2 Mobilizing quality restoration seeds

The origin and quality of the propagation material used (seeds, cuttings or seedlings) are key factors that require close attention for a successful outcome of degraded land restoration. Indeed, failure to mobilize and use quality seeds can jeopardize the entire restoration project or program. Mobilizing large quantities of quality seeds for restoration planting of thousands hectares of land can be difficult. While forest seed handling should be done by specialized seed centres, cascade training of community technicians on wild seed collection is recommended, as they live next to the natural stands. This process is an investment for a longer term but a good exit strategy when external funds phase out.

Determining the right quantity of seeds needed and planning seed collection

Seed quantity is a key variable of any plantation initiative that should not be underestimated and must be determined as soon as possible to allow for the timely mobilization of quality seeds. The quantity of the seeds is determined by the weight (and not by number of seeds) as this variable is easier to use whether the seeds be collected or purchased. An estimated amount is determined for each species once both the surface area to restore, as well as the planting and seeding density are known. In addition, it is important to take into account the following variables so as to determine the weight of the seeds required:

- 1 000 seed weight (i.e. the weight of 1 000 seeds of a given species);
- germination response (i.e. the percentage of seeds of a given seedlot likely to germinate over a given period).

Examples of these two variables can be found in the table in the annex, or through an online database such as the Seed Information Database (SID) of Royal Botanic Gardens, in Kew (UK). Table. 1 provides an example of the calculation of the quantity of seeds needed based on a mix of three tree species (acacia, baobab and balanites). In practice, however, trees should be combined with herbaceous seeds of 3-4 species and, due to the fact that grasses generally produce smaller seeds (thousands in 1 kg), it is recommended to plant about 5 kg per hectare.

Furthermore, appropriate training of the seed collectors is important and requires careful planning as seed collection requires specific skills and practice. Botanical skills, knowledge on seed physiology and tree climbing skills are some of the qualifications required. In addition, due to the fact that seeds are a forest resource, the legal aspects regarding seed collection rights (national regulations, permits, local rights, etc.) should be taken into consideration when planning seed collection, especially in protected areas and private properties.

TABLE 1. Tree seed quantity calculation for large-scale restoration (seedlings plantation)

EXAMPLE: What is the quantity of seeds needed to restore a 100 ha village woodlot (planting density of 1 000 woody seedlings per hectare) using the following species: 70% of *Acacia senegal*, 20% of *Balanites aegyptiaca* and 10% of *Adansonia digitata*? What is the minimum quantity of seeds to collect on wild stands of *A. senegal* (population of 75 trees), *B. aegyptiaca* (population of 210 trees) and *A. digitata* (population of 90 trees)?

Determine the germination response and 1 000 seed weight of each species

Species	Germination response	1 000 seed weight (g)	Seed weight (g)
Acacia senegal	100%	46	0.046
Balanites aegyptiaca	100%	3 000	3.000
Adansonia digitata	80%	399	0.399

Calculate the weight of seeds to mobilize

Species	Number of seedlings per hectare	Total number of seedlings (100 ha)	Weight of seeds needed (g)
Acacia senegal	0.70 x 1 000 = 700	70 000	70 000 x 0.046 = 3 220
Balanites aegyptiaca	0.20 x 1 000 = 200	20 000	20 000 x 3.000 = 60 000
Adansonia digitata	0.10 x 1 000 = 100	10 000	(10 000 x 0.399)/0.80 = 4 987

Determine the minimum number of trees where the seeds will be collected, and the quantity of seeds to collect per tree

Species	Minimum number of trees for seed collection (1/3)	Minimum weight of seeds to collect per tree (g)
Acacia senegal	25	3 220 / 25 = 129
Balanites aegyptiaca	70	60 000/70 = 857
Adansonia digitata	30	4 987/30 = 166

Collecting quality seeds for restoration

The propagation material should match the current and expected climate and environmental conditions in the desired restoration site as closely as possible (Bozzano *et al.*, 2014), which is why local (native) species are preferred to exotic species. Generally, seeds are collected from the wild plant populations near the restoration site in order to minimize the need for transportation and in addition, because the site conditions are similar in terms of climate, altitude and soil type.

Genetic diversity is an important aspect of climate and environmental change, as it can widen the range of opportunity and provide solutions that will increase the resilience of the restored area. Genetically eroded or fragmented stands should be avoided, therefore, maintaining the appropriate distance (i.e. 50-100m between trees or grass patches) where seeds are collected is strongly advisable. The constraints associated with low genetic diversity include a higher risk of diseases and a reduced adaptation capacity to environmental change, such as drought.

In a natural forest, seed collection (table 2) is recommended in different areas and from as many trees as possible, that is at least 25-30 trees. Although collection seeds from a smaller number of trees or from more accessible trees (e.g. near a road) could seem more tempting, collecting seeds from a larger plant population ensures much better seed quality with a broader genetic base.

Whether in a natural forest, grassland or in a cultivated area, seed collection is carried out on plants growing in the same environment as the target site (including soil, altitude, and rainfall). Plus trees are chosen according to the desired characteristics (tree height, straight stem, foliage density, etc.) irrespective of site conditions. For example, a tree that is taller than others may be so because it is growing in better site conditions, and not necessarily because of its genetic predisposition. The best period to collect seeds is when trees reach a peak in seed production and most of the fruit has reached maturity (i.e. min 60 per cent mature fruit). Seed collection should be carried out close to the time of their natural dispersion period in order to maximize quality.

It is important to consistently keep track of the seed provenances for performance monitoring and information input in the country forestry seed center database, provided one exists. Record-keeping is essential to evaluate the quality of the material used, as well as to provide information for future decisions on where to collect seeds. Adoption of the OECD[1] forest scheme is recommended to ensure systematic record-keeping.

[1] The OECD Scheme for the Certification of Forest Reproductive Material - http://www.oecd.org/agriculture/forest

TABLE 2. Seed collection in practice

TREE SEEDS	GRASS SEEDS
→ Collect seeds from a minimum of 25-30 trees, with a distance of 50-100 mm and take seeds from different branches of the tree. → Only undamaged normal seeds are to be collected. Avoid amassing seeds already dropped or found on the ground or old seeds. → Fruits/seeds are usually collected by hand, after clearing them or by placing recipients or a tarp on the ground, and shaking the tree by hand or with a tool or rope.	→ Grass seeds are usually collected and husked by hand, using similar techniques as for cereal harvesting. → Seed collection should be carried out at maximum maturity or close to the time of their natural dispersion period. In the Sahel, the best period is usually from September-November. → Always carry out seed collection in non-fragmented populations, and in the largest populations possible.

Seed handling and storage for restoration

Depending on the species, tree seeds need to be extracted from the fruit (depulping) after drying when necessary, before cleaning (avoid mechanical cleaning that can damage the seeds) and sorting out (through filtering, flotation, sifting, etc.).

It is important to understand the parameters that affect initial seed quality, as this will determine viability, germination, response, longevity and long-term conservation. In each population the proportion of viable seeds after storage in given conditions depends on mainly two variables: moisture content and temperature. In sum, a higher initial viability will ensure a higher germination response and seed longevity.

Seed longevity potential is affected by environmental parameters during development as well as by post-harvest conditions; for example, immature seeds dried too quickly will have a reduced longevity. The period during which seeds can be stored varies considerably between species, provenances of the same species and storing conditions (see box 2) and need to be stored in the appropriate conditions corresponding to the type of seed (recalcitrant, intermediate, orthodox). Recalcitrant seeds cannot be stored for long periods and should be planted as soon as possible.

Generally, grass seeds are orthodox and can be stored after being properly dried in a cold room for many years, but infrastructure and maintenance is costly and not necessarily required for short term use of restoration collections. In fact, under ambient conditions these seeds maintain their germination capacity for several years.

BOX 2. Classes of seed storage behavior and how to store seeds short term

	What they are	How to store them	How long they can be stored	Examples
Orthodox seeds	Can be dried to a low moisture content and are resistant to low temperatures for long periods (dry seeds)	Need to be dried (<5% humidity content) and stored in clean and sealed containers. The containers need to be stored in a cool, dark, dry and ventilated place, and preferably above ground to avoid humidity	One to two years, but up to more than five years	*Panicum laetum* Most *Acacia* sp.
Intermediate seeds	Survive drying but cannot survive at low temperature	Need to be dried and stored in normal temperatures	Up to a year in ideal storage conditions	*Khaya seneglensis Balanites aegyptiaca*
Recalcitrant seeds	Cannot survive drying below a relatively high moisture content and low temperatures (moist seeds)	Need to be kept in a relatively humid environment (humid sawdust or vermiculite) and sowed as soon as possible	One to two weeks in ideal storage conditions	*Boscia senegalensis Detarium microcarpum*

Source: Royal Botanic Gardens Kew, 2019 (Sacande, Sanogo and Beentje, 2016).

KEY RECOMMENDATIONS
CHAPTER 2

Estimate the quantity (in weight) of seeds needed for each species to cover the entire restoration site and identify where and how to mobilize these seeds.

Plan seed collection carefully and maximize genetic diversity within collected seeds by collecting seeds from large populations and from a large number of trees within the population.

Pay attention to the specific seed characteristics that will determine how and for how long the seeds can be stored before being planted in a nursery or directly in the field.

NURSERY, AAD PROJECT, OUEDRAOGO SALIF, DJIBO, BURKINA FASO