Seed quality: what you need to know, to know what you get

This document synthesises standard practices and quality measures in the native seed supply services at BiobankSeed. The standards aim to (1) strike a balance between reasonable quality expectations for the seed user and what is practically achievable and economically viable for seed management, and (2) provide confidence in the purchase of native seed while setting appropriate methodology for seed testing.

Who do seed quality standards apply to?

Seed suppliers/producers, merchants, native seed banks, restoration ecologist and regulators from government or industry-based, as well as end-users of native seed. However, standards should be accessible for anyone involved from the collection, production and use of native seeds at all levels, from indigenous community programs to large-scale commercial native seed enterprises.

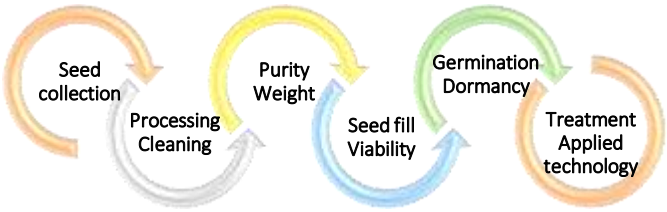
Native seed market overview

Seed is the foundation of most restoration programs worldwide. The growing demand for native seeds whether for mining, forestry, or ecosystem restoration, has resulted in major pressure in the sourcing, supply, and sale of native seeds. Yet, native seed is often a limited resource, mostly sourced from wild stands and there are no controls on the supply to guarantee a minimum quality standard – similarly to commercial crop seed– so native seed is mostly traded with little consideration of quality and viability.

In contrast to crop and horticultural varieties, native wild species usually vary in morphology, physiology, dormancy state, seed mass, purity, quality, desiccation tolerance and other factors out of the control of the seed supplier.

Although seed suppliers and users should aim for the highest and best seed, high variability in seed quality among suppliers occur, with poor-quality seed batches and even dead seed entering the system. Such scenarios restrict the effectiveness of restoration programs and meeting targets of the enterprises or projects.

Applying standards on seed quality maintains the confidence of purchasers and restoration practitioners in the efficacy of native seeds. Meeting minimum standard quality requires seed testing management protocols adapted and customized on a species-by-species and batch basis; and results communicated to the seed user. The process for meeting these quality standards at Biobank seeds are:



Ethical collection and handling of wild harvested seed is critical to retain as much viable seed as possible and make every seed count, as the strong demands of seed for restoration result in considerable pressure on the few precious remaining natural ecosystems. Correct management of seed after harvest is also essential to ensure that seed quality is maintained to a high standard.

BioBankSeed

Seed collection from the wild should represent the genetic diversity of the donor population without harming its reproductive capability. To increase the prospects of sourcing high genetic diversity, information on seed collection should track the seed batch through the supply chain to the end-user. Seed collections from the wild, or from managed seed production areas (SPAs), should always indicate collection details such as species name, origin, date and time of collection, collector, or production of the seed batches; as well as all other aspects such as seed quality and seed dormancy state when applicable.

All the relevant records should be kept and indicated in labels. **Labelling of seed batches is the main means for communicating seed information** between seed supplier/tester and end-user.

Each seed batch needs to be processed or cleaned to the highest practicable degree to ensure high seed purity. This involves removing any non-seed material (leaves, flowers, branches, soil, rocks, empty/predated seeds) or seeds of different species.

Cleaning of native grass seed collected from the wild using a tailored trommel screen

Testing seed quality:

- Determines the value of the seed batch as a product.
- Informs the seed user of expected seed performance outcomes.
- Estimates the actual amount of germinable/viable seed contained in a seed batch.
- Provides feedback to the seed supplier (collector–producers) regarding collection and cultivation methods and strategies.

Seed quality testing comprises the essential attributes of a seed batch that can be given a numeric value, such as purity, viability, germinability, and, if applicable, dormancy state.

Lack of test results usually leads the end-user to assume that all the seeds in the batch are viable and readily germinable and consequently overstate the seed quality and expected outcomes.

To guarantee the impartiality of seed testing results, seed quality tests should be performed by independent seed testing entities or by seed suppliers with capabilities to follow the pertinent standards and guidelines.

Sampling is relevant to each seed batch after collection/harvest and prior to field deployment if the seed has been stored for extended periods. Seed testing for purity, viability, and germinability analysis requires appropriate subsamples of the primary seed sample taken from each seed batch.

Resampling and retesting are often required when uncertain about seed storage conditions and handling or due to potential loss of seed viability through time.

A purity test indicates the percentage of pure seed, inert material, and contaminating (nontarget species) seeds in the seed batch expressed as a weight percentage.

The results of the purity test provide valuable feedback on the collection and farming methods along with indications for improvement of the seed processing and cleaning. Although useful, the results of the purity test alone do not inform on the viability/germinability of the pure seed and should not be used as a predictor of seed germination outcomes.

Pure Eucalypt seed (left) and the inert matter (right).

Seed fill test assess if seed units are filled or empty, usually by applying pressure to the seed unit using forceps, squeezing, diaphanoscope (that provides sub-stage illumination) or X-rays. Fill seed fraction is weighed and presented as a percentage of the total.

Seed Weight Determination consists in weighting a fixed quantity of pure seed units (usually a thousand). Seed weight is relevant for instance when composing seed mixes and calibrating seeding rates.

Viability test determines the percentage of pure live (viable) seeds that could potentially germinate.

Common methods for assessing viability are:

- **Cut Test** is a simple method to estimate viability by bisecting the seed unit with a sharp instrument and examining the internal contents of the seed visually. Viable seeds have white and turgid endosperm (no observable shrinkage) with an embryo with no discoloration or shrinkage. If seed internals are missing, shrivelled, diseased, infected, detached, or abnormal, the seed could be considered nonviable. This test requires good knowledge of seed morphology and experience. A limitation is that cutting test can overestimate viability for seeds that appear healthy but have lost the ability to germinate (i.e. dead seed).

Cut test in seed of Capparis sp

- **X-Ray evaluation** determines which seed units appear intact and most likely viable. This nonintrusive procedure retains viable seed after imaging that can be combined with other viability and germinability tests to improve accuracy and calibration. This method may potentially overestimate the viability of the seed batch and is not available at Biobank Seed.
- **The tetrazolium test** considered the most complete viability tests, entails the use of 2,3,5-triphenyl tetrazolium chloride (TZ). This compound reacts with the hydrogen ions released by living cells during respiration, then visible as a red-pink stain in the parts of the seed where the dehydrogenase is active. Exposed tissues of the seed (by cutting with a sharp instrument) are immersed in a 1% aqueous TZ solution at 30°C for 2 to 24 hours depending on the species. This test is time consuming, requires skilled operators to perform and understand seed morphology to recognise the vital parts of the seed that should be coloured (e.g. radicle tip, shoot apex), and to what intensity (red, pink, light pink) to deem seeds viable.

Kangaroo grass seeds after TTZ stain

- **Germinability tests** can be used as a surrogate test for viability for seeds with no or low dormancy; however, it should be combined with a viability test to address if non-germinated seeds are in fact viable, but dormant, or indeed nonviable. Germination is recorded when a visible radicle emerges to a length of 1–2 mm depending upon seed size; however, this does not provide information about the health/vigor of the seedling in cases where abnormal seedlings occur.

Germinability test estimates the average percentage of pure seed that are readily germinable. Germination is the expression of a pure viable seed to a germinant and ultimately a plant. Germinability is a significant step in the seed testing protocol as it defines the outcome of a sowing or restoration program and expected plant numbers.

Germination tests in dormant seeds can have limitations, if dormancy breaking treatments are not fully understood, germination may significantly underestimate the amount of germinable and viable seed. Generally, the difference between the viable seed and germinable seed represents the dormant seed. **Dormant seed is the seed that are viable, but not able to germinate** due to dormancy.

Dormancy is the mechanism whereby seed persist over time and space. **Seed dormancy cues germination to only occur when environmental conditions are favorable for germination and seedling establishment**.

Unlike crops where dormancy has been eliminated or reduced after millennia of human selection, **seed of wild species can possess simple to complex dormancy systems**. Dormancy represents a key constraint in the use of seed in restoration programs. Species are broadly divided into species that are nondormant or have one of five possible dormancy classes

The dormancy state can be identified by inspecting the seed and testing. Once detected, the type of dormancy could be revealed (based on literature or expert opinion) and where possible a dormancy breaking method prescribed. Some species have *deep intractable dormancy*. Such germination blocks are not easily resolved and these species respond to singular germination cues (i.es smoke application following a period of aging in soil that can be months to years or treating with a pulse of dry heat).

Germination tests of dormant seeds are conducted when environmental constraints on germination are fully understood and after dormancy release treatments are appropriately applied to the seed (i.e. after-ripened, stratified, scarified, boiling treatment etc).

Seed enhancement technologies are all treatments applied to the seed that break dormancy and/or increase germination (after-ripening, stratification, scarification, chemical agents, and priming) and promote establishment success (including seed coating and emerging technologies i.e. extruded composites with embedded seed or seed agglomerations).

Coating seed with polymers: a seed technology applied to improve seed shape and flowability.

When seed enhancements are undertaken, the treatment applied (dormancy release, germination stimulation, priming, coating) should also be specified, and the concentration of the compounds reported.