

The Australian Pastures Genebank - A short history and update of progress

Steve Hughes¹, Rowan Smith², Kendrick Cox³, Alan Humphries¹, Daryl McClements⁴, Carol Harris⁵ and Mary-Jane Rogers⁶

¹ South Australian Research and Development Institute. Waite Campus, 2b Hartley Grove, Urrbrae SA 5064, steve.hughes@sa.gov.au, alan.humphries@sa.gov.au

² Tasmanian Institute of Agriculture, University of Tasmania. Private Bag 1372, Launceston, TAS 7250, rowan.smith@utas.edu.au

³ Department of Agriculture and Fisheries, 28 Peters St, Mareeba QLD 4880, Kendrick.Cox@daf.qld.gov.au

⁴ Department of Agriculture and Food Western Australia, Baron-Hay Court, South Perth, WA 6155, daryl.mcclements@agric.wa.gov.au

⁵ New South Wales Department of Primary Industries. 444 Strathbogie Road, Glen Innes, NSW 2370, carol.harris@dpi.nsw.gov.au

⁶ Department of Economic Development, Jobs, Transport and Resources, Ferguson Rd. Tatura, VIC 3616, maryjane.rogers@ecodev.vic.gov.au

Abstract

The Australian Pastures Genebank (APG), Australia's first national genebank housing pasture and forage genetic resources was officially launched in December in 2014 at the South Australian Research and Development Institute's Waite Campus in Adelaide. Over the last two years, pasture and forage genetic resources from major temperate pasture and tropical forage genebanks around the country have been transferred to the national collection. More than 83,400 accessions, including approximately 75,000 unique accessions (found in no other genebanks) are now under one roof. An assessment of the collection's health is underway along with the prioritisation of species and accessions for regeneration at four regeneration sites around Australia. A backup of accessions will be deposited into the Global Seed Vault in Svalbard, Norway in February 2018. To date 3,489 accessions have been provided to 80 researchers representing 50 institutions in 25 countries with 70% of materials supporting Australian research and development.

Keywords

Pastures, forages, genebank, conservation, Treaty, seed.

Introduction

Improved germplasm of pasture and forage species are the foundation of Australian grazing and mixed farming industries. Access to pasture and forage genetic resources is critical to national and global food security. It will underpin Australia's ability to remain competitive and continue to adapt grazing and mixed farming systems to meet the challenges of climate change and increasing variability, new plant diseases, and maintain catchment and other environmental grasslands. Australia has been a major beneficiary from the importation and utilisation of genetic resources in pasture and forages. Australia is custodian of one of the world's largest and globally significant collection of pasture and forage genetic resources. Much of this material is unique and was held in State-based collections and represents an invaluable resource for plant research and improvement in Australia and internationally. These collections were built up progressively over the past 70 years and were at risk due to a reduction in funding from host agencies and industry groups and were becoming increasingly inaccessible to potential clients. Australia required a national approach to the conservation of genetic resources of pastures and forages to benefit industry, the environment, and to support the International Treaty on Plant Genetic Resources for Food and Agriculture (Treaty) (FAO 2017a).

In July 2014 an agreement was reached between the South Australian Research and Development Institute (SARDI) and five research and development corporations (RDCs); Meat and Livestock Australia, Australia Wool Innovation, Grains Research and Development Corporation, Dairy Australia, and Rural Industries Research and Development Corporation, and all State governments, for the establishment and operation of the Australian Pastures Genebank (APG). Governance of the APG is undertaken through a Steering Committee chaired by the Australian Department of Agriculture and Water Resources with representation from all five RDCs and State Departments. With the support of every state government's agricultural department and the Commonwealth Scientific and Industrial Research Organisation (CSIRO), pasture and forage seed from major collections around Australia is being transferred to the APG located at SARDI's Waite Campus in Adelaide. Mandated material to be included in the APG are pasture and forage species that have actual, or potential, value to Australian agriculture, either for livestock, in crop rotation or natural

resource management. The APG's responsibility is to 'acquire, conserve, document, safeguard and distribute plant genetic material in the form of seed and associated data of mandated pasture and forage species for use nationally and internationally as the basis for enhanced agricultural productivity and environmental preservation now and in the future'. The APG will operate to world's best practice in accordance with FAO Genebank Standards for Plant Genetic Resources for Food and Agriculture (FAO 2014) for the benefit of Australian Industry and national and global food security.

Methods

Acquisition

A scoping study was undertaken to understand the nature, extent and health of germplasm in major national collections with over 101,000 accessions representing over 280,000 packets of inventory identified for transfer to the APG. The acquisition activity has focussed on supporting the transition and receipt of seed and data from 12 major collections (Table 1) into the APG. To facilitate the transition process in consideration of the significant differences between genebanks in both inventory, storage conditions, capacity and information systems, a Deposit Agreement and a Deposit Template were developed to establish the procedures for a "point to point" transfer of seed and data and importantly to manage risk, standardise procedures and formally recognise the materials to be transferred into the APG. Seed was catalogued at each of the 12 genebanks prior to shipment to the APG ensuring that the uniqueness of a packet could be identified. Data documented included accession, line number(s), taxa, cold storage conditions, generation, year harvested, weight and viability if known. Seed was packed into polystyrene boxes for shipment, which took place either during winter or under refrigerated transport to reduce the risk of seed degrading. Importantly all available passport and characterisation data associated with the seed was also provided.

It was recognised that there was a significant amount of historical sharing of accessions between collections, and on receipt of the seed the APG systematically rationalised each collection through the identification of "potential" biological duplicates between and within collections though cross-referencing passport and inventory data. Of the 101,220 accessions received to date, 83,482 unique accessions have been identified including their most original inventory and best quality seed. All inventories are assigned a new APG accession identifier, dried, weighed, vacuum-sealed and placed into appropriate cold storage. In order to fulfil the simultaneous demands of conservation and utilisation the APG has three types of storage facilities; cold rooms maintained at -20°C for long-term conservation (Base collection) a +2°C for medium term storage (Active collection) and short-term storage facilities at +12°C and 30% relative humidity (Residual collection). On completion of cataloguing a collection, a report is provided to the depositing institute on the new APG identity for all inventory deposited.

Table 1. Summary of seed deposits to the Australian Pastures Genebank from collections around Australia.

Institution	Collection	Major focus	# Accessions	% Collection acquired to date	% Inventory catalogued to date	% Inventory Conserved to date
CSIRO	Black Mountain	Tropical forages	11,827	100	100	95
DAF Queensland	AusTRCF	Tropical forages	12,617	100	100	100
DAF Queensland	Walkamin	Commercial Tropical forages	120	0	0	0
DAF Queensland	Toowoomba	Naturalised Medic	432	100	100	100
DAFWA	ATGRC	Trifolium and temperate legumes	19,009	95	100	10
DETJTR Victoria	Hamilton -ARD	Temperate grasses & legumes	2,082	100	100	100
DETJTR Victoria	Hamilton -BRD	Temperate grasses & legumes	2,436	100	100	100
DPIPWE Tasmania	Mt Pleasant	Temperate legumes and grasses	5,569	100	100	95
NSW DPI	Glenn Innes	White clover	730	100	100	100
NSW DPI	Grafton	Subtropical forages	1,364	100	100	100
NSW DPI	Wagga Wagga	Lotus	527	100	20	0
SARDI	AMGRC	Medicago and temperate legumes	44,507	100	100	100
TOTAL			101,220			

Conservation - Viability Testing

In order to conserve and maintain the material, base line germination tests have been undertaken on seed from collections that have not been tested in the last 20 years. This activity is undertaken in partnership with Seed Services Australia to International Seed Testing Association Standards. The quality and quantity of the seed forms part of the decision making process of which seed to prioritise for regeneration in a given year.

Conservation - Regeneration

The formation of the APG Technical Advisory Committee (TAC) in 2015 saw research leaders and technical staff from each state of Australia come together to share knowledge, experiences, challenges and solutions. Three TAC meetings have now been held; Waite Campus (SA) in February 2015, Walkamin Research Station (QLD) in May 2016, and Mt. Pleasant Laboratories (TAS) in November 2016. Key guiding principles of the regeneration of programs are that, priority should be placed on (1) plants of high potential application to Australian primary industries or of significant environmental or conservation value, and (2) the development of the capacity to supply suitable numbers of high-quality seeds of high genetic integrity to develop plants for these purposes. There are always more accessions in need of regeneration than can be managed in a given year and to guide the prioritisation process TAC representatives put forward suggestions for the species they think should be prioritised for regeneration and why. As part of this process, representatives engage with pasture industry stakeholders to get their views and they are conveyed to the committee. This information is then combined with quantity and quality of seed to choose individual accessions for regeneration. The number of accessions and the choice of species grown in any one year will also reflect the practicalities of undertaking regeneration efficiently and the need to minimise the opportunity for accessions (and occasionally species) to cross-fertilise, either through isolation distances, physical barriers or pollination cages. Regeneration activities have commenced to rejuvenate the collection at four sites around Australia that best match an accession's climatic and edaphic requirements; North Queensland, Tasmania, South Australia and Western Australia. As part of the regeneration activities, each accession, which has not been previously characterised, has basic trait data collected. The traits collected are dependent on the species being grown. Species are aligned to a defined Pasture Group with specific protocols and principal and secondary 'check' cultivars used for comparison. Seed and trait information is then forwarded to the APG to be incorporated into the collection for the purposes of research, development or education upon request. While collecting the characterisation data is important, the number one priority is ensuring the integrity of the accession for multiplication.

Information management, distribution and safety backup

Quality passport, inventory and descriptor information associated with the collection is essential for effective management and utilisation of the collection. The APG has adopted GRIN-Global (GG) as its genebank management system. GG centralises genebank data storage, supports curators to store and manage plant genetic resources internally, and delivers information associated with the germplasm to the research community via a public website.

Seed will be distributed for 'scientific research, plant breeding, genetic resource conservation and for education purposes' under a Standard Materials Transfer Agreement (SMTA) (FAO 2017b) in accordance with the provisions of Treaty's Multilateral System of Access and Benefit Sharing as outlined in APG seed distribution policy (Hughes 2015). All accessions within the APG should be safety-duplicated off-site as insurance to secure the collection in the event of a natural or man-made disaster. To help secure this extremely valuable national resource the APG is currently preparing seed of over 25,000 samples including all historical, current and pending commercial varieties of importance to Australian agriculture, for offsite safety backup into the Global Seed Vault in Svalbard in February 2018.

Results and Discussion

Over the last 2 years, the APG has received over 270,000 packets of seed representing 101,220 accessions from 12 collections. Accessions have been consolidated to 83,482 accessions unique to the national collection. Within the collection, over 75,000 accessions were collected by Australian scientists from the wild over the last 70 years and it is anticipated that they will be unique to the world collection. Over 12,800 accessions have been viability-tested and approximately 60% of the collection is considered viable (greater than 85% germination rate). Seed multiplication and trait capture protocols have been developed and two full seasons of regeneration activities have now been undertaken at each of the four sites. The regeneration target for the 2017-18 growing season is 880 accessions. Priority has been placed on subterranean clover, lucerne

and its wild relatives, cocksfoot, brome, and topical forages suited to beef production, particularly legumes within the seasonally dry tropics. Future priorities are likely to remain similar with the inclusion of phalaris from Mediterranean environments. The collection has been well utilised with 3,448 accessions provided to 80 researchers representing 50 institutions in 25 countries with 70% of materials supporting Australian research and development. It is anticipated that utilisation will further increase with the launch of the public website and with the future availability of associated trait data.

Conclusion

The establishment of the APG has been the result of over 30 years of reviews and recommendations. The fruition of the APG must be attributed to the support of champions. Many passionate individuals recognised and advocated the role of plant germplasm in underpinning our agricultural systems, providing both an immediate and a longer term strategic resource base for plant improvement (Auricht et al., 2009). The establishment of the APG has provided an opportunity for Australia to meet its obligations under the Treaty, and support the conservation and management of Australia's pastures and forage genetic resources to the FAO Genebank Standards for Plant Genetic Resources for Food and Agriculture for the benefit of Australian Industry and national and global food security. The APG is progressing well and producers can be assured that the diversity required to support their industries is being well looked after. The APG is currently undergoing an external review. The outcomes of the review will ideally identify areas for improvement and strengthen the case for ongoing investment in the APG to secure operations beyond this establishment phase and provide strategies for the development of a 100-year plan. The TAC is always seeking feedback from stakeholders with regards to species for regeneration prioritisation. Contact information is provided in the author summary at the beginning of the paper.

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