Reversing the declining quality of the tropical forages collection

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Value of the Australian Tropical Forages Collection

The Australian Tropical Forages Collection (ATFC) is a unique collection of seeds of grasses and legumes collected throughout the tropical and subtropical world over some 40 years. It comprises 10 016 (614 species) warm-season grasses and 2677 (255 species) legumes (Lawrence 2002). The collection is currently administered by QPIF at Biloela in Queensland and is combined with the tropical crops collection.

The ATFC has been the key plant resource for the development of sown pastures in northern Australia, mostly through the provision of well adapted perennial plants suitable for ruminant grazing. Over 120 grass and legume cultivars were developed for the grazing industries using this resource. Today, sown pastures provide the primary feed resource for dairy and beef-finishing in Queensland. During the mid-1990s, the net present value to beef production in northern Australia was estimated at AUD 712 million (Walker *et al*. 1997). The net annual benefit was estimated at AUD 40 million with additional annual benefits of AUD 2 million per annum (Robbins *et al*. 1996). Through the development of green manures and ley-legumes, the ATFC has also contributed significantly to cropping and mixed grazing/cropping systems in Queensland.

New roles for the ATFC are emerging as the grazing industries seek to capitalise on opportunities and respond to emerging challenges. A key example over the past 5 years has been the planting of warm-season perennial grasses in cooler areas of Australia to enhance summer feed supply and mitigate the effects of dry-land salinity. Other emerging roles include the use of perennial pasture plants to sequester carbon and provide sources of bio-energy on areas not suited to intensive food production.

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Status of the collection

The collection has deteriorated over the 30 or so years of active use. Although the seed lots were stored under conditions suitable for minimal storage deterioration, many older accessions have declined in viability. This can be attributed variably to the length of time in storage (40+ years for some accessions), the maturity or aging status of seed upon entry to storage and fluctuations in storage conditions associated with movement of seed. Many stocks have also been simply eroded as they were requested by outside parties.

A review of seed viability and stocks was completed after transfer of the ATFC from CSIRO to QPIF during 2000 (Lawrence 2002). Sub-samples of seed lots were tested for viability by an independent commercial seed laboratory and stocks measured. It was found that over 2700 ecotypes had insufficient volumes and ~600 had low viability, representing together about 25% of the entire collection. Many of these accessions were of genera and species of current importance as sown pastures in Australia and overseas (Table 1).

Seed-regeneration program

A seed-regeneration program was implemented by QPIF over the last 5 years to replace deteriorating stocks. This followed a QPIF grow-out of grass accessions for evaluation as warm-season perennial pastures in salt-prone areas of Australia under a program supported by the CRC for Plant Based Management of Dryland Salinity (Moore *et al*. 2003). Under that project, 245 grasses were regenerated and sub-samples transferred to

Table 1. The number of grass and legume accessions requiring regeneration and the number of accessions regenerated in north Queensland by DPI&F, 2005–2008.

Genus	Number of accessions requiring regeneration (number of species[1])	Number of accessions regenerated (number of species[1]), 2005–2008
Grasses		
Aerva	2 (1)	
Alloteropsis	2 (2)	1 (1)
Andropogon	16 (2)	
Anthephora	34 (1)	20 (1)
Apluda	1 (1)	
Anthraxon	1 (1)	
Arundinella	1 (1)	
Austrostipa	2 (1)	
Bothriochloa[2]	31 (5)	29 + 29[3] (5)
Bouteloua	5 (3)	
Brachiaria[2]	11 (2)	13 + 5[3] (2)
Capillipedium	4 (2)	1 (1)
Cenchrus[2]	39 (2)	1 (1)
Chloris[2]	24 (4)	24 + 16[3] (4)
Chrysopogon	31 (4)	
Chrysoscias	1 (1)	
Cymbopogon	11 (2)	2 (1)
Cynodon[2]	38 (7)	6 (1)
Dactyloctenium	10 (2)	
Dichanthium[2]	54 (4)	33+14[3] (3)
Digitaria[2]	191 (12)	4 + 50[3] (2)
Echinochloa	6 (4)	
Enteropogon	4 (2)	
Eragrostis	13 (5)	15 + 3[3] (6)
Eriochloa	6 (6)	
Eustachys	8 (1)	5 + 5[3] (1)
Heteropogon	16 (1)	4 (1)
Hyparrhenia	7 (3)	
Ischaemum	7 (2)	7 (2)
Iseilema	6 (1)	
Leptochloa	2 (1)	2 (1)
Manisuris	1 (1)	
Marina	1 (1)	
Megathyrsus[2]	20 (1)	36 + 41[3] (1)
Melinis	2 (1)	2 (1)
Monachather	2 (1)	
Panicum[2]	140 (12)	35 + 27[3] (10)
Paspalidium	1 (1)	1 (1)
Paspalum[2]	73 (19)	71 + 30[3] (19)
Phalaris	2 (2)	
Piptatherum	2 (1)	
Schizacyrium	1 (1)	
Schmidtia	17 (1)	2 (2)
Sehima	16 (2)	2 (2)
Setaria	19 (4)	19 + 4 [3] (4)
Stipagrostis	5 (2)	1 (1)
Tetrapogon	6 (1)	1 (1)
Themeda	28 (1)	3 (1)
Triodia	1 (1)	1 (1)
Urochloa[2]	3 (3)	39+ 18[3] (11)

Genus	Number of accessions requiring regeneration (number of species[1])	Number of accessions regenerated (number of species[1]), 2005–2008
Legumes		
Abrus	2 (1)	2 (1)
Adesmia	1 (1)	
Aeschynomene[2]	62 (18)	17 (5)
Albizia	2 (1)	
Alysicarpus	48 (10)	
Calliandra[2]	8 (4)	
Calopogonium	1 (1)	
Cassia	9 (1)	
Centrosema[2]	468 (13)	142 (16)
Chamaecrista[2]	10 (7)	22 (7)
Clitoria[2]	13 (3)	
Codariocalyx	14 (1)	
Dalea	2 (1)	
Dendrolobium	4 (2)	
Desmanthus[2]	31 (8)	99 (18)
Desmodium[2]	721 (53)	9 (5)
Dolichos	19 (2)	5 (2)
Eriosema	1 (1)	
Galactia	74 (8)	
Gliricidia	17 (1)	
Indigastrum	1 (1)	
Indigofera	38 (17)	
Lablab[2]	29 (1)	11 (1)
Lespedeza	1 (1)	
Lessertia	3 (3)	
Leucaena[2]	28 (9)	
Lotononis[2]	2 (2)	2 (2)
Lysiloma	1 (1)	
Macroptilium[2]	151 (12)	116 (12)
Macrotyloma[2]	44 (5)	
Mucuna	3 (1)	
Neonotonia[2]	29 (1)	29 (1)
Neptunia	1 (1)	
Pseudovigna	1 (1)	
Psoralea	1 (1)	
Pterocarpus	1 (1)	
Pueraria	4 (1)	
Pycnospora	3 (1)	
Rhynchosia	266 (28)	
Senna	11 (6)	
Strophostyles	1 (1)	
Stylosanthes[2]	447 (19)	138 (17)
Tadehagi	2 (1)	
Tephrosia	39 (20)	6 (2)
Teramnus	40 (5)	6 (1)
Uraria	5 (1)	
Zapoteca	1 (1)	
Zornia	85 (21)	5 (1)

[1] Some accessions listed at genus level only, so the number of species may be an under-estimation.

[2] Genus contains species commonly sown in recent years for pasture or other forms of animal fodder in Queensland.

[3] Grown as a component of another project. Includes accessions of adequate stocks for genetic resource conservation.

the ATFC. This provided information useful for developing realistic expectations for the regeneration of ecotypes in the ATFC and planning required resources. The program proper began during 2005, using funding from the Grains Research and Development Corporation (GRDC).

The regeneration program was designed to efficiently recover true-to-type seed and information. Priority was placed on genera which include species adopted commercially in Queensland (Table 1). All regeneration work was undertaken at the QPIF research station at Walkamin (17°S, 145°E; 700 masl) as the climate, soils, location and infrastructure had previously proven suitable for producing seed of a wide range of tropical and subtropical grasses and legumes. Standardised non-replicated plots of spaced plants were established. The methods used minimised the amount of time spent on each accession, particularly for weed and insect control and during plant establishment. Simple data on plant habit, leafiness, flowering time, pathogens and pests and seed yield were recorded and digital photographs taken of each accession. Some activities, such as hand harvesting and processing, were unavoidably time-consuming. Plant samples were submitted to the Queensland Herbarium for species verification. The target was to produce and quickly document 300–350 accessions per year using approximately 70% of the time of 1 technical officer and 1 experimental officer, a cost of approximately AUD 85 000 pa including operating costs.

The regeneration program has been successful overall. Over 3.5 years, 380 (81 species) grass and 609 (91 species) legume accessions were planted for regeneration (Table 1). Nearly all accessions established successfully after raising in controlled conditions and transfer to field plots. Target populations of 5 plants/legume accession were mostly achieved. However, the target population of 20 grass plants was rarely achieved because of poor seed viability. Survival was excellent after transplanting (February–March).

Most grass and legume accessions flowered and set seed within 6 months of transplanting and seed was harvested by October. The key exceptions were long-day flowering grasses, mostly *Paspalum* spp., which did not flower until January and then often weakly. The target yield of 5 g was achieved for most grasses. However, seed-set of some *Digitaria* grasses, particularly *D. eriantha*, was consistently poor across years, contributing to lower yields. Other grasses, particularly *Dichanthium* and *Bothriochloa*, were affected by seed-head ergots and a new disease (*Conidiosporomyces* sp.) was identified on *Megathyrsus* and *Panicum* accessions. The legumes were comparatively easy to produce and the target of 2000 seeds/accession was comfortably achieved for most accessions, although delayed by late flowering in some accessions. Seed-set was very poor for *Centrosema macrocarpum* despite vigorous flowering. Overall, over 89% of sown grasses and 94% of sown legumes were regenerated. Additional seed was supplied for most accessions.

Although not rigorous, the simple plant descriptions provided information which will be useful for selection and which complements collection or evaluation data. There was appreciable variation within species in growth habit, flowering time and seed production, all useful characteristics for selecting accessions for pasture systems.

Long-term maintenance of the collection

The ATFC, like other plant genetic resources, requires on-going investment to ensure the availability of new genes to meet evolving needs. This will become increasingly important as the collection ages and stocks decline. Failure to address this will result in fewer new plants (or genes) available to the grazing and graze/cropping industries in northern Australia, to which these plants are particularly well suited.

Genetic resources can be problematic to fund as they provide no immediate return on investment. Indeed, it is likely only a small proportion of the accessions within such collections will be used commercially. In Australia, funding and activity roles of state and federal governments and industries have been debated over the last 20 years and are yet to be resolved (Lawrence 2009). The 8 genetic resource centres are currently managed and co-funded by state governments with recent additional funding provided by the GRDC.

Further regeneration of the tropical forages collection is currently stalled by lack of funding. The QPIF provides funding for storing, sourcing (AusPGRIS web-site) and supplying germplasm, but not for regenerating accessions. Funding for regeneration was provided by the GRDC, even though the grains industry is not the key beneficiary of the tropical forages collection. This financial support ended during 2008, prompting the need to develop an alternative approach for funding future regeneration of the ATFC.

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