An update of the Florabank Guidelines

National guidelines for best practice native seed collection and use

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PRESENTATION OVERVIEW

• When do we need seeds? What do we need to know about seeds? Why do we need guidelines?
• Our revision process for the second edition
• What’s in the guidelines – 15 modules
• Complementary publications

Key message: Everyone associated with native seeds, from policy right through to planting, should read the Guidelines
WHEN DO WE NEED SEED FOR RESTORATION?


Figure courtesy of Craig Miskell, CAM Graphics, www.camgraphics.com.au
WHEN DO WE NEED SEED FOR RESTORATION?

<table>
<thead>
<tr>
<th>In Situ Conservation</th>
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<td><strong>Restoration</strong></td>
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Figure courtesy of Craig Miskell, CAM Graphics, [www.camgraphics.com.au](http://www.camgraphics.com.au)
WHEN DO WE NEED SEED FOR RESTORATION?

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WHEN DO WE NEED SEED FOR RESTORATION?

Ex Situ Conservation
- Cryostorage
- Seed Banking
- Micropropagation
- Nursery Propagation
- Living Collections
- Germination

In Situ Conservation

Source of propagules

Exchange of information

Restoration
- Translocation
  - Seed/plant collection
  - Reinstating fire regimes
  - Removal of feral animals and invasive plants
- Assisted Regeneration
  - Seeding
- Natural Regeneration
  - Managing pathogens
  - Ceasing mowing/logging
  - Maintaining ecological processes

Maintain viable habitat
- Managing threats (e.g., clearing)
- Protected area status
- Maintaining ecological processes

Figure courtesy of Craig Miskell, CAM Graphics, www.camgraphics.com.au

SO MANY QUESTIONS!

Which species?

Where from?

How much?

Which licence?

What’s the quality?

How to store?

Pre-treatments?

How to sow?

Best practice guidelines can help answer these questions

Opportunity:
- for knowledge sharing within parts of the sector
- for knowledge to reach policy and end users
- to collaborate across parts of the sector
- to lift standards

C. Miskell
FLORABANK GUIDELINES

- First edition
  - 1999/200
  - 10 guidelines

- Second edition
  - Part of the ANPC Healthy Seeds Project
    - Consortium of ANPC and 7 organisations
    - Funded by the NSW Government through its Environmental Trust
  - Expanded to 15 modules
  - Released August 2021
  - Free download
    www.florabank.org.au/guidelines
WHO SHOULD READ THE GUIDELINES & WHY

- All restorative activities
  - restoration, revegetation, rehabilitation, regeneration, translocation, tree planting, enhancing remnant vegetation
- Seed supply chain & decision making roles
  - policy, funding, collectors, research, practitioners, end-users, botanic gardens, nurseries, landcare
- Learn about other parts of the sector
- Please distribute to your collaborators, seed collectors/suppliers, end users
- Help improve ‘seed literacy’ across the sector
UPDATE PROCESS

- Formed a reference group
- Listed modules – some merged, some split, some new
- Invited >85 authors, >45 said yes
- Drafted each module
- Invited >120 reviewers, >50 reviewed at least 1 module
- Addressed reviews
- Proof reading
- Production
**What’s New**

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**Weed Mat Beds**

Weed mats, typically woven or spunbond, are used as a surface cover for growing beds into which plants (or seeds) are simply planted. The first step is preparation of the soil (Figure 17). Before sowing the seeds, the soil is prepared, either by careful hoeing or a small shovel (Figure 17). This means that existing soil (weed) seeds are not able to germinate (see Figure 17). Weed mats have been used for many years by farmers, helping to reduce the growth of weeds in covered areas. However, they can also still emerge from areas where they are exposed, such as planting holes or along paths in making and in some instances, through the soil. Therefore, the effectiveness of weed mats is often offset by the quality of the product, the effectiveness of its installation, and the competitive abilities of the native crops (or weeds).

A further benefit of weed mats is that they can still be harvested off the surface if it is not too wet, allowing to be protected or inspected by the preceding conditions.

Weed mats can also be configured in various ways from flat to raised beds, from a small to very large areas. Vertical barriers made from motoring or polymer bails can be used to separate different crops from one another, creating zones for cross-pollination and reducing weed loads. In some cases, weed mat is unnecessary, and in areas where it is, water generally enters the soil via the planting hole. Seed or soil culture weed mat is the most versatile, and these can reach very high temperatures. For some species, high temperatures may impact on growth or performance of plants, particularly those that are sensitive to high temperatures or are not used in a wide range of conditions. These new approaches can make growing in such areas during high summer temperatures difficult and unviable for people.

Because weed mats degrade over time (i.e., so they prevent it from being eaten by fresh traffic or viral those surface weeds are not to be removed periodically), site growers should plan and budget for the cost of chemical (e.g., pesticides), purchasing new material, re-fixing, and then replacing beds on a 4 to 6-year cycle.

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**Box 2. Fruit types (continued)**

See Figure 3 for images of different fruit types.

Fruits can also be classified as simple (formed from one ovary x 1 nut), aggregate (formed from the portions of ovaries from a single flower x 1 style), and multiple (formed from the petals of a cluster of flowers), or a combination, e.g., symmetrical. Fruits may contain one or more seeds. This is important to note when assessing seed quality, especially for indigenous fruit, as even after cleaning and processing, the fruit may contain multiple seeds (e.g., macadamia and Solanum philadelphicum).

For further information on fruit types see Skip (1991) and Paintbrush (2023).

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**Seed Quality Testing**

Seed quality testing involves assessing the quality, seed fill, and seed viability of a seed lot.

Seed quality testing determines the proportion of sound to non-sound seeds in the seed lot.

Seed fill testing determines whether or not the seed contains an embryo.

Seed fill testing determines whether or not the seed contains an embryo.

Seed viability testing determines whether or not the seed is alive.

Reporting seed quality information is essential for calculating seed yield and ensuring that only seeds containing the necessary attributes are used for propagation and restoration.

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**Figure 3. Examples of different fruit types**

[Image showing examples of different fruit types, with labels for each type.]
1. Introduction

• Regeneration vs reintroduction
  • When additional seeds are needed for restoration, and when they are not

• The Australian native seed industry
  • Key issues

• Content & structure
  • 15 Modules
  • Follows supply chain
  • Supporting modules

• Species selection for seed-based restoration
  • see International principles and standards for the practice of ecological restoration 2nd ed. (Gann et al. 2019)
2. Working with Indigenous Australians: Seed Knowledge, Partnerships, Intellectual Property and Permissions

Partnerships should be flexible but include agreed roles and responsibilities of each partner and establishing a shared purpose with clear goals and anticipated outcomes. Partnerships can be mutually beneficial.

Permission must be obtained to access Indigenous managed lands and collect seeds.

Engagement with Indigenous Australians to obtain access to Indigenous Knowledge and to undertake research with them must adhere to the principle of Free, Prior and Informed Consent as endorsed by the United Nations Declaration on the Rights of Indigenous Peoples.

3. Approvals, Principles and Standards for Seed Collection

Legislation
- Licencing
- Seed licencing checklist
- Record keeping for licencing

Guiding Principles

Standards and accreditation
- Code of practice
- RIAWA accreditation
4. Record Keeping

• Why keep records
  • Basis to learn and develop best practice

• Record keeping concepts
  • The easier data is to capture, the more likely it will be recorded

• Design of electronic record keeping

• What to record

• Technology
  • Smart phones, apps, GPs, spreadsheet, databases, GIS, QR codes, barcodes

5. Seed Sourcing

• Where to collect the seeds?
  • Location of a seed collection
  • Collect close to site (local provenance) or more distant (non-local provenance)

• What is a provenance?
  • Delivers short- and long-term success in a changing environment
  • Local: local adaptation, limits outbreeding depression and maladaptation
  • Alternative / mixed strategies address concerns associated with habitat fragmentation, maintaining or maximising genetic diversity, and climate change
  • Decision tree for selecting a strategy

• Which provenancing strategy?
  • If records are not kept on source location, or collections from different locations are not kept separate – decisions on where to source seeds can be difficult!

• Key message: Capturing greater genetic diversity in seed collections by sourcing seed from as many well-spaced plants across a population as is practicable
6. Seed Collection

• Planning
  • Species list or reference site?
  • Desktop survey using FloraBase, Atlas of Living Australia, Nature Map, Australian Seed Bank online
  • Reconnaissance trips to check flowering, maturation and collect herbarium specimens
  • Make sure the collectors can correctly identify the target species

• Safety
  • Risk assessment, check in procedure, first aid kit, PPE

• When
  • At natural dispersal – change in colour, dry pods, fall from plant easily, fruit split
  • Canopy stored species – check fruit colour or hardness

• How much
  • Fewer seeds from lots of plants rather than lots of seeds from fewer plants
  • Only collect ~20% of available seed
  • Communicate with other collectors / the landholder to prevent overcollection

• Methods & Equipment

7. Seed Production

Do I need a Seed Production Area?

- You do not need seed quickly
- You can’t collect or purchase sufficient seed
- You need large quantities of seed

Decisions

- Where to source founding material & avoiding selection pressure
- Abiotic environment (sun, shade, water)
- Biotic interactions (pollinators)
- Weed management
- Protection from wind, herbivores, fire
- Growing systems: managed populations, containers, weed mat beds, trellis
- Maintenance and harvest

Photo: Paul Gibson-Roy, Jim Begley
8. Seed Processing:
Post-harvest Drying, Seed Extraction and Cleaning

Post-harvest drying
- Place in appropriate post-harvest drying conditions

Separating
- Separate seed material from non-seed material e.g. leaves and sticks

Extracting
- Fleshy fruits: de-pulp to extract seeds
- Dehiscent fruits: wait for fruits to open and release seeds
- Dehiscent fruits: extract seeds if necessary
- Dry, indehiscent fruits: no extraction required

Cleaning
- Clean seeds to remove chaff, insects, empty fruits & empty seeds

Pre-storage drying
- Place in appropriate pre-storage drying conditions

9. Seed Drying and Storage

Ensure that seeds are fully mature at the time of collection.

Avoid exposing freshly collected seeds to high temperatures and high relative humidity.

Dry and clean seeds as soon as possible after collection.

Store seeds under dry conditions at a constant, cool temperature.

Storage length and purpose:
- Short (≤ 5 years): Restoration/Revegetation
- Medium (5-10 years): Restoration/Plant breeding
- Long term (>10 years): Conservation

Size of collection:
- Large or small scale

Drying conditions:
- Air-conditioned room (23°C); Ambient conditions (indoors or outdoors) if relative humidity <50%
- Relative humidity 15-20%; Temperature 15-20°C

Storage conditions:
- Refrigerator or cool room (5-10°C); Relative humidity 15-20%
- Air-conditioned room (23°C); or refrigerator or cool room (5-15°C); Ambient relative humidity <50%
- As per short-term storage for large collections and if RH of room 15-20%. Press sealed or heat-sealed plastic bags for small collections if RH of room 15-20%. Air-tight, sealed laminated foil bags or glass jars for small collections and if RH not controlled (e.g. a refrigerator).

Storage containers:
- Calico bags, Woven polypropylene (WPP) bags, Wool bales.
- Opaque plastic drums with a sealing ring.
- As per short-term storage.
- Air-tight, sealed laminated foil bags. Glass jars.
10. Seed Quality Testing

• If seed is not tested:
  • Non-viable seeds could be used
  • Purchasers could pay too much
  • Sowing rates can’t be calculated

• Type of test depends on:
  • Species, storage history, end use

Figure courtesy of Craig Miskell, CAM Graphics, www.camgraphics.com.au

11. Seed Germination and Dormancy

Germination testing

• Understand requirements for seed germination & the germination potential of the seed lot, can improve the success
• Info on designing tests, reporting and interpreting results
• Why don’t seeds germinate? Dead, not filled, dormant, or the test conditions were not appropriate.

Dormancy classification

• What it is, why we need to classify it
• Dormancy class and seed’s natural environment provide clues for conditions that overcome dormancy (pre-treatments)
• Smoke, scarification, stratification, after-ripening and chemicals such as Gibberellic Acid
12. Seed Enhancement Technologies

- Post-harvest treatments to improve:
  - seed delivery, germination, plant performance, and tolerance to environmental stress

- *Physically alter* the shape of seeds
  - *Manipulate the physiology* of the seeds

- *Additives* can be incorporated that target specific barriers,
  - e.g. soil surfactants or germination regulators

- Seed coating, priming, extruded pelleting, acid digestion and flash flaming

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13. Nursery Propagation of Tubestock and Restoration Planting

• Tubestock vs direct seeding
• Growing conditions, containers & media
• Non-seed propagation method
• Hygiene & infrastructure
• Propagation timing
• Site prep, planting, maintenance

14. Direct Seeding

• Approaches
  • Niche, broadcast

• Planning checklist

• Site assessment & preparation

• Machinery

• Seeding rate calculations
  • Based on parameters: seed lot characteristics, estimated seedling survival and plant density goals

• Maintenance, monitoring & reporting
  • Keep track of what was done
  • Report on outcomes
  • Enable adaptive management, and indicate when intervention (e.g. additional seeding) is required
  • Learn for the future
15. Buying and Selling Seeds

- Top tips for seed purchasers & calculating value for money using testing data
- Options for purchasing:
  - buying seeds that the seller has in stock
  - order seeds to be collected from specific sites and species or at particular times
- Plan seed requirements (species and quantities) well in advance
- Decide the seed source location
  - If seeds from that location are not in stock, they may take time to be sourced
- Seeds should be sold with quality information, so the purchaser can:
  - make informed decisions
  - knows what they’ve bought
  - adjust their seeding rates accordingly.
- Ask for information on seed quality
  - Don’t just purchase the cheapest seed lot, calculate the value for money
Free download: www.florabank.org.au/guidelines
COMPLEMENTARY PUBLICATIONS

Plant Germplasm Conservation in Australia: strategies and guidelines for developing, managing and utilising ex situ collections

Guidelines for Translocation of Threatened Species in Australia

www.anpc.asn.au

www.greeningaustralia.org.au/project-phoenix-resources/
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