promising, highly productive legume. Two varieties, Wilpena and Moonbi, have been commercialised with seed available in 2007. Sulla will be used on the less sodic soils, probably as a mono-specific, highly productive short term winter legume and, if successful in this role, will find favour as it does not cause bloat.

Coolamon®️, Izmir®, Urana®️ and Mintaro are new hardseeded subclover varieties suited to the acid, pastoral soils of the granite belt and traprock in QLD and the north-west slopes in NSW. Urana is the most productive and persistent early-mid season variety that has been developed for these lands.

Cavalier®️ and Scimitar®️ spineless burr medics that have been very promising should find a place in medic mixtures on loamy marginal soils in particular, but perhaps in any grass/medic pastures. In addition, the button medic line South Australia 8460,
is in the commercialisation pipeline as Bindaroo. This is a very early flowering medic that sets large quantities of seed quickly and would be used to develop a more resilient medic component in long term sown and native pastures. This project has played a role in identifying resistance to powdery mildew in medics and in providing disease inoculum from QLD for the initial phase of a SARDI breeding program to develop powdery mildew resistant barrel, strand and burr medics. These products will be readily adopted by industry.

A first variety of Lotus ornithopodioides will be released. This will be a useful adjunct to medics in long term pastures.

Naturalised burr medic is recommended but duty-of-care resulted in NAPLIP placing a moratorium on release owing to spines.

There were some species where new varieties had been anticipated. Perennial lablab crosses that were hoped to be more drought tolerant than Endurance were evaluated. However, in dry conditions, they proved to be no better than commercial Endurance and a new variety was not released.

Similarly, butterfly pea accessions were evaluated for a better growth response to lower subtropical temperatures than Milgarra but none were better than Milgarra although one accession, 72451 may have potential if longer term comparisons could be undertaken. An issue at present is that burgundy bean is being successfully adopted in southern QLD and northern NSW for short term pastures where lucerne remains the major legume for longer term phases. Milgarra remains very successful in central QLD where it fills the perennial role of lucerne in that region.

Promotion through on-farm demonstrations has been enhanced through the EC 300 NAPLIP support project. This has been supported by Agnotes and Fact Sheets, media releases, the development of the NAPLIP product booklet and its placement on the DPI&F website. Further promotion in the tropical legumes has been delivered by fact sheets developed under an Australian Centre for International Agricultural Research (ACIAR) project. Those fact sheets and an associated selection tool for forages are available on the web at www.gropicalforages.info

These fact sheets are being used by seed companies to provide information to producers and are included in the final technical report to be sent to Australian Wool Innovation (AWI).

There is a vital need to understand the role of the new legumes, particularly burgundy bean and sulla, in forage provision systems. There is also an urgent need to conduct agronomic and systems research to support the adoption of new legumes into these farming systems. Better and more reliable information reduces the risks associated with the adoption of new technologies and would undoubtedly enhance rates of adoption and lead to more rapid benefits to farm profitability and the environment.

The project has also been instrumental in growing the science capacity and knowledge in the partner institutes. Since this project began, both CSIRO and DPI have undertaken associated research which has either been funded internally by the research providers, or external agencies other than GRDC. This has resulted in very significant advancement in research capacity and knowledge in legume physiology and modelling of lablab, (see Hill et al. in publications) and in systems analysis (see Whitbread et al. and Hill et al. in publications). This work has evolved from the initiatives developed in both the NAPLIP projects and has been a very important outcome for the producers in the region, for science, and for the research institutes.

**Other research**

1. What are the best options for management of accumulated symbiotic N to benefit subsequent crop yields and quality for a number of years by mechanisms such as the incorporation of grasses or other non-legumes in the system to build soil carbon?
2. Research to better match feed systems to meet market demands in livestock industries. Livestock producers who are finishing animals need to have a better understanding of the feed potential of forages and the feed demands to meet targeted markets. This research needs to include the role of native and exotic grass pastures in such analysis, and also include the environmental benefits from better use of feed through existing crop and pasture systems.
3. Better management of weeds in both the tropical and temperate legume systems. Weeds are of particular concern in this region because of the rainfall distribution which has summer and winter peaks.
4. Is there potential to use both tropical and temperate species in the same paddock and system to deliver production over a longer period, and, if so, what are the best species for doing this? What are the constraints (soil water, weeds, competition), and the benefits in production and weed control?
5. On-farm research and demonstrations through grower groups of the pasture options available to producers in studies is being undertaken in the Grain & Graze program.
6. A detailed economic analysis of the potential role of legumes in systems to demonstrate the benefits, constraints and risks associated with the range of crop-livestock enterprises.
7. An analysis of the impact of global changes such as climate change, rapidly increasing fuel prices and growing demand for livestock products internationally on mixed crop-livestock systems in this region, and more specifically, the role of pastures.

**Intellectual property summary**

New varieties have been or are being released according to NAPLIP protocols with the lead being taken by CSIRO SE regarding the commercialisation for all tropical species. Burgundy bean was not eligible for Plant Breeder's Rights (PBR) but released as a public variety through exclusive arrangement with Heritage Seeds. The same will apply for the potential release of desmanthus. For temperate species, SARDI will release sulla, burr medic, powdery mildew resistant medics and Mintaro subclover; Ag Western Australia will release Coolamon®, Urana® and Izmir® subclovers and lotus; and DPI&F Queensland, button medic. In each of these releases, PBR is sought for bred varieties. Exclusive rights for varieties by private companies have been sought through an expression of interest (EOI) process after variety release.

**Additional information**

List of papers published:


Lloyd, David, Johnson, Brian, Teasdale, Kemp and O'Brien (2004). NAPLIP II - temperate annual pasture legumes for QLD Western Farming Systems (WFS) - QLD Results Booklet 2004. ed. Michael McDonald (Department of Primary Industries and Fisheries, QLD).


