final report

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Protecting north Australian grasslands from rejected forage plants of high weed potential

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Abbreviations

AQIS	Australian Quarantine and Inspection Service
ATCFGRC	Australian Tropical Crops and Forages Genetic Resources Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DNR&M	(Queensland) Department of Natural Resources and Mines (now Department of Natural Resources, Mines and Water)
DPI&F	(Queensland) Department of Primary Industries and Fisheries (previously Department of Primary Industries)
EPA	(Queensland) Environmental Protection Agency
MLA	Meat and Livestock Australia (previously the Meat Research Corporation)
NAPPEC	North Australian Pasture Plant Evaluation Committee

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Abstract

During the second phase of a six-year plant eradication program, four unpalatable perennial legumes (*Acacia angustissima*, *Aeschynomene brasiliana*, *Aeschynomene paniculata* and *Indigofera schimperi*) were treated for eradication at 66 locations in Queensland before they invade grazing lands. The methods used included selective herbicides, manual removal, cultivation, controlled grazing and fire. The target plants were contained at all locations. Plant populations declined over the three years and seeding was prevented at most sites. However, continued monitoring and treatment is required at these sites to ensure future control. Larger, more mobile, populations are a concern at six sites, one in particular. A more substantial effort will be required to contain and eradicate plants at these sites. Two applications for funding were submitted to undertake continued eradication. To assist with the development of long-term control strategies, awareness of the target plants and the eradication was promoted to a range of stakeholders and an information resource produced. A Code of Practice for the evaluation of pasture plants in Queensland was refined and progressed. These activities will benefit the Beef Industry through preventing future loss of animal production and costs associated with the control of pasture weeds originating from plant evaluation programs.

Executive Summary

Project NBP.327 is the second phase of a six-year plant eradication program begun during 1999. The eradication program was developed following concerns by researchers and Industry representatives that some of the many grasses and legumes evaluated in Beef Industry and state and federal plant evaluation programs may become significant weeds of north Australian grasslands. These concerns appeared justified as, later, the potential cost, in terms of lost beef production and costs of plant eradication, of one of these plants (*Aeschynomene paniculata*) was estimated at over $350 M (Brinkley and Bomford, 2002). The eradication program targeted control of this species and three other legumes considered to have high weed potential.

Previous plant evaluation and eradication
The plant evaluation programs, undertaken between 1986 and 1998, were of a broad scale, covering a wide range of land-classes in Queensland and a wide range of species (mostly exotic) and ecotypes within these species (over 2000 accessions). Overall, the programs are considered to have been successful: characterisation of the tropical forages collection has enabled researchers to identify useful species and ecotypes, some later being commercially released, and to identify species or ecotypes of little potential future value, contributing to the rationalisation of the tropical forages collection. However, the programs involved the establishment, effectively biological release, of new plants at sites across Queensland on a variety of scales (small plots to 40 ha grazing trials). In keeping with responsible practice, the proponents of the evaluation programs sought to undertake actions to prevent any undesirable plants becoming widely naturalised.

During Phase I of the eradication program, NAP3.225 (1999-2002), all species established at evaluation sites were appraised for weed potential. Four perennial legumes were identified as high priority for control and eventual eradication: *Acacia angustissima*, *Aeschynomene brasiliana*, *Aeschynomene paniculata* and *Indigofera schimperi*. All are well-adapted to (various) large areas of northern Australia, prolific producers of long-lived seed and have either moderate (*A. brasiliana*) or low (other three species) palatability to livestock. Each can form dense stands, which often exclude companion plants, and are considered to have no, or very limited, production value. *Acacia angustissima* is considered a high priority weed by DNR&M in Queensland and *A. paniculata* has subsequently been nominated as a priority national 'Sleeper' weed.

Early in Phase I, each of the 100+ evaluation sites planted to one, or more, of the target plants was surveyed and the data compiled in a DPI&F database. Where present, plants were killed prior to flowering using a range of techniques and plant populations monitored over successive visits. The plants were restricted to the eradication sites and mature (seeding) plants removed from most sites. Plant populations were reduced by the end of the project, but most sites still had new plants emerging each year, many at some sites.

The proponents of Phase II, NBP.327 (2002-2005), sought to continue the plant eradication activities of Phase I, but also increase awareness of the target plants amongst stakeholders and promote best practice during pasture plant evaluation to minimise the risk of future release of undesirable plants.

Plant containment and eradication
As for Phase I, the purpose of the eradication activities was to contain the plants to current sites/properties, prevent seeding where possible and reduce plant populations. Project objectives included eradication of plants at 80% of evaluation sites, with reduced plant populations and soil-seed loads at the remainder, and the development of plans for sites where plants had not been eradicated by Project end.

There were 66 locations in Phase II, divided into 93 sites based on species present and the distribution of the species at each location. Similar methods were used to that of Phase I to

contain and reduce plant populations: timing visits to coincide with vegetative growth; killing plants with selective herbicides, manual removal, cultivation or rotational cropping and using heavy grazing, fire and tree-clearing to assist in these processes; surveying surrounding areas and monitoring plant populations. The approach was effective overall, although drought delayed activities at southern inland sites and poor access hindered treatment at a few remote sites in monsoonal areas. By June 2005 plant populations had been contained at all locations and were significantly reduced at 70% of sites. One third of locations had no plants emerge for at least two years and 86% were considered to be under absolute control (*ie* all emerging plants killed before seeding). Six locations, originally established on a large scale, contain large or mobile populations and therefore require substantial future effort.

Following internal Project review, the most appropriate and effective approach for short-term site management was considered to be extension of the eradication program, using a similar approach and effort to the previous two program phases. Additional effort and funding was required at one northern site (Batavia Downs, Weipa) to locate and control *A. paniculata*. Two funding proposals were developed by DPI&F and submitted to MLA and the Federal Government respectively.

Increased awareness amongst stakeholders
Project objectives linked to this outcome were to increase awareness of both the risk of the target plants and the eradication program amongst a broad network of land protection agencies and to develop technical information packages to assist in awareness and long term control of the target plants. A wide range of stakeholders (policy through to on-ground eradication and stakeholder industries) were exposed, and contributed, to the eradication program through: a multi-agency forum; a presentation at the 2005 Queensland Weed Symposium; and a community event. A comprehensive CD-ROM information resource was produced which includes information useful for locating, identifying and controlling the target plants.

Prevention of future release of undesirable plants
The proponents sought to document best practice for pasture plant evaluation and commercialisation, so that new beneficial plants may be developed as required by the grazing (or other primary) industries, while minimising the risk of release of undesirable plants. Within the Project, a previously developed Code of Practice was reviewed for potential effectiveness, rewritten and submitted to DPI&F, the custodian of the forage plant collection, for adoption as a working document. The use of a Code of Practice was also promoted at an international herbage seeds conference.

Benefits to the Beef Industry and other stakeholders
The benefit of the eradication program can be interpreted as the *potential cost prevented* should the target plants become widely naturalised (*ie* the cost to control them and/or losses of production). The value is difficult to estimate, but considered substantial. The benefit requires that the plants are restricted in distribution, now and in the future. This project has contributed to this end through containment and continued reduction of the target plants at all known sites. Increased involvement of agencies outside the immediate project team, as promoted during the Project, will also likely contribute to long-term control.

A secondary long-term benefit of the Project is, through the adoption of best practice protocols, the future capacity to develop new pasture plants held within the tropical forages collection, with the confidence that there is a low risk of releasing undesirable plants.

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1 Background

1.1 Duty of care when evaluating new pasture plants

1.1.1 The need for new pasture plants in Queensland

Well-managed sown pastures, using introduced grasses and legumes, are a productive, and now essential, component of coastal and sub-coastal beef grazing production systems in northern Australia (Walker *et al*., 1997; Walker and Weston, 1990). They enable graziers in many environments to cost-effectively achieve desirable stock growth rates, while using minimal water and fertiliser application to do so. The annual gross benefits of this production was estimated at $80 million during the 1990s (Walker *et* al, 1997). Certain sown pastures also help to conserve native grasslands, a key feed resource of the beef industry, through enabling higher production on certain land classes and therefore allowing strategic spelling of native pastures, minimising erosion and out-competing unpalatable weeds.

The potential area in Queensland well-suited to sown pastures has been estimated at 22.1 M ha (Walker and Weston, 1990) and by 1997 an estimated 4.9 M ha had been planted (Walker *et al*., 1997). Over 140 cultivars of grasses and legumes have been developed in Queensland, principally by State and Federal government agencies, and many are still being used successfully in sustainable grazing and cropping production systems. Until the 1990s,the primary purpose of the evaluation and release of new grasses and legumes was to increase or maintain productivity of the grazing industries, mostly through replacing or complementing native grasslands considered to be less suited to the demands of profitable grazing systems. There was also a perceived need to provide options to replace useful cultivars should they, as for other useful cultivars before them, succumb to pests and diseases.

1.1.2 Pasture plant evaluation for the beef industry

During the 1980s and 1990s, short-term, but comprehensive, plant evaluation programs were undertaken by the (Queensland) Department of Primary Industries (now DPI&F) and CSIRO, with funding from the Meat Research Corporation (now MLA). The intention was to identify and release pasture plants to enhance the productivity of grazing systems in northern Australia. The three key projects were:

- Coordinated pasture evaluation in northern Australia (COPE) – Project DAQ.081 (1986-1995);
- Backup legumes for stylos (BULS) – Project DAQ.083 (1992-1998); and
- Legumes for Clay Soils (LCS) – Project DAQ.086 (1992-1996).

These projects are discussed in detail in Appendix 1 (originally prepared for the first phase of this eradication program). In essence, the proponents sought to assess a wide range of (mostly) exotic grasses and legumes planted in small plots at sites strategically placed throughout Queensland. A limited number of promising accessions were evaluated under controlled grazing conditions and some of these later recommended for commercial release following independent review.

The projects enabled researchers to identify the most promising species and accessions held within the ATCFGRC, then managed by CSIRO but now by DPI&F. In addition to identifying, and later releasing, promising accessions, the projects served to identify undesirable plants, assisting to reduce the collection from 26 000 to 12 700 elite accessions.

1.1.3 Potential risks of biological release of undesirable plants

Pasture plants for extensive beef systems must be productive (produce sufficient biomass of suitable forage quality), persistent and have good colonising ability. These can all be considered characteristics of weeds if the plants are not genuinely useful for primary production or readily colonise undisturbed areas of high conservation value. Plants with the above characteristics, but low palatability or acceptance to live-stock, are generally considered to have weed potential. It is

therefore implicit that considerable care be taken when evaluating new plant material, particularly from exotic locations (whether in Australia or overseas), for pasture production.

Weed risk is first assessed by AQIS as plants enter the country. However, at the time of the plant evaluation programs, prevention of the accidental release of a new weeds of material in the forage collection relied on the research agencies and their collaborators. Care was taken to identify, and prevent the release of, weedy types before they were evaluated on a large scale. However, although the projects were conducted conscientiously, it is now apparent that several legumes with high weed potential were sown at larger sites in Queensland and formed persistent populations.

The concerns of staff involved in the evaluation programs prompted development of a proposal to assess the weed potential of undesirable plants established, effectively biologically released, at the plant evaluation sites. This led to the two phases of an eradication program, the second of which is reported in this document. It was also proposed that actions be taken to develop protocols for researchers undertaking the evaluation of new pasture plants to minimise future accidental release of potential weeds. This was undertaken during the late 1990s and progressed during the eradication program.

1.2 The first phase of the eradication program

1.2.1 Project structure

Project NAP3.225 'Managing Old (discontinued) Plant Evaluation Sites (MOPES)' (1999-2002) was led by DPI&F, co-funded by MLA and involved on-ground support from staff of CSIRO and James Cook University and liaison with staff of DNR&M and EPA (Department of Primary Industries, 2003). The staff involved, mostly of DPI, were familiar with the plant evaluation programs and the sites used.

The scope of the Project was Queensland-wide, sites located from Cape York to the southern border, including coastal, sub-coastal and (in a few occasions) inland pastoral districts. On-ground staff were based at Walkamin, Townsville, Mackay, Gympie, Toowoomba, Roma and Brisbane.

1.2.2 Progress towards objectives

The Project had four key objectives:

- to compile a register of forage plant evaluation sites established in Queensland since 1986 (when the first of the three plant evaluation programs began);
- to develop and implement a management plan for discontinued evaluation sites;
- to monitor, contain and, if possible, eradicate currently identified, and potential of concern, introduced forage plants; and
- to record procedures and document results, for development of a site management manual.

The QPastures database was used to compile a list of evaluation sites originally planted to one, or more, of the following target plants:

- *Acacia angustissima*;
- *Aeschynomene brasiliana*;
- *Aeschynomene paniculata*; and
- *Indigofera schimperi.*

Each of the 'target' species were nominated for eradication because, during the plant evaluation programs, they were persistent (perennial or recruited readily from seed) and well-adapted to many sites, produced large volumes of long-lived seed, had low palatability to stock and

demonstrated the potential to dominate companion vegetation. *Acacia angustissima* and *I. schimperi* also demonstrated the ability to regenerate from roots.

Eighty-two sites were monitored for the target plants and, where present, control of plants was undertaken. Selective herbicides, many previously identified in herbicide screenings conducted during the evaluation programs, were the major control method, although cultivation and cropping, manual removal of plants and strategic grazing were also used to suppress flowering and kill plants before they set viable seed. Eradication activities were timed (with rainfall or normal growing season) so that plants were treated before seeding.

The duration of the eradication program was too short to ensure eradication of plants at sites where the target plants had persisted (approximately 60 sites). However, plants (as well as could be detected) were restricted to their sites and plant populations and soil seed reserves had begun to decline at most sites. Low rainfall likely contributed to low levels of plant emergence at many sites in non-monsoonal areas. Control was best at the small plot-scale sites: large plant populations remained at some of the larger (up to 40 ha) grazing sites.

A site management manual was not prepared because a more applicable (because it addressed the Environmental Protection Act (1994)) protocol, a Code of Practice, was being developed. The Code of Practice for the Evaluation and Release of Pasture Plants was being developed by NAPPEC (now disbanded), a multi-agency group of researchers and representatives of commerce involved in the development of new pasture plants.

1.2.3 Key recommendations

The full recommendations of NAP3.225 are listed in Appendix 2. The foremost recommendation was to continue plant eradication activities to build on progress. It was suggested that the program would benefit from the involvement of a wider range of agencies, perhaps eradication programs from other government agencies. The development of information packages to promote future best-practice in plant evaluation was also seen as a priority. These recommendations were strongly considered when developing Phase II of the eradication program. [A copy of the final report for NAP3.225 is contained in the CD-ROM package attached to this report.]

1.3 The second (current) phase of the eradication program

1.3.1 Project aims

During Phase II of the eradication program (NBP.327), the proponents sought to:

- continue eradication at all sites where the target plants were known to have persisted (65 sites), or were subsequently found (one site);
- increase awareness, amongst a wide range of land-protection agencies, of the risk posed by the target plants and measures that may be taken to promote long-term control; and
- develop or promote measures to minimise the risk of accidental releases of weeds when developing pasture plants in the future.

The involvement of a wider range of stakeholders recognised that, even given absolute vigilance by the Project team, the target plants may somehow escape from the evaluation sites *ie* there is a recognition that the target plants have been biologically released. However, there is good opportunity to prevent them becoming serious weeds of grasslands in northern Australia.

1.3.2 Project structure

Phase II of the eradication program continued immediately on from Phase I and was completed in January 2006. The proponents, on-ground staff and funding arrangements were similar to Phase I, although the role of Project Leader was transferred from Harry Bishop to Kendrick Cox (both DPI&F). Staff of EPA and DNR&M continued involvement in the strategic direction of the Project.

Plant eradication activities continued throughout the three years of the Project, undertaken as conditions at each of the sites allowed. Activities to promote awareness of the project and best practice protocols for pasture plant evaluation were undertaken during final two years. The development of extension resources was a major component of the final year.

The Project was reviewed by MLA during the final six months of 2005. It was recommended that an application be submitted by DPI&F to MLA for the continuation of eradication activities.

1.3.3 Report content

This Final Report primarily presents progress towards achieving the Project objectives, aligned to the three Project aims (above), and the methods used to do so. Key outputs are summarised and many referred to Appendices. A copy of the extension resource CD-ROM is attached for reference. Recommendations for future eradication activities are presented, along with a copy of the submitted application for extension of the Project (Appendix 3).

2 Project Objectives

By January 2006:

Objective 1 Target plants will be eradicated at 80% of evaluation sites and plants and soil seed loads significantly reduced at the remainder of the sites.

Objective 2 Develop action plans at sites where plants are not eradicated to ensure eradication is achieved. These plans will include the groups/organisations that will undertake the work and where the funding is to be sourced.

Objective 3 Technical information packages will be produced and made available in a range of formats suitable for use by other stakeholders.

Objective 4 All relevant data from the Project will be entered on the QPastures database, and other relevant databases, and made available for use by all stakeholders.

Objective 5 A broad network of land protection agencies will be aware of the significant risks of the target plants, control measures and the activities of other agencies in managing these weeds.

Objective 6 Plant evaluation and commercialisation best practices will be documented.

The following communication media were proposed to variously address Objectives 2-5:

- CD-ROM information resource including technical reports, identification tools, potential distribution maps, site descriptions and best practice management with selected technical notes available through the DPI&F website;
- relevant information on the QPastures database available to the public;
- plant release forum involving researchers, policy makers and representative of the grazing and seed industries;
- scientific media; and
- internal project reports and publicity through the MLA media.

3 Methodology

Project activities are reported below in three categories aligned to the broad project aims of plant containment and control; increasing awareness and documenting best practice in future plant evaluation. A similar approach was used for the reporting and discussion of results.

3.1 Plant containment and eradication

3.1.1 Strategy

The overall strategy was simply to use staff with good knowledge of the target plants and the plant eradication sites to undertake or supervise weed control and monitoring in combination with site managers. It was recognised that persistence and spread for all of the target species relied heavily on seeding and the transport of seed. Accordingly, methods were employed to kill plants prior to seeding, thereby slowly eroding soil seed-banks and reducing long-term plant populations, and monitoring undertaken to detect plants moving from the core eradication areas at each site. The plant eradication methods employed were those found to have been successful during the first phase of the program, these based on the plant populations and features particular for each site. Control methods were also chosen for efficiency of officer time and resources and timed to maximise efficacy (particularly herbicide application).

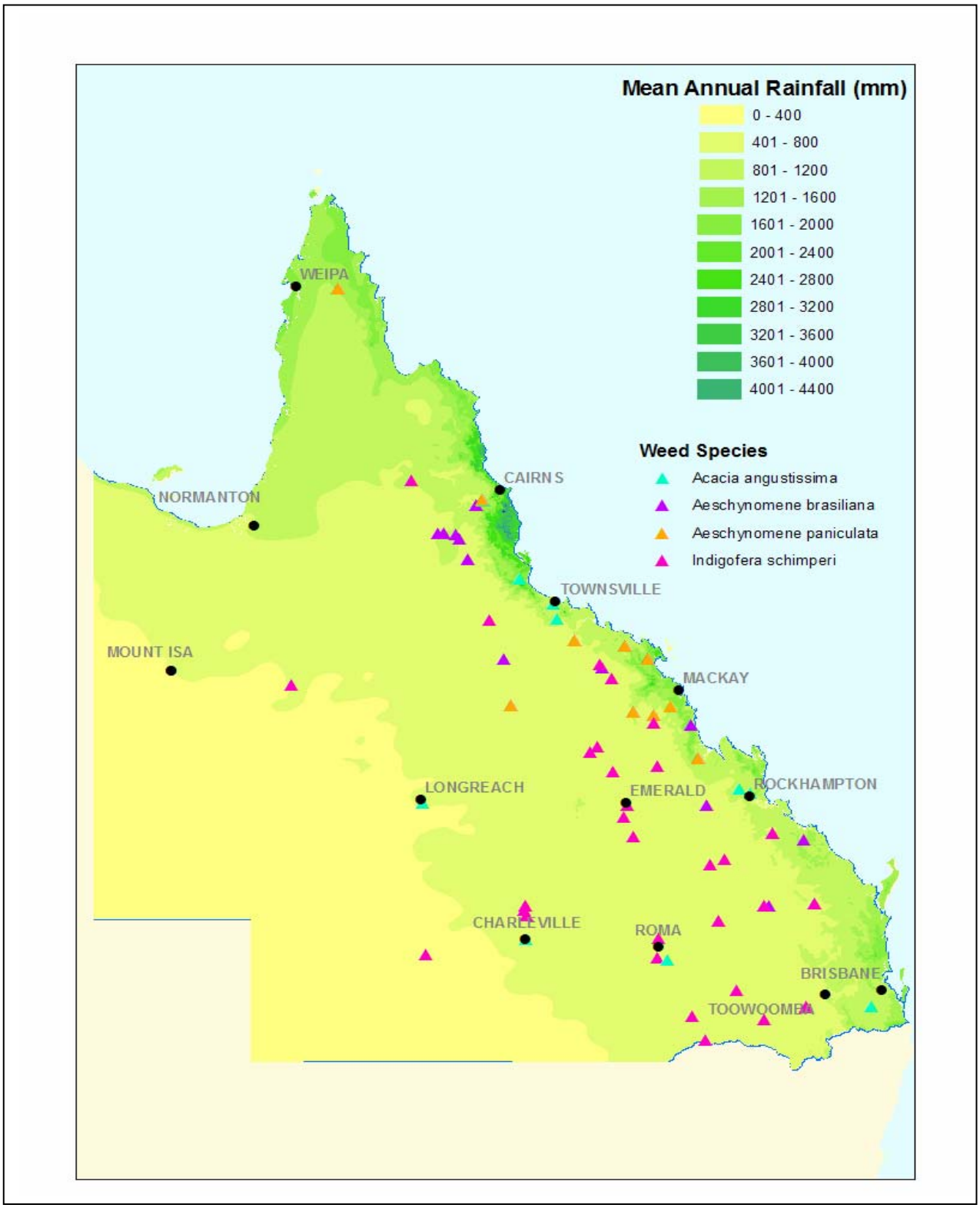
3.1.2 Technical approach

Sites where the target plants had been sown, and those where the plants had persisted, were identified during Phase I of the eradication program, mostly through records of the agencies involved in the plant evaluation programs. Sites where the plants were known to have successfully established became the core sites of the Phase II (Figure 1). However, other sites where it was considered that some plants may eventually occur (*ie* where seeding was suspected) were also occasionally visited.

All core eradication sites were visited regularly, aiming for control of plants before seeding. Visits were usually timed to coincide with good growing conditions, moderate to high temperatures and prior rainfall the key criteria. In monsoonal areas visits were timed to coincide with early season storms, which encouraged seedling emergence, and following the peak wet period to kill remaining plants before they seeded. Often an additional visit was undertaken during early winter to kill any plants previously missed. In areas with less reliable rainfall, visits were conducted when the officer, based on his experience of the local area, considered it likely that the plants would have established.

The frequency of visits and the resources used were also determined by the perceived likelihood of seeding if no intervention was undertaken or the likelihood of missing plants in a particular visit. Accordingly, those sites with larger plant populations, a few into the tens of thousands emerging annually, were visited more frequently and more resources (labour and equipment) used than for the (many) sites containing small plant populations. The frequency of visits required for each site is presented in the Results and Discussion section. One or two officers were required to treat and monitor the smaller sites, with activities usually over half to one full day once or twice per year: minimal resources were required. Larger sites required considerably more effort and equipment: four weeks work for three or four staff per annum plus mobile spray units were required at the worst site. Many of the sites were remote, requiring appropriate equipment and precautions. The distribution of project resources amongst officers was determined by these factors.

Figure 1. Distribution of core eradication sites.



The methods used to kill plants at each site were dependant on the target species present, the size and nature of the plant population and certain characteristics of the site (eg. cleared or uncleared, cultivatable or not). The key methods used to control the target plants are presented in Table 1. Selective herbicides, applied as spot (knapsack or quad-bike) or boom application, were by far the most used method of killing plants because they could be applied efficiently and provided good control of plants. Areas treated with selected herbicides were often grazed or burnt to enhance detection of the target plants. Cultivation, sometimes in combination with selective herbicides, was used when possible because it provided promise of excellent weed control. Small populations were often treated manually, with plants removed by hand or with a mattock, and seeds carefully removed from the site and later burnt. Competitive grasses, usually exotic pasture grasses used locally, were encouraged at some sites to suppress establishment of the target plants.

The system used to detect plants varied by site and the particular method chosen was left to the discretion of the local officer. Sites with small plant populations and no, or few trees, (many southern sites) required no special systematic approach. Larger sites, and those containing dense tree populations, required a more systematic approach to avoid missing plants. At northern sites, for example, spray 'runs' were conducted between marked trees and spray dyes used to mark treated plants. GPS coordinates were also used to assist the location of plants found, treated and logged in previous years.

During each visit, staff surveyed the area surrounding the infestation for any escapees. Landholders were also shown the plants and encouraged to report any occurrences to the project officer so that the plants could be treated. This also encouraged better quarantine of vehicles and stock. Each officer was responsible for maintaining records of their eradication activities, the weed status of each site and any changes to the site which may impact on control of the target plants.

At one large (40 ha) fenced site (Sugarbag) containing a large population of *A. brasiliana* which had previously seeded, the strategy of containing and suppressing growth and seeding through heavy grazing and the use of competitive grasses was used, rather than directly killing plants. This approach was reviewed (Department of Primary Industries and Fisheries, 2005) during 2004/2005 at the request of MLA and subsequently the site was managed for eradication.

Technical reviews were conducted each year to monitor overall progress of the eradication program and to identify any changes which could improve plant control. During the final year of the project, each officer assisted in the completion of a site survey, including: GPS locations; site specifications and management; weed status, seeding and changes to plant population; and the estimated future effort and resources required to control the plants.

3.2 Improved awareness of the target plants

3.2.1 Strategy

It was considered that there is greater opportunity to control the target plants in the long term if a greater range of agencies is aware of the potential problem and have access to appropriate information. Two broad audiences were targeted: land protection agencies involved in weed policy; and organisations more likely to be involved in on-ground activities, such as detection. The activities undertaken differed for the target audiences.

Table 1. Methods used to control the target plants under various circumstance.

Acacia angustissima	
Small populations (<100 plants)	Small plants or seedlings: Plants removed with a mattock, ensuring that as much of the root system was removed as possible. Selective herbicides, particularly Grazon1 applied using spot-spray equipment (knapsack or quad-mounted spray tank). Cultivation and cropping. Mature plants: Selective herbicides, particularly Access2 and diesel applied using basal bark spray or cut stump methods. If seeds were present, they were removed and burnt.
Large populations (100+ plants)	Not required within the eradication project.
Aeschynomene brasiliana	
Small populations (<100 plants)	Small plants or seedlings: Hand pulling individual plants. Selective herbicides, particularly Grazon1 or Starane3 + Brushoff4 applied using spot-spray equipment (knapsack or quad-mounted spray tank). Mature plants: Selective herbicides as above. Seeds are difficult to collect.
Large populations (100+ plants)	Selective herbicides, particularly Grazon1 or Starane3 +Brushoff4 applied using spot- or boom-spraying equipment. Strategic heavy grazing was used to reduce seeding at a few sites and grazing and fire used to enhance detection.
Aeschynomene paniculata	
Small populations (<100 plants)	Small plants or seedlings: Hand pulling individual plants. Selective herbicides, particularly Grazon1 or Starane3 + Brushoff4 applied using spot-spray equipment (knapsack or quad-mounted spray tank) or Graslan5 pellets scattered by hand. Mature plants: Selective herbicides as above or removal by hand (has a weak root system). If seeds were present, they were removed and burnt.
Large populations (100+ plants)	Selective herbicides, particularly Grazon1 or Starane3 + Brushoff4 applied using spot- or boom-spraying equipment. Grazing and fire used to enhance detection.
Indigofera schimperi	
Small populations (<100 plants)	Small plants or seedlings: Plants removed with a mattock, ensuring that as much of the root system was removed as possible. Selective herbicides, particularly Grazon1 applied using spot-spray equipment (knapsack or quad-mounted spray tank) or Graslan5 pellets scattered by hand. Mature plants: Plants removed with a mattock. Selective herbicides, particularly Access2 and diesel, treating as for woody weeds. If seeds were present, they were removed and burnt.
Large populations (100+ plants)	Repeated cultivation and cropping where possible. Selective herbicides, particularly Grazon1 and Starane3 +Brushoff4 applied using spot- or boom-spraying equipment.

[1] triclopyr + picloram @ 300 mL product /100L water + non-ionic surfactant
[2] triclopyr + picloram @ 1 product: 60 diesel
[3] fluoroxypyr @ 750 m product/100 L water + non-ionic surfactant
[4] metsulfuron @ 10-15g product/100 L water
[5] tebuthiuron @ 1.5 g product/m^2

3.2.2 Activities undertaken

Agencies developing policy
Staff of the DNR&M weeds policy unit attended all annual technical meetings. This enabled the progress of the eradication program to be reviewed with consideration to evolving weed policy. In particular, this assisted the development of the Code of Ethics for the Evaluation and Release of Pasture Plants (see Section 3.3.2).

A multi-agency forum was hosted by DPI&F and MLA during January 2005 in Brisbane to increase awareness of the eradication program and seek guidance on the development of best-practice protocols for pasture plant evaluation. The forum was attended by senior representatives of a wide range of agencies including: DPI&F, DNR&M, EPA, Weeds CRC, the Australian Seeds Federation, Agforce and MLA. The proceeds of the Forum are discussed in Section 4.2.1.

Agencies involved in on-ground weed-control activities
The key extension resource from the Project was a technical CD-ROM, intended for use as an information tool for organisations or individuals potentially contributing to the control of the target plants, particularly local councils. The CD included: information on the four target species useful for weed control; an overview of the eradication program plus specific information on all sites; best practices and potential options for weed control; and sources for additional information and assistance. The CD-ROM is attached to this report and the content discussed in Section 4.2.2.

The Project was presented as a poster-paper (Cox *et al.*, 2005) at the 2005 Queensland Weed Symposium, Townsville. The Symposium was attended by a wide range of people involved in weed issues in Queensland and was considered a particularly appropriate audience. The Project was also represented at the Townsville 2004 Weedbusters Day, which involved the local community becoming aware of *Acacia angustissima* in Townsville and undertaking some limited eradication.

3.3 Prevention of future accidental releases of undesirable plants

3.3.1 Strategy

When preventing the accidental release of undesirable plants during the evaluation of new pasture plants it was recognised that:

- official quarantine protocols do not always prevent the introduction or availability of germplasm of certain weedy species, or races within species; and
- the establishment of any new pasture plant (species or race) into an environment where there is not *absolute* control of seeding, or other forms of propagation, represents biological release of the plant.

During Phase I of the eradication program, it was decided that progression of a NAPPEC initiative, a Code of Practice for organisations handling new forage germplasm, was the most realistic way of preventing accidental releases of undesirable plants when developing new pasture plants in Queensland. The (draft) Code of Practice for the Evaluation and Release of Pasture Plants, developed by NAPPEC following experiences during the broad-scale plant evaluation programs in Queensland, was used as the template. Although a useful document, progress towards adoption had stalled. It was decided that actions be undertaken during Phase II to progress the Code, including a review to best ensure that implementation would be effective. The target audience was organisations involved in the policy, evaluation and commercialisation of new pasture plants in Queensland.

3.3.2 The Code of Ethics for pasture plant evaluation

Three actions were undertaken to assist progression of the Code:

- The concept of a Code of Practice was a key topic discussed at the multi-agency forum held during January 2005 (see 3.2.2 above). This was instrumental in progressing the Code and allowed scrutiny of an advanced draft by a wide audience. Recommendations for adoption and revision were tabled for progression within the Project (see Section 4.3.1).
- During 2005, and following the Forum, the Code was reviewed by policy staff of the DNR&M and technical staff of DPI&F, with a view for adoption by DPI&F as policy.
- The application of a Code of Practice was presented (Cox and Cook, 2003) at the 5th International Herbage Seeds Conference (2003), attended by seed researchers and commerce from around the world.

4 Results and Discussion

4.1 Plant containment and eradication

4.1.1 Required eradication methods and effectiveness

Sixty-six locations were included in the eradication program, these known to have populations present at the end of Phase I (2003) or known to have seeded prior to 2003 (Table 2). All sites but one were on government facilities or private properties, all traced back to the original plant evaluation programs and containing one or more of the four target species. The remaining site was a small roadside infestation south of Ingham, the plants of unknown origin. Initially considered to be *Acacia angustissima*, and therefore included in the Project, the species was identified during 2005 as *Acacia curassavica* (Appendix 4). A full list of sites known to have ever contained either of the target plants, and the accessions sown at each is presented in Appendix 5.

The eradication sites tended to differ in target species and scale between regions, reflecting the activities of the various plant eradication programs: sites in northern Queensland included one or more of the *Aeschynomene* spp and were often of large scale (up to 40 ha); southern Queensland sites were mostly *I. schimperi* planted on a small scale; and all four species were planted in central Queensland, with *I. schimperi* and *A. angustissima* tending to be planted in small plots and the *Aeschynomene* spp. on a larger scale. The effort required to treat the sites usually depended simply on the scale of the original site (Table 2). Four sites were considered to require considerable control effort: Batavia Downs (Weipa) and Tedlands (Mackay) containing both *Aeschynomene* spp. ; and Burlington, (Mt. Surprise) and Sugarbag (Mt. Garnet) containing *A. brasiliana* only. Of these, Batavia Downs required the greatest effort: three or four officers for three weeks per year and investment in mobile spray units (quadbikes) and tree clearing. Most of the other 62 sites were able to be treated with one or two one-day visits by one or (sometimes) two officers per annum.

The timing of eradication was generally more seasonal in northern and coastal Queensland than southern inland Queensland, reflecting greater reliability of rainfall in northern and coastal areas (Appendix 6). In these areas, eradication was normally conducted during late spring and summer, particularly if the area was prone to a strong monsoonal influence. In southern and inland areas plant eradication occurred throughout the year provided there was adequate soil moisture and temperature (frost prevented winter control at some sites). It was critical to apply plant controls, particularly herbicides, during active vegetative growth and prior to seeding. The flowering physiology of each species, and characteristics of the sites where they were established, meant that, in general, there was one growing season for the *Aeschynomene* spp. per annum and potentially two for *I. schimperi*. *Acacia angustissima* took longer to become reproductively active, particularly at dry sites, so there was more time to undertake eradication before seeding.

The characteristics of each site, and the populations of target weeds present, determined the choice of control method used. These characteristics are presented for each site in Appendix 6 and summarised in Table 3. Selective herbicides were the most commonly required control treatment, particularly for the species with larger plant populations or sites (the *Aeschynomene* spp.). The smaller, often scattered, populations of *I. schimperi* and *A. angustissima* were also controlled effectively through manual removal of plants, although care was required to remove as much of the root system to prevent suckering. The use of competitive exotic grasses, to suppress weed establishment, had some (anecdotal) success with *I. schimperi* in southern Queensland, but was found to be ineffective at suppressing *A. brasiliana* in north Queensland.

Table 2. Sites, north to south, included in the plant eradication program and weed status at June 2005.

Location	Shire	Latitude	Longitude	Species	Number of accessions sown	Site effort status[1]
Batavia Downs RS	Cook	12.66	142.66	*A. brasiliana*	2	3
				A. paniculata	1	3
Wrotham Park	Mareeba	16.71	144.07	*I. schimperi*	3	1
Walkamin RS	Atherton	17.13	145.42	*A. angustissima*	5	1
				A. brasiliana	3	2
				A. paniculata	1	2
Springmount	Mareeba	17.24	145.30	*A. brasiliana*	2	2
Burlington	Etheridge	17.82	144.36	*A. brasiliana*	2	3
Sugarbag	Herberton	17.94	144.99	*A. brasiliana*	2	3
Lamonds Lagoon	Herberton	18.37	145.14	*A. brasiliana*	1	2
Helen's Hill	Hinchinbrook	18.78	146.13	*A. angustissima*	not sown	2
Campus Creek	Townsville City	19.32	146.75	*A. angustissima*	unknown	2
Lansdown RS	Thuringowa	19.66	146.83	*A. angustissima*	unknown	2
Bluff Downs	Dalrymple	19.67	145.5	*I. schimperi*	1	1
Swans Lagoon	Burdekin	20.08	147.17	*A. paniculata*	unknown	1
Mt Dangar	Bowen	20.20	148.67	*A. brasiliana*	2	1
				A. paniculata	1	1
Goorganga	Whitsunday	20.45	148.45	*A. brasiliana*	2	2
				A. paniculata	1	1
Braceborough	Dalrymple	20.48	145.82	*A. brasiliana*	2	2
Birralee	Bowen	20.65	147.68	*A. angustissima*	5	1
				A. brasiliana	2	1
				A. paniculata	1	1
Myuna	Bowen	20.67	147.67	*I. schimperi*	1	1
Havilah	Bowen	20.88	147.86	*I. schimperi*	1	1
Toorak RS	Mackinlay	21.03	141.78	*A. angustissima*	unknown	1
				I. schimperi	unknown	1
Crediton	Mirani	21.18	148.50	*A. brasiliana*	2	1
Tedlands	Sarina	21.36	149.18	*A. brasiliana*	4	3
				A. paniculata	1	3
Glensfield	Sarina	21.47	147.97	*A. brasiliana*	2	2
				A. paniculata	unknown	1
Strathdale (Blue	Sarina	21.53	149.00	*A. paniculata*	unknown	2
Lynford	Nebo	21.75	148.67	*A. brasiliana*	2	2
				A. paniculata	1	1
Oxford Downs	Nebo	21.82	148.67	*I. schimperi*	1	2
Carmilla Glen	Broadsound	21.96	149.5	*A. brasiliana*	2	1
Willunga	Broadsound	22.20	148.37	*I. schimperi*	4	1
Eungy	Broadsound	22.36	148.87	*A. brasiliana*	2	1
				A. paniculata	1	1
Granite Vale	Broadsound	22.42	149.53	*A. brasiliana*	2	2
				A. paniculata	unknown	1
Mutation	Balyando	22.48	147.48	*I. schimperi*	1	2

Table 2. continued.

Location	Shire	Latitude	Longitude	Species	Number of accessions sown	Site effort status[1]
Carramah	Peak Downs	22.87	147.90	*I. schimperi*	1	1
Rosebank	Longreach	23.20	144.10	*A. angustissima*	4	1
Correctional unit	Rockhampton	23.23	150.30	*A. angustissima*	4	1
Parkhurst pasture	Rockhampton	23.32	150.52	*A. angustissima*	unknown	1
Emerald RS	Emerald	23.46	148.01	*I. schimperi*	4	2
Sorrell Hills	Duaringa	23.57	149.68	*A. brasiliana*	1	2
Raglan	Calliope	23.75	150.75	*A. angustissima*	1	1
Goondooroo	Emerald	23.82	148.12	*I. schimperi*	1	1
Galloway Plains	Calliope	24.10	150.57	*A. brasiliana*	3	2
				I. schimperi	4	1
Birrong	Bauhinia	24.23	148.30	*I. schimperi*	1	2
Wadeleigh	Miriam Vale	24.28	151.53	*A. brasiliana*	2	2
Kapalee	Banana	24.40	150.42	*I. schimperi*	1	1
Rangeview	Banana	24.70	150.10	*I. schimperi*	1	2
Brigalow RS	Banana	24.82	149.77	*I. schimperi*	4	2
Brian pastures RS	Gayndah	25.40	151.40	*A. angustissima*	4	2
				A. brasiliana	4	2
				I. schimperi	4	2
Kiamanna	Bungil	25.42	148.85	*I. schimperi*	1	1
Brumich	Murweh	25.68	146.20	*I. schimperi*	5	1
Narayen RS	Eidsvold	25.68	150.88	*A. brasiliana*	2	2
				I. schimperi	4	2
Glen Eden	Murweh	25.77	146.22	*I. schimperi*	5	1
Valera Vale	Murweh	25.88	146.27	*I. schimperi*	5	1
Kookaburra	Taroom	25.92	149.78	*I. schimperi*	1	2
Belcrest	Taroom	26.00	149.90	*I. schimperi*	4	2
Rolfe Park	Broadsound	26.38	148.77	*I. schimperi*	1	1
Norton	Bungil	26.39	148.76	*I. schimperi*	2	1
Charleville	Murweh	26.41	146.24	*A. angustissima*	4	1
Holyrood	Bungil	26.49	148.45	*I. schimperi*	5	2
Bindaroo (Roma)	Bungil	26.67	149.03	*I. schimperi*	1	1
Ellenvale	Chinchilla	26.73	150.72	*I. schimperi*	1	1
Lyndon Caves	Bungil	26.83	148.94	*A. angustissima*	1	2
Sunset Downs	Tara	27.28	150.25	*I. schimperi*	3	2
Warrill View	Boonah	27.50	152.40	*A. angustissima*	3	1
Glenbower	Pittsworth	27.84	151.58	*I. schimperi*	4	2
Ula Ula	Balonne	28.02	149.42	*I. schimperi*	2	1
Bringalily	Millmerran	28.09	151.17	*I. schimperi*	1	1
Kindon	Millmerran	28.09	150.78	*I. schimperi*	3	2
Boongargil	Waggamba	28.53	149.67	*I. schimperi*	3	2

[1] *Site effort status*

1 Minimal effort: one visit per year by one officer to check for and kill occasional plants which may have established.

2 Moderate effort: two visits per year by one or two officers to kill plants before flowering and monitor the site

3 Major effort: three+ visits per year by three+ officers to kill plants before flowering and monitor the site. Equipment such as mobile spray rigs likely to be required.

Table 3. Site and plant population characteristics influencing chosen control method.

	Target Species			
	Acacia angustissima	***Aeschynomene brasiliana***	***Aeschynomene paniculata***	***Indigofera schimperi***
Number of sites in eradication program[1]	14	28	13	38
Range of site survey area	0.1 – 2.0 ha	0.05-40 ha	0.25-600 ha	0.02 – 10 ha
Eradication methods[2]				
Selective herbicide (%)	78.6	78.6	76.9	57.9
Cultivation (%)	0	3.6	7.6	23.6
Manual removal (%)	21.4	21.4	46.2	36.8
Competitive grasses (%)	7.1	0	0	23.7
Other (%)	0	7.1 (hard grazing)	7.6 (tree clearing)	0
Plant population characteristics of sites containing plants				
Few or occasional plants (%)	41.7	35.7	53.8	57.9
Scattered populations (%)	54.5	50.0	30.7	36.1
Clumped/dense populations (%)	3.8	14.3	15.5	6.0
Woody vegetation				
Cleared woodland or open country (no trees)	100	64.3	69.3	100
Open or dense woodland	0	35.7	30.7	0
Access				
All year access	64.3	46.4	23.1	57.9
Restricted when wet	35.7	53.6	76.9	42.1

1 Sites defined as a particular target plant population at a particular location. Often more than two species at one location, each with up to three sites per location.

2 Totals often greater than 100 because more than one method often used at one site.

Ease of access to sites influenced efficacy of plant control. Many sites were difficult to access during wet periods (Table 3). This did not hinder plant control efforts at most sites because poor access was only temporary. However, in north Queensland, road closures during the monsoon season prevented access to some sites during vegetative growth and flowering, particularly Batavia Downs. In this instance it was necessary to access the site as quickly as possible after the wet season. At many southern inland sites, poor rainfall prevented seed germination, and therefore the opportunity to kill plants and erode soil seed banks.

The presence of dense tree populations also hindered plant eradication at some sites, particularly those in central-coastal and northern Queensland. Dense woody vegetation reduced the ease of plant detection and access for treatment. The effect was greatest at sites with widely distributed populations, mostly those containing *Aeschynomene* spp. Tall grasses or those which formed a dense sward also interfered with the detection of seedlings, especially smaller legumes such as *I. schimperi.* Eradication at such sites benefited from grazing or the use of fire.

4.1.2 Progress towards eradication

Progress towards eradication of the target plants at each site was reviewed during June 2005 and summarised (Appendix 7). Variables which are considered to influence the weed status of each site, grazing and control of seeding, are presented in Table 4. Estimated plant populations at June 2005, close to the end of the Project, are presented in Table 5.

The target plants are believed to have been contained to their original plant sites or the areas closely surrounding those plant sites (at 65 locations). There is one notable exception, that of Batavia Downs, (Weipa), where patches of *A. paniculata* plants have been found up to 2 km from the original plant site (but on the same property). Mobility of *A. paniculata* was also noted at Tedlands (Mackay), where a small patch was found in a *Melaleuca* swamp some distance from the original infestation.

The *Aeschynomene* spp. have demonstrated (anecdotally) more mobility than *A. angustissima* or *I. schimperi* within the eradication program, the latter two tending to move very slowly from the areas where they were established, if at all. There may be many reasons for this, including (often) larger original plant populations and establishment at sites where eradication efforts are more difficult (treed, difficult access during the growing season). In some instances, the controls required to increase detectability of plants (*eg* grazing) at these larger sites may also have been partial spread vectors. However, it also seems that the two *Aeschynomene* species are intrinsically more mobile than the other two species, at least under present environmental and management conditions:

- *Aeschynomene paniculata* produces masses of seed (800 per plant counted on some one-year-old plants) which easily detaches onto vehicles and readily establishes on a range of soil types (granite ridges through to *Melaleuca* swamps). Although seed production is not suppressed by grazing (although detectability is enhanced), the seed (if eaten) can germinate in dung. *Aeschynomene paniculata* also forms very dense stands, which present a large population of seed available for transport by vehicles or animals.
- *Aeschynomene brasiliana* is more readily eaten (sometimes down to crowns by the end of the dry season), but generally only during the early dry season when viable seed is often present. The seed also survives the ruminant gut and germinates readily in dung, so can be spread by stock and (potentially) wildlife. Although there is no direct evidence, it is suspected that the sticky seeds, again in segments which easily detach from the parent plant, may stick to animal coats and aid plant dispersal.
- *Acacia angustissima* produces masses of seed and seeding is not suppressed by grazing, but the seed is not presented in a fashion where it can be easily transported by animals or vehicles. Instead, within the Project, it tended to form dense thickets, which can exclude other local vegetation if not controlled. A longer period between establishment and the presentation of mature seed than for the other legumes also makes it easier to control seeding.
- *Indigofera schimperi* appears to be a ‘steady coloniser’, slowly accumulating soil seed banks and spreading short distances by seed or by root suckers. Although grazing does not generally suppress seeding, this plant has shown a relatively poor tendency to establish large populations: perhaps because it competed poorly with companion plants at many sites.

Table 4. Factors contributing the future weed effort of the four target species.

(a) Control of seeding

Species	*Level of seeding over 6 years*					
	No plants seeded	90% not seeded	60-90% not seeded	30-60% not seeded	Regular seeding	Unknown
A. angustissima	9	1	0	2	0	2
A. brasiliana	9	9	9	0	0	1
A. paniculata	6	5	1	1	0	0
I. schimperi	25	6	4	1	1	1
Total	49	22	14	4	1	4
% of total sites	53%	23%	15%	4%	1%	4%

(b) Population change

Species	*Estimated trend in population change over 6 years*[1]				
	No change	Declining, >50%	Declining <50%	Increasing, >50%	Increasing <50%
A. angustissima	1	12	0	0	0
A. brasiliana	4	14	2	1	2
A. paniculata	0	5	2	0	1
I. schimperi	5	16	2	0	0

[1] where officers believe they can make a reasonable estimate. Most of the sites omitted were those with very low plant populations or those considered clean.

(c) Grazing

Species	*Growth stage when grazed (when able to be assessed)*					
	Never	Infrequent	Vegetative	Flowering	Grazing reduces seeding	Grazing doesn't reduce seeding
A. angustissima	2	1	0	1	1	1
A. brasiliana	1	1	6	18	7	9
A. paniculata	2	1	0	4	0	6
I. schimperi	1	11	2	3	0	7

Table 5. Estimated plant populations at the end of the eradication program[1].

	Target Species			
	Acacia angustissima	***Aeschynomene brasiliana***	***Aeschynomene paniculata***	***Indigofera schimperi***
Clean, no plants (%)	50.0	17.9	46.1	34.2
1-10 plants (%)	42.9	14.3	7.7	39.5
10-100 (%)	7.1	42.9	15.4	21.0
100-1000 (%)	0	14.3	7.7	5.3
1-10 000 (%)	0	10.6	15.4	0
>10 000 (%)	0	0	7.7	0
Total number of sites[1]	14	28	13	38

[1] Sites defined as a particular target plant population at a particular location. Often more than two species at one location, each with up to three sites per location. The data is based on a review of site status at June 2005.

The reduction of plant numbers at each site is based simply on killing plants as they emerge and before they set seed so that soil seed banks are eventually eroded. All methods used to kill plants were effective, although there were concerns at some sites of terbutiuron pellets (Graslan) causing poor regrowth of companion species one or two years after application. The use of strategic (summer/autumn) grazing at high stocking rates suppressed seeding of the most palatable species, *A. brasiliana*, at some sites, but not the other target species (Appendix 7). Overall, it is believed that seeding was completely prevented at half of sites over the 6 years of the eradication program (Table 4). It is expected that plant numbers will rapidly erode at these sites as soil seed ages. At another 40% of sites, there has not been absolute control of seeding over the 6 years, but the level of control was sufficient to reduce plant populations. A longer term effort will be required to completely erode soil seed banks at these larger sites. It is anticipated that, as plant populations continue to decline, the control of seeding will be more effective, and the erosion of soil seed banks will accelerate.

The emergence of new plants (plant populations) at a site was used as the indicator of progress towards plant eradication. It is recognised that this method has certain restrictions if conditions at a site prevent the onset of seed germination (*ie* preserve seed) and remove the opportunity for killing the resultant plant (if it establishes). However, it was impractical to collect the number of soil seed samples required to provide a reliable measure of changes in soil seed across the (often) diverse site with non-uniform population distributions. Instead, staff time and resources were considered to be better utilised treating plants. Overall, it is considered that environmental conditions conducive to overcoming hardseed dormancy and promote germination occurred at most sites during the two phases of the program, although germination was prevented by drought at some southern-inland sites containing *I. schimperi*: at one site over 500 seedlings emerged following drought-breaking rains where relatively few plants had been found during previous years.

Plant populations are considered to have declined at approximately 70% of the sites containing appreciable numbers of plants over the six years of the eradication program (Table 4). Plant populations have not significantly increased or decreased at 15% and increased at four sites. Three of the latter sites were new infestations found at eradication locations, originally large grazing-scale plantings, towards the end of the program. The other is a small site where plant populations were declining, but there has been an increase in seedling number towards the end of the Project.

Plant populations at the end of the project varied considerably between species (Table 5), sites containing the *Aeschynomene* spp. often having larger plant populations than the other two target legumes. Most *A. angustissima* and *I. schimperi* sites were either clean or had less than 10 plants emerging annually, whereas 3 *A. brasiliana* and 3 *A. paniculata* sites contained over 1000 plants. All of these sites were at locations originally planted to grazing-trials, mostly in remote areas.

Sites with populations of less than 100 are considered to be under absolute control, because it is easy to locate and kill plants before they set seed. This applies to 86% of the 93 sites, and includes most sites containing *A. angustissima* and *I. schimperi*. Plants can be killed before seeding with plant populations between 100 and 1000, but it requires considerably more vigilance and care. For sites with plant populations above 1000, it is likely that some plants will be missed and flower, although plant populations as a whole can be reduced. The highest-population locations were Batavia Downs (three sites of *Aeschynomene paniculata*), Brian Pastures (*I.* schimperi), Sugarbag (Mt. Garnet), Tedlands (Koumala) and Lynford (Nebo) (all *A. brasiliana*). Substantial effort will be required at these sites to suppress plant movement and reduce plant populations and soil-seed levels. A high level of effort will also be required to control a smaller but mobile population of *A. paniculata* at Tedlands and a widely spread population of *A. brasiliana* at Burlington (Mt. Surprise).

4.1.3 Development of future action

There is an on-going need to undertake plant eradication activities at all locations to ensure that the plants are prevented from spreading into grasslands. In most cases, the effort required is one or two half- to one-day visits each year to undertake plant eradication and monitor the surrounding area (Table 2). Considerable effort, requiring 2-4 officers for 1-5 weeks per annum is required at five locations, the greatest effort required at Batavia Downs to control *A. paniculata*.

During June 2005, a discussion paper was composed by the Project Leader following consultation with policy staff of DNR&M (Appendix 8). The purpose was to explore options available for the long-term control of the target plants, not necessarily by the Project proponents. The key conclusions and recommendations of the Discussion Paper were:

- All attempts should be taken to eradicate the target plants as they represent a considerable threat to the grasslands of northern Australia.
- There is a need for on-going eradication activities at all sites, ranging in scope from annual monitoring through to regular eradication.
- Eradication is to be undertaken regardless of landowner opinion of the plant.
- The eradication program must be extended immediately to avoid the risk of plants producing viable seed.
- There are limited options for undertaking eradication at the sites using organisations outside of those already involved in the Project. This is because the state (DNR&M) and local governments have limited resources for undertaking eradication programs. However, particularly for *A. angustissima* (a class 1 declared weed), state and local governments can be involved in the control of escaped plants (should this occur) on public lands and surrounding properties.
- There is a realistic opportunity, though the federal government's 'Defeating the Weed Menace' program, to source funds to eradicate certain priority weeds, including *A. paniculata* (a nationally recognised 'Sleeper weed').
- The eradication activities are best undertaken by the agencies currently involved in the eradication program and, where possible, by the same officers that have undertaken eradication to date. This is because: many of the priority properties remain under the ownership these agencies; the staff have the best knowledge of the plants and the sites; and the staff are motivated to undertake the eradication activities.

Following these recommendations, two funding applications were developed: the first developed with, and submitted to, MLA to continue eradication effort at similar levels to that at June 2005 for a further five years; the second to the federal government through the Defeating the Weed Menace initiative to undertake additional survey, quarantine and plant eradication activities to control *A. paniculata* at Batavia Downs for three years. Copies of the applications can be found in Appendices 3 and 9.

4.2 Improved awareness of the target plants

4.2.1 Events to increase publicity

Increased awareness of the risk posed by the target plants and the eradication program, beyond the immediate Project group and prior to the end of the Project, was promoted by a plant release forum, presentation at the Queensland Weeds Symposium and involvement in the 2005 Townsville Weedbusters community event. Each had different target audiences and it is believed that each activity was successful at creating greater awareness.

Forum of pasture plant release in Queensland (January 2005, Yeerongpilly)
The intention of the Forum was to increase awareness of the program amongst land-protection stakeholders operating at a policy level, and to review recent Government and industry initiatives

undertaken to minimise the risk of accidentally releasing an environmental contaminant while under taking future pasture plant evaluation and release programs in Queensland. These initiatives included: the eradication program; the Code of Practice for the evaluation and release of pasture plants; new information repositories to aid selection of elite, non-weedy pasture plants for use in evaluation programs; and the rationalisation of the tropical forages genetic collection to species considered to be useful in Australia. Following presentations by technical specialists in pasture plant evaluation and release, weed issues and policy relating to pasture plants in Queensland, the initiatives were discussed in an open forum attended by 15 staff representing state and federal land protection agencies and primary industry groups (see Section 3.2.2). The management of accessions held in the ATCFGRC and protocols for weed risk assessment procedures under the Code were also discussed. A report summarising the content and proceeds of the Forum was submitted to MLA and has since been distributed to attendees at the Forum and stakeholders in other states. A key recommendation of the report was to review and progress the Code of Practice for plant evaluation (see Section 4.3.1 below). [The report has not been included in the appendices because of size, but can be sourced from the Project Leader].

Queensland Weed Symposium, Townsville 2005.
The presentation of the poster paper (Appendix 10) at the symposium targeted staff involved in research and on-ground eradication activities. The poster-paper (Cox *et* al., 2005) summarised the need for the plant eradication program and the activities undertaken to date as part of that program. The poster provides a good overview of the Project, which can be used for future awareness if required. Chris Gardiner of James Cook University represented the Project at this event.

Weedbusters Day, Townsville 2004.
The Weedbusters community event held in Townsville near to one of the *A. angustissima* eradication sites provided a good opportunity to involve the community in the Project, albeit on a limited scale (Appendix 11). Members of the community were encouraged in the removal of weeds at the site including *A. angustissima* (although few plants were present). The event was considered to be more successful in raising awareness of weeds in general than assisting in the eradication program, but may assist in detection of *A. angustissima* near to the site.

These activities are have engaged a wide range of stakeholders and are considered to have been successful at increasing awareness of the target plants and the eradication program overall. Perhaps the most valuable was the Forum as it involved active interaction with land protection agencies and industry groups and progressed initiatives to minimise future risk of releasing weeds when undertaking future plant release programs.

4.2.2 Extension package

The CD-ROM information resource, the major extension resource produced during the Project, is intended to increase awareness of the eradication program and assist in the long-term control of the target plants through providing relevant information and contacts for organisations involved in plant detection and control. The package was also designed as an information repository to assist the current eradication program and the development of future tools or initiatives to control the target plants if necessary. The approach recognised that, despite best efforts of the eradication team, plants of the target species may escape some sites and evade immediate detection.

The key target audience was staff working for land-protection agencies, particularly those overseeing plant eradication programs. The format and level of information was designed to suit this audience. The content of the CD-ROM is summarised in Table 6 and linkages used in the CD-ROM presented in Appendix 12. A copy of the package is provided as a companion to this report.

It will be necessary to promote and demonstrate the use of the CD, rather than simply post it out, to ensure recipients review appropriately. It is recommended that a member(s) of the Project team present the CD-ROM at regional pest advisory meetings (usually attended by a wide range of on-ground and policy land-protection staff) or conduct special presentations to pest-control officers in shires potentially effected by the target plants. This should be undertaken during 2006-07 and undertaken in a manner which minimises staff-time and costs.

Table 6. Content of the CD-ROM package and progress towards completion.

Component
Plant fact sheets (one per species) Contains nomenclature, taxonomic description; images to assist identification; native range; preferred growing environments; plant development characteristics; agronomy and weediness details; weed ecology; and sources of further information. Based on a combination of information in the recently developed 'Tropical Forages' database, experiences in Queensland and resources from the current project.
Potential weed distribution (one per species) Maps presenting overall climatic ranges in Australia where the four target plants are best adapted. Generated using CLIMATE software using a range of input data: actual collection points overseas of the accessions used in Queensland; collection points of accessions of the target species held in international germplasm banks; known sites in Queensland; reports of plant ranges overseas.
Current distribution maps A variety of maps inlaid onto Arcview so that GIS information can be overlaid if required. Maps include: whole of Queensland (each species) with rainfall and shire boundary overlays; and current weed status (each species) with shire overlays using three maps to cover the sites.
Eradication location summaries (66 locations) A table summarising the history (planting, success of establishment, management) of each site known, accurate location (GPS coordinates plus shire), brief site description (including a photograph of the typical country/site), current weed status and anticipated effort required for control.
Best practice eradication For each weed, the weed characteristics from an eradication perspective and present methods that have proven useful for the control of the target plants to date. Additional, potentially useful herbicides identified in Queensland herbicide screenings are also listed.
Package linkages This includes the tools required by the user to effectively navigate the package: introduction; précis of the two DPI&F/MLA projects; the two Final Reports; an introduction to, and copy of, the Code of Ethics for Pasture Plant Evaluation; and a guide to navigating the package.
Further information A bibliography of references used in the package and contact details for staff and organisations which may assist users in the future. Required forms for confirmation of identification by the Queensland Herbarium.

4.3 Prevention of future accidental releases of undesirable plants

The eradication program has demonstrated that the eradication of unwanted pasture plants, in this case legumes, from (even small) plant evaluation sites is expensive and time consuming, requiring a formal funded eradication program. If new pasture plants are to be developed to respond to future needs of the primary industries, or society in general, practices during plant evaluation and release must minimise the risk of biological release of plants which either demonstrate no clear advantage over coexistent plants or have potential as invasive weeds. Other than ethically correct behaviour, this is legislated for in Queensland under the 1994

Environmental Protection Act (Queensland Government, 2004). Under the Act any individuals or organisations are liable for prosecution if they have failed to demonstrate appropriate duty of care when undertaking activities which have resulted in the release of an environment contaminant.

4.3.1 Promotion of a Code of Practice for pasture plant evaluation

The undertaking of activities under an appropriate Code of Practice can be used to demonstrate duty of care as defined by the Environmental Protection Act (1994) (Appendix 13). The adoption of the NAPPEC Code of Practice was seen as high priority, particularly for DPI&F as the key agency involved in the introduction, evaluation and release of new pasture plants (albeit at a lesser level than previous). Discussion of the application of the Code of Practice was a key component of the plant release forum held during January 2005 (see Section 4.2.1). Following presentation of the concept and protocols of the Code of Practice, it was recognised by the attendees that adoption by DPI&F would reduce the risk of accidentally introducing a contaminant of environmental or primary production systems when undertaking plant evaluation programs to develop new pasture plants in Queensland.

At the Forum it was noted that the Code of Practice needed to be re-written to be better suited as a policy document. There were also concerns that adoption of the Code of Practice may impact on the service provided by organisations such as DPI&F to primary industries seeking new plants from the genetic resources collection. In recognition of these issues, the following route of progressing the Code was outlined:

1. Review and re-draft the Code in a format better suited to a policy document. It was suggested that the pre-amble in the draft Code be kept. This could be undertaken by DPI&F and NR&M staff.
2. Industry consultation, Beef. To be facilitated by Meat and Livestock Australia. Adjust the Code if necessary, using staff of DPI&F and NR&M.
3. Attain endorsement of the Code by DPI&F, through the Animal Science Unit, and adoption as DPI&F policy. Beth Woods (Executive Director, DPI&F) was suggested as a contact for assistance with progressing the Code of Practice.
4. Present the Code to the Australian Seed Federation for review and endorsement.
5. Present the Code to the Australian Weed Council for review and endorsement.
6. Seek Ministerial approval of the Code following recommendation from DPI&F and endorsement from the primary industries and other stakeholders.
7. DPI&F and other agencies voluntarily adopt the Code if approved by the Minister.
8. Circulate to the nursery industry.

DPI&F was the recommended lead agency considering the clear incentives to adopt the Code and experience of senior staff in developing the Code to date. Progress is discussed in section 4.3.2.

Prior to the Forum, the need for, and concept of, a Code of Practice during the evaluation and release of new pasture plants was presented at the 5th International Herbage Seeds Conference (Cox and Cook, 2003) (Appendix 14). The audience was diverse, including researchers and seed industry representatives of temperate and tropical countries. It is difficult to determine the impact of the paper other than to state that, through the proceedings of the largest herbage seed conference organisation, the issue has reached a large audience.

4.3.2 Progression of the NAPPEC Code of Practice

During the late 1990s, the members of NAPPEC developed a Code of Practice suited to the evaluation and release of pasture plants in northern Australia, particularly Queensland. The Code of Practice provides a rigorous, but workable, methodology to follow when introducing, assessing and commercializing tropical forage germplasm in a manner which identifies plants of high merit while removing those considered of high weed risk. Since the demise of NAPPEC, the

Code was championed by Bruce Cook (DPI&F) through discussions with other state agencies, attendance at weed committees and lobbying for endorsement within DPI (now DPI&F).

The NAPPEC Code of Practice provided an excellent starting model for the purposes of the current Project. Following the recommendations from the Forum (see Section 4.3.1), the Code was redrafted by staff of DPI&F (mostly Bruce Cook) and DNR&M (Craig Walton). The most recent version, now a *Code of Ethics*, contains a preamble, guiding principles and protocols for groups undertaking pasture plant evaluation and forms to promote responsible and accountable material transfer from the Tropical Crops and Forages Genetic Resource Centre. A final draft was submitted to the Animal Science business group of DPI&F during December 2005. At the point of writing this report, the Code of Ethics was being recommended for adoption by the relevant groups within DPI&F.

It should be noted that there has also been interest from other organizations seeking to develop similar protocols in other states and for other industries. Copies of the Code of Ethics have been sent to staff of these organizations for their consideration.

A copy of the most recent version of the Code of Ethics can be found in the CD-ROM accompanying this report.

5 Success in Achieving Objectives

5.1 Overall

The project team has, overall, been successful at meeting the Project objectives. In retrospect, the wording of Objective 1 should have been more precise as 'eradication' of plants is difficult to measure during a short term project when applied to plants with extended seed dormancy. To assist with estimating progress against Objective 1, trends in plant populations, and suppression of seeding, at each site were used to estimate progress. The interpretation of progress against the other objectives was more obvious.

5.2 Specific Objectives

Objective 1 Target plants will be eradicated at 80% of evaluation sites and plants and soil seed loads significantly reduced at the remainder of the sites.

Eradication activities have been undertaken at all known locations, the frequency dependent on weed status. A summary of the current weed population status at all *sites* was compiled in June 2005 and is considered to be the best estimate of plant population status at the end of the Project. When classified by target plants *emerging annually* across sites, 33% of the 93 sites are currently considered clean (no plants found for a number of years), 28% have 0-10 plants emerging each year only and 25% have 11-100 plants emerging each year. Often there was more than one eradication site for a particular species at a given location, reflecting distances between original plantings or plant spread. When progress is considered in terms of species x location (81 sites), and nominating the highest plant population of each site at a given location, the following population status was estimated at June 2005: 'clean' 33%, 0-10 plants emerging annually 30%; 11-100 plants 22%; 101-1000 plants 9%; > 1000 plants 6%.

Clearly, plants have not been eradicated (*ie* all current and potential, represented by seed, plants removed from the site) at 80% of locations. This simply reflects prolonged emergence of the target plants, caused by an effective seed dormancy mechanism and, at some sites, long periods of climatic conditions (mainly drought) unsuitable for germination once the seed is non-dormant. So, although the project officers killed plants before seeding at most sites and in most years, sites cannot be considered to be free from the target plants, now or in the short-term future. However, as plant control is considered to be reliable at sites with populations less than 100 emerging annually, it can be considered that approximately 85% of (location x species) sites are under 'absolute control'.

There has been varying success at controlling the plant populations of each species, reflecting original scale of establishment, species mobility and site access. Using the concept of 'absolute control', the following is believed to have been achieved for each species: *A. angustissima* 100% of locations; *A. brasiliana* 68%; *A. paniculata* 82%; *I. schimperi* 91%. There will be an on-going effort required (say for 1-5 years) to continue to erode soil seed levels at these sites through killing emerging plants before they seed.

At a few locations large populations of mobile target plants have been more difficult to control, even when additional resources (labour and equipment) were applied. Although the plants have, to the best knowledge of the project officers, been contained to the locations (properties) where they were established and plant populations have in most cases been decreasing, seeding has not always been prevented and new patches have been found at some sites. The worst site is Batavia Downs (Weipa), where a substantial eradication effort has been undertaken and is required into the foreseeable future (at least 5-10 years). This site is particularly difficult to treat because of poor access during the growing season, large scale and difficult terrain. Other sites requiring a substantial, but lesser, effort include Tedlands (Koumala) (*A. brasiliana* and

A. paniculata), Brian Pastures (Gayndah) (*I.* schimperi), Sugarbag (Mt. Garnet), Burlington (Mt. Surprise), and Lynford (Nebo) (all *A. brasiliana*).

Objective 2 Develop action plans at sites where plants are not eradicated to ensure eradication is achieved. These plans will include the groups/organisations that will undertake the work and where the funding is to be sourced.

It is likely that continued monitoring and eradication will be needed at most sites in the future: sites with small populations and declining populations to ensure complete erosion of seed banks, minimal effort; more intensive effort at sites with larger and more mobile populations to eliminate plant seeding and erode soil seed banks. At Batavia Downs, a major eradication program is required to prevent plant spread, prevent flowering and eventually reduce soil seed levels. Overall, the level of eradication activity will be similar to present, reflecting the progress made during NBP.327 and NAP3.225, but it is recommended that increased effort be invested in surveying the areas surrounding the eradication sites.

Options for the long-term control of each species were assessed in collaboration with policy staff of DNR&M and the Project team. A discussion paper which included review of the various options was compiled during July 2005 (see Section 4.1.3). Key recommendations which relate to long-term site management included:

- continued eradication and monitoring effort at all sites, using similar resources and effort as at the end of NBP.327; and
- additional effort at Batavia Downs (Weipa) to contain and reduce plant populations of *A. paniculata*, in particular surveying and treatment of the areas surrounding the current 'core' eradication zone.

In recognition of these recommendations, two funding applications were developed and submitted: the first between MLA and DPI&F to extend the eradication program for another 5 years; the second developed by DPI&F and submitted to the federal government seeking funding through the 'Defeating the Weed Menace' program for 3 years of monitoring and eradication at Batavia Downs (see Section 4.1.3). Both of these programs address long-term control at the sites where plants are still found and nominate the organisations involved. At the time of writing this report, the MLA/DPI&F project had been tentatively approved and the results of the 'Defeating the Weed Menace' program had not been released (delayed).

Although not the key purpose of the activity, the compilation of plant population and management data for each site and presentation in the fact sheets for each eradication location will aid long-term control at the sites (see Section 4.2.2). This information aids communication within the Project team and, perhaps more importantly, should assist in plant detection by other people (land managers, local land protection groups) *should* the plants move from their immediate plant sites. The plant identification and treatment tools in the extension resource should also assist local control of the target plants.

It is considered that this objective has been completed.

Objective 3 Technical information packages will be produced and made available in a range of formats suitable for use by other stakeholders.

The CD-ROM extension resource is the major information package designed to address off-site control of the target plants and the development of long-term strategies to control them (see Section 4.2.2). The key target audience was staff working for land-protection agencies, particularly those overseeing, or directly involved in, plant eradication programs at local and state government levels. The format and level of information was designed to suit this audience: technical information presented in maps, tables and brief fact-sheets all linked through a standard web-page format. The information can be easily extracted (*eg* printed) for distribution of selected

information to staff or land-owners undertaking plant surveying or control. If deemed appropriate, information to assist sourcing the package can be placed on the DPI&F website.

The production of the extension package meets Objective 3 of the Project. However, it will be necessary to promote and demonstrate the use of the CD to ensure recipients review it appropriately. It is recommended that, during the next phase of the eradication program, a member(s) of the Project team demonstrate the CD-ROM at regional pest advisory meetings or conduct special presentations to pest-control officers in shires potentially effected by the target plants. This should be undertaken during 2006-07 and undertaken in a manner which minimises staff-time and costs.

Objective 4 All relevant data from the Project will be entered on the QPastures database, and other relevant databases, and made available for use by all stakeholders.

Data relating to the four target legumes has been progressively entered, under the supervision of Richard Silcock (DPI&F), into the DPI&F QPastures database prior to, and during, Phases I and II of the eradication program. Richard Silcock supervised this process. The information entered into QPastures includes, for a large range of species included in government plant evaluation programs: site specifications, planting lists, plant performance, site management and information sources. Some of this data was particularly useful during Phase I of the eradication program.

At the onset of Phase II, it was considered beneficial to make data related to the four target plants available to any current or future stakeholders *ie* effectively public information. The original strategy was to make QPastures, directly accessable by DPI&F staff only, available on the DPI&F website. However, there were concerns about this because QPastures does not currently hold complete data (across all species at all sites in Queensland) and the use of QPastures in the current format can be difficult. Attempts are being made to incorporate QPastures data into, or link data to, the AusPGRIS database (of the ATCFGRC) already publicly available on the DPI&F website. However, combination of the two formats is proving difficult and this process is considered to be a long-term exercise.

Instead of making QPastures publicly available, the appropriate data was extracted and presented in more user-friendly formats in the CD-ROM extension resource: within the fact-sheets on each eradication location and a table listing all known plantings. It is considered that this approach better meets the immediate requisites of the Project and Objective 4.

Objective 5 A broad network of land protection agencies will be aware of the significant risks of the target plants, control measures and the activities of other agencies in managing these weeds.

Increased awareness of the target plants, the threat that they pose, and the eradication program was a key element of phase II of the eradication program. A range of activities were undertaken to achieve this, each targeting different audiences/stakeholders:

- cooperation with land-holders at the plant eradication sites;
- active involvement of staff from EPA and DNR&M to assist in the development of long-term strategies for controlling the target plants and preventing future release of potential weeds (through the NAPPEC Code of Practice, later the Code of Ethics);
- the forum on pasture plant evaluation and release and distribution of the Forum report to advise representatives of national and state land protection agencies and pertinent primary industries and stakeholders of the target plants and the eradication program;
- delivery of the paper at the 2005 Queensland Weeds Symposium, attended by researchers, policy staff and plant eradication officers from stakeholders in Queensland (Section 4.2.1);
- development of the extension package, targeting staff of land-protection agencies including policy and on-ground eradication staff (Section 4.2.2); and
- involvement in the Weedbuster community event, Townsville. (Section 4.2.1).

Overall, it is considered that appropriate stakeholders were targeted and successfully engaged and the objective completed satisfactorily.

Objective 6 Plant evaluation and commercialisation best practices will be documented.

This objective was included in the Project to ensure that there are no future recurrences of biological release of weedy plants in programs seeking new pasture plants for the grazing industries. As the aim relates to genetic material such as that in the ATCFGRC, the precautions would also potentially benefit other industries seeking to develop germplasm for other purposes.

The inclusion of this objective in the program formalised the progression of an initiative which pre-dated the eradication program: the development of a Code of Practice for the evaluation and release of pasture plants, instigated by NAPPEC (Section 3.3.1). The Code of Practice, although recognised as a useful initiative by staff of DPI&F and DNR&M had not progressed beyond an advanced draft prior to the Project. The approach taken by the Project team was to use the Code of Practice as documentation of best practice and implement it where effective.

Review and progression of the Code of Practice was a key focus of the Forum held within this project (Section 4.3.2). Recommendations from the Forum prompted review of the Code of Practice so it was better suited to application by DPI&F, the custodian of the tropical forages collection. Adoption by DPI&F will effectively implement the best practices within Queensland. At the time of preparing this report, the final edition of the Code of Practice, now a Code of Ethics, had been submitted to Animal Science within DPI&F and recommended for adoption.

In addition to promoting best practice within DPI&F, the concept of a Code of Practice for pasture plant evaluation was promoted at an international conference and regional pest management meetings.

It is considered that the actions undertaken, through developing and moving towards implementing best practice in pasture plant evaluation, have achieved the intended result of Objective 6.

6 Impact on Meat and Livestock Industry

6.1 Weed potential within northern Australia

The four target legumes have three key characteristics which provide good potential to spread across northern Australia and dominate native vegetation in many situations: the species are well adapted to the climate and soils, have low acceptance to grazing or browsing animals and are prolific producers of long-lived seed which readily establish.

Geo-climatic adaptation to northern Australia
The four legumes were originally selected from environments in other tropical or sub-tropical countries similar to target environments in northern Australia. Three of the target legumes (*Acacia angustissima*, *Aeschynomene brasiliana* and *Aeschynomene paniculata*) originate from central America and one (*Indigofera schimperi*) from eastern Africa. Each are (variously) potentially adapted to substantial areas of Queensland and northern Australia in general, including wetter sub-coastal environments (*A. paniculata*), through to drier environments in central and southern Queensland (*A. angustissima, I. schimperi* and *A. brasiliana*), and on a range of soils. Using standard current climate modelling (Climate package, Bureau of Rural Sciences 2004a,b) and data collected from Queensland and overseas, maps of potential distribution in Australia have been developed (Figure 2.). These were created using knowledge of where the plants have successfully established in Queensland and where plants have been collected from other countries. Although it is recognised that such approaches are not perfect at predicting long-term distribution, they do provide a guide of the overall climatic range where they could survive if not controlled. Each of the four target plants have enormous potential climatic ranges across northern Australia. The climatic ranges include extensive grazing lands and lands preserved for natural conservation and cultural purposes. A complete discussion of the analysis used, and other analyses, is provided on the CD-ROM accompanying this report.

Low acceptability to grazing or browsing animals
The four target plants all have moderate-low to low palatability, and therefore have limited application as a feed resource for livestock (Figure 3.). Each legume is generally not eaten during the growing season when more palatable companion plants are eaten. This allows the legume to dominate, particularly under high stocking rates, sometimes forming mono-specific stands. *A. angustissima, A. paniculata* and *I. schimperi* are rarely eaten during the dry season, when seeding usually occurs. This means that seed production can occur unabated in most situations. *Aeschynomene brasiliana* was eaten during the dry season at some sites, effectively suppressing seeding. However, high stocking rates are required making it difficult to manage the balance of grass and legume on extensive grazing properties.

Persistent plants and seeds
All four of the target legumes are perennial and prolific seed producers, each having the potential to produce hundreds of seeds per season if not controlled. All of the species can form dense stands near to parent plants. The two *Aeschynomene* spp. have also demonstrated high mobility, vectors including livestock, vehicles (both strong anecdotal evidence) and wild animals (suspected). Each species produces seeds with dormancy mechanisms which enhance survival in soil, in particular enabling seeds to survive over dry seasons and germinate under more favourable conditions. Seed life varies between species, the quality of the seed produced and the environmental conditions at a particular site. However, during the eradication program, all four of the target legumes have demonstrated the potential to survive as seed in soil over a number of years, particularly in drier environments. At one site, *I. schimperi* seedlings have continued to emerge 6 years after the last plant flowered. Although there is no clear data for the other species, anecdotal evidence suggests that their seeds can also remain viable for extended periods.

Figure 2. Potential adaptive range of the target legumes in Australia based on climate-match analysis.

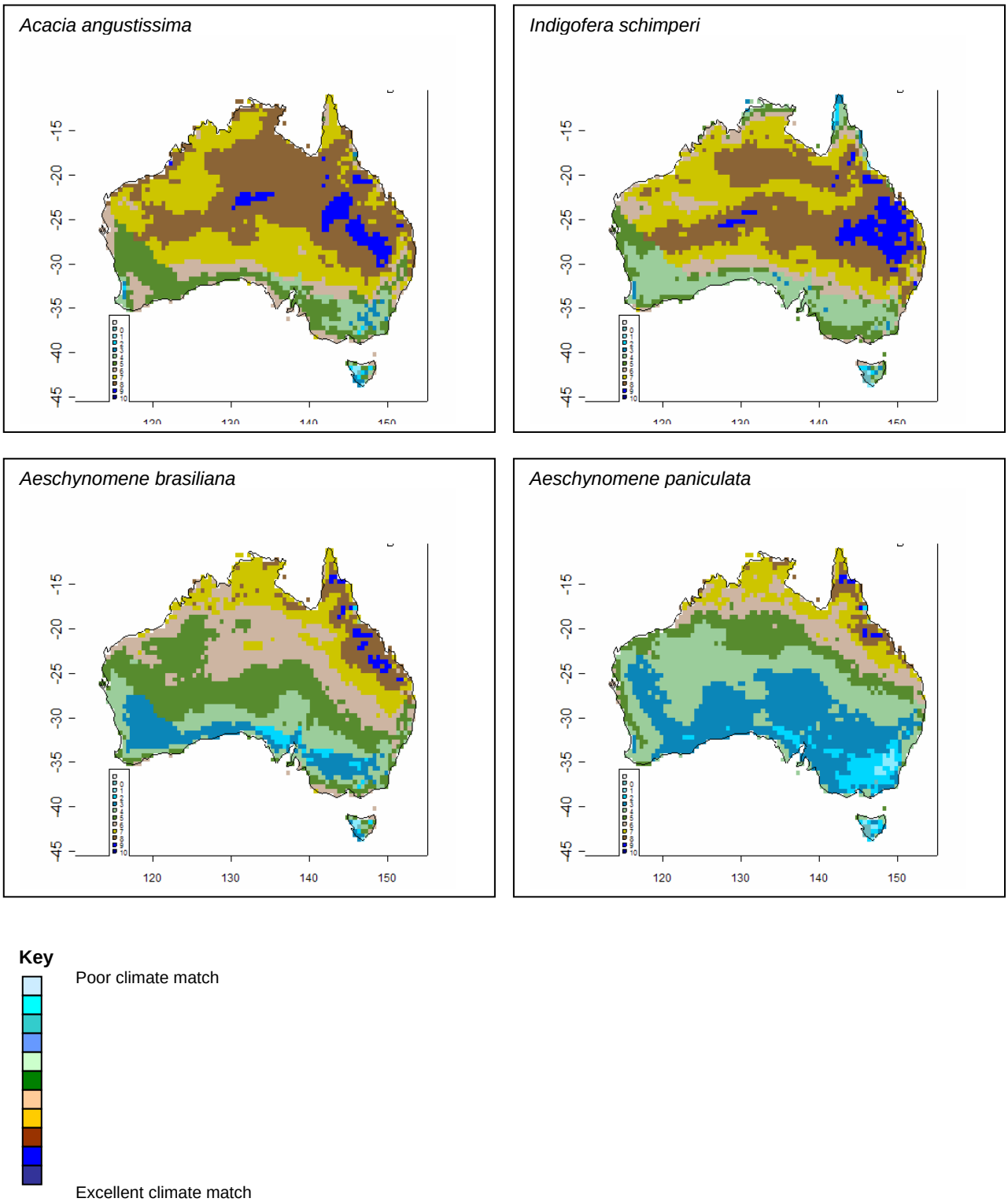
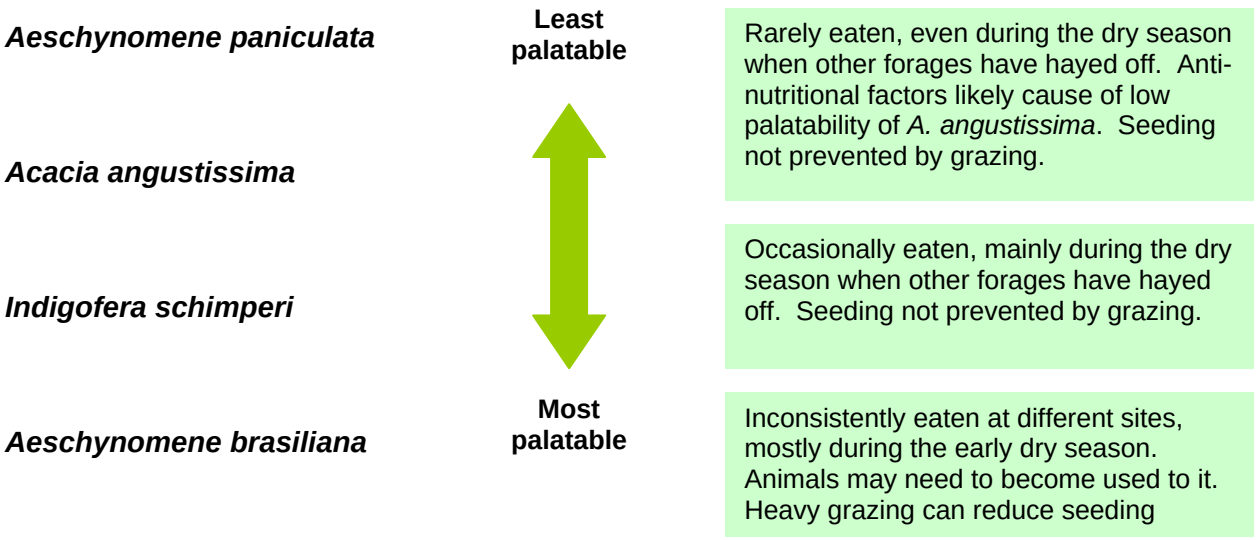


Figure 3. Acceptability of the target plants to livestock.



6.2 Potential impact on the Beef industry

The benefit of the Project to the beef industry is interpreted here as the *potential cost prevented* should the target plants become widely naturalised ie. the cost to control them or losses of production. This premise requires that the plants have been restricted in distribution: this is the current situation based on the information available to the Project team.

Economic analyses of the potential costs of not controlling the target plants have only been conducted on *A. paniculata*, now a nationally recognised Sleeper Weed (Brinkley and Bomford, 2002; Cunningham *et al*. 2003). Using an economic analysis based on modelled potential distribution of *A. paniculata* and the value of the major industry in that area (beef production), it was estimated that the cost of not treating the weed could conservatively be estimated at $45 M per annum or a total cost of $352 M. The analysis did not include cultural or conservation costs, which are more difficult to estimate. Similar costs could be attributed to the other three target legumes, as they also include extensive grassland used for beef production. Some, such as *I. schimperi*, also include other forms of primary production (cropping) in their areas of adaptation. It must be remembered that these are only estimates. However, it does indicate substantial potential economic cost if these plants are not controlled. A major component of this cost would be to graziers as the plants would likely be weeds on extensive beef properties.

The benefits of undertaking control of the target plants can be assessed in terms of the ratio of the opportunity cost to production if the plant becomes widespread versus the cost of eradicating it. To date, the beef industry has contributed $257 000 over six years to the eradication program, in terms of operating, capital and a portion of salary. The project collaborators, mostly DPI&F, but also CSIRO, James Cook University, DNR&M and EPA, have contributed approximately that amount again as staff salary. The total cost is approximately $0.5 M. (Conservatively) assuming that the plant impact was 10% of the dollar value of production in the potentially affected area (ie. 10% of $352 M), the Benefit/Cost ratio calculated is $70 (ie. $70 benefit for every dollar spent to control *one of the four species*).

It is emphasised again that it is very difficult to quantify the potential cost of not controlling the target legumes. However, experience to date in Queensland indicates that the plants have virtually no value to production, have the potential to colonise large areas of northern grasslands used by beef producers and are likely to reduce production if allowed to naturalise widely. Control of these plants is of strong benefit to the beef grazing industry in northern Australia.

7 Conclusions and Recommendations

7.1 Conclusions

Plant eradication

1. The target species have varying degrees of weed potential, and the potential costs to the Beef industry far outweigh the benefits. All four should be treated for eradication at all sites.

2. The target plants have been contained to the eradication sites or properties. Plant populations have been greatly reduced at most sites, many now considered to be free of the target plants.

3. On-going eradication and monitoring activities are required to ensure that the target plants are contained to current sites and populations reduced. The effort required to control the target plants in the next five years is expected to be similar to that at the end of the current project: most sites require annual visits to monitor and remove plants before seeding; a few, larger sites require longer term eradication programs and more resources

4. Additional monitoring and eradication activity is required to control the target plants at a few larger sites featuring larger and more mobile plant populations, particularly *Aeschynomene paniculata* at Batavia Downs (Weipa).

5. Funding is required to continue eradication: at similar levels to present to continue plant eradication at most sites; at higher levels to control the target plants at sites containing larger plant populations.

Increased awareness amongst stakeholders

6. A wide range of stakeholders, across many levels of land-protection, have become aware of the risks posed by the target plants and the eradication program as a result of activities undertaken during the Project.

7. The application of the extension package developed during the Project should continue to increase awareness and improve the effectiveness of control off-site if required. Careful delivery of the extension package to land-protection agencies is required to maximise benefits.

Documenting (and implementing) best practice in pasture plant evaluation

8. Adoption of the Code of Ethics for Pasture Plant Evaluation will best minimise the risk of future releases of undesirable plants during pasture plant evaluation programs. This is best applied to the DPI&F, custodians of the tropical forages collection in Queensland. Activities undertaken during the Project have progressed adoption of the Code of Ethics by DPI&F.

7.2 Recommendations

1. The eradication program be continued for another 5 years for all species at all sites, using a similar level of effort to present, but with additional surveying of areas surrounding current eradication zones. Similar proponents, staff and resources should be used to those of the current project.
2. Additional surveying, quarantine and eradication activities be undertaken at Batavia Downs to restrict and control *Aeschynomene paniculata*. Funding in addition to that for 1. should be sought from external sources.

[Funding applications have been developed and submitted for Recommendations 1. & 2.]

3. Where possible, effort should be undertaken to increase awareness of the target plants. In particular, the extension resource should be demonstrated to appropriate land protection agencies, particularly shire councils.
4. Where possible, information developed during the eradication program should be used to assist in the development of long-term control strategies for the target weeds and other plants with weed potential in north Australian eg. develop guiding principles for the pre-emptive control of potential weeds in extensive grasslands.

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9 Appendices

Appendix 1 History of fodder plant evaluation in Queensland.

Prior to 1987, pasture species evaluation in northern Australia was largely carried out on an individual basis, focusing primarily on local needs. This approach did not result in widely applicable outcomes. To extend the impact of evaluation research, it was recognised that there needed to be a broader focus to the work, and a more structured approach adopted. In a process initiated through the Northern Australian Pasture Plant Evaluation Committee (NAPPEC), a series of collaborative projects was undertaken, each with a different end in view. There have been three major species evaluation research activities undertaken between 1987 and 1998:

- Coordinated pasture evaluation in northern Australia (COPE) – Project DAQ.081
- Backup legumes for stylos (BULS) – Project DAQ.083
- Legumes for Clay Soils (LCS) - Project DAQ.086

COPE (1986 to 1995) and LCS (1992 to 1996) were collaborative projects between DPI and CSIRO. NTDPIF (now an agency within DBIRD in NT) collaborated with DPI and CSIRO on the BULS project (1992to 1998). COPE, was a screening project, initiated to assess the wide range of grass and legume genetic material then held in the Australian Tropical Forages Genetic Resource Centre, a collection comprising some 17 000 legume and 11 000 grass accessions (Hacker 1997). Many of these accessions had never been assessed in field trials. This project was the precursor of the other two projects.

BULS, as the name implies, sought to identify alternative species to the various *Stylosanthes* spp available at the time. Experience with this genus had shown that resistance to anthracnose disease could break down as new strains of the organism (*Colletotrichum gloeosporioides* developed, sometimes with near disastrous consequences, as happened with *S. humilis.* The project further aimed to assess the animal production potential and nutrient responsiveness of some elite species relative to *Stylosanthes* in the area. LCS sought to select legume species to colonise the large areas of cracking clay soils in northern Australia, as the various grass pastures in the area were losing productivity through nitrogen rundown. Other activities within the project aimed to elucidate agronomic and production characteristics of elite accessions.

Selection of species for evaluation

Selection of germplasm for inclusion in the COPE program was based on previous knowledge of certain species, and the intention to draw material of diverse genetic makeup from a range of environments. Selection of intra-generic diversity was achieved using the results from 16 characterisation projects in which certain genera and species were divided into morphological and agronomic groups. Geographic diversity was achieved using the detailed passport data recorded for each accession in the collection. Species or accessions that were known or suspected to be toxic or unpalatable, or to possess thorns, were not considered for inclusion in the program. Entries in the BULS project were selected on the basis of merit in the COPE series of experiments, as well as accessions that had shown superiority in previous work. Selection of entries for LCS presented some difficulty since few warm season legumes grow naturally on heavy clay soils. They are largely found on lighter textured, less fertile soils. Entries were therefore limited to those species endemic to or known to perform well on heavy clays. This included the genus, *Desmanthus*, and species such as *Indigofera schimperii, Clitoria ternatea, Vigna trilobata* and *Macroptilium bracteatum*. In a number of cases, this reflected adaptation to an alkaline environment (typical of many heavy clay soils) rather than adaptation to clay soils *per sé.*

Selection of evaluation sites

The COPE program was developed to enable evaluation of accessions at representative sites throughout Queensland. Sites were selected to take account of variation in climate, soils and vegetation, with a focus on those areas with the greatest potential for economic impact – notably the speargrass and *Bothriochloa-Aristida* grasslands. While most sites (12) were situated in these sub-humid environments of the State, four were chosen in the humid zones of north and south Queensland. Average rainfall at the sites ranged from about 550 mm per year near Charters Towers to 3550 mm per year at Silkwood south of Innisfail. Since the BULS project was instituted to seek alternative species to stylos, it was important to select sites on the basis of their dependence for pasture improvement on the genus, *Stylosanthes*. A total of 55 legumes was sown in a network of 27 sites on soils suitable for stylos in Queensland and the Northern Territory.

The sites in Queensland were located in coastal and sub-coastal districts between Gympie and Mt Garnet, and in the Northern Territory, at Katherine and Daly Waters. Another 5 sites were sown to selected legumes to record liveweight gain, and phosphorus response of 9 elite legumes assessed at a further 3 sites. Average rainfall varied from about 650 mm at Nebo, Charters Towers and Daly Waters to 1500 mm near Sarina. The LCS project was conducted over many research station and farm sites in southern and central Queensland, at Gayndah, Mundubbera, Theodore, Biloela, Wandoan, Middlemount, and Emerald, all in the sub-humid zone, and all on dark clay soils in the downs and brigalow regions of the State.

Evaluation procedure (design, methodology, data recorded)

The COPE project was carried out in two phases, COPE I (CS.054/DAQ.053, 1987 – 91) and COPE II (CS.185/DAQ.081, 1992 – 95). The design of the project aimed at enhancing the introduction, quarantining, initial seed increase, and finally the evaluation of tropical grass and legume germplasm over a representative set of experimental sites. Both phases were conducted using a randomised block design with two replications. In COPE I, entries were sown in single 4 m rows to facilitate ease of observation, and measurement of spread and persistence. Observations on flowering time, seed set and vigour were also recorded. Following a review in 1990, it was determined that entries should be sown in mini-swards, 4 x 1 m2, and that fertiliser response should be assessed. Accordingly, in COPE II one replicate was fertilised at recommended rates and the other treated as a control; whereas, in COPE I, all plots were fertilised in accordance with local recommendations.

With a total of some 1100 accessions evaluated over the life of the project, and at least annual measurements taken of development and performance of each entry, enormous data sets were generated. A summary of results was entered on QPASTURES, and researchers with a responsibility for individual genera distilled the data further and collated into the form presented in “Final Report of MRC Projects CS054/185 and DAQ053/081, Development of new legumes and grasses for the cattle industry of Northern Australia” (1996).

In the species evaluation component of the BULS project, larger plots were used in order to give a better assessment of animal preferences. Micro-plots as used in COPE can give a misrepresentation of palatability ratings. Seed was mostly broadcast onto the surface of a disturbed seedbed at 3 to 5 kg/ha. A minimum germination of around 30% was attempted, and all legumes were inoculated with the appropriate rhizobium. Pasture presentation yield and composition were recorded towards the end of each growing season using “BOTANAL” (Tothill *et al.* 1992). Legume population and other observations (palatability, disease, etc.) were also recorded during BOTANAL assessments.

All sites were grazed by cattle following the first winter, either in conjunction with an adjacent (small) paddock or with weaner steers locked on the site. In the grazing evaluation, the aim was to compare over a number of sites the liveweight gain from a grazable area of a promising

legume in one paddock with a similar area of a standard cultivar in another. Pasture presentation yield and composition were recorded towards the end of the wet season using BOTANAL, as well as legume populations. At other sites, phosphorus response was measured by destructive sampling of small plots in a randomised block layout. A complete dressing of other nutrients was applied so as not to confound P responses.

The LCS on-farm evaluation 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. 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 blade-ploughed 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.

In the LCS small-plot trials, 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.

Data storage

QPASTURES is a QDPI computer database of pasture species evaluation trials conducted by DPI (largely) around Queensland. Some of its records go back 100 years but most begin about 1940 and fully detailed trials only exist currently from about 1965. However, the intention is to continually expand the content as resources allow so that the database contains a fairly comprehensive record of the forage species evaluation trials, and their results, that have been undertaken in Qld. The research results are supported by a sizable bibliography relating to the plants involved and official publications relating to the research and the formally released cultivars.

Cultivar release

Plant release is the process of transferring an elite variety from research to commerce. Related to this, but not an integral part of it, is cultivar registration. This is simply the process of describing and cataloguing that elite variety, at or about the time of release. Before 1987, new cultivars were released publicly. A Seed Increase Committee (SIC) appointed by and from the Queensland Herbage Plant Liaison Committee, oversaw the initial phase of release of each new cultivar in Queensland. The SIC comprising four members, one each from Department of Primary Industries, the Seed Industry Association, and the Queensland Seed Producers' Association, together with a representative of one of the other bodies on QHPLC, ensured that adequate supplies of seed were made available to seed growers. This was done in association with growers. The SIC, having determined the amount of seed required, approached prospective growers, who entered into contracts to produce seed at a price determined by the SIC. The SIC was disbanded when members felt confident that the new variety had every chance of being successfully absorbed into commerce. This early approach accommodated a large volume market, the initial seed increase being spread over a number of seed producers. At that stage, there was less emphasis on public sector accountability than there is now, and methods for selecting growers may not have stood today's critical scrutiny.

In the early 1990s, a new system of release emerged via the Plant Varieties Rights Act and subsequently the Plant Breeders Rights Act, by virtue of which, new varieties became the property of the discoverer. Proprietary rights to a selected variety could be granted under licence to the commercial sector by the organisation developing the new variety. This provided an extremely transparent, although expensive means of plant release. However, in 1998, the Plant Breeders Rights Office, in response to questions raised by farmers' rights groups, Rural Advancement Foundation International (RAFI) and Heritage Seed Curators Association (HSCA), about the propriety of the pasture plant commercialisation system in tropical Australia, chose to interpret the PBR Act more narrowly, thus excluding most pasture plant releases from eligibility for PBR protection. The fact that their criticisms were flawed and verging on libel did not deter RAFI and HSCA. None of the organisations accused of "Biopiracy" chose to challenge the allegations. The PBRO reacted by not accepting any variety that could not be shown to be different from the parents. Since most of our grasses are apomictic and most of our legumes cleistogamous, there was unlikely to be much, if any, variation in the populations of wild species that we are dealing with, and hence little chance of even selecting from within a population. This process may have bestowed eligibility, but our conventional approach of selecting from a range of wild type populations was no longer seen by the PBRO as "breeding".

It has now become necessary to revisit the release process to accommodate changes in the various organisational structures together with the need for transparency and accountability. This has become further complicated by the disbandment of QHPLC and NAPPEC at the 2002 combined meeting. It was agreed that the two organisations should merge, and that an alternative release process be developed.

Appendix 2 Recommendations from Phase I of the eradication program.

1. Management of old plant evaluation sites (monitoring, containment and eradication activities) needs to continue for another 3 to 4 years, to build on the progress made during this initial three year project. A draft new project proposal is presented in appendix 10.7.
2. Strong links need to be made with the Department of Natural Resources and Mine's (NR&M) Strategic Weed Eradication and Education Program (SWEEP) team in any ongoing project, plus continuing links with the other participating inter-agency groups.
3. Develop under graduate and post graduate research projects with Universities and Colleges to study specific environmental weed issues, as in ecological and life cycle studies and control methods.
4. Future forage plant evaluation and cultivar development programs need to follow the new NAPPEC code of practice as outlined in appendix 10.8 of this report. Short term funding for short-term evaluation projects, which specify the number of cultivars to be released, increases the risk of premature release prior to appropriate assessment of palatability and weed potential.
5. Up-to-date information packages on the role, production and sustainable grazing management benefits provided by currently available pasture cultivars, need to be develop. The current emphasis on potential environmental weeds should not be allowed to threaten or lessen the very positive benefits that introduced sown forage plant cultivars provide to grazing industries and to the environment in northern Australia.
6. Positive case studies on the economic and environmental benefits from integrating sown pastures into whole enterprise grazing/cropping production systems, need to be prepared by land holders, land managers and DPI and published in all media forms and at forum events.

Appendix 3 Application submitted by DPI&F to MLA for extension of the eradication program.

Research Organisation

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Title

Pre-emptive eradication of weedy tropical forages

Protecting northern grasslands from rejected forages of high weed potential (2006-2011)

Background

Sown pastures are an essential component of coastal and sub-coastal grazing production systems in northern Australia. They enable graziers to cost-effectively achieve desired growth patterns while using minimal water and fertiliser application and providing a stable, erosion-minimising ground cover. Many cultivars have been developed in Queensland, principally by State and Federal government agencies, and are currently being used successfully in sustainable grazing production systems.

During the 1980s and 1990s, short-term plant evaluation programs (COPE, BULS, LCS, Browse-net and CSLG) were undertaken by DPI (now DPI&F) and CSIRO, with funding from MRC (now MLA), to identify and release pasture plants to enhance the productivity of grazing systems in northern Australia. Although the projects were generally successful, it is now apparent that several legumes with high weed potential were sown at demonstration sites in Queensland.

These concerns led to the development of an eradication project (NAP3.225, 1999-2002) which was led by DPI, funded by MLA and had active participation from staff of CSIRO, James Cook University, DNR&M and EPA. Four perennial legumes, *Acacia angustissima*, *Aeschynomene paniculata*, *Indigofera schimperi* and *Aeschynomene brasiliana* (in decreasing order of weed threat), were identified as posing serious threats to northern Australia and priority plants for eradication or control. The target legumes are extremely well geo-climatically adapted to large areas of northern Australia and have the potential to threaten coastal and sub-coastal grasslands of Queensland, the Northern Territory and Western Australia. All have low palatability, can form thickets and can persist in soil through dormant seed for over ten years.

Under project NAP3.225, sites where the target plants had been sown were identified and monitored for the target plants. Effective eradication methods were developed and eradication (seeking prevention of seeding and erosion of soil seed reserves) undertaken at all sites for three years. By the end of the Project, over 100 sites throughout Queensland had been monitored and an eradication program undertaken at over 60 where plants had persisted. It was recommended that monitoring and eradication be continued for another three years to further erode soil seed levels (see the Final Report for further information on NAP3.225).

The eradication program was extended from 2002 until present as Project MLA NBP.327 (due for completion in January 2006). Under this project, monitoring and eradication was continued at 73 sites where the target plants are known to have established or are considered high risk. In a review of progress undertaken during June 2005, and when classified by target plants *emerging annually* across sites, 41% of the 73 sites were considered clean (no plants found for a number of years), 45% had small numbers of plants emerging each year only and 12% had larger populations requiring two or more eradication visits per annum. At one other site, Batavia Downs near Weipa, a considerable eradication effort is required to contain large populations of *Aeschynomene paniculata*. The project proponents also sought to develop long-term strategies for controlling the target plants and to promote best-practices for the future evaluation and release of pasture plants. To date the issue has been: promoted at international and Queensland conferences; included in a community weed event; and used to motivate the progression of a Code of Practice for pasture plant evaluation in Queensland. Extension materials are currently being prepared, which are intended to assist awareness and best practice control of the target plants.

There is a strong need to extend the current project beyond the completion date (31 January 2006) to prevent the target plants becoming significant weeds in many areas of Queensland. This view was supported by an independent review panel (MLA Mid-Term project reviews, July 2005), which assessed progress of NBP.327 and the need to undertake future actions.

Following discussion with weeds policy staff of DNR&M and Animal Science staff of DPI&F during May 2005, a discussion paper relating to future required activities was produced and submitted to MLA in the 2005 annual report The key conclusions and recommendations of the Discussion Paper were:

- All attempts should be taken to eradicate the target plants as they represent a considerable threat to the grasslands of northern Australia.
- There is a need for on-going eradication activities at all sites, ranging in scope from annual monitoring through to regular eradication.
- Eradication is to be undertaken regardless of landowner opinion of the plant.
- The eradication program must be extended immediately to avoid the risk of plants producing viable seed.
- There are limited options for undertaking eradication at the sites using organisations outside of those already involved in the Project. This is because the state (DNR&M) and local governments have limited resources for undertaking eradication programs. However, particularly for *A. angustissima* (a class 1 declared weed), state and local governments can be involved in the control of escaped plants (should this occur) on public lands and surrounding properties.
- There is a realistic opportunity, though the federal government's 'Defeating the Weed Menace' program, to source funds to eradicate certain priority weeds, including *A. paniculata* (a nationally recognised 'Sleeper weed'). It is anticipated that there will be a call for applications during August 2005.
- The eradication activities are best undertaken by the agencies currently involved in the eradication program and, where possible, by the same officers that have undertaken eradication to date. This is because: many of the priority properties remain under the ownership these agencies; the staff have the best knowledge of the plants and the sites; and the staff are motivated to undertake the eradication activities.

DPI&F seeks to extend the eradication program, consistent with the above recommendations and conditions, for an additional five years. DPI&F strongly supports on-going eradication of the target plants and is prepared to contribute resources, particularly labour which comprises a large component of Project cost. However, DPI&F resources are limited and assistance is sought from

MLA to support on-going eradication. Financial assistance will also be sought from external sources (Defeating the Weed Menace Program) to support eradication at the worst site, Batavia Downs.

Purpose

Aim: To minimise the risk of four weedy perennial legumes invading, and decreasing the production potential of, northern grazing lands.

Intention: To continue towards eventual eradication of the target plants at all sites through both containment of the target plants within current sites and progressive reduction of plant populations and soil seed loads at those sites.

Description

The Project is a five-year monitoring and eradication program targeting four weedy perennial legumes variously located at 94 sites (species x location) throughout Queensland (and more should they be identified). The Project extends the activities of MLA NAP3.225 and NBP.327, the overriding focus being to locate the target legumes and kill them before they seed, thereby gradually eroding soil seed banks. Progress towards eradication at each site is to be assessed and reported to key stakeholders. The activities complement activities instigated during NBP.327 to increase awareness of the eradication program.

Objectives

By February 2011, for the sites previously treated in MLA NBP.327, the project will:
1. Prevent seeding at all sites, with seeding prevented at sites containing smaller plant populations over the course of the project (80% of sites).
2. Have no plants detected beyond the control area of all sites.
3. Have no plants detected for the previous two years at 70% of sites.

Method

Strategy
The program includes plant monitoring and eradication activities at sites of varying scale, target species, target plant population, ease of access and eradication history throughout coastal and sub-coastal Queensland. The proposed MLA/DPI&F five-year program includes works at 60 + sites considered to be of low or moderate required effort and two sites (Sugarbag and Batavia Downs) containing large plant populations and soil-seed loads. At Batavia Downs, the worst site in the program, funding will be sought from the federal government to undertake extensive surveys and eradication in areas adjoining the core infestation (where MLA-funded works are to be undertaken) (Appendix 1). At the end of the federally-funded program (should the application be successful), routine eradication at any identified patches within the survey zone will be included in the broader MLA/DPI&F project.

Activities
Each site will be visited by DPI&F staff, or cooperating staff of CSIRO and James Cook University (a few sites only), at least once per year to assess plant populations by visual survey and working to a grid pattern. The survey will be extended to the surrounding area not less than 1000% of the area where plants were originally sown or detected (whichever is larger). If grazed, the entire fenced area is to be surveyed plus areas immediately adjacent to the fence. High risk areas, such as vehicle tracks, cattle camps and watering points near to the site are also to be checked.

Occurrences of plants will be recorded using a GPS and field markers used to assist location at the next visit. Site-specific data will be compiled in a central database. This data will include the number of occurrences, the nature of the plant population (scattered or clumped, dominant or not), an estimate of plant numbers (using a log scale) and plant growth stage.

If the target plants are present, they will be killed before they seed using one, or a combination of, mechanical removal, selective herbicides or cultivation and crop rotation. Application of herbicides will be by hand, knapsack, from a quad motorbike fitted with a spray equipment or tractor mounted boom spray depending on the terrain and target plant distribution. At some sites, seeding may be suppressed using heavy (and controlled) grazing or fire. Where target plants are located, sites will be visited two to four times per annum, dependant on the particular species, the growing season and the size of the infestation.

Progress towards eradication will be compiled in a technical annual report preferably developed after an annual winter meeting for key DPI&F project staff and stakeholders (*eg* CSIRO, James Cook University, DNR&M and EPA).

Resources
DPI&F officers can access, assess and treat most sites within southern and central Queensland within one day, but it is often most efficient to overnight in order to treat a number of sites over a few days, particularly distant sites. The sites in north Queensland tend to be larger and more remote, most requiring at least one overnight for each visit (mostly camping) in order to complete rigorous monitoring and eradication. Two sites, Sugarbag Station (Mt Garnet) and Batavia Downs (Weipa) contain relatively large infestations, requiring 2-3 and 4-5 weeks per annum for 3-4 staff, respectively.

The key non-labour resources are vehicles to access sites, spraying equipment (mounted onto quad-bikes for the northern sites) and herbicides. Additional equipment to that previously budgeted for NBP.327 is required to improve eradication efficiency at northern sites where work is to be increased (notably Sugarbag and Batavia Downs). These include lease of an additional quad-bike mounted with spray equipment, two basic GPS to replace obsolete models, camping requisites and occasional lease of a vehicle to transport the additional quad-bike.

Potential Industry Benefit

Prevention of spread of four invasive and unpalatable legumes from sites throughout Queensland into extensive native grasslands. This will prevent grazier expenditure on weed control and maintain the major beef production resource of north Australia.

Communications

This is an on-ground eradication activity rather than having a major communication focus. Communication is expected to be limited to reports of progress towards eradication between the Research organisation and MLA plus other key stakeholders (*eg* CSIRO, James Cook University, DNR&M and EPA). Annual technical reports, preferably following annual technical meetings, are a suitable form of communication. The information is not considered to be confidential or to have commercial confidences attached. However, care will be taken not to disclose certain details where deemed inappropriate eg. details of property owners).

The Research Organisation will ensure the Project communicates the following key messages:

COMMUNICATION ACTIVITY	KEY MESSAGE	RESPONSIBLE PERSON AND DATE
Annual technical reports	Review of progress towards plant eradication at all sites, including actions taken, plant populations and characteristics and required actions in the next year.	Kendrick Cox (DPI&F) 31 July 2006 31 July 2007 31 July 2008 31 July 2009 31 July 2010

The Research Organisation will also provide MLA with:

a) a final report. The report will be written with the end user in mind and should include a section detailing the implications of the research findings to industry. The report will be supplied in both electronic and hard copy format and may be reproduced and published in the standard MLA style, with due acknowledgment to the Research Organisation and authors. Only reports submitted in accordance with MLA's style guide will be accepted by MLA. Report guidelines may be provided by MLA on request;

b) where required, a regular update indicating progress on the project. Information may be used in the MLA monthly magazine *(Feedback*), or other MLA publications, to keep producers informed of progress; and

c) a summary report of 3-5 pages will also be provided with key information from the Project. This will be in a format that is suitable for use in the production of a brochure or similar extension material.

Interest

MLA:	40 %
Research Organisation:	60 %

Milestones

MILESTONE AND ACHIEVEMENT CRITERIA		DATE FOR ACHIEVEMENT
	Start Date	1 February 2006
1.	Eradication teams and resources organised	28 February 2006
2.	Review progress towards Objectives 1-3 at annual technical meeting and report submitted to MLA. Aim for: surveying and eradication at all sites known to contain plants; prevention of seeding at 80+% of sites; no reports of plants outside control areas.	31 July 2006
3.	Annual budget report	31 July 2006
4.	Review progress towards Objectives 1-3 at annual technical meeting and report submitted to MLA. Aim for: surveying and eradication at all sites known to contain plants; prevention of seeding at 80+% of sites; no reports of plants outside control areas.	31 July 2007
5.	Annual budget report	31 July 2007
6.	Review progress towards Objectives 1-3 at annual technical meeting and report submitted to MLA. Aim for: surveying and eradication at all sites known to contain plants; prevention of seeding at 80+% of sites; no reports of plants outside control areas.	31 July 2008
7.	Annual budget report	31 July 2008
8.	Review progress towards Objectives 1-3 at annual technical meeting and report submitted to MLA. Aim for: surveying and eradication at all sites known to contain plants; prevention of seeding at 80+% of sites; no reports of plants outside control areas; no reports of plants at 70% of sites in previous year.	31 July 2009
9.	Annual budget report	31 July 2009
10.	Review progress towards Objectives 1-3 at annual technical meeting and report submitted to MLA. Aim for: surveying and eradication at all sites known to contain plants; prevention of seeding at 100% of sites; no reports of plants outside control areas; no reports of plants at 70% of sites in previous two years.	31 July 2010
11.	Annual budget report	31 July 2010
12.	Final report	28 February 2011
13.	Final budget report	28 February 2011

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Funding

Indicative Budget (all values GST exclusive)

For a full budget detailing inputs of the Research Organisation, please refer to Appendix 2. The following budget only details proposed costs to MLA.

	Year 1	Year 2	ar 3	Year 4	Year 5	Total
Salaries and on-costs						
Casual staff (Total 0.08 FTE x 1.26)	5 000	5 000	000	5 000	5 000	25 000
Travel						
Vehicle (0.55)	8 700	8 700	700	8 700	8 700	43 500
Overnight expenses	11 550	11 550	550	11 550	11 550	57 750
Travel to annual mee*tings*	2 000	2 000	000	2 000	2 000	10 000
Operating						
Lease quad-bikes/sprayer	1 350	1 350	350	1 350	1 350	6 750
Herbicides and adjuvants	3 200	3 200	200	3 200	3 200	16 000
Site marking materials	800	800	0	800	800	4 000
Safety equipment	950	950	0	950	950	4 750
Fuel, maintenance and repairs	800	800	0	800	800	4 000
Misc. requisites for remote operations	900	350	0	350	350	2 300
IT, office and associated costs	3 000	3 000	000	3 000	3 000	15 000
Capital						
GPS (x 2 basic models)	400	0		0	0	400
Equipment to preserve supplies while camping (northern sites)	1 200	0		0	0	1 200
Hose retractors (for quad bikes)	500					500
a) Total Project Cost	**141 161**	**142 342**	**6 318**	**150 445**	**154 730**	**734 996**
b) Requested MLA Contribution	**40 350**	**37 700**	**700**	**37 700**	**37 700**	**191 150**
c) Applicant's contribution[1]	**100 811**	**104 642**	**8 618**	**112 745**	**117 030**	**543 846**
d) Funds Requested from other sources[2][3]:						

[1] Please refer to Appendix 2 for details.

[2] There will be an in-kind contribution from staff of CSIRO, NRM, EPA and JCU contributing time and some operating expenses when managing the treatment of, monitoring and making recommendations for the future management of evaluation sites. This could be estimated at a total of five to ten days per year for a professional officer and approximately $300 for a vehicle and other operating expenses.

[3] A project application is to be submitted to the federal government to undertake eradication activities at Batavia Downs in addition, and complementing, those of this project. Approximately $130 000 will be sought over three years for that activity.

Cash Flow Budget

Total Funds = **$ (GST exclusive)**

DATE**	PAYMENT DEPENDENT ON MILESTONE	FEES/ OPERATING COSTS	CAPITAL	TOTAL
28/02/2006	1	11 633	1650	13 283
31/07/2006	2	23 267	0	23 267
31/07/2007	4	34 900	0	34 900
31/07/2008	6	34 900	0	34 900
31/07/2009	8	34 900	0	34 900
31/07/2010	10	23 267	0	23 267
28/02/2011	12	11 633	0	11 633

* on signing of this agreement with invoice for payment attached

** on acceptance and approval of corresponding milestone report, with tax invoice for payment and copy of receipts attached

*** on receipt and acceptance of final report, with tax invoice attached

Note: any money uncommitted at the end of the Project must be returned to MLA

Contributors/Other funds

There will be an in-kind contribution from staff of CSIRO, DNR&M, EPA and JCU contributing time and some operating expenses when managing the treatment of, monitoring and making recommendations for the future management of evaluation sites. This could be estimated at a total of ten days per year for a professional officer plus the costs of a vehicle and other operating expenses. The overall in-kind contribution is estimated to be approximately $6 000 per annum.

A project application is to be submitted to the federal government to undertake eradication activities at Batavia Downs in addition to, and complementing those of, this project. Approximately $130 000 will be sought over three years. It is anticipated that the application will be submitted during September 2005.

Subcontractors

There are no sub-contractors, although casual labour will be employed using the DPI&F system to undertake eradication and monitoring activities (see budget above).

Appendix 1. Coordination of proposed MLA and federal government activities.

Funders	MLA/DPI&F			Federal Govt./ DPI&F
Sites	~ 60 small-medium sized sites	Sugarbag Station	Batavia Downs Station 1. core infestation	Batavia Downs Station 2. containment area
Population characteristics	Few scattered plants to scattered populations, plant populations declining.	Large site and population with expected high levels of soil seed	Large site and population with expected high levels of soil seed	Scattered patches over ~ 600 ha found in low intensity surveys to date
Effort required	Monitoring and low to moderate eradication effort	Monitoring and high eradication effort	Monitoring and high eradication effort	Extensive surveys and eradication
Timing Year 1 Year 2 Year 3	⇩	⇩	⇩	⇩
Year 4 Year 5			⇦	
MLA project targets by 5 years	70+% 'clean'	All plants non-seeding	All plants non-seeding	
	<<	100% containment	>>	

Appendix 2. Full budget detailing inputs of the Research Organisation and MLA.

	Year 1	Year 2	Year 3	Year 4	Year 5	TOTAL
Salaries and on-costs						
Technical staff (1.0 FTE x 1.26)	66 050	68 560	71 165	73 869	76 676	356 320
Professional staff (0.4 FTE x 1.26)	34 761	36 082	37 453	38 876	40 354	187 526
Casual staff (Total 0.08 FTE x 1.26)	5 000	5 000	5 000	5 000	5 000	25 000
Travel						
Vehicle (0.55)	8 700	8 700	8 700	8 700	8 700	43 500
Overnight expenses	11 550	11 550	11 550	11 550	11 550	57 750
Travel to annual meetings	2 000	2 000	2 000	2 000	2 000	10 000
Operating						
Lease quad-bikes/sprayer	1 350	1 350	1 350	1 350	1 350	6 750
Herbicides and adjuvants	3 200	3 200	3 200	3 200	3 200	16 000
Site marking materials	800	800	800	800	800	4 000
Safety equipment	950	950	950	950	950	4 750
Fuel, maintenance and repairs	800	800	800	800	800	4 000
Misc. requisites for remote operations	900	350	350	350	350	2 300
IT, office and associated costs	3 000	3 000	3 000	3 000	3 000	15 000
Capital						
GPS (x 2 basic models)	400	0	0	0	0	400
Equipment to preserve supplies while camping (northern sites)	1 200	0	0	0	0	1 200
Hose retractors (for quad bikes)	500					500
a) Total Project Cost	**141 161**	**142 342**	**146 318**	**150 445**	**154 730**	**734 996**
b) Requested MLA Contribution	**40 350**	**37 700**	**37 700**	**37 700**	**37 700**	**191 150**
c) Applicant's contribution	**100 811**	**104 642**	**108 618**	**112 745**	**117 030**	**543 846**
d) Funds Requested from other sources[1][2]:						

Appendix 4 Correspondence updating the classification of the target weed at the Helen's Hill site.

Queensland Government

Queensland Herbarium
Brisbane Botanic Gardens Mt Coot-tha • Toowong 4066 Queensland • Australia
Telephone +61 7 3896 9326 • Facsimile +61 7 3896 9624
e-mail Queensland.Herbarium@epa.qld.gov.au • www.epa.qld.gov.au

Environmental Protection Agency
Incorporating the Queensland Parks and Wildlife Service

Enquiries Wayne Harris
Telephone 07 3896 9318
Your reference
Our reference WKH:ycs 1082/05

20th October 2005

Nanette Hooker
Tropical Plant Sciences
School of Tropical Biology
James Cook University
Townsville Qld 4811

Dear Nanette

The botanical specimen submitted with your letter of 3rd September, has been identified as:

> *Acacia curassavica*. This species is a native of the West Indies and has previously been misidentified as *A. angustissima*, which has not been recorded from Australia. It is similar to *A. boliviana* but differs in being less distinctly hairy, having fewer pinnae with fewer wider leaflets and a less expansive terminal panicle.

Yours sincerely

G.P.Guymer
Director

Appendix 5 Known plantings of the four target species in Queensland.

Key for 'Site Effort Status'
A classification based on the perceived effort to control the target plants, based on plant population history at the site.
0 = Very occasional visits only (say every 5 years). Plants failed to establish or did not persist at the site.
1 = Minimal effort: one visit per year (usually after rains) by one officer to check for and kill occasional plants which may have established.
2 = Moderate effort: two visits per year by one or two officers recommended to kill plants before flowering and monitor the site
3 = Major effort: three+ visits per year by three+ officers recommended to kill plants before flowering and monitor the site. Equipment such as mobile spray rigs likely to be required.

Site name	Shire	Latitude	Longitude	Species	Accession number(s)	Sowing date	Site effort status
Walkamin RS	Atherton	17.13	145.42	*Indigofera schimperi*	CPI16055	22/12/1983	0
					CPI16055	10/01/1996	
					CPI52621	22/12/1983	
					CPI52621	23/01/1995	
					CPI65477	22/12/1983	
					CPI69495	22/12/1983	
					CPI73608	22/12/1983	
					CPI65477	7/01/1987	
Walkamin RS	Atherton	17.13	145.42	*Acacia angustissima*	CPI40175	9/02/1978	1
					CPI40175	1/03/1983	
					CPI51651	1/03/1983	
					CPI57959	1/03/1983	
					CPI84971	15/04/1982	
Walkamin RS	Atherton	17.13	145.42	*Aeschynomene brasiliana*	CPI92519	11/12/1985	2
					CPI92519	27/12/1984	
					CPI93592	7/01/1987	
Walkamin RS	Atherton	17.13	145.42	*Aeschynomene paniculata*	CPI93653	1987	2

Site name	Shire	Latitude	Longitude	Species	Accession number(s)	Sowing date	Site effort status
Mulga View	Balonne	27.97	148.30	*Acacia angustissima*	CPI84971	21/10/1986	0
Mulga View	Balonne	27.97	148.30	*Indigofera schimperi*	CPI69495 CPI73608	21/10/1986 21/10/1986	0
Ula Ula	Balonne	28.02	149.42	*Acacia angustissima*	CPI84971	3/12/1985	0
Ula Ula	Balonne	28.02	149.42	*Indigofera schimperi*	CPI69495 CPI73608	3/12/1985 3/12/1985	1
Woodbine	Balonne	28.25	148.83	*Acacia angustissima*	CPI84971	5/12/1985	0
Woodbine	Balonne	28.25	148.83	*Indigofera schimperi*	CPI69495 CPI73608	5/12/1985 5/12/1985	0
Mutation	Balyando	22.48	147.48	*Indigofera schimperi*	CPI69495	1994	2
Brigalow RS	Banana	24.82	149.77	*Aeschynomene brasiliana*	CPI92519 CPI93592 Q24801 Q24813	7/01/1988 7/01/1988 7/01/1988 7/01/1988	0
Brigalow RS	Banana	24.82	149.77	*Aeschynomene paniculata*	Q24804	7/01/1988	0
Brigalow RS	Banana	24.82	149.77	*Indigofera schimperi*	CPI16055 CPI52621 CPI69495 CPI73608	7/01/1988 7/01/1988 7/01/1988 7/01/1988	2
Kapalee	Banana	24.40	150.42	*Indigofera schimperi*	CPI69495	1994	1
Rangeview	Banana	24.70	150.10	*Indigofera schimperi*	CPI69495	1994	2
Birrong	Bauhinia	24.23	148.3	*Indigofera schimperi*	CPI69495	1994	2
Mutdapilly Graznet site	Boonah	27.46	152.40	*Aeschynomene brasiliana*	CPI92519 CPI93592 Q24801	19/01/1988 19/01/1988 19/01/1988	0
Mutdapilly Graznet site	Boonah	27.46	152.40	*Aeschynomene paniculata*	Q24804	19/01/1988	0

Site name	Shire	Latitude	Longitude	Species	Accession number(s)	Sowing date	Site effort status
Mutdapilly Graznet site	Boonah	27.46	152.40	*Indigofera schimperi*	CPI16055 CPI52621 CPI69495 CPI73608	19/01/1988 19/01/1988 19/01/1988 19/01/1988	0
Mutdapilly pasture nursery	Boonah	27.46	152.40	*Aeschynomene brasiliana*	CPI93593	1/01/1983	0
Carmilla Glen	Broadsound	21.96	149.5	*Aeschynomene brasiliana*	CPI93592 CPI92519	16/11/1988 16/11/1988	1
Eungy	Broadsound	22.36	148.87	*Aeschynomene brasiliana*	CPI92519 CPI93592	1987 1987	1
Eungy	Broadsound	22.36	148.87	*Aeschynomene paniculata*	CPI93653	1987	1
Granite Vale	Broadsound	22.42	149.53	*Aeschynomene brasiliana*	CPI92519 CPI93592	12/03/1992 12/03/1992	2
Granite Vale	Broadsound	22.42	149.53	*Aeschynomene paniculata*	unknown	presume 1992	1
Rolfe Park	Broadsound	26.38	148.77	*Indigofera schimperi*	CPI52621	1994	1
Willunga	Broadsound	22.20	148.37	*Aeschynomene brasiliana*	CPI92519 CPI93592 Q24801 Q24813	15/12/1987 15/12/1987 15/12/1987 15/12/1987	0
Willunga	Broadsound	22.20	148.37	*Aeschynomene paniculata*	Q24804	15/12/1987	0
Willunga	Broadsound	22.20	148.37	*Indigofera schimperi*	CPI16055 CPI52621 CPI69495 CPI73608	15/12/1987 15/12/1987 15/12/1987 15/12/1987	1
Bindaroo (Roma)	Bungil	26.67	149.03	*Indigofera schimperi*	CPI52621	1995	1

Site name	Shire	Latitude	Longitude	Species	Accession number(s)	Sowing date	Site effort status
Holyrood	Bungil	26.49	148.45	*Aeschynomene brasiliana*	CPI92519 CPI93592 Q24801	29/01/1988 29/01/1988 29/01/1988	0
Holyrood	Bungil	26.49	148.45	*Aeschynomene paniculata*	Q24804	29/01/1988	0
Holyrood	Bungil	26.49	148.45	*Indigofera schimperi*	CPI16055 CPI52621 CPI69495 CPI73608 CPI16055	29/01/1988 29/01/1988 29/01/1988 29/01/1988 3/01/1990	2
Kiamanna	Bungil	25.42	148.85	*Indigofera schimperi*	CPI52621	1995	1
Lyndon Caves	Bungil	26.83	148.94	*Indigofera schimperi*	CPI69495 CPI73608	30/10/1986 30/10/1986	0
Lyndon Caves	Bungil	26.83	148.94	*Acacia angustissima*	CPI84971	30/10/1986	2
Norton	Bungil	26.39	148.76	*Acacia angustissima*	CPI84971	5/02/1986	0
Norton	Bungil	26.39	148.76	*Indigofera schimperi*	CPI69495 CPI73608	5/02/1986 5/02/1986	1
Swans Lagoon	Burdekin	20.08	147.17	*Aeschynomene paniculata*	unknown	presume 1993	1
Galloway Plains	Calliope	24.10	150.57	*Aeschynomene paniculata*	Q24804	22/12/1987	0
Galloway Plains	Calliope	24.10	150.57	*Aeschynomene brasiliana*	CPI92519 CPI93592 Q24801	22/12/1987 22/12/1987 22/12/1987	2
Galloway Plains	Calliope	24.10	150.57	*Indigofera schimperi*	CPI16055 CPI52621 CPI69495 CPI73608	22/12/1987 22/12/1987 22/12/1987 22/12/1987	1

Site name	Shire	Latitude	Longitude	Species	Accession number(s)	Sowing date	Site effort status
Raglan	Calliope	23.75	150.75	*Acacia angustissima*	CPI40175	early 1990s	1
Beerburrum seed production area	Caloundra	26.96	152.98	*Acacia angustissima*	CPI51651	unknown	0
Double Lagoons	Carpentaria	17.30	141.29	*Aeschynomene brasiliana*	CPI93592	3/12/1991	0
Inverleigh	Carpentaria	18.00	140.57	*Indigofera schimperi*	CPI69495 CPI73608	3/01/1990 3/01/1990	0
Milgarra	Carpentaria	18.12	140.88	*Acacia angustissima*	CPI40175	23/11/1988	0
Milgarra	Carpentaria	18.12	140.88	*Aeschynomene brasiliana*	CPI92519 CPI92519 CPI93592 CPI93592	23/11/1989 17/12/1987 23/11/1989 17/12/1987	0
Warranvale	Carpentaria	18.42	140.82	*Indigofera schimperi*	CPI16055 CPI52621 CPI65477 CPI69495 CPI73608	2/01/1984 2/01/1984 2/01/1984 2/01/1984 2/01/1984	0
Woodview	Carpentaria	17.76	141.08	*Aeschynomene brasiliana*	CPI92519 CPI93592	17/12/1987 17/12/1987	0
Ellenvale	Chinchilla	26.73	150.72	*Indigofera schimperi*	CPI52621	1995	1
Batavia Downs RS	Cook	12.66	142.66	*Aeschynomene brasiliana*	CPI92519 CPI93592	23/10/1990	3
Batavia Downs RS	Cook	12.66	142.66	*Aeschynomene paniculata*	CPI93635	23/10/1990	3
Kalinga	Cook	15.18	143.86	*Acacia angustissima*	CPI40175 CPI51651 CPI57959	17/12/1975 17/12/1975 17/12/1975	0
Kalinga	Cook	15.18	143.86	*Indigofera schimperi*	CPI52621	17/12/1975	0

Site name	Shire	Latitude	Longitude	Species	Accession number(s)	Sowing date	Site effort status
Narayen RS	Eidsvold	25.68	150.78	*Indigofera schimperi*	CPI69495	1992/93	2
					CPI73608	1992/93	
					CPI52621	1992/93	
					CPI16055	1993/94	
					CPI69495	1993/94	
					CPI73608	1993/94	
					CPI52621	1994/95	
					CPI73608	1994/95	
					CPI16055	1994/95	
					CPI52621	1994/95	
					CPI73608	1994/95	
Emerald RS	Emerald	23.46	148.01	*Indigofera schimperi*	CPI16055	1993	2
					CPI52621	1993	
					CPI69495	1993	
					CPI73608	1993	
					CPI16055	1994	
					CPI52621	1994	
					CPI69495	1994	
					CPI73608	1994	
					CPI16055	1995	
					CPI52621	1995	
					CPI69495	1995	
					CPI73608	1995	
Goondooroo	Emerald	23.82	148.12	*Indigofera schimperi*	CPI69495	1994	1
Burlington	Etheridge	17.82	144.36	*Aeschynomene brasiliana*	CPI92519	28/12/1986	3
					CPI93592	28/12/1986	

Site name	Shire	Latitude	Longitude	Species	Accession number(s)	Sowing date	Site effort status
Forest Home	Etheridge	18.25	143.05	*Acacia angustissima*	CPI40175 CPI51651 CPI57959	9/01/1980 9/01/1980 9/01/1980	0
Mistletoe	Etheridge	18.22	143.57	*Acacia angustissima*	CPI40175 CPI51651 CPI57959	10/01/1980 10/01/1980 10/01/1980	0
Mt.Surprise	Etheridge	18.18	144.21	*Acacia angustissima*	CPI40175 CPI51651 CPI57959	8/01/1980 8/01/1980 8/01/1980	0
Mt.Surprise	Etheridge	18.16	144.27	*Aeschynomene brasiliana*	CPI92519 CPI93592	18/12/1987 18/12/1987	0
Rosella Plains	Etheridge	18.42	144.46	*Acacia angustissima*	CPI40175 CPI51651 CPI57959	11/01/1980 11/01/1980 11/01/1980	0
Yaramulla	Etheridge	18.22	144.69	*Aeschynomene brasiliana*	CPI92519 CPI93592	19/12/1990 19/12/1990	0
Brian Pastures RS - Basalt site	Gayndah	25.40	151.40	*Aeschynomene paniculata*	Q24804	1/01/1988	0
Brian Pastures RS - Granite site	Gayndah	25.40	151.40	*Aeschynomene paniculata*	Q24804	1/01/1988	0
Brian pastures RS	Gayndah	25.40	151.40	*Acacia angustissima*	CPI40175 CPI51651 CPI57959 CPI84971 CPI51651 CPI51651	1/02/1990 1/02/1990 1/02/1990 1/02/1990 4/01/1977 4/01/1977	2

Site name	Shire	Latitude	Longitude	Species	Accession number(s)	Sowing date	Site effort status
Brian Pastures RS	Gayndah	25.40	151.40	*Aeschynomene brasiliana*	CPI92519	1/01/1988	2
					CPI93592	1/01/1988	
					Q24801	1/01/1988	
					Q24801	30/01/1989	
					CPI92519	1/01/1988	
					CPI93592	1/01/1988	
					Q24801	1/01/1988	
					CPI92519	12/04/1992	
					CPI93592	12/04/1992	
Narayen RS	Eidsvold	25.68	150.78	*Indigofera schimperi*	CPI69495	1992/93	2
					CPI73608	1992/93	
					CPI52621	1992/93	
					CPI16055	1993/94	
					CPI69495	1993/94	
					CPI73608	1993/94	
					CPI52621	1994/95	
					CPI73608	1994/95	
					CPI16055	1994/95	
					CPI52621	1994/95	
					CPI73608	1994/95	

Site name	Shire	Latitude	Longitude	Species	Accession number(s)	Sowing date	Site effort status
Brian Pastures RS	Gayndah	25.40	151.40	*Indigofera schimperi*	CPI16055 CPI52621 CPI69495 CPI73608 unknown CPI16055 CPI52621 CPI69495 CPI73608	1/01/1988 1/01/1988 1/01/1988 1/01/1988 1/12/1984 1/01/1988 1/01/1988 1/01/1988 1/01/1988	2
Lamonds Lagoon	Herberton	18.37	145.14	*Aeschynomene brasiliana*	CPI93592	14/01/1993	2
Meadowbank	Herberton	18.28	144.98	*Acacia angustissima*	CPI40175 CPI51651 CPI57959	9/01/1980 9/01/1980 9/01/1980	0
Sugarbag	Herberton	17.94	144.99	*Aeschynomene brasiliana*	CPI92519 CPI92519 CPI93592	29/01/1992 2/02/1995 29/01/1992	3
Woodleigh	Herberton	17.71	145.15	*Acacia angustissima*	CPI40175 CPI51651 CPI57959	12/01/1980 12/01/1980 12/01/1980	0
Helen's Hill, Ingham	Hinchinbrook	18.78	146.13	*Acacia angustissima*	unknown	not planted	2
Silkwood	Johnstone	17.46	146.02	*Aeschynomene brasiliana*	CPI92519 CPI93592 Q24801 Q24813	12/01/1988 12/01/1988 12/01/1988 12/01/1988	0
Silkwood	Johnstone	17.46	146.02	*Aeschynomene paniculata*	Q24804	12/01/1988	0

Site name	Shire	Latitude	Longitude	Species	Accession number(s)	Sowing date	Site effort status
Silkwood	Johnstone	17.46	146.02	*Indigofera schimperi*	CPI16055 CPI52621 CPI69495 CPI73608	12/01/1988 12/01/1988 12/01/1988 12/01/1988	0
South Johnstone RS	Johnstone	17.62	146.00	*Acacia angustissima*	CPI40175 CPI51651 CPI57959 CPI84971	7/12/1989 7/12/1989 7/12/1989 7/12/1989	0
South Johnstone RS	Johnstone	17.37	146.00	*Aeschynomene brasiliana*	CPI92519 CPI93592 Q24801 Q24813	16/12/1987 16/12/1987 16/12/1987 16/12/1987	0
South Johnstone RS	Johnstone	17.37	146.00	*Aeschynomene paniculata*	Q24804	16/12/1987	0
South Johnstone RS	Johnstone	17.37	146.00	*Indigofera schimperi*	CPI16055 CPI52621 CPI69495 CPI73608	16/12/1987 16/12/1987 16/12/1987 16/12/1987	0
Kingsthorpe field station	Jondaryan	27.51	151.78	*Indigofera schimperi*	CPI52621 CPI73608 unknown	1/12/1983 1/12/1983 1/12/1983	0

Site name	Shire	Latitude	Longitude	Species	Accession number(s)	Sowing date	Site effort status
Bakers Creek	Mackay	21.10	149.10	*Aeschynomene brasiliana*	CPI92519	1/01/1982	0
					CPI93056	1/01/1982	
					CPI93592	1/01/1982	
					CPI93593	1/01/1982	
					CPI93594	1/01/1982	
					CPI93627	1/01/1982	
					CPI93630	1/01/1982	
					CPI93637	1/01/1982	
					CPI93643	1/01/1982	
Bakers Creek	Mackay	21.10	149.10	*Aeschynomene paniculata*	CPI93635	1/01/1982	0
Mackay Nursery	Mackay	21.10	149.10	*Aeschynomene brasiliana*	CPI92499	1/01/1982	0
					CPI92499	1/01/1986	
Mackay Nursery	Mackay	21.10	149.10	*Aeschynomene paniculata*	CPI107160	1/01/1986	0
Mackay pasture nursery II	Mackay City	21.10	149.10	*Aeschynomene brasiliana*	unknown	1/01/1975	0
Toorak RS	Mackinlay	21.03	141.78	*Acacia angustissima*	unknown	unknown	1
Toorak RS	Mackinlay	21.03	141.78	*Indigofera schimperi*	unknown	unknown	1
Brooklyn	Mareeba	16.51	145.02	*Acacia angustissima*	CPI40175	5/01/1980	0
					CPI51651	5/01/1980	
					CPI57959	5/01/1980	

Site name	Shire	Latitude	Longitude	Species	Accession number(s)	Sowing date	Site effort status
Southedge RS	Mareeba	16.75	145.34	*Acacia angustissima*	CPI40175	7/01/1980	0
					CPI51651	7/01/1980	
					CPI57959	7/01/1980	
					CPI40175	17/01/1990	
					CPI51651	17/01/1990	
					CPI57959	17/01/1990	
					CPI84971	17/01/1990	
Southedge RS	Mareeba	16.98	145.34	*Aeschynomene brasiliana*	CPI92519	23/12/1987	0
					CPI93592	23/12/1987	
					Q24801	23/12/1987	
					Q24813	23/12/1987	
Southedge RS	Mareeba	16.98	145.34	*Aeschynomene paniculata*	Q24804	23/12/1987	0
Southedge RS	Mareeba	16.98	145.34	*Indigofera schimperi*	CPI16055	23/12/1987	0
					CPI52621	23/12/1987	
					CPI69495	23/12/1987	
					CPI73608	23/12/1987	
Springmount	Mareeba	17.24	145.30	*Aeschynomene brasiliana*	CPI92519	21/12/1990	2
					CPI93592	21/12/1990	
Wrotham Park	Mareeba	16.71	144.07	*Indigofera schimperi*	CPI16055	13/12/1989	1
					CPI69495	13/12/1989	
					CPI73608	13/12/1989	
Bringalily	Millmerran	28.09	151.17	*Indigofera schimperi*	CPI52621	1/01/1978	1
'Dandarriga', Bringalily brig. clay	Millmerran	28.09	151.17	*Acacia angustissima*	CPI40175	1/01/1978	0
					CPI51651	1/01/1978	

Site name	Shire	Latitude	Longitude	Species	Accession number(s)	Sowing date	Site effort status
Kindon	Millmerran	28.09	150.78	*Indigofera schimperi*	CPI52621 CPI69495 CPI73608	1/11/1988 1/11/1988 1/11/1988	2
Crediton	Mirani	21.18	148.50	*Aeschynomene brasiliana*	CPI92519 CPI93592	1987 1987	1
Wadeleigh	Miriam Vale	24.28	151.53	*Aeschynomene brasiliana*	CPI92519 CPI93592	25/01/1993 25/01/1993	2
Brumich	Murweh	25.68	146.20	*Indigofera schimperi*	CPI16055 CPI52621 CPI65477 CPI69495 CPI73608	1980 1980 1980 1980 1980	1
Charleville laboratory	Murweh	26.41	146.24	*Acacia angustissima*	CPI51651 CPI84971 CPI90744 CPI90841	26/08/1976 30/10/1981 28/11/1983 30/10/1981	1
Glen Eden	Murweh	25.77	146.22	*Indigofera schimperi*	CPI16055 CPI52621 CPI65477 CPI69495 CPI73608	1980 1980 1980 1980 1980	1
Murweh site	Murweh	26.41	146.29	*Acacia angustissima*	CPI84971 CPI90841	22/03/1983 22/03/1983	0

Site name	Shire	Latitude	Longitude	Species	Accession number(s)	Sowing date	Site effort status
Valera Vale	Murweh	25.88	146.27	*Indigofera schimperi*	CPI16055 CPI52621 CPI65477 CPI69495 CPI73608	1980 1980 1980 1980 1980	1
Lynford	Nebo	21.75	148.67	*Aeschynomene brasiliana*	CPI92519 CPI93592	4/11/1987 4/11/1987	2
Lynford	Nebo	21.75	148.67	*Aeschynomene paniculata*	CPI93653	4/11/1987	1
Oxford Downs	Nebo	21.82	148.67	*Indigofera schimperi*	CPI69495	1994	2
Carramah	Peak Downs	22.87	147.90	*Indigofera schimperi*	CPI52621	10/01/1995	1
Southedge RS	Mareeba	16.75	145.34	*Acacia angustissima*	CPI40175 CPI51651 CPI57959 CPI40175 CPI51651 CPI57959 CPI84971	7/01/1980 7/01/1980 7/01/1980 17/01/1990 17/01/1990 17/01/1990 17/01/1990	0
Glenbower	Pittsworth	27.84	151.58	*Indigofera schimperi*	CPI52621 CPI16055 CPI52621 CPI69495 CPI73608	4/02/1987 16/12/1987 16/12/1987 16/12/1987 16/12/1987	2
Parkhurst pasture nursery	Rockhampton City	23.32	150.52	*Aeschynomene brasiliana*	CPI92519	9/12/1976	0
Parkhurst pasture nursery	Rockhampton City	23.32	150.52	*Acacia angustissima*	Unknown	9/12/1976	1

Site name	Shire	Latitude	Longitude	Species	Accession number(s)	Sowing date	Site effort status
Rockhampton correctional unit	Rockhampton City	23.23	150.30	*Acacia angustissima*	CPI40175 CPI51651 CPI57959 CPI84971	21/01/1991 21/01/1991 21/01/1991 21/01/1991	1
Rockhampton RS	Rockhampton City	23.25	150.50	*Aeschynomene brasiliana*	CPI92519 CPI93593	1/01/1984 1/01/1984	0
Roma RS	Roma	26.30	148.50	*Acacia angustissima*	CPI40175 CPI51651 CPI57959 CPI84971	1/03/1990 1/03/1990 1/03/1990 1/03/1990	0
Glensfield	Sarina	21.47	147.97	*Aeschynomene brasiliana*	CPI92519 CPI93592	12/03/1992 12/03/1992	2
Glensfield	Sarina	21.47	147.97	*Aeschynomene paniculata*	unknown	presume 1992	1
Strathdale (Blue Mt)	Sarina	21.53	149.00	*Aeschynomene paniculata*	unknown	presume 1992	2
Tedlands	Sarina	21.36	149.18	*Indigofera schimperi*	CPI16055 CPI52621 CPI69495 CPI73608	12/02/1988 12/02/1988 12/02/1988 12/02/1988	0
Tedlands	Sarina	21.36	149.18	*Aeschynomene brasiliana*	CPI92519 CPI93592 Q24801 Q24813	12/02/1988 12/02/1988 12/02/1988 12/02/1988	3
Tedlands	Sarina	21.36	149.18	*Aeschynomene paniculata*	Q24804	12/02/1988	3
Sunset Downs	Tara	49.82	148.67	*Indigofera schimperi*	CPI16055 CPI69495 CPI73608	6/01/1992 6/01/1992 6/01/1992	2

Site name	Shire	Latitude	Longitude	Species	Accession number(s)	Sowing date	Site effort status
Belcrest	Taroom	26.00	149.90	*Indigofera schimperi*	CPI16055 CPI52621 CPI52621 CPI69495 CPI69495 CPI73608 CPI73608	22/01/1993 22/01/1993 11/01/1994 11/01/1994 22/01/1993 11/01/1994 22/01/1993	2
Kookaburra	Taroom	25.92	149.78	*Indigofera schimperi*	CPI69495	1994	2
Sylvan Hills	Taroom	26.01	149.81	*Acacia angustissima*	CPI40175 CPI51651	2/01/1978 2/01/1978	0
Sylvan Hills	Taroom	26.015	149.8183	*Indigofera schimperi*	CPI52621	2/01/1978	0
Sylvan Hills	Taroom	26.0217	149.8183	*Indigofera schimperi*	CPI52621	1/12/1978	0
Lansdown RS	Thuringowa	19.66	146.83	*Acacia angustissima*	unknown	unknown	2
Tor Street DPI glasshouse pots	Toowoomba	27.53	151.93	*Indigofera schimperi*	CPI52621 CPI73608	1/11/1983 1/11/1983	0
Campus Creek, Townsville	Townsville City	19.32	146.75	*Acacia angustissima*	unknown	Unknown	2
Boongargil	Waggamba	28.53	149.67	*Indigofera schimperi*	CPI52621 CPI69495 CPI73608	1/10/1988 1/10/1988 1/10/1988	2
Goorganga	Whitsunday	20.45	148.45	*Aeschynomene brasiliana*	CPI92519 CPI93592	8/02/1988 8/02/1988	2
Goorganga	Whitsunday	20.45	148.45	*Aeschynomene paniculata*	CPI93653	8/02/1988	1
Yallatup	Whitsunday	20.30	148.42	*Aeschynomene brasiliana*	CPI93653	18/01/1993	0

Appendix 6 Eradication activity and plant population status at June 2005.

Site	Locality	Visits	Area assessed	Popn type[1]	Control method[2]	Plant pop[n 3]
Acacia angustissima						
Birralee	Colinsville	Jul-03, Dec-03, May-04, May-05, Dec-05	0.1 ha	o	H	1
Brian Pastures 1	Gayndah	Regular local checks, Nov-04, Feb-06	1 ha	o	HE	0
Campus Creek	Townsville	Regular local checks	2 ha	s	H	0
Charleville Laboratory	Charleville	Regular local checks	1 ha	s	H,M	0
Correctional unit	Rockhampton	Jul-03, Dec-04, Mar-05	1.0ha	o	H	1
Helen's Hill	Ingham	Regular Council control	0.5 ha	c2	H	2
Lansdown RS	Woodstock	Local control, Nov-03	2 ha	s	H	0
Lyndon Caves	Roma	Mar-04, Nov-05	0.1 ha	o	M	1
Parkhurst	Rockhampton	Regular local control	0.5 ha	s	Mowing, H	1
Raglan	Rockhampton	local	2.0 ha	clean	none	0
Rosebank	Longreach	Local control, Jul-03	2 ha	o	H	0
Toorak DPI	Julia Creek	Regular local control	1 ha	s	H, M	1
Walkamin RS	Walkamin	Regular	2 ha	s	H	1
Warrill View	Peak Crossing	Unknown location	0.5 ha	Sus. clean	none	unknown
Aeschynomene paniculata						
Batavia Dns - surrounds	Weipa	Feb-03, May-03, Jan-04, May-04, Jun-04, Apr-05, Jul-05, Sep-05	20 ha	s	H	5
Batavia Dns – distant	Weipa		600 ha	c1	H	4
Batavia Dns - plant area	Weipa		2 ha	s	H	4
Blue Mt	Mackay	Dec-03, Feb-04, May-04, Dec-04, Mar-05, Dec-05	8.0ha	c1	H,M	2
Eungy	Nebo	2002, Dec-05	small plots	clean	M	0
Glensfield	Sarina	Dec-03, Feb-04, May-04, Dec-04, Mar-05, Dec-05	0.4 ha	clean	M	0
Goorganga	Proserpine	Dec-03, Mar-04, May-04, Jan-05, May-05, Dec-05	0.25 ha	o	H,M	1

Appendix 6 continued

Site	Locality	Visits	Area assessed	Popn type[1]	Control method[2]	Plant pop[n 3]
Granite Vale	St. Lawrence	Dec-03, Feb-02, May-04, Dec-04, Dec-05	1.0 ha	clean	H	0
Lynford	Nebo	Manager, Dec-05	1.0 ha	clean	H	0
Mt Dangar	Bowen	May-04, Dec-05	1.0 ha	clean	M	0
Swan's Lagoon	Ayr	Dec-03, Mar-04, Jan-05, Dec-05	5.0 ha	clean	H	0
Tedlands	Koumala	15 visits 2003-05	10 ha	s	H,M	3
Walkamin RS	Walkamin	regular	1 ha	s	H,C	2
Aeschynomene brasiliana						
Batavia Downs	Weipa	8 visits as above	6 ha	s	H	2
Birralee	Colinsville	Jul-03, Dec-03, May-04, May-05, Dec-05	50m^2	clean	M	0
Braceborough	Charters Twrs	Dec-03, Mar-04, Jan-05	0.25ha	c2	H	2
Brian Pastures 2	Gayndah	Regular local checks, Nov-04, Feb-06	0.5 ha	s	H,M	1
Burlington - plant area	Mt. Surprise	May-03, Apr-04(2), Jun-04, Mar-05, May-05, Feb-06	1 ha	s	H	2
Burlington - surrounds	Mt. Surprise		20 ha	s	H	3
Burlington - other (creek)	Mt. Surprise		0.5 ha	o	H	1
Carmilla Glen	Carmilla	2002, Dec-05	0.06 ha	o	H	2
Crediton	Eungalla	2002, Dec-05	small plots	clean	M	0
Eungy	Nebo	2002, Dec-05	small plots	clean	M	0
Gallaway Plains	Calliope	Dec-03, May-04, Dec-05	1.0ha	o	H	1
Glensfield	Sarina	Dec-03, Feb-04, May-04, Dec-04, Mar-05, Dec-05	0.4 ha	o	H	1
Goorganga	Proserpine	Dec-03, Mar-04, May-04, Jan-05, May-05, Dec-05	0.25 ha	s	H,M	2
Granite Vale	St. Lawrence	Dec-03, Feb-02, May-04, Dec-04, Dec-05	1.0 ha	s	H	2
Lamonds - surrounds	Mt. Garnet	Apr-03, May-03, Mar-04, Jun-04, Mar-05, May-05, Feb-06	20 ha	c1	H	3
Lamonds - plant area	Mt. Garnet		4 ha	s	H	2
Lynford	Nebo	Manager, Dec-05	1.0 ha	c2	grazed	4
Mt Dangar	Bowen	May-04, Dec-05	1.0 ha	clean	M	0
Narayen R.S.	Munduberra	May-03, Apr-04, May-5	0.1 ha	s	H	2
Sorrell Hills	Duaringa	Dec-03, Feb-04, May-04, Dec-04, Mar-05, Dec-05	4 ha	s	H	3

Appendix 6 continued

Site	Locality	Visits	Area assessed	Popn type[1]	Control method[2]	Plant pop[n 3]
Springmount	Mutchilba	Apr-03, May-03, Mar-04, Apr-04, May-04, Mar-05, Aug-05, Jan-06	5 ha	s	H	3
Sugar bag - surrounds	Mt. Garnet	May-03, Apr-04, May-04, Apr-05	10 ha	s	H	2
Sugar bag - plant area	Mt. Garnet		40 ha	s	grazed	4 or 5
Swan's Lagoon	Ayr	Dec-03, Mar-04, Jan-05, Dec-05	5.0 ha	s	H	2
Tedlands	Koumala	15 visits 2003-05	10 ha	c1	H	4
Wadeleigh	Miriam Vale	Jul-04, Dec-04, Mar-05, Dec-05	1.0ha	o	H	2
Walkamin RS	Walkamin	regular	1 ha	s	H,C	2
Yallatup	Proserpine	2002, Dec-05	1 ha	clean	H	0
Indigofera schimperi						
Bellcrest	Wandoan	Apr-04, May-03, Dec-03, Apr-04, Dec-05, Apr-05	1 ha	o	H,E	1
Bindaroo (Roma)	Roma	May-05, Nov-05	4 ha	o	M, C, E	1
Birrong	Rollestone	2002, Feb-06	1 ha	s	H,E	1
Bluff Downs	Chrtrs Towers	Jul-03, Dec-05	0.5ha	clean	M	0
Boongargil	Toobeah	Apr-04, May-03, Dec-03, Apr-04, Dec-04, May-05	0.5 ha	clean	H	0
Brian Pastures 3	Gayndah	Regular local checks, Nov-04, Feb-06	7 ha	c3	H,C	3,4
Brigalow RS	Theodore	Regular local checks, Nov-03, Feb-06	2 ha	s	H,C	1
Bringalily	Millmerran	Dec-01, Nov-05	3 ha	clean	C	0
Brumich 1 - plain	Augathella	May-05	1.5 ha	clean	M	0
Brumich 2 - Homestead	Augathella	May-05	0.025 ha	clean	M	0
Carramah	Capella	Local control	2 ha	clean	C	0
Ellenvale	Chinchilla	Jun-03, Jun-04, May-05, Nov-05, Feb-06	2 ha	clean	H,E	0
Emerald R.S.	Emerald	4 visits 2003-04, Apr-05	1.0 ha	s	H,M	2
Galloway Plains	Calliope	Dec-03, May-04, Dec-05	1.0 ha	o	H	1
Glen Eden	Augathella	May-05	1.5 ha	clean	M	0
Glenbower dam	Pittsworth	Apr-03, Dec-03, Apr-04, May-05	1.0 ha	o	H	2
Glenbower house	Pittsworth		1.0 ha	o	H	0
Goondooroo	Springsure	2001, Feb-06	1 ha	s	H	0 or 1

Appendix 6 continued

Site	Locality	Visits	Area assessed	Popn type[1]	Control method[2]	Plant pop[n 3]
Havilah	Collinsville	Jul-03, Nov-03, May-04, Dec-05	1.0 ha	clean	M	0
Holyrood	Roma	Dec-03, Feb-04, May-04, May-05, Nov-05	10 ha	s	H, M, E	2
Kapalee	Biloela	Jun-03, Sep-05, Feb-06	0.5 ha	s	C	2
Kiamanna	Arcadia valley	2000, Nov-05	1 ha	s	C	1
Kindon	Millmerran	May-04, Dec-03, Apr-04, Dec-04, May-05	0.5 ha	o	H	1
Kookaburra	Wandoan	Jun-04, May 05, Nov-05, Feb-06	1 ha	c2	H,E	2
Mutation	Clermont	Aug-03, Dec-05	0.5 ha	s	H	1
Myuna	Collinsville	Dec-03, May-04, Jul-05, Dec-05	1.0 ha	o	H	1
Narayen R.S.	Munduberra	May-03, Apr-04, May-05	0.25 (1)+ 25 ha (2)	s	H, C	2
Norton	Roma	Apri-03, Mar-04, Nov-05	0.02 ha	o	M	1
Oxford Downs	Nebo	Dec-03, Feb-04, May-04, Dec-04, Jan-05, Feb-05, Dec-05	0.025 ha	s	H	2
Rangeview	Theodore	Jun-03, Jun-04, May-05, Feb-06	1 ha	s	H,E	3
Rolfe Park	Middlemount	Dec-03, Feb-04, May-04, Dec-04, Mar-05, Dec-05	0.025 ha	s	H	2
Sunset Downs	Tara	May-03, Dec-03, Apr-04, Dec-04, Apr-05	0.5 ha	o	H	1
Toorak DPI	Julia Creek	Local control, May-05	3 ha	s	M, C	1
Ula ula	Westmar	Apr-03, Mar-04, Nov-05	1 ha	o	M	1
Valera Vale 1 – Grazing	Augathella	May-05	6 ha	clean	M	0
Valera Vale 2 - Species	Augathella	May-05	1 ha	clean	M	0
Willunga	Nebo	Dec-04, Dec-05	small plots	clean	H	0
Wrotham Park	Chillago	Apr-03, May-04, May-05, Dec-05	10 ha	s	M	1

[1] population characteristics: clean = no plants in recent years; o = occasional plants only; s = scattered plants: C1 = clumps of plants < 3 m across; C2 = clumps of plants 3-10 m across; C3 = clumps > 10 m across

[2] management technique: H = herbicide, C = cultivation, M = manual removal, E = establish grasses, T = clear trees

[3] population status: 0 = none; 1 = 1-10 plants; 2 = 10-100; 3 = 100-1 000; 4 = 1 000-10 000; 5 = >10 000

Appendix 7 Factors contributing to weed potential at all sites.

Site	Locality	Pop'n change[1]	Seeding[2]	Grazing response[3]	Expected 2006 population[4]
Acacia angustissima					
Birralee	Colinsville	D1	ns	g0le	1
Brian Pastures 1	Gayndah	D1	ns	g3 ds	0
Campus Creek	Townsville	D1	ns	ng	0
Charleville Laboratory	Charleville	D1	unknown	ng	0
Correctional unit	Rockhmptn	D1	ns90	ng	1
Helen's Hill	Ingham	D1	ns30	ng	2
Lansdown RS	Woodstock	D1	ns30	ng	1
Lyndon Caves	Roma	D1	ns	g1	1
Parkhurst	Rockhmptn	D1	ns	no plants	1 or 0
Raglan	Rockhmptn	S	ns	no plants	0
Rosebank	Longreach	D1	ns	ng	0
Toorak DPI	Julia Creek	D1	ns	g0	0
Walkamin RS	Walkamin	D1	ns	ng	1
Warrill View	Peak Crossing	unknown	unknown	unknown	unknown
Aeschynomene paniculata					
Batavia Downs - surrounds	Weipa	D2	ns60	g1 le	4
Batavia Downs - distant	Weipa	D2	ns30	g1 le	4
Batavia Downs - plant area	Weipa	I2	ns90	ng	3
Blue Mt	Mackay	D1	ns, ns90	g3le	2
Blue Mt	Mackay	D1	ns, ns90	g3le	2
Eungy	Nebo	No plants	ns	no plants	0
Glensfiled	Sarina	No plants	ns	no plants	0
Goorganga	Proserpine	D1	ns90	g3le	1
Granite Vale	St. Lawrence	No plants	ns	no plants	0
Lynford	Nebo	No plants	ns	no plants	0
Mt Dangar	Bowen	No plants	ns	no plants	0
Swan's Lagoon	Ayr	No plants	ns	no plants	0
Tedlands	Koumala	D1	ns60	g2g3le	2
Walkamin RS	Walkamin	D1	ns90	ng	2

[1] Population change: S = static; D1 = declining by > 50% over 6 years; D2 = declining by < 50% over 6 years; I1 = increasing by > 50 % over 6 years; I2 = increasing by < 50% over 6 years.

[2] Plant seeding over 6 years: ns = not seeded; ns90 = >90% of plants not seeded; ns60 = 60-90% plants not seeded; ns30 = 30-60% plants not seeded; rs = regular seeding > 70% plants.

[3] Grazing response: ng = not grazed therefore no assessment; g0 = plants never grazed; g1 = plants occasionally grazed; g2 = plants commonly grazed during vegetative devt,; g3 = plants commonly grazed during reproductive development; le = grazing has little effect on seeding; ds = grazing depresses seeding.

[4] Expected plant population by January 2006: 0 = none; 1 = 1-10; 2 = 10-100; 3 = 100-1 000; 4 = 1 000-10 000; 5 = >10 000

Site	Locality	Pop'n change[1]	Seeding[2]	Grazing response[3]	Expected 2006 population[4]
Aeschynomene brasilana					
Batavia Downs	Weipa	D1	ns60	g3 ds	2
Birralee	Colinsville	No plants	ns	no plants	0
Braceborough	Charters Towers	D1	ns90	g2g3le	2
Brian Pastures 2	Gayndah	D1	ns60	unknown	1
Burlington - plant area	Mt. Surprise	D1	ns90	g3 ds	2
Burlington - near plant area	Mt. Surprise	D2	ns90	g3 ds	3
Burlington - other (creek)	Mt. Surprise	I2	ns90	g3 ds	1
Carmilla Glen	Carmilla	S	ns	g3le	2
Crediton	Eungalla	No plants	ns	no plants	0
Eungy	Nebo	No plants	ns	no plants	0
Galloway Plains	Calliope	D1	ns	g2g3le	1
Glensfield	Sarina	D1	ns90	g2g3le	1
Goorganga	Proserpine	D1	ns60	g3le	1 or 2
Granite Vale	St. Lawrence	D1	ns90	g3le	2
Lamonds Lagoon - surrounds	Mt. Garnet	I2	ns	g3 ?	3
Lamonds Lagoon - plant area	Mt. Garnet	D1	ns90	g3 ds	2
Lynford	Nebo	D2	ns60	g2g3le	4
Mt Dangar	Bowen	No plants	ns	no plants	0
Narayen R.S.	Mundubrra	S	ns60	ng	2
Sorrell Hills	Duaringa	I1	ns60	g1le	4
Springmount	Mutchilba	D1	ns90	g3 ds	2
Sugar bag - surrounds	Mt. Garnet	D1	ns90	g3 ?	2
Sugar bag - plant area	Mt. Garnet	S	ns60	g3 ds	4 or 5
Swan's Lagoon	Ayr	D1	ns60	g0	2
Tedlands	Koumala	S	ns60	g2g3le	3
Wadeleigh and Bethome	Miriam Vale	D1	ns90	g2g3le	2
Walkamin RS	Walkamin	D1	ns	ng	1
Waverley	St. Lawrence	unknown	unknown	unknown	unknown

Site	Locality	Pop'n change[1]	Seeding[2]	Grazing response[3]	Expected 2006 population[4]
Indigofera schimperi					
Bellcrest	Wandoan	D1	ns60	g1 le	1
Bindaroo (Roma)	Roma	S	ns, ns90	ng	0
Birrong	Rolleston e	S	ns	g2 le	1
Bluff Downs	Charters Towers	No plants	ns	no plants	0
Boongargil	Toobeah	No plants	ns	no plants	0
Brian Pastures 3	Gayndah	D2	ns	g1 le	3
Brigalow RS	Theodore	D1	ns30	g1 le	1 or 0
Bringalily	Millmerran	No plants	ns	no plants	0
Brumich 1 – plain	Augathella	No plants	ns	no plants	0
Brumich 2 - homestead	Augathella	No plants	ns	no plants	0
Carramah	Capella	No plants	ns	no plants	0
Ellenvale	Chinchilla	No plants	ns	no plants	0
Emerald R.S.	Emerald	S	ns90	ng	2
Gallaway Plains	Calliope	D1	ns	g2g3le	1
Glenbower dam	Pittsworth	D1	ns	ng	2
Glenbower house	Pittsworth	D1	ns	ng	0
Glen Eden	Augathella	No plants	ns	no plants	0
Goondooroo	Springsure	unknown	unknown	unknown	0 or 1
Havilah	Collinsvlle	No plants	ns	no plants	0
Holyrood	Roma	D1	ns	g0	2
Kapalee	Biloela	No plants	ns	no plants	0
Kiamanna	Arcadia valley	No plants	ns	no plants	0
Kindon	Millmerran	D1	ns	G1	1
Kookaburra	Wandoan	D2	ns60	g3 ds	2
Mutation	Clermont	D1	ns	unknown	1
Myuna	Collinsville	D1	ns90	g1	1
Narayen R.S.	Mundubra	S	ns60	ng	2
Norton	Roma	D1	ns	g1	1 or
Oxford Downs	Nebo	D1	ns60	g3le	2 or
Rangeview	Theodore	S	rs	g1	3
Rolfe Park	Middlemnt	D1	ns90	g1le	2 or 1
Sunset Downs	Tara	D1	ns	g1	1
Toorak DPI	Julia Creek	D1	ns	ng	0
Ula ula	Westmar	D1	ns 90	g1	1
Wilunga	Nebo	No plants	ns90	no plants	0
Wrotham Park	Chillago	D1	ns	g1	0
Valera Vale 1 - grazing	Augathella	No plants	ns	no plants	0
Valera Vale 2(- species	Augathella	No plants	ns	no plants	0

Appendix 8 A discussion paper to explore long-term strategies to control the target plants.

Future management of sites containing the species targeted for eradication in MLA/DPI&F project NBP.327 'Protecting Northern Grasslands from Rejected Forage Plants of High Weed Potential'.

Kendrick Cox (DPI&F Project Leader)
12 July 2005

Abbreviations

DNR&M	(Queensland) Department of Natural Resources and Mines
DPI&F	(Queensland) Department of Primary Industries and Fisheries
EPA	(Queensland) Environmental Protection Agency
MLA	Meat and Livestock Australia

Introduction

Between 1999 and 2005 two consecutive plant eradication projects (MLA NAP3.225 and NBP.327) were undertaken by DPI&F (with support from CSIRO, James Cook University, EPA and DNR&M) and co-funded by MLA. The over-arching aim was to assess the weed potential of legumes evaluated by state and federal departments of agriculture as pasture species in Queensland and to eradicate those which had persisted and were considered to pose a significant weed threat to production or natural systems. Four legumes were identified for eradication: *Acacia angustissima*, *Aeschynomene brasiliana*, *Aeschynomene paniculata* and *Indigofera schimperi*. These were originally targeted because they were considered to have low palatability and were prolific producers of hardseed. Monitoring and eradication activities (where necessary) have now been conducted for these four species at over 90 sites throughout Queensland over the six years.

A key component of the Project NBP.327, phase two of the program, is to develop strategies for the eradication of target plants after the completion of the currently funded eradication and monitoring activities in January 2006. The developed policies are to be communicated to relevant stakeholders and the general public in a CD-ROM format along with information which will aid plant eradication teams to locate, identify and control any remaining target plants.

The following paper follows meetings with policy staff of DNR&M and a preliminary discussion within DPI&F (Animal Science). This paper also builds on recent initiatives conducted under NBP.327 to promote best practice in the evaluation and release of pasture plants, particularly the promotion of a Code of Practice for the Evaluation and Release of Pasture Plants (CoP). The intention of this paper is to act as a base for developing long-term eradication strategies for the target plants and is intended for particular consideration by project and program leaders in MLA and DPI&F.

The situation at May 2005

Eradication activities have been undertaken for six years at all sites, the frequency dependent on weed status. A summary of the current weed population status at all sites, anticipated status at the end of the project and anticipated resources required for long-term control was compiled during May 2005. When classified by target plants emerging annually across sites, 41% of the 73 confirmed sites are currently considered clean (class 0, no plants found for a number of years), 45% have only small numbers of plants emerging each year (class 1) and 12% have larger populations requiring two or more eradication visits per annum (class 2). At one other site, Batavia Downs near Weipa, a considerable eradication effort has been required to contain large populations of *Aeschynomene paniculata.* It is anticipated that some sites currently considered

class 1 will reach class 0 by the end of the project, because recent plant counts have been very low and seeding has been suppressed for a number of years.

Priority of eradication effort has latterly been based on perceived weed threat (palatability, ease of establishment and ability to spread) and site scale. Highest priority was placed on *Acacia angustissima* and *Aeschynomene paniculata* (unpalatable and establish and spread readily) and *Indigofera schimperi* (unpalatable, but spreads more slowly). Full effort was undertaken to eradicate these at all sites and officers have been generally been effective at killing plants before seeding. *Aeschynomene brasiliana* is grazed and well-adapted to large areas of north Queensland, but was not considered suitable for plant release. Full eradication effort of this plant has been undertaken at sites where it was not desired by landholders. Current weed status is variable between the four target legumes (Table 1).

Although plant populations have been reduced to zero each year (following establishment and treating before flowering) in greater than 80% of sites, it is unlikely that most sites will be considered completely 'clean' by the end of the project. This is because of the presence of hardseed in soil, that can be long-lived and contribute new plants under favourable growing conditions. A continued, if lower intensity, eradication effort will be required to slowly erode the soil seed bank at sites with low plant populations (class 1) through treating emergent plants over the next 5 years. At the 'class 2' sites, a more intensive effort will be required over a longer period (say, 5-10 years) and a major program is needed at Batavia Downs to control the spread of *A. paniculata*.

Table 1. Population status of the target legumes at all sites, May 2005.

Species	***Number of sites***	***Weed status***		
		Class 0[1]	***Class 1[2]***	***Class 2[3]***
Acacia angustissima	12	50%	50%	0%
Aeschynomene brasiliana	20	20%	50%	30%
Aeschynomene paniculata	11	55%	27%	18%
Indigofera schimperi	30	47%	47%	6%

[1] Class 0 - no plants found for a number of years
[2] Class 1 - low populations requiring 1 treatment per year, confident of control before seeding
[3] Class 2 – larger populations requiring 2+ visits per year, less confident of controlling all plants before seeding

Non-voluntary approach to controlling weeds

Declaration of plants as weeds
State and local government legislation can be used to motivate the control and/or eradication of certain weeds. One of the key methods is through the declaration of a plant as a weed. Under state law, plants can be declared in one of three Classes; 1, 2 or 3. If declared as a Class 1 weed at State level, the eradication of the plant comes under the jurisdiction of DNR&M, working in cooperation with local governments. If declared in Class 2 or 3, responsibility for management rests primarily with local governments and landowners. Under the Land Protection (Pest and Stock Route Management) Act 2002, declared plants are restricted in terms of introduction, supply and cultivation and landholders can be forced to control all three classes of weeds on their properties at their own expense. . The DNR&M and local governments undertake on-ground eradication programs for Class 1 declared weeds, although the resources to undertake this are

very limited. Existing resources are currently fully committed targeting a range of high priority potential weeds.

Weeds can also be declared at a local government (shire council) level under model local law. Declaration under local law provides the shire council with the authority to enforce control by all land-holders. It also commits shire councils to control the nominated plants on land under their direct management.

Application of declaration procedures to the target plants
Of those in the current project, *Acacia angustissima* is a Class 1 declared weed under state law. As most of the cases of *A. angustissima* are on government properties, there is an obligation by government agencies to control the plants. There is also an obligation for shire councils to control plants on land under their management, as is currently being done by the Ingham Shire Council, and for other land-holders to control the plants on their properties.

It seems unlikely that any of our other three target legumes will be declared at a state level in the future. This is because a potentially invasive plant is usually declared in Class 1 only if it has a well documented history as a serious weed overseas or interstate and if it appears vulnerable to eradication in Queensland. These criteria are not satisfied for the other three legumes.

All of the target plants can potentially be declared at a shire level and therefore be subject to control by landholders within the local government's area of jurisdiction. Theoretically, this approach could be useful in reducing plant populations and spread of the target plants. However, this approach does not guarantee that the target plants will be treated: limited plant eradication resources, prioritisation on class 1 declared weeds and operator (land-holder or shire council officer) inexperience in plant identification may result in less effective control of plants than at present. Another consideration is that the target sites cover most of coastal and sub-coastal Queensland: if this route is to be used, a large number of shire councils will need to be engaged.

'Sleeper weeds' initiative and linked funding
Nine plants have been identified nationally by the Australian government's Bureau of Rural Sciences as 'sleeper weeds'. They are naturalised plants which have the potential to affect large areas of agricultural land, but which can potentially be eradicated before they exponentially increase in number (Brinkley and Bomford, 2002). *Aeschynomene paniculata* has been included as a 'sleeper' weed, with the reported potential to invade 46 000 km^2 of coastal and sub-coastal grazing lands in northern Australia, an area with an annual commodity production value of approximately $41 million. The control of priority weeds is a target of the Australian government's new program entitled 'Defeating the Weed Menace' (to be launched for the second time during August 2005), which funds initiatives which can contribute to long-term control of certain priority weeds. The priority weeds include 'sleeper' weeds (including *A. paniculata*), Weeds of National Significance and weeds on the National Alert List. This program respresents a potential funding option for *A. paniculata* control only, since the other three species have not been adequately recognised as threats to date.

Voluntary approaches to controlling the target weeds

Motivation for voluntary control of weeds
In the absence of declaration legislation, eradication of potentially significant weeds becomes subject to 'voluntary' measures. For example, it may be possible to appeal to landholders to voluntarily adopt plant eradication practices, either individually or through organisations (*eg* Landcare), motivated by their sense of responsibility to sustainable landscape management, or because they want to maintain a productive farming resource.

Alternatively, organisations involved in the distribution of plants that become weeds, and either damage native ecosystems or impose control costs onto landowners and thereby potentially expose the state to liability claims, need to accept their responsibility to take all reasonable steps

to eradicate these plants, or to minimise their impact. Moreover, the Environmental Protection Act (1994) requires all individuals and organisations to take reasonable steps to avoid environmental harm. The legislation dictates that every person and organisation has a 'duty of care' to prevent environmental harm and that prosecution can occur if a person or organisation is found to be negligent. This directly impacts on activities which involve the spread of significant weeds. The legislation also dictates that operation in accordance with an appropriate Code of Practice can be used to demonstrate the 'duty of care' required under the Environmental Protection Act (1994).

Application of voluntary eradication procedures to the target plants
With the possible exception of *A. angustissima* (declared), it is most likely that the target plants will, at least partially, be subject to voluntary eradication procedures in future. This is essentially what was undertaken by DPI&F, CSIRO, James Cook University and MLA during NBP.327 and its predecessor NAP3.225. This approach has been very successful to date because the on-ground staff had excellent knowledge of the sites and the characteristics of the plants, were well resourced, had the flexibility to access sites when required and (in most cases) could access sites conveniently. However, specific funding has been required, mostly from DPI&F and MLA, in order to undertake the activities.

Whereas project staff have undertaken virtually all of the eradication work to date, there may be opportunity for future eradication to be conducted in cooperation with land holders and shire councils (if included in a PMP). Other landholders/shire councils may see eradication as the responsibility of the agencies involved in introducing the target plants, and not volunteer any services. It is difficult to estimate the degree of this latter response, particularly as land-holders may change their position over time or the sites may change ownership.

In consideration of (1) the capability to undertake plant eradication and (2) the motivation for undertaking plant eradication, the most effective way to eradicate the target plants may be through using the current project team.

Support for on-going eradication of the target plants by DPI&F
Discussions have been instigated with managers of the Animal Science business group within DPI&F, seeking support for on-going eradication of the target plants. At this stage, it seems likely that the equivalent of one technical officer will be made available across the State for five years to undertake eradication of the target plants. Previously, technical officers were funded by MLA, with in-kind contributions of professional staff by DPI&F. It is understood that DPI&F will be seeking external operating expenses to support on-going treatment of sites.

Such moves provide evidence that "due care" has been exercised by DPI&F when undertaking pasture plant evaluation programs. This is also reflected by DPI&F support for the development of the CoP and the (proposed) adoption of the CoP as policy. The CoP outlines best practices when introducing, evaluating and releasing pasture plants, with the aim of eliminating the risk of releasing a contaminant of the environment or production systems when developing new pasture plants. An important component of the CoP is the eradication of plants which have been evaluated, but not deemed sufficiently beneficial for release. Although this does not apply retrospectively (and therefore to the four plants targeted here), adoption of the CoP indicates an on-going commitment to sustainable landscape management.

Long-term eradication strategies for each species

Each of the four species have different weed potentials and current weed distributions (Table 2), which determine the options available for long-term control. The four species also have differing official weed status, which can determine levels of financial support for eradication and the level of responsibility for eradication. Because of these factors, approaches to long-term eradication of each species are considered separately.

Table 2. Weed characteristics and status of the target weeds.

Target plant	Weed potential	Reason	Distribution & control
Acacia angustissima[1]	High	Unpalatable, prolific producer of hard seed, can reproduce using root suckers and can form thickets.	Small populations at <10 sites, mostly on Govt. research stations, 1 large infestation near Ingham. Seeding prevented at most sites for a long period.
Aeschynomene paniculata[2]	High	Unpalatable, prolific producer of hardseed and can form dense stands.	Isolated plants under control at < 10 sites. Limited spread at one site near Mackay. Large infestation requiring a large eradication effort at 1 site near Weipa.
Aeschynomene brasiliana	Moderate/low	Grazed but usually once mature seed has been produced (dry season), producer of hardseed, can form dense stands.	Planted mostly at sites in northern Queensland, often at large sites. Plant populations declining under current management. One large site near Mt Garnet requires a significant eradication effort.
Indigofera schimperi	High	Unpalatable, prolific producer of hard seed and can reproduce using root suckers.	Planted mostly at sites in southern and central Queensland, often with poor establishment. Current control actions are effective.

[1] This plant is a Class 1 declared weed within Queensland

[2] This plant has been placed on the Sleeper Weeds List, reviewed by BRS and AWC.

Acacia angustissima

This unpalatable species was originally planted in very controlled conditions and has only become naturalised at one site (near Ingham). Most occurrences are on government properties, where plants can be observed and treated routinely. This plant is a Class 1 declared species, so land-holders or shire councils are responsible for controlling plants. Seeding has been suppressed at most sites for a prolonged period, and in plant populations are generally declining. At the largest infestation (Ingham) local shire council officers are routinely treating plants and have greatly reduced plant populations. There is a high likelihood of eradicating this species with continued treatment of sites.

Recommended course of action (next 5 years):

1. The Project Team formally notify DNR&M of the locations and weed status of the sites containing *A. angustissima*.
2. The Project Team formally notify the relevant shire councils of the locations and weed status of the sites containing *A. angustissima*.
3. Eradication be undertaken or supervised by DPI&F officers at DPI&F sites (and CSIRO at old CSIRO plant sites) and on other properties where *A. angustissima* was established.
4. Eradication at the Ingham site be continued by the Ingham Shire Council, with monitoring conducted by DPI&F officers (or collaborators).

Indigofera schimperi

This unpalatable species was planted at many sites throughout southern and central Queensland, on both government properties and stations. Original plant sites were mostly small. Establishment was often poor and this species does not seem to spread quickly. However, this species has been persistent at a number of sites because of prolific production of hardseed. In most cases, seeding has been prevented for long periods. However, the rate of eradication has been slowed by drought, which has prevented establishment and therefore the opportunity to reduce viable seed. There is a high likelihood of eradicating this species with continued treatment of sites. The time taken for eradication may be dependent on rainfall at some sites. It is unlikely that this species will be declared.

Recommended course of action (next 5 years):

1. The Project Team formally notify the relevant shire councils of the locations and weed status of the sites containing *I. schimperi.*.
2. Eradication be undertaken or supervised by DPI&F officers at DPI&F sites (and CSIRO at old CSIRO plant sites) and on other properties where *I. schimperi* was established.

Aeschynomene paniculata

This unpalatable species was planted mostly on a small scale at a low number of sites, occasionally accidentally as a contaminant of plant seed. In most situations, plant populations are very low and declining. However, at two sites (Tedlands, Mackay and Batavia Dows, Weipa) plants have shown the capacity to spread. The Batavia Downs site is particularly problematical due to the size of the infestation, the propensity for the plant to set seed and spread and the difficulty of accessing the site between establishment and plant seeding (monsoon season). Within NBP.327, a considerable portion of resources were remobilised to contain plants at this site. There is a high likelihood that this plant can be eradicated from all sites except Batavia Downs by continuing the current eradication effort for another five years. A more intensive effort over a longer period (say 5-10 years) will be required to control this priority plant at Batavia Downs. Control of this plant is regarded as high priority, nominated as one of nine 'sleeper' weeds present in Australia. Funding to support eradication may be available through the 'Defeating the Weed Menace' program.

Recommended course of action (next 5 years):

1. The Project Team formally notify the relevant shire councils of the locations and weed status of the sites containing *A. paniculata*. Special effort be taken to liase with the Cook Shire Council to discuss Batavia Downs.
2. Eradication be undertaken or supervised by DPI&F officers at DPI&F sites (and CSIRO at old CSIRO plant sites) and on other properties where *A. paniculata* was established.
3. DPI&F apply for funding from the 'Defeating the Weed Menace' program to support eradication at Batavia Downs.
4. DPI&F seek clarification from DPI&F and DNR&M regarding the long-term future of Batavia Downs and ensure all parties are aware of the need for long-term control of *A. paniculata* at the site.

Aeschynomene brasiliana

Accessions of *A. brasiliana* were established at sites of varying size throughout coastal and sub-coastal Queensland. This plant is more palatable than the other three legumes, observations during NAP3.225 and NBP.327 suggesting that it is grazed by cattle during the dry period when the feed value of grasses declines (much like other legumes released for use in the dry tropics). However, it was not originally released because there was dispute as to whether it was grazed (a decision made difficult because of a run of dry years) and because seed production was extremely difficult, making it unrealistic for release. This species has shown the capability to produce dense stands, although rarely mono-specific, and adaptation and the rate of spread seems to differ widely between sites. Of the four legumes, this species is considered by the project team to have the lowest weed potential.

During NBP.327, eradication effort to control *A. brasiliana* has been determined by (1) perceived weed risk compared to the other target legumes, (2) the resources available to undertake work, (3) views of the land-holder and (4) the scale of the effort required to undertake eradication. The overall policy for *A. brasiliana* has been to manage for eradication at sites where:

- plant populations are small and there is considered a good opportunity to eradicate the plant in the short term (regardless of producer preference)
- plant populations are large but producers do not like the plant.

During NBP.327, *A. brasiliana* has been treated for eradication at all but one site.

Control of *A. brasiliana* has been excellent at sites where eradication has been targeted. At 60% of sites plant populations are declining and populations have been reduced to either no, or scattered plants. It is anticipated that current effort will eradicate plants from the sites in 5 years. At large sites (mostly in north Queensland) emerging plant populations have been reduced significantly during NBP.327 and it is expected that numbers will be reduced to scattered plants only in five years if current effort is maintained.

At one site (Sugarbag, Mt. Garnet) the decision was made to contain the target plant to the original planted area. This decision was made because: the landholder found it to be a useful legume (the plant was grazed and was not showing signs of spreading rapidly); and the site was the largest plant site in the project (40 ha). The resultant effort taken to eradicate the plant would have significantly reduced eradication effort and resources at higher priority sites, particularly Batavia Downs. At that site plants have been contained to the original plant area. A considerable effort, probably over 5-10 years, will be required to eradicate plants at that site. Following concerns by staff of MLA regarding management of the site for containment rather than eradication, a short technical report (Cox, 2005) was produced outlining the rationale for past treatment and proposed future action. This site is to be treated for eradication in future.

Recommended course of action (next 5 years):

1. The Project Team formally notify the relevant shire councils of the locations and weed status of the sites containing *A. brasiliana.*
2. Eradication be undertaken or supervised by DPI&F officers at DPI&F sites (and CSIRO at old CSIRO plant sites) and on other properties where *A. brasiliana* was established. This applies to all sites.

Funding

The undertaking of continued plant eradication by DPI&F officers will require external funding to assist with operating expense (mostly herbicides, vehicle and travel expenses). Based on previous costs and eradication effort, operating expenses to treat the sites at the same level of effort as previous will be approximately $22 000 per annum.

Two sites, Batavia Downs and Sugarbag (both in north Queensland), require additional effort than in the past if plants are to be eradicated, rather than contained. Of these, Batavia Downs, containing a large infestation of *A. paniculata*, poses the greatest weed threat. It is recommended that this site be given highest priority and that the eradication effort be increased mostly through increasing man-hours and enabling access during the Wet season (flying in to the site if needed or paying on-station staff to undertake eradication). It is anticipated that the additional activity at Batavia Downs, to access, completely survey and treat the site, will require an additional $11 000 operating per annum plus some capital equipment. The additional activity at Sugarbag Station to eradicate, rather than contain as previously, *A. brasiliana* is expected to require approximately $6000 per annum of operating expenses.

It is likely that funding will be sought from:

- MLA, approximately $28 000 per annum to cover operating expenses, but possibly declining over time as the required effort declines. This will be to treat all current sites with effort at levels similar to that used during 2005 plus management for eradication at Sugarbag Station.
- The Commonwealth Government through the Defeating the Weed Menace' program to provide additional support for eradication at Batavia Downs for three years, probably $25000-$30000 per annum to cover expenses and to supplement project salary costs. Key activities will be detailed surveys and eradication and monitoring of plants away from the original plant site. There is expected to be a funding round announced in August 2005.

References

Brinkley, T.R. and Bomford, M (2002) *Agricultural sleeper weeds in Australia. What is the potential threat?* Short report. Bureau of Rural Sciences, Canberra.

Cox, K.G. (2005) *Control of* Aeschynomene paniculata *at Sugarbag Station.* A short report prepared for Meat and Livestock Australia. Department of Primary Industries and Fisheries, Walkamin.

Appendix 9 Funding application submitted to the federal government to undertake activity at Batavia Downs.

Australian Government

Department of the Environment and Heritage

Department of Agriculture, Fisheries and Forestry

Defeating the Weeds Menace Programme
2005-06 National and Cross-Regional Projects to Reduce the Impact of Weeds
NEW PROJECT APPLICATION

1. Project title

Protection of north Australian grasslands from pannicle jointvetch (*Aeschynomene paniculata*).

2. Organisation details

(a) What is the name of the organisation with responsibility for managing the project contract?

State of Queensland through the Department of Primary Industries and Fisheries.

(b) Which of the following best describes the organisation named in (a)?

☐ Commonwealth agency *Name:*	☐ Tertiary institution *Name:*
☑ State/Territory agency *Name:* Department of Primary Industries and Fisheries, Queensland	☐ Local Government *Name:*
☐ NRM Regional body *Name:*	☐ Indigenous group *Name:*
	☐ Other *Name:*

(c) What is the ABN for the organisation named in (a): 78 342 684 030

3. Project outline

Pannicle jointvetch (*Aeschynomene paniculata*), a nationally recognised 'Sleeper' weed, has high potential to dominate 40 000 km^2 northern grasslands from Brisbane to Broome (Brinkley and Bomford, 2002). A 6-year eradication program has restricted *A. paniculata* to 7 Queensland sites (Cox, 2005). Plant populations are restricted at all but the largest, least accessible site (Batavia Downs, Weipa), where plants have recently been found outside the core infestation. This Project seeks to prevent plant spread and enable routine long-term control at Batavia Downs. Activities include rigorous surveys, plant eradication and quarantine in ~ 600 ha high-risk areas surrounding the core eradication area.

4. Project location

Australia wide or more than one state	☐ Yes ☑No	On-ground activities are restricted to one site, but impacts are across northern Australia	
State wide (located within one state)	☐ Yes ☑No		
Region wide (located within one region, or located in several regions)	☑Yes ☐ No	Name of NRM Region(s):	Cape York
Name of town or suburb nearest to site and latitude/longitude:	Weipa Batavia Downs: 12 40'47"S, 142 39'48"E		
For on-ground projects or study sites the area (hectares) covered by the project:	600 ha		

5. Expected start and finish dates

Start (mm/yy) **07/06** Finish (mm/yy) **06/09**

6. Budget summary – Use totals in line F from Question 13.

Year	Proponent's funds (GST inclusive)	Australian government funds sought (GST inclusive)	Total project budget (GST inclusive)
Year 1	$54 270	$ 45 403	$ 99 673
Year 2	$ 55 926	$ 43 118	$ 99 044
Year 3	$ 57 899	$ 43 828	$ 101 727
Total	$ 168 095	$ 132 349	$ 300 444

7. Contact person details

Name: Dr. Kendrick Cox		Organisation: (Queensland) DPI&F
Address: DPI&F Research Station, Walkamin		Phone: 07 4092 9924 Fax: 07 4093 3903
State: QLD	Postcode: 4872	email: Kendrick.cox@dpi.qld.gov.au

8. Project description

Aeschynomene paniculata is not a WONS, but a priority Sleeper weed. The weed is not legislated against in Queensland, but is a likely candidate for future declaration if it becomes widespread. Eradication is strongly supported by the Queensland Department of Natural Resources and Mines (please see letter of support attached).

Project description and objectives

This three-year surveying, eradication and quarantine program is designed to locate, kill and prevent the spread of *Aeschynomene paniculata* at Batavia Downs, the only site where this Sleeper weed is not considered under absolute control[1]. Project activity will be undertaken in ~600ha of woodland (surrounding the key infestation area) where *A. paniculata* plants have recently been found. The project activities complement on-going DPI&F/Meat and Livestock Australia (MLA) eradication activities at the core Batavia Downs site (20 ha) and other sites in Queensland containing *A. paniculata* (where it is considered under control).

The overarching objectives are to (1) prevent the further spread of *A. paniculata* and (2) reduce plant populations enabling routine long-term control. Specific objectives include:

1. Location of all plants outside the core eradication area
2. Destruction of all plants before seeding
3. Prevention of seed transfer off site through quarantine procedures
4. Development of protocols to ensure long-term containment and eradication of *A. paniculata* at Batavia Downs.

Methodology

Over three years:

Ground surveys (once per year) Thoroughly assess plant population distribution of *A. paniculata* in the Project area using teams on foot and on quad bikes working in grid patterns; mark all sites by GPS; survey plant populations at more distant locations considered of increased risk, namely cattle camps, water points and vehicle tracks.

Map plant distributions (update annually) Combine GPS data with GIS mapping to understand factors contributing to plant spread and therefore better focus monitoring and eradication.

Kill plants at all surveyed sites (three times per growing season) Kill all adult and emerging plants before seeding using selective herbicides active against *A. paniculata* but not native grasses. For isolated patches, remove seed, bag and burn. Undertake during: November-December to control seedlings emerging after storms (and before the monsoon); March to control actively growing plants before seeding and when they can easily be detected; April-May to control any missed plants.

Quarantine Formalise (year 1) and implement (all years) a stock and vehicle quarantine protocol to minimise seed spread. Install appropriate signage.

Develop long-term site management protocols (year 3) A formal report detailing the population status of *A. paniculata* at Batavia Downs, works undertaken, progress towards eradication, future required effort and protocols for plant eradication and quarantine.

Expected outcomes and outputs

The long-term outcomes are absolute control and (eventually) eradication of *A. paniculata,* thereby protecting northern grasslands, and the industries reliant on them, from this highly invasive plant. The report[2] detailing the site status at the end of the Project (maps, actions taken) and best practice protocols (eradication and quarantine) will be the key tangible output.

[1] killing of all plants before seeding to erode soil seed levels

[2] it should be noted that an information resource, designed for the purpose of informing stakeholders of the distribution, control and weed threat of *A. paniculata* (and three other weedy legumes), is currently being compiled as part of the DPI&F/MLA project (NBP.327).

9. Claims against the eligibility criteria.

The priority and benefits of eradicating A. paniculata.
This project addresses the pre-emptive control of a 'Sleeper weed'[1], considered to have high potential to affect grazing lands in northern Australia valued at $45 M per annum (Bomford and Brinkley, 2002). The calculated cost of not-treating this cost (in terms of revenue at risk based on potential spread and the production value of the land class) has been estimated to be $352 M (Cunningham *et al*., 2003) [it should be noted that the analysis does not place a value on the potential conservation cost of the target plant].

The benefits of the Project can be assessed in terms of the ratio of the opportunity cost to production if the plant becomes widespread versus the cost of eradicating it. Cunningham *et al*. (2003) calculated that the eradication cost of *A. paniculata* (modelled for 95% likelihood of success) to be $457 000. (Conservatively) assuming that the plant impact was 10% of the dollar value of production in the potentially affected area, the Benefit/Cost ratio calculated was $77 (*ie* $77 benefit for every dollar spent).

Regional Priorities
The Project meets the objectives of the Cape York Pest Management Strategy and those of the Cape York Pest Management Plan (draft) and the Cook Shire Pest Management Plan (current) – the plans used to implement the Stategy . The Strategy and Plans will eventually be incorporated into the Cape York Natural Resources Management Plan (FNQNRM Ltd), which is expected to be accredited in February/March 2006. [see letters of support in appendices]

Contributions of stakeholders
The cost of *A. paniculata* eradication in Queensland, based on costs to date (MLA and DPI&F) and estimated for the next three years, is estimated to be $444 161 (Table 1). Applying the same *conservative* method of assessment used above (*ie* assuming only 10% of productive land is affected), there is expected to be a benefit of $304 for every dollar spent by the Australian government.

Table 1. Contributions of project proponents compared to funding sought from the Australian government.

Site of A. paniculata eradication	DPI&F contribution	MLA contribution	Australian government funds sought	Total
Batavia Downs: 2002-2005[1]	24 750	34 145	NA	58 895
Batavia Downs: 2005-2008	135 749	18 864	115 468	270 081
Other 6 sites: 2002-2005[2]	16 810	13 830	NA	30 640
Other 6 sites: 2005-2008[3]	69 455	15 090	NA	84 545
Total	246 764	81 929	115 468	444 161

[1] Estimated as 25% of the project cost. NBP.327
[2] Estimated as 20% of project cost NBP.327
[3] Estimated as 20% of cost new MLA/DPI&F project

The proponent (DPI&F) and its co-funder (MLA) have contributed, and will continue to contribute, significantly to the cost of *A. paniculata* eradication. Over all sites (to 2008), DPI&F and MLA will contribute 74 % of costs. Within the proposed term of the Project (2005-2008), DPI&F and MLA will contribute approximately 57 % of the cost of the Project *at Batavia Downs*. This does not include any contributions (in-kind or funded) by the other organisations supporting the Project.

[1] A 'Sleeper weed' is an invasive plant which has naturalised in a region but not yet increased their size exponentially (Groves, 1999).

Project design to address causes (rather than symptoms) and deliver long-term benefits to Australia
The nature of the Project, taking the opportunity to eradicate an invasive weed before it spreads exponentially and becomes a more expensive problem, addresses the key threat to northern grasslands

posed by *A. paniculata*. The actions proposed (monitoring and eradication in the area surrounding the core infestation, quarantine and the development of site protocols for these activities), coordinated with DPI&F/MLA eradication in the core infestation area, address the need to (1) prevent spread from the key area, and (2) reduce plant populations and soils seed reserves.

The procedures used are known to be effective at locating and killing *A. paniculata* in environments such as those encountered at Batavia Downs. The project team will consist of staff currently undertaking eradication of *A. paniculata* at Batavia Downs: experienced with the identification and control of *A. paniculata*; the Batavia Downs site; and working in Cape York in general (an environment which can be challenging). The staff are highly motivated to undertake the eradication required and there is strong support for the activity within DPI&F and MLA.

The Project will permit the additional effort (number of visits, staff numbers) required at Batavia Downs to detect and control *A. paniculata*, so that long-term routine weed monitoring and control can be undertaken by DPI&F staff in collaboration with MLA and the land-holder. This is imperative as current resources, although they have been significant and are reducing plant numbers in the core eradication area, are not expected to restrict *A. paniculata* at Batavia Downs. *Aeschynomene paniculata* is proving highly mobile, with isolated patches found up to 1.5 km from the core eradication area. If all patches are not detected and treated, there will be a massive eradication program needed to prevent *A. paniculata* spreading throughout Cape York and further. The site is particularly important as it is located at the junction of the two major roads servicing Weipa and the top of Cape York. Vehicles are known to readily transport seed of *A. paniculata*.

The project will contribute to future preventative measures in the following ways:

- On-site, through the development of protocols (detection, eradication and quarantine) to be used at Batavia Downs to prevent the spread of seed and reduce plant populations. The protocols will become a condition of land ownership and transferred to new owners should the property be sold.
- Off-site, through increased collaboration between the responsible shire council and other stakeholder organisations (DNR&M and EPA). Information developed within the complementary eradication programs will be supplied to these organisations to assist them with developing strategies (routine monitoring and awareness) to detect *A. paniculata* off-site (should this occur). This will complement the information (CD resource) available from DPI&F/MLA project NBP.327.

Project meets the objectives of the National Weeds Strategy

The National Weeds Strategy (revised 1999) has four cardinal principles: weed management is an essential part of sustainable natural resource management; prevention and early intervention are the most cost effective techniques that can be deployed against weeds; successful weed management requires a coordinated national approach; the primary responsibility for land management lies with landholders but collective action is necessary when the problem transcends their capacity to control weeds. One of the three goals of the Strategy (Goal 1) is to *prevent the development of new weed problems*. There are three sub-objectives:

1. To prevent the introduction of new plant species with weed potential
2. To ensure early detection of, and rapid action against, new weed problems
3. To reduce weed spread to new areas within Australia

This project addresses sub-objectives 2. and 3 of Goal 1, through the detection of *A. paniculata* in areas not yet accurately surveyed, reduction of plant populations in these areas, on-site quarantine and the development of on-site protocols for restricting the future spread of *A. paniculata* and reducing plant populations. The Project addresses all four of the cardinal principles of the National Weeds Strategy, in particular the efficacy and cost-effectiveness of eradication through early intervention.

Acceptance of the terms and conditions in the Project Agreement

The terms and conditions are accepted.

10. Communications plan

Being essentially an eradication program at one site, communication relates mostly to those directly involved in the Project: DPI&F, MLA, the site manager, the Cook Shire Council and FNQNRM Ltd (Table 2). In addition, project progress will be reported to pertinent staff of Queensland DNR&M and EPA and members of North Queensland Pest Advisory Committee. It is not intended to undertake an awareness campaign, as this is being addressed in the DPI&F/MLA project NBP.327. In that project a package, containing information useful for the location, identification and eradication of *A. paniculata* is being prepared for distribution to land protection agencies.

Table 2. Planned activities to ensure effective Project communication.

Purpose of communication	Action	Target audience	Years
1 Progress of plant detection	Produce a map detailing plant location and weed status and update annually. Include in the annual technical report.	Project team	1,2 & 3
2 Progress of eradication	Report details of each location where plants are found (plant number, growth stage and whether seeded) and update annually. Report the weed status of each paddock. Include in the annual technical report.	Project team	1,2 & 3
3 Progress of quarantine	Develop a quarantine protocol. Report progress towards implementing the quarantine protocol. Include in the annual technical report.	Batavia Downs manager Pro ject tea m	1 1,2 & 3
4 Progress of Project overall	Annual technical reports. In the previous year, details progress towards 1, 2. and 3. plus spending and any recommendations to alter the project or budget. To be submitted to the Australia government at the end of each funded year.	Federal Govt. DPI&F management Batavia Downs manager Project stakeholders	1,2 & 3
5 Site protocol	Produce a report documenting works undertaken, progress towards eradication, future required effort and protocols for plant eradication and quarantine.	Federal Govt. DPI&F management Batavia Downs manager	3
6 Final report	A comprehensive final report documenting for the entire project: situation at the onset of the Project; activities undertaken; progress towards plant detection, eradication and containment (quarantine); anticipated required future activity and resources; protocols for long-term management; spending compared to budget; and documents/resources produced during the Project.	Federal Govt. DPI&F management Batavia Downs manager Project stakeholders	3

11. Monitoring and evaluation

The measurements and performance indicators used to determine progress against objectives are presented in Table 3. Progress against objectives will be communicated to the Australian government in three annual reports and one final report as presented in Table 2 (above).

Table 3. Techniques used to assess Project progress.

	Objective	Measurements	Performance indicators
1	Location of all plants	GPS readings at each patch referenced to paddock during annual surveys.	Number of complete surveys Plant incidence maps (one per year)
2	Destruction of all plants before seeding	Field data recorded at each patch including estimate of live plant number, growth stage and whether seeded.	Number of complete eradication visits Number of infestations and weed status of each paddock
3	Prevention of seed transfer off site	Records of plants outside the project area, based on checks on high risk areas.	Development of quarantine protocols Number of infestations found outside quarantine area
4	Development of long-term site protocols	No deliberate measurements.	Completion of protocols Endorsement of protocols by stakeholders

12. Project workplan

Phase and reporting requirement		Date	a) Activity	b) Expected outcome and/or outputs
1.	Payment on signing the agreement	1 May 2006	Contract finalised Invoice sent	Signed contract Payment received
2.	Estimated starting date	1 July 2006	Staff and resources organised	Ready to undertake project
3.	Quarantine procedures developed	31 July 2006	Develop and implement quarantine procedures	Quarantine procedures adopted on-site.
4.	Yr 1 financial report	30 Aug. 2006	Report submitted Invoice sent	Report accepted
5.	Survey 1	30 Sept. 2006	Field survey of entire project area and mapping	Identification of locations containing target
6.	Eradication and monitoring, visit 1	31 Dec. 2006	Eradication and monitoring at Batavia Downs	Reduced plant populations, field data collected
7.	Progress report 1	20 Jan. 2007	Report submitted	Report accepted
8.	Eradication and monitoring, visit 2	30 April 2007	Eradication and monitoring at Batavia Downs	Reduced plant populations, field data collected
9.	Eradication and monitoring, visit 3	30 June 2007	Eradication and monitoring at Batavia Downs	Reduced plant populations, field data collected
10.	Progress report 2	9 July 2007	Report submitted	Report accepted
11.	Yr 2 financial report	30 Aug. 2007	Report submitted Invoice sent	Report accepted
12.	Survey 2	30 Sept. 2007	Field survey of entire project area and mapping	Identification of locations containing target
13.	Eradication and monitoring, visit 4	31 Dec. 2007	Eradication and monitoring at Batavia Downs	Reduced plant populations, field data collected
14.	Progress report 3	20 Jan. 2008	Report submitted	Report accepted
15.	Eradication and monitoring, visit 5	30 April 2008	Eradication and monitoring at Batavia Downs	Reduced plant populations, field data collected
26.	Eradication and monitoring, visit 6	30 June 2008	Eradication and monitoring at Batavia Downs	Reduced plant populations, field data collected
27.	Progress report 4	9 July 2008	Report submitted	Report accepted
28.	Yr 3 financial report	30 Aug. 2008	Report submitted Invoice sent	Report accepted
29.	Survey 3	30 Sept. 2008	Field survey of entire project area and mapping	Identification of locations containing target
30.	Site management protocols	30 Nov. 2008	Protocols developed and reviewed	Protocols adopted as site policy
31.	Progress report 5	20 Jan. 2009	Report submitted	Report accepted
32.	Eradication and monitoring, visit 7	30 April 2008	Eradication and monitoring at Batavia Downs	Reduced plant populations, field data collected
33.	Eradication and monitoring, visit 8	30 June 2008	Eradication and monitoring at Batavia Downs	Reduced plant populations, field data collected
34.	Final report	30 June 2009	Final report submitted	Report accepted and Project completed
35	Audited financial report	30 Sept. 2009	Financial report submitted	Report accepted

13. Detailed project budget (similar costs for years 2 and 3, not shown here)

Year 1

Employees and Positions Held	Proponent funds (without GST)	Australian government funds sought (without GST)	Total employment budget (without GST)
Scientist (Leader), 0.18 FTE	15 706		15 706
DPI&F salary at Batavia Downs (DPI&F/MLA project)[1]	27 867		27 867
Technical officer, 0.1 FTE		6600	6600
Farmhand 1, 0.1 FTE		4900	4900
Farmhand 2, 0.1 FTE		4900	4900
Casual labour, ~ 25 days		5000	5000
Total Employment Costs	**$ 43 573**	**$ 21 400**	**$ 64 973**
Operating Cost Items	**Proponent funds (without GST)**	**Australian government funds sought (without GST)**	**Total employment budget (without GST)**
MLA, operating at Batavia Downs	5763		5763
4WD utility lease share, 7%[2]		1000	1000
4WD utility lease, 25 days + fuel		4725	4725
Quad bike lease share[2]		150	150
Additional quad-bike lease + fuel and repairs		1100	1100
Travel allowance		6400	6400
Flights Cairns-Weipa [3]		1400	1400
Eradication materials		2100	2100
Total Operating Costs	**$ 5 763**	**$ 16 875**	**$ 22 638**
Capital Cost Items	**Proponent funds (without GST)**	**Australian government funds sought (without GST)**	**Total employment budget (without GST)**
Vehicle fridge		900	900
GPS x 2		600	600
Portable water blaster		200	200
Hose retractors (quad-bike)		500	500
Camping requisites		800	800
Total Capital Costs	**$ 0**	**$ 3000**	**$ 3000**
Total Cost (without GST)	49 336	41 275	90 611
GST (10%)	4 934	4 128	9 062
Total Cost (inc. GST)	54 270	45 403	99 673

[1] Costs undertaken by DPI&F and MLA to complete plant eradication at the core site.

[2] These costs are being shared with the DPI&F/MLA project used to treat *A. paniculata* at the core infestation and reflect the use of equipment used to undertake activities as stipulated in the project proposed here.

[3] To be used if poor weather prevents access to the site by road at times when plant eradication needs to be undertaken.

14. Long-term maintenance

Restriction of plant spread from the current work area and reduction of plant numbers (and erosion of soil seed banks) will be achieved through on-going activity by DPI&F staff/MLA and implementation of the Site protocols developed in the third year of the project. The protocols will include:

- Plant distribution maps
- Works undertaken
- Best practice plant control methods
- Quarantine procedures for stock, vehicles and visitors.

The protocols will be provided to the site manager and will be provided to new owners should there be a change of ownership. They will complement the CD-ROM resource, containing information useful for the location, identification and eradication of *A. paniculata* in general, which is being prepared for distribution to land protection agencies.

Appropriate signage will be displayed on key thoroughfares to alert passing public of the need to not access Batavia Downs without seeing the manager.

Project DPI&F/MLA 3.27 has alerted key stakeholders, including Land Protection Agencies, to the situation at Batavia Downs. The project proposed here will further that awareness, particularly amongst local land protection agencies. Information from the two projects will be supplied to these organisations to assist in general awareness of *A. paniculata* in the northern Cape York area.

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(Appendices removed)

Appendix 10 Poster paper presented at 2005 Queensland Weeds Symposium.

Protection of northern grasslands from rejected forage plants of high weed potential – a project précis.

Kendrick Cox[1], Department of Primary Industries and Fisheries, Walkamin, QLD 4872
Christopher Gardiner, James Cook University, Townsville, QLD 4811
Cam McDonald, CSIRO Sustainable Ecosystems, St. Lucia, QLD 4067
Terry Hilder, Department of Primary Industries and Fisheries, Mackay, QLD 4740
Trevor Hall, Department of Primary Industries and Fisheries, Toowoomba, QLD 4350
Bob Clem, Department of Primary Industries and Fisheries, Gympie, QLD 4570

The need for pasture plant introduction and evaluation

Northern Australia has a vast native pasture resource, which supports over 70% of the beef herd and 95% of the sheep flock of the area. However, native pastures alone are often not capable of supporting the levels of animal production necessary to economically meet market demands.

Native grasses generally mature early, with a consequent rapid decline in feed quality, thus placing a ceiling on levels of animal production attainable over a given season. Further, many of the native species that have evolved under a regime of moderate marsupial grazing pressure are intolerant of the grazing pressures applied under commercial production conditions. Consequently, large areas of native grassland are in a state of change, with a shift towards less productive, unpalatable species such as *Aristida* spp. and *Imperata cylindrica.*

It has been well recognised that certain exotic grasses and legumes differ from native species, through being more tolerant of grazing, and/or being able to produce (higher yields of) better quality herbage. To improve the grazing industries of northern Australia, a large range of tropical pasture species was introduced and tested. Many commercial plant cultivars are now available. A 1996 assessment of the value of these sown pastures in northern Australia suggests that the annual gross benefit to be at least $80 million.

Exotic pasture species have a complementary role to that of native pastures in the development of sustainable production systems. Not only do these introduced species play an important role in improving productivity and conserving soil, they can also assist in maintaining natural biodiversity. Judicious use of carefully selected exotic cultivars can relieve the grazing pressure on the less grazing tolerant native pasture plants, thus enhancing their survival.

The Project

The (Queensland) Department of Primary Industries and Fisheries, with active involvement by staff of the Commonwealth Scientific and Industrial Research Organisation, James Cook University, the (Queensland) Environmental Protection Agency and the (Queensland) Department of Natural Resources and Mines and funding from Meat and Livestock Australia, has undertaken two consecutive three-year projects (MLA NAP3.225 and NBP.327) to assess forage legumes for weed potential, eradicate plants considered of an unacceptable weed risk, understand the dynamics of such eradication programs and develop long term strategies to control the target plants.

The program is focussed on exotic legumes evaluated as pasture plants in Queensland during the 1980s and 90s by state and federal governments in Queensland, but rejected prior to commercialisation because they were deemed to either have no productive advantage over existing cultivars or had characteristics considered to impart some potential as weeds of pastures or the environment. Concerns that one or more of these legumes may become a future weed of primary industries or the environment prompted the development of the current program. The Project also provided the opportunity to understand the dynamics of pre-emptive eradication of

seeding legumes in a wide range of tropical grassland environments, thereby assisting the refinement of plant evaluation protocols for pasture plants in northern Australia.

Four legumes (in decreasing order of perceived weed potential) were nominated for eradication: *Acacia angustissima*, *Aeschynomene paniculata*, *Indigofera schimperi* and *Aeschynomene brasiliana*. These perennial legumes were planted on a range of scales at over 60 field sites throughout Queensland, covering a wide range of land-types. All are prolific producers of hardseed and are potentially adapted to large areas of northern Australia. All are regarded to have limited palatability, particularly *A. angustissima* and *A. paniculata*, so seeding often occurs unhindered by grazing. *Aeschynomene brasiliana* and *I. schimperi* are variously grazed, although usually only once the palatability of companion plants has declined.

During phase one of the Project, plant eradication techniques were developed and the target plants were systematically treated at all sites over three years using combinations of selective herbicides, cultivation, mechanical control, strategic grazing and the establishment of competitive grasses. Population decline was monitored and progress reviewed at the end of that Project. In the second three year phase (current), eradication and monitoring has continued and the Project has evolved to address long-term control of the plants. At May 2005, some 45% of sites were considered 'clean' and at another 40% of sites only scattered plants are now found. Continued intensive eradication will be required at other sites, typically those originally planted on larger scales. Site plans and extension resources are to be developed for long-term control and eradication of the target plants.

Lessons from the current project have assisted the development of best-practice procedures for the evaluation and release of pasture plants in extensive grasslands in northern Australia, and the Project has been instrumental in the promotion of a Code of Practice for the Evaluation and Release of Pasture Plants (CoP), originally developed by the (now disbanded) North Australian Pasture Plant Evaluation Committee).

The activities of projects MLA NAP 3.225 and NBP.327, and adoption of the CoP, are key steps toward preventing the accidental release of undesirable plants during the development of useful pasture plants for the grazing industries in northern Australia.

Queensland **the Smart State**

the pre-emptive control of weedy pasture legumes

NBP.327 Protecting northern grasslands from rejected forages of high weed potential

Kendrick Cox, Department of Primary Industries and Fisheries, Walkamin, QLD 4872
Christopher Gardiner, James Cook University School of Tropical Biology, Townsville, QLD 4811
Cam McDonald, CSIRO Sustainable Ecosystems, St. Lucia, QLD 4067
Terry Hilder, Department of Primary Industries and Fisheries, Mackay, QLD 4740
Trevor Hall, Department of Primary Industries and Fisheries, Toowoomba, QLD 4350
Bob Clem, Department of Primary Industries and Fisheries, Gympie, QLD 4570


Acacia angustissima

Background

During the 1980s and 1990s large-scale evaluation programs were undertaken in Queensland to identify legumes to improve the productivity of beef pastures. Although the programs were successful, there were concerns that some unpalatable legumes posed a threat to the production and conservation values of grasslands in northern Australia. A six-year MLA-funded program was undertaken by DPI&F, with support from James Cook University, CSIRO, DNRM and EPA, to identify and eradicate legumes of high weed potential before they began to spread from plant sites.


Aeschynomene paniculata

Project activities

1. Four perennial legumes identified: *Acacia angustissima*, *Aeschynomene paniculata, Indigofera schimperi and Aeschynomene brasiliana*. All are prolific producers of hardseed and are widely adapted. All are considered unpalatable, although *I. schimperi* and *I. brasiliana* are grazed when companion plants become unpalatable (dry-season).
2. Control methods were identified.
3. Eradication and monitoring undertaken at that 60+ sites over six years, the method dependent on plant-type and site characteristics: selective herbicides, cultivation and cropping, mechanical removal, strategic grazing and the establishment of competitive grasses.
4. Extension resources produced to assist long-term control of the target plants.
5. Best-practice protocols, as an industry Code of Practice, for the evaluation and release of pasture plants in north Australia promoted, through presentation at regional weeds meetings, an international herbage seeds conference and a multi-agency forum on pasture plant release.


Indigofera schimperi

Project outcomes

1. Eliminate the risk of the target legumes spreading into the grasslands of northern Australia.
2. Maintain the capability to develop new pasture plants (as the need arises) while minimising the risk of accidentally releasing a weed of production or environmental systems.
3. Provide information useful when developing programs seeking to eradicate plants in northern grasslands.


Aeschynomene brasiliana

mla MEAT & LIVESTOCK AUSTRALIA JCU JAMES COOK UNIVERSITY CSIRO

Delivery

Queensland Government
Department of Primary Industries and Fisheries

Appendix 11 Media release for the 2004 Weedbusters week, Townsville.

Outstanding Community Support for Fight Against Weeds

Weedbuster Week is just around the corner and this year promises to be bigger and better than ever with over 20 community groups, local government and private businesses joining together to promote this event. Held from October 16 to 24 the theme for this year is **Fighting the Weed Invaders** and many Townsville and Thuringowa residents will be doing just that.

"Weedbuster Week is an opportunity for every group and individual to do something practical for our economy and environment and have some fun at the same time," said Katrina Cullen, Townsville and Thuringowa's Weedbuster week coordinator. "If everyone gets together, we can have a significant impact on weeds, not just in our local area, but state and nation-wide."

"This event has shown how passionate people are about protecting our unique and beautiful Coastal Dry Tropics environment. The support we have received from so many areas of the community has been outstanding. With all the people involved we can really make a difference."

Support from the Coastal Dry Tropics Inc., Townsville & Thuringowa City councils, Townsville General Hospital, James Cook University, NQ Water, Conservation Volunteers Australia, the Natural Resources & Environment Forum for the Townsville-Thuringowa Coastal Plain, Greening Australia, Greencorp, Meat & Livestock Australia, Department of Primary Industries & Fisheries, Northern Tree Specialists, Community Revegetation Groups and individuals from the area have all helped to make this event happen.

A major Weedbuster Week activity will be the **Campus Creek Weed Blitz**, from October 18-22. Various organisations will work together to target Campus Creek - a local 'Weed Black Spot' flowing from Mt Stuart to the Ross River though the university, the hospital and the Palmetum.

"In many places, the invasion of Chinee Apple and Leucaena has entirely displaced local native plants. Weedbusters will put this once-beautiful urban waterway back on the road to recovery," said Ms Cullen.

Other activities run during Weedbusters week:
Weedbuster Fun Day – Sunday October 24 at Palmetum with BBQ, tree planing, kids events and Woody the Weed – Oct 24th 8am -12pm

Weed Swap – swap your garden weeds for ornamental native plants *for free* at the Vantassel Street landfill – Oct 24th 1-4pm

Weedbuster Action Days – at Ross Creek, The Bushgarden, Corveth's Lagoon, Marabou Park & Bluewater Creek throughout the week

Weedbuster Info Stalls – at Bohle, Willows and Cotters Markets

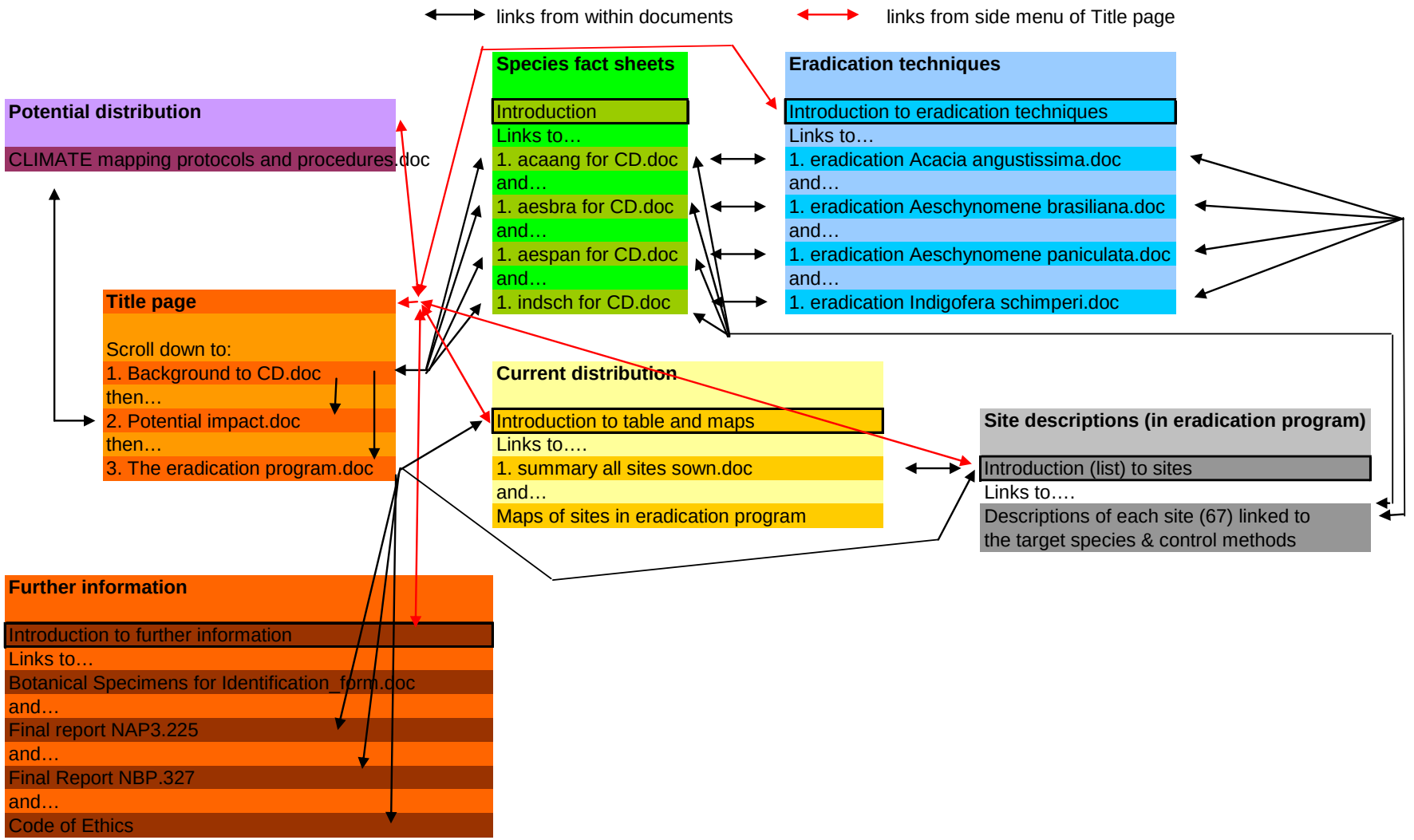
Know Your Weed Challenge – Go in the draw to win a CVA work crew performing conservation activities on your land for one week

Weed Raffle – Have your chance to win a professional tree-lopper remove large weed species from you yard and have them replaced with local native plants

Over 3000 native garden plants to be given away – at various locations throughout the week

For further information on how you can be a part of Weedbuster Week, contact: **Katrina Cullen, 4721 4322 (p) 0438 760 145 (m)** Weedbusters Website: http://www.weedbusters.info

Appendix 12 Schematic diagram of the CD-ROM extension resource.



Appendix 13 Selected sections from the Environmental Protection Act (1994).

Queensland

Environmental Protection Act 1994

Reprinted as in force on 31 December 2004
(includes commenced amendments up to 2004 Act No. 53)

Reprint No. 5I

This reprint is prepared by
the Office of the Queensland Parliamentary Counsel

Chapter 12 Miscellaneous

Part 1 Approval of codes of practice and standard environmental conditions

548 Codes of practice

(1) The Minister may, by gazette notice, approve codes of practice stating ways of achieving compliance with the general environmental duty for any activity that causes, or is likely to cause, environmental harm.

(2) The Minister must keep copies of approved codes of practice open for inspection by members of the public during office hours on business days at—
(a) the department's head office; and
(b) the other places the Minister considers appropriate.

549 Minister may approve standard environmental conditions

(1) This section applies if a code of environmental compliance contains standard environmental conditions for carrying out an environmentally relevant activity.
(2) The Minister may, by gazette notice, approve the conditions.
(3) The Minister must keep copies of approved standard environmental conditions open for public inspection during office hours on business days at—
(a) the department's head office; and
(b) the other places the Minister considers appropriate.

549A When standard environmental conditions must be complied with

(1) This section applies if the Minister, under section 549(2), approves standard environmental conditions for carrying out a chapter 4 activity.
(2) If there is a difference between a development condition applying for the activity before the approval and a standard environmental condition for the activity, the standard environmental condition prevails to the extent of the difference.
(3) However, for a person who was, immediately before the approval under section 549(2) was given, lawfully carrying out the activity, section 435A does not apply until 1 year after the standard environmental conditions for the activity were approved.[116]

550 Effect of changes to standard environmental conditions

(1) This section applies if—
(a) standard environmental conditions apply for an environmental authority (the ***existing conditions***); and
(b) after the grant of the authority, the standard environmental conditions are changed.
(2) The existing conditions continue to apply to the authority, despite the change.
(3) Subsection (2) is subject to any amendment of the authority.

550A Effect of changes to standard environmental conditions (chapter 4 activities)

(1) This section applies if a change is approved to a standard environmental condition applying to a chapter 4 activity for which there is a code of environmental compliance.
(2) The changed conditions do not apply until 1 year after the day the change is approved.[117]

116 Under section 333 (Voluntary submission of draft program), a registered operator could apply for an environmental management program within 1 year.
117 Under section 333 (Voluntary submission of draft program), a registered operator could apply for an environmental management program within 1 year.

Appendix 14 Poster paper presented at the 5th International Herbage Seeds Conference, 2003.

EVOLVING PROCEDURES FOR THE EVALUATION AND COMMERCIALISATION OF HERBAGE PLANTS IN QUEENSLAND

K.G. Cox [1] and B.G. Cook [2]
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Abstract
Queensland derives a significant part of its Gross Domestic Product from grazing-based livestock industries. The dairy industry and sectors within the beef and sheep industries depend on sown pastures using exotic germplasm as a primary or significant source of forage for the grazing animal. If these industries are to continue to play a part in the State's economy, it will be important to maintain processes within the State to provide forage varieties that are relevant to industry needs as these emerge. Forage varieties have also found application in cropping systems, horticulture, and soil conservation. Traditionally, public sector agencies, supported in part by industry funding bodies, bore the largest part of the responsibility for plant improvement research. As agricultural research moves more towards development of partnerships with the private sector, so too must the process of pasture plant improvement evolve to maintain a transparent and responsible system of plant release.

New Varieties - the Continuing Need

Sown forage cultivars have made a significant contribution to the development of grazing industries in Queensland for many years. The dairy industry in the State depends almost entirely on forage cultivars derived from temperate and tropical exotic germplasm. Although much of Queensland's beef turnoff comes from grazed native pastures, sectors within the industry are reliant on sown warm-season forages to breed, grow and finish cattle for particular markets. Sown pastures make a comparatively minor contribution to the sheep industry. In the past forty years, some 120 cultivars of exotic perennial grasses and legumes have been released in northern Australia, mainly in Queensland, with a view to providing high quality and/or late-maturing forages for specific areas and applications. More recently, perennial grasses and legumes have been selected for use in ley farming systems, while other applications relating to road verge stabilisation and rehabilitation of land disturbed by mining and large-scale construction have been identified. An important prerequisite to and consequence of sown pasture development has been a pasture seed industry, which has not only served the needs of livestock industries in the State, but has also generated valuable export income.

While the existing suite of cultivars largely satisfies current needs, history has taught us that there is no room for complacency. Over the years, many cultivars have lost relevance due to the development of disease or insect problems, or changing needs and perceptions. During the 1970s and 1980s, cultivars of *Stylosanthes humilis, S. guianensis,* and *S. scabra* were severely affected by anthracnose disease caused by *Colletotrichum gloeosporioides*. Although not annihilated by the disease, these members of the main tropical legume genus were sufficiently affected to be no longer commercially relevant. This led to the research agencies' undertaking breeding and selection programmes to produce cultivars resistant to the disease. In anticipation of continued strain mutation within the pathogen in Australia, a programme was initiated to protect *Stylosanthes scabra,* probably the most widely planted *Stylosanthes* species,

from the fate met by other members of the genus. Development of a cultivar, 'Siran', with multiple gene resistance to anthracnose, provided industry with a safety net against breakdown of the single gene resistance in the original and most commonly planted cultivar, 'Seca'. Similar programs overseas have produced anthracnose resistant varieties of *Stylosanthes guianensis*, the now ubiquitous wild selection, CIAT 184, and the CIAT-bred lines, introduced to Australia as ATF 3308 and 3309, all of which are now being produced in Queensland. Similar programs have been undertaken with *Macroptilium atropurpureum* to overcome leaf rust in Siratro, and in *Leucaena leucocephala* in a search for resistance to the damaging psyllid insect, *Heteropsylla cubana*.

Disease and insects are not the only stimuli for the search for new varieties. Changing perceptions of need have also resulted in demand for new varieties. In relatively recent times, grain yields and protein levels have been declining in old cultivation areas, due to loss of soil structure and decline in available soil nitrogen. This prompted a search for species that might fit into ley pasture systems, which have the potential to reverse the degradation process and improve both soil structure and fertility. Species that were hitherto rejected on the grounds they were not sufficiently persistent were now found to have qualities that satisfied the criteria for ley legumes – *Clitoria ternatea* and *Macroptilium bracteatum*. *Setaria incrassata*, a rapidly establishing grass adapted to the heavy clay cropping soils, had already been released for use in ley systems.

Earlier Release Protocols

The primary source of germplasm for release in Queensland is the Australian Tropical Forages Genetic Resource Centre (ATFGRC). The ATFGRC was initially managed by CSIRO, and was housed at Samford near Brisbane. In 2001 it was amalgamated with the Australian Tropical Crops Genetic Resource Centre at Biloela where it is now managed by DPI. This amalgamation brought the ATFGRC in line with other genetic resource centres around Australia where designated collections e.g. winter cereals, *Medicago*, etc., are managed by particular State departments. To achieve this amalgamation, a measure of rationalisation was necessary. Only those genera that were likely to have application in the future were retained in Australia. The balance was sent to the International Livestock Research Institute at Addis Ababa in Ethiopia where it was merged with the already large collection held there. The collection that once comprised some 11 000 grass and 16 000 legume accessions, is now reduced to a total of 12 300 accessions.

For many years, plant release was overseen by the Queensland Herbage Plant Liaison Committee (QHPLC), a body drawing its membership from DPI, CSIRO, the University of Queensland, and various seed industry bodies. Under this system, the organisation or individual proposing release of a new variety would present a submission to the QHPLC outlining the reasons for release. In more recent years, that submission has had to be accompanied by a weed risk statement. If the QHPLC felt the variety actually contributed to plant improvement, it would endorse the submission and the new variety would be recommended for registration in the Australian Herbage Plant Register. A Seed Increase Committee (SIC) appointed by and from the QHPLC, oversaw the initial phase of release of each new cultivar in Queensland. The SIC ensured that adequate supplies of seed were made available to seed growers. This was done in association with growers. The SIC, having determined the amount of seed required, approached prospective growers, who entered into contracts to produce seed at a price determined by the SIC. The SIC was disbanded when members felt confident that the new variety had every chance of being successfully absorbed into commerce. This early approach accommodated a large volume market, the initial seed increase being spread over a number of seed producers. This system worked well for public release of cultivars.

In the 1990s, the Plant Variety Rights Act and its successor, the Plant Breeders Rights Act, brought about a number of changes to the system. Under the initial interpretation of the Acts, selections from the wild were eligible for protection if it could be demonstrated that intellectual

effort was involved in the discovery or development of the variety. For a few years, this provided the seed industry with a means of obtaining exclusivity over a new variety at the same time giving the public sector a transparent process for transfer of material to industry without favouring any individual or group. In many ways, the emergence of PBR protection rendered the QHPLC irrelevant, since commercial arrangements could be made between the research body and an industry client, bypassing the implied authority of the QHPLC. In reality, the QHPLC had no legislative backing, and could only act as a conscience for plant evaluators. However, this system, in which the PBR process acted as a surrogate release process, did not prevail for long.

In 1998, farmers' rights groups, Rural Advancement Foundation International (RAFI) and Heritage Seed Curators Association (HSCA) raised question on the Internet about the propriety of the pasture plant commercialisation system in tropical Australia. Although the accusations of "Biopiracy" were blatantly wrong in the case of tropical pastures, none of the research organisations chose to challenge the allegations. In response, the Plant Breeders Rights Office chose to interpret the PBR Act more narrowly, in a way that excluded most tropical pasture plant releases from eligibility for PBR protection. The PBRO would now accept only varieties that could be shown to be distinct from the parents. It may still have been possible to select an eligible entry from the natural variation within a population. However, most tropical grasses are apomictic and most tropical legumes are cleistogamous. As such, there was little likelihood of the existence of much, if any, variation in the populations of wild species.

The need for the QHPLC at all was now called into question. The situation under PBR had demonstrated that alternative systems could operate. There was now less demand for new varieties with a consequent reduction in publicly and industry funded research activity. There was also the ever-present threat to members in regard to liability for the release in the event that it should cause unforseen problems in the future, particularly with the advent of the *Environmental Protection Act* of 1994. The QHPLC was disbanded in 2002, with an undertaking being given by key members to explore alternative methods to effectively guide the process of release and commercialisation. No alternative system has yet been formalised.

The Release Process - Transparent and Responsible

There is still, as determined by industry, a need for new forage varieties, albeit at a lower level than existed in earlier decades. These needs can mostly be met from the current collection of tropical forage germplasm held at Biloela, or by linking into international networks. Knowledge of the collection resides with individuals within the research institutions, as do the network linkages. Databases are being compiled in an effort to conserve some 40 years of research experience for use by staff of R, D & E agencies in Australia and abroad who will not have the opportunity for the same level of hands-on, intensive experience enjoyed by researchers of the past. The challenge now is to link industry needs with the agencies' capacity to satisfy them. Overriding this is the need to ensure that any product from this relationship must take into account not only the needs of the client group, but also the values of the remainder of the community. There is also the need to ensure that obligations under the various international agreements are observed in relationship to ownership of native plant species by the country of origin.

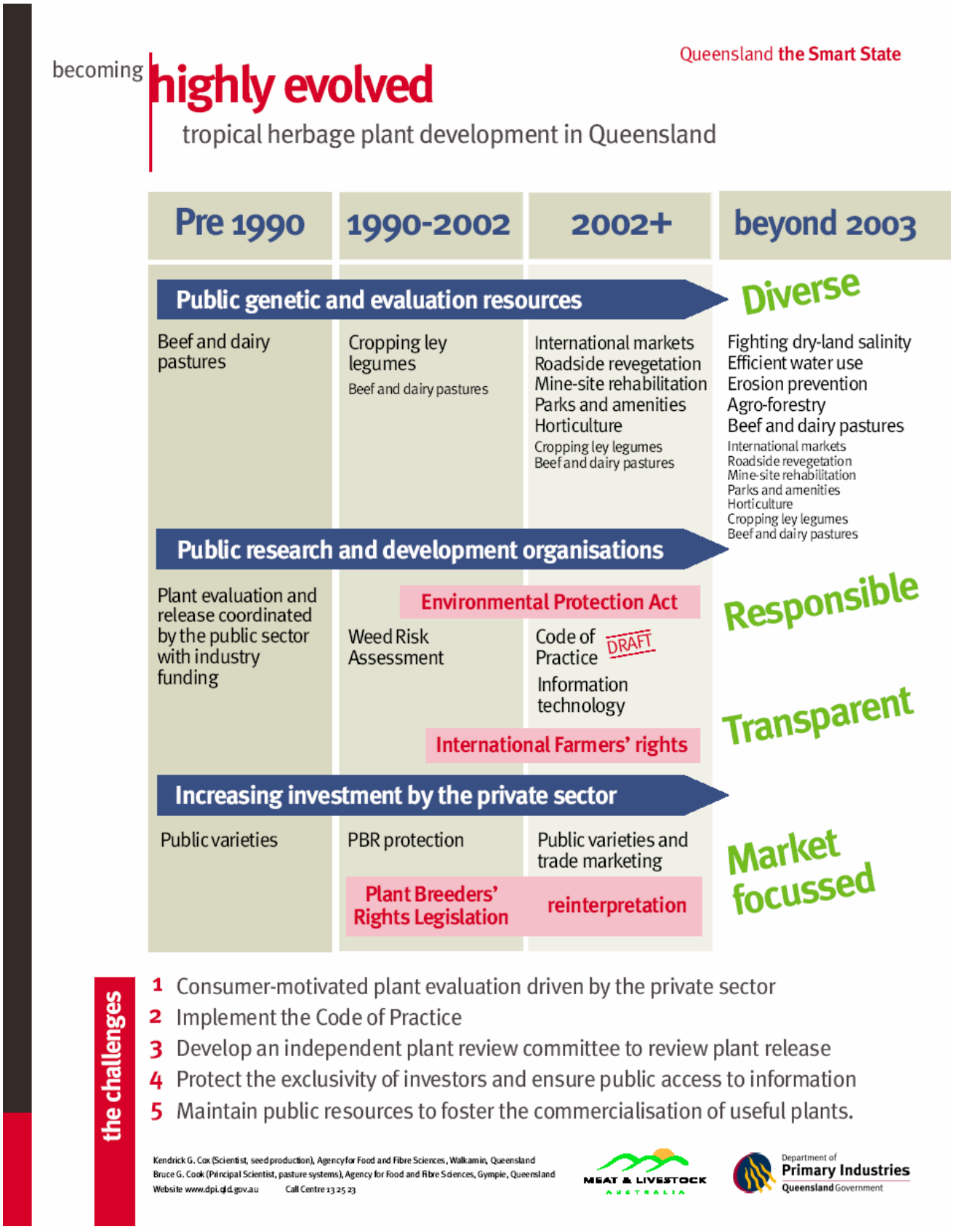
Release of exotic germplasm into the Australian environment is a two-level process – 1) release from the genetic resource centre for evaluation, and 2) release to the private sector for commercial application. Historically, the focus has been on public release, but obligations to the community as a whole are now paramount, which moves the focus to release of seed from the GRC and early stage plant evaluation. The precautionary principle, "When in doubt, out", must always apply. The Northern Australian Pasture Plant Evaluation Committee (NAPPEC), a group drawing membership from all major forage research groups in northern Australia together with the Environmental Protection Agency and Natural Resources and Mines, developed a Code of Practice for adoption by the various research agencies for application in this early stage. The most important part of the Code, after the recognition of the rights of all, is that all

new species released from the ATFGRC should be subject to the Weed Risk Assessment System (WRAS) developed by AQIS primarily for use in relation to pre-entry quarantine. It is not safe to assume that all doubtful varieties will be identified in the first instance with the WRAS. Constant vigilance throughout the evaluation and seed increase process will improve chances of rejecting varieties with undesirable characteristics. The authors believe that it will be in the best interests of all if a system is developed whereby a duly appointed and authorised release panel of experts is formed to assess the appropriateness of a request for release of germplasm from the GRC, and for release into commerce.

Development of Partnerships

All project activity must have a source of funding. Earlier systems of evaluation and release largely depended on the public sector for identification of needs and the conduct of research. Funding of activities was shared between government agencies and industry, the latter through industry funding bodies. Little heed was paid to the value of intellectual property. There is a current trend towards greater industry involvement in the whole process - in identification of needs, evaluation of germplasm, and funding of activities. However, no industry member wants to fund an activity that might favour a competitor. Since most cultivar releases represent relatively minor markets to the seed industry, there is an obvious preference among seed merchants for exclusive rights to a variety, as existed under the PBR system. To this end, Trade Marking provides one avenue for companies to explore, recognising that only the name is protected, not the genetic base of the cultivar. The PBR Office has also reassessed its narrow interpretation of “breeding”, and may accept selections from within a population as eligible for protection.

The next challenge to private and public sector stakeholders in cultivar release is the development of a completely transparent system of knowledge sharing in relation to plant genetic resources, so that each member of the private sector has equal access to information. In accordance with funding policy, it will be important for public sector service agencies to somehow share in the benefits of plant improvement in order to continue to provide for the needs of industry and the community.


becoming highly evolved
tropical herbage plant development in Queensland
Queensland the Smart State
Pre 1990
1990-2002
2002+
beyond 2003
Public genetic and evaluation resources
Diverse
Beef and dairy pastures
Cropping ley legumes
Beef and dairy pastures
International markets
Roadside revegetation
Mine-site rehabilitation
Parks and amenities
Horticulture
Cropping ley legumes
Beef and dairy pastures
Fighting dry-land salinity
Efficient water use
Erosion prevention
Agro-forestry
Beef and dairy pastures
International markets
Roadside revegetation
Mine-site rehabilitation
Parks and amenities
Horticulture
Cropping ley legumes
Beef and dairy pastures
Public research and development organisations
Responsible
Plant evaluation and release coordinated by the public sector with industry funding
Environmental Protection Act
Weed Risk Assessment
Code of Practice
DRAFT
Information technology
Transparent
International Farmers' rights
Increasing investment by the private sector
Market focussed
Public varieties
PBR protection
Public varieties and trade marketing
Plant Breeders' Rights Legislation
reinterpretation
the challenges
1 Consumer-motivated plant evaluation driven by the private sector
2 Implement the Code of Practice
3 Develop an independent plant review committee to review plant release
4 Protect the exclusivity of investors and ensure public access to information
5 Maintain public resources to foster the commercialisation of useful plants.
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MEAT & LIVESTOCK AUSTRALIA
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Queensland Government