Seed Bank Establishment

Standard Operating Procedures (SOP)

August 2021

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SOP Objective

The purpose of this document is to define the procedures and processes for establishing and managing Trees for the Future Seed Banks.

Seed Bank Goals

1. To maintain a consistent supply of high-quality tree seeds for TREES' project purposes. The establishment and management of seed banks will ensure:
    a. High quality seeds are sourced and procured in season
    b. Quality testing (on viability, purity, moisture content, and physical quality) can be conducted to ensure the best seed possible is distributed to farmers
    c. Seeds are stored safely to maintain viability until distribution/planting
    d. Accurate and detailed seed records can be maintained for all seed that enters and exits the seed banks
    e. Seeds are available for projects when they are needed, and are distributed efficiently
2. To reduce the costs for seeds, by:
    a. Purchasing directly from collectors rather than through formal suppliers
    b. Limiting the procurement of seed that is not viable, and has to be repurchased
    c. Reducing waste or over-distribution of seed
3. To build and maintain a roster of trained local seed collectors that can supply TREES (and other buyers) with high-quality seeds to meet demand.

Standard Operating Procedures

SOP 1: Facility Establishment

The seed bank facility is the building or room(s) where the seeds are stored, and from where the seed bank coordinator/manager will operate related activities.

1.1 Site Considerations

The following considerations should be made when identifying an appropriate seed bank site:

- The structure can be a room or rooms within a TREES office, or if possible, at the Training Site. If neither of these is an option another accessible location that meets the requirements can be found.
- It should be a cool, dry room with electricity for lighting and air conditioning.
- It should be large enough to store the seeds needed for all projects. Sturdy shelving may need to be installed to safely hold multiple, heavy seed containers.

- Air conditioning and an interior thermometer should be installed to keep the storage room at a constant, cool temperature year-round. Depending on the construction materials of the structure, it may be economical to install insulation in ceiling and/or walls to reduce the need for air-conditioning, especially in the hot season.
- If needed, there should be a secure outdoor workspace near the facility for setting up seed drying racks, germination testing, and other preparation and testing activities.
- The storage room should have a secure door and windows that can be locked.
- The storage room should be secure from pests (rodents, insects, etc.) that can attack the seeds.
- There should be a desk space, preferably in an adjacent or nearby room, where the Seed Bank Manager can manage administrative activities (weighing, recordkeeping, etc.).

1.2 Materials Needed

The materials and equipment that will need to be purchased for the seed bank facility include:

- Shelving
- Hermetic containers (multiple types/sizes)
- Scales (large and small)
- Drying racks
- Screens
- Digital moisture meter
- Thermometer
- Bag sealer
- Airconditioning unit
- Curtains
- Insulation
- Gloves
- Masks
- Bags for seeds (large and small)
- Labels
- Pest control
- Seed trays

SOP 2: Seed Procurement

Seed Procurement is a process that involves careful planning and budgeting, outreach to and contracting of vendors to meet demand, and follow up for due diligence, seed testing, and purchasing. These activities are supported in part by program and project leadership, as well as the finance and procurement team, and seed bank manager.

2.1 Planning and Preparation

There are a few planning items that need to be completed prior to purchasing seeds, to ensure good quality seed is procured on time, from trusted sources, at good prices:

- *Detailed Seed Procurement Plan and Budget* – Program leadership and technicians develop a procurement plan and budget each year, that includes the total amount of seed that needs to be procured, by species and weight, for every project. Once approved, this plan is to be sent to the Seed Bank Coordinator and Manager for planning purposes.
- *Training of Seed Vendors* – All seed vendors should complete TREES' Seed Collection and Processing Training prior to collecting seed for TREES' projects. This is a two-day training, conducted annually in each program region for farmers who are interested in collecting and selling seed to TREES. Once a farmer completes the training, they can be added to the Vendor List in the Seed Bank Management Booklet.
- *Seed Bank Management Booklet* – This excel file is the heart of the seed bank's record keeping. It includes all the information that the Seed Bank Manager needs to have on file and is updated constantly. The sheets in the management booklet include: instructions on procurement, management, and recordkeeping (also found in this document); a list of all vendors (seed collectors) and relevant information about them; the procurement plan summary to guide seed bank planning and procurement; a summary of all seed inventory in the seed bank; a seed record that documents all relevant information for every batch of seed that enters the seed bank; and separate inventory sheets for each species kept in the seedbanks, to track seed intake and outturn (distribution)
- *Preparing the Seed Bank Management booklet* – in preparation for each new calendar year, a copy of the year's seed bank should be backed up. Then each page of the Seed Bank Management Booklet should be updated for the new year. For example, vendors should be checked and marked active/inactive as needed; the procurement plan should be updated for the year; seed records should be cleared (though the previous year's records will still need to be referenced/updated until those seeds are distributed); and inventory sheets should be cleared of seed batches that have been fully distributed.

2.2 Procurement

The following describes the procedures that should be followed when procuring small seed orders (i.e. under $2,500USD). If a given purchase is above $2,500USD, the procurement procedures may change.

1. *Determine seed requirements and budgets* – This should be completed during the budgeting process, prior to each program year. The requirements should be input in the Seed Procurement Plan in the Seed Management Booklet.
2. *Contact vendors* – When it is time to begin the procurement process for each species, approximately one to two months before the species produce seed, contact vendors to fill demand and negotiate fair seed prices. Seed prices should generally follow the seed procurement plan and budget.
3. *Issue Purchase Order (PO)* – to each collector to formalize agreement. The PO lists the species and amount of seed to be collected and purchased, as well as the price per kg, and the purchase terms (e.g. collection practices, cleaning & drying requirements, and payment terms)
4. *Agree to purchasing terms* – It should be made clear to the seed collectors during the purchase order process that TREES will pay for the seed after testing on quality, purity, moisture, and germination are complete.
5. *Source verification* – It is important that TREES procures high-quality seed for distribution. Efforts to ensure this include talking with vendors to ensure they are aware

of best practices and that they make all reasonable efforts to collect quality seed and to prepare it appropriately for storage. Seed Bank Managers should also visit collectors and their seed sources periodically to ensure that collectors are using appropriate seed sources.

6. *Run seed quality tests* – on germination, purity, moisture content, and quality. Record results.
7. *Pay for seed* – If seed quality is acceptable, payment should be made as soon as possible to the seed collector. If seed is found to have excessively poor germination rates (generally below 75% but this may change depending on species), a high amount of impurities (leaves, dirt, twigs, etc), poor physical quality (pests, deformities, mold), or high moisture content, the seed should be returned to the collector as soon as the issue is identified, with an explanation and discussion as to why it is being returned. There is room for negotiation to reduce the price of the seed rather than return it in full. This would have to be made based on a case-to-case basis however, depending on the quality of the seed. The testing process should take no longer than 30 days from receipt of the seeds, so payment should be made to the collector within one month.

SOP 3: Seed Collection & Processing

The procedures below describe the various guidelines and best practices to be followed for seed collection and processing. These activities and processes, in most cases, will be done by seed collectors/vendors. However, it is up to the TREES team to ensure that vendors are well trained on these practices, and that the vendors, sources, and seed are vetted and tested to ensure best practices are used.

In some the country program may decide to take on some of the processing (e.g. drying and sorting) at the seed bank. This decision could be made based on the capacity of the seed bank team to take on these important steps, or if the seed collector(s) are unable to do so sufficiently (e.g. drying during the rainy season). The responsibility and (if outsourced) the process/practices to be followed, should be made clear during the contracting process and is noted in the Purchase Order. If any part of the process is not completed by the vendors, then it should be reflected by paying a lower price per kg for the seed.

Basic guidelines for collection and processing are noted below. **For more detailed descriptions of the practices, see TREES training and technical resources on seed collection and processing.**

3.1 Seed Collection

One of the most important components in seed collection is identifying good seed sources. Collecting seed from good mother trees significantly increases the likelihood that the seeds will have good genetic characteristics. Some of the key things that collectors must look for when selecting the mother trees from which they will collect seed include:

- *Good Health* – Good mother trees should generally be: healthy (free from pests/disease and damage), big-crowned, uniform in size, uniform in flowering & seeding, well-formed

and well-spaced with high branches. The specific qualities however depend on the species of tree and the planting purpose (e.g. for timber, fruit, leaves, etc.).

- *Good Production* - they should yield good quality products, whether it is timber, fruit, fodder, or anything else. Depending on the products, you are looking for straight trunks, fast growth, good production quantity and quality, pest/disease resistance, and good form; do not select mother trees that are poorly developed, diseased, dying, or are isolated from others of the same species.
- *Maturity* - young (or very old trees) may produce a lot of seeds, but the seed quality is generally not as good as healthy, mature trees. Young trees are more likely to produce underdeveloped seeds, and seeds from trees at the end of their life are likely to be less vigorous. Age can be difficult to determine (especially for older trees) so when in doubt, collect seed from trees that appear to be well-established, full-grown, and thriving.
- *Cross-pollinated* – Many species of trees cross-pollinate with other trees of the same species near them. Good genetic mix is obtained by collecting seeds that are produced by many trees of the same species cross-pollinating. Selected parent trees should be surrounded by or near other good quality trees. The tree populations could be in a line, grouped or scattered. Avoid collecting seeds from trees grown in isolation, as they are less likely to cross-pollinate, and will have less genetic diversity represented in their seed.
- *Separate from other mother trees of the same species* – Keep a good distance between selected mother trees. During natural regeneration of some species, seeds fall near the parent stock. In time, inbreeding may occur, which will result in lower quality trees. A 100-meter distance between mother trees of the same species is recommended.

Seed should be collected from numerous trees across a species' range that is representative of the best parent stock (note: TREES purchases seed from various collectors in different areas, increasing the likelihood that seeds are collected across the species' range in a given area). Parent trees should cover a broad geography, including the environmental extremes at the edge of their range if possible. Seed selected from a narrow sampling of trees will limit genetic diversity. Trees generally grow best in the middle range and less well on the extremes, so parent trees on extremes may not be as vigorous or productive but are genetically significant as they exhibit genetic qualities that help trees survive and thrive in abnormal conditions.

3.2 Seed Processing

Seed processing begins after the seed is collected from the tree, and includes sorting the fruit/pods, extracting, drying, cleaning, and grading the seed. Following proper seed processing practices helps to ensure good physiological and physical qualities of seed, reduces storage space needed, decreases likelihood of pests and disease, and increases the amount of time seed (especially orthodox seed) can be safely stored. Basic practices for seed processing include.

- Sorting fruit and pods
    - Carefully look over all fruit and pods harvested. Discard any underdeveloped fruits/pods, or any that are visibly infected with pests or disease. If fruit is not fully matured, or pods not fully dried, they can be set aside to allowing for ripening/drying and processing at a later date.

- Extracting seed from fruit or pods – there are three commonly used methods for safely extracting seed:
  - De-pulping – This method can be used for all fleshy fruit. First soak the fruit in water for 1 or 2 days to soften the flesh. Then, squeeze and rub the fruit against a wire mesh, taking care not to crush the seed. Add plenty of water while scrubbing and washing fruit to remove the fleshy material from the seed. The fleshy material will float while the seeds sink to the bottom.
  - Pounding – This method is only used for seeds that have very hard seed coats (e.g. *Melia azedarach* and *Cordia Africana*. First soak the fruits in cold water for 1 to 2 days to soften the pulp. Then pound the fruits with a mortar and pestle. Wash away fruit to clean and extract the seeds.
  - Threshing – This is most commonly used for non-pulpy fruit with pods or capsules that open when mature but whose opening is not wide enough to release the seed. This method is used for pods of many agroforestry species as well as species such as *Grevillea robusta* and Casuarina spp. that develop in capsules. Pods and capsules may not always open when mature so need to be dried for 2 to 5 days until the outer walls are brittle and will break easily when threshed. When pods are dry, they release the seed. Capsules can be shaken by hand to release the seed. In all cases, seeds should be protected from rain, birds, and insects.
- Cleaning and grading seed – helps to maintain high physiological and physical quality by removing impurities, deformed, pest- or disease-ridden seeds.
  - The best method for cleaning is determined by the seed size and type. *Blowing and winnowing* can be used when impurities (pieces of dried pulp, fruit/pod walls, twigs, or leaves weigh less than the seed. The wind blows away the lighter impurities, leaving just the seed. *Screening* or *sieving* separates impurities that are larger or smaller than the seeds.
  - *Flotation* can also be used to separate impurities as well as good and bad seed, as mature, healthy seed will generally sink to the bottom while impurities and damaged seeds will float on top for easy removal.
  - *Grading seed* generally involves sorting through the seed after it has been cleaned to remove any seeds that look deformed, discolored, pest or disease-attacked, or otherwise non-uniform (including significantly larger or smaller than the average seed).

3.3 Seed Drying

Technically seed drying is a part of seed processing, but its importance warrants a separate sub-section. It is critical to dry seeds with high moisture content before storage, as seeds with a high moisture content do not remain viable for long periods of time. Drying seeds prior to storage helps to prevent seed deterioration, reduce rotting, and improve the seeds' resistance to pests and diseases during storage. As with seed processing the responsibility for drying seeds should be agreed on with vendors prior to purchasing the seed. The three main types of seed (recalcitrant, intermediate, and orthodox) each have different drying and storage requirements

Recalcitrant seeds – should maintain a higher moisture content and cannot be stored for very long. They should be dried under shade to maintain a moisture content of 20% to 40% and stored

between 12-15°C Recalcitrant seeds cannot be stored for long in storage containers, even under favorable conditions. Common examples include *Mangifera indica* and *Persea americana.*

Intermediate seeds – can withstand only a limited amount of drying, to a moisture content of 15% to 19% and should not be stored at low temperatures. Intermediate seeds should be dried using shading or air-drying methods. Air dry seeds for 1-3 days before storing, or plant the seeds immediately for better germination. Common examples of intermediate seed include *Azadirachta indica, Maesopsis eminii,* and *Dovyalis caffra.*

Orthodox seeds – can withstand the highest level of drying and can thus be stored for longer periods than intermediate or recalcitrant seeds. Orthodox seeds are commonly dried under direct sunlight for 2-3 days. As a rule of thumb, for orthodox seeds, the mean viability period (seed lifespan) doubles each time the moisture content is lowered 1% below the maximum 14% to 15% moisture content level that is acceptable for storage. Common examples of orthodox seed include most leguminous trees, like *Leucaena, Calliandra, Gliricidia,* and *Sesbania.* The simplest option to dry orthodox seeds is to do so naturally in the outdoors, which works best for seeds that are already nearly dry. A few simple steps for drying are to:

1. Place clean, sorted seed on a drying rack
2. The seed should be protected from predators
3. The rack should be placed in a location with good air circulation
4. Dry the seed until the moisture content is between 3% and 8%
5. When sufficiently dry, the seed should be stored following SOP 5.

Note: outdoor seed drying should not be attempted during rains or in humid areas. In these cases, a temperature-controlled drying cabinet may be needed.

SOP 4: Seed Quality Testing

For the purposes of TREES Seed Banks, four tests will be used to monitor seed quality: germination tests, purity tests, physical quality tests, and moisture content tests, as described below. These tests should be conducted for every lot or batch of seed that is brought into the seed banks. The results of these tests are to be documented in the Seed Record Sheet of the Seed Management Booklet (see Section 2.8 below)

4.1 Germination Tests

It is important that the seed TREES procures and distributes have good germination rates, as that is a common measurement of seed viability. This is particularly important for orthodox seed, that may be stored for longer periods. Below are some guidelines for conducting germination tests:

1. Obtain a seed sample that is typical (representative) of the entire batch of seed (i.e. take some seeds from the top, center, and bottom of a batch of seed).
2. The larger number of seeds tested, the more accurate the results will be, so it is good to test as many as 100 seeds, if possible.
3. Plant the prepared seed tray following the recommended sowing practices for the seed being tested.
4. Place the tray in an area that is protected from predators.

5. Water the seed as required for the seed type and observe them daily.
6. When the seeds germinate, document how many germinate and when. You can also measure and record the growth rates to document seed vigor.
7. Calculate the germination rate using this equation: Number of seeds germinated/Number of seeds sown x 100%

For any seed batches that are stored in the seed bank for longer than six months, germination tests should be conducted prior to outturn/distribution.

4.2 Purity Tests

Purity tests show how much non-seed (impurities) is included in a batch of seed. Impurities can include twigs, sticks, dirt, rocks, leaves, seed of other species, any bad seed (mis-shaped, discolored, damaged, pest-attacked), and other debris. The purpose of monitoring the purity is to enable determination of how much seed there is, by weight, in a kilogram of seed. This is used, in part, to determine how much seed should be weighed out for distribution to fill an order. It is also a quality check on the seed collector, as it shows the extent of effort, they put in to seed cleaning. Finally, it shows the true cost of the seed (if for instance a kg of seed is 50% pure by weight, then only one-half kg of seed was purchased for the price of 1 kg). To measure the purity of a batch of seed:

1. Obtain a sample of seed that is typical (representative) of the entire batch of seed (i.e. take 1 bowl-full of seed from the top, 1 bowl-full from the center, and 1 bowl-full from the bottom of a batch of seed).
2. Place the three bowls of seed together, and weigh them, recording the exact weight (in grams).
3. Separate any impurities (debris) from the pile of seed.
4. Weigh the seed with all impurities removed.
5. Perform the calculation: Purity % = (weight of pure seed (g) / weight of sample (g) x 100%

4.3 Physical Quality Tests

The physical quality of each batch of seed should be checked prior to storage, and documented. TREES uses a subjective observation test for this purpose, which at least ensures each batch of seed is sifted through and checked closely for significant deformations or pests/disease that would be likely to affect the viability and growth of trees in the field. To perform a physical quality check, the same sample of seed that was used for the purity check can be used as a sample here, as follows:

1. Obtain a sample of seed that is typical (representative) of the entire batch of seed (i.e. take 1 bowl-full of seed from the top, 1 bowl-full from the center, and 1 bowl-full from the bottom of a batch of seed).
2. Sift carefully through the sample of seed, observing if the seed is uniform in size, weight, shape, and color, that it is dried to an acceptable level, and if there is any instance of pest or disease attack.
3. Determine a score of 1-5 for the physical quality of the seed, using the scale below:
    1. Seed is uniform in size, shape, color with no signs of pests or disease
    2. There are minor differences in some seeds in the sample, but no signs of pests or disease

3. There are minor differences in some seeds in the sample, and minor (but insignificant) signs of pests or disease
4. There are considerable differences in the physical quality of the seed, and minor (but insignificant) signs of pests or disease. (Note: if this is the case, a decision may need to be made to discard the seed. Germination tests may be helpful in determining if the seed is still viable or there are significant differences in viability/vigor of germinants)
5. Seed has significant signs of pests or disease. (Note: if this is the case, the seed will likely need to be safely disposed of).

4.4 Moisture Content Tests

Moisture content (or humidity) tests determine the amount of moisture that is in a seed. The drier orthodox seed is when stored, the longer it can be stored and retain its viability. Moisture tests are more difficult to perform manually than others, as it requires weighing the seed, then drying it in an oven following certain specifications, then weighing it again. The difference in weight after drying in the oven tells you how much moisture was in the seed prior to drying. TREES will use a digital meter that determines the moisture content of seed without having to perform these more tenuous oven-drying processes.

SOP 5: Seed Storage

Safe storage of seed is critical for maintaining seed viability until distributed and planted. Seed viability can deteriorate quickly under hot and moist conditions, and they are always prone to attacks by pests and disease. Though seed storage requirements can vary by seed type and species, there are a number of best practices for storing orthodox seed (seed that survives drying so can be stored for long periods of time).

- The room where seeds are stored should be:
    - Dry, with limited sunlight. A dehumidifier may be needed in areas with high humidity. Blinds can be placed on windows where needed to reduce sunlight.
    - Cool. Air conditioning and an interior thermometer should be installed to keep the storage room at a constant, cool temperature year-round. Technically the room should be below 16°C. Normal air conditioners are not able to keep temperatures this low, so they should be kept as low as is possible with the given budget. Depending on the construction materials of the structure, it may be economical to install insulation in ceiling and/or walls to reduce temperature variations and air conditioning costs.
- Storage bags:
    - All seed should be stored in moisture-proof plastic bags. Suitable materials can be polythene plastic or PICS that can be securely sealed (i.e. air-tight)). The material should be strong enough to resist damage during normal handling.
    - Seeds from different lots should not be mixed (nor should seeds of different species). All seed should be stored separately in bags and labeled appropriately (see Seed Labels under SOP 8.2 below).
    - After placing the seed in bags, place the label in it, facing outward so it can easily be read once the bag is closed (if the bag is not see-through, then the label should

be tied to the top of the bag after sealing it). Before closing the bag, remove as much air as possible. The bags should then either be heat-sealed or tied with a goose-neck (leave ~10 inches at the top of the bag; grab the top and twist it tightly down to the top of the seed; then fold the top end of the twist over to the bottom; tie it off tightly with a heavy elastic band or tie to ensure it is air-tight).
    - These bags can then be placed in larger storage containers that hold the same species.
- Storage containers:
    - Bags should be placed in larger containers, to maintain order and ensure seeds are securely stored, if not completely airtight.
    - Storage containers should be opaque if possible (not see-through or transparent). They should be rodent-pest proof, and as much as possible, be air-tight when closed, preferably with a screw-on or lock-on lid.
    - They should contain only one species of seed. Though they can contain multiple bags with seeds of the same species, but from different sources or lot, as long as they are each labeled properly.
    - If a container is used to store a single source or lot of seed that is not bagged and labeled, the container should be labeled clearly, following labeling requirements.
- Pest control:
    - If unable to control pests through use of hermetic (air-tight) storage, it is necessary to use other means. An organic mix of wood ash and neem powder can be used to minimize pests. If neem powder is not available, a chemical product can be used. Based on the Senegal team's experience, Malathion was used. For every 5kg of seed, they add one small spoonful of Malathion. **Note:** staff should wear a mask and gloves when working with chemical pest control and seeds that have it mixed in.

SOP 6: Seed Distribution

The seed bank manager should know well in advance the quantities and species that need to be distributed for each project, along with the timelines. This requires that project managers plan well ahead of time to ensure plenty of time for the seed bank manager to procure the species and amounts needed.

One month prior to distribution, the project management should give a formal request to the seed bank manager for the species and amounts needed, along with the date that distribution is required. This will allow time for the seed bank manager to prepare the seeds (separating into packets, labeling, etc.), update records, and conduct any germination tests, if needed.

When seeds are distributed, the oldest seeds of a given species should be distributed first, assuming they have acceptable germination rates. When the time between seed intake and distribution/planting is minimized, germination is likely to be better.

Seeds should be individually bagged in small packets for each farmer, separated by species, with each packet labelled (see Seed Packet Labels, under SOP 8.2 below)

When distributing seeds for projects, the following formula should be used to calculate the amount of seed to distribute:

Quantity of seeds required (kg) *= # of seedlings desired / ((Purity (%) x Germination (%) x Estimated survival in nursery (%)) / # of seeds/kg*

3SOP 7: Seed Management Process

The steps below outline the processes for procurement, management, documentation, and record keeping for TREES' seed banks. Details and descriptions of the documentation, record keeping in the various spreadsheets in the Seed Bank Management Booklet, and procurement, processing, testing, storage, and distribution of seeds are found below the processes.

7.1 Process Outline

1. **Develop Seed Procurement Plan** – Each year, program leadership and technicians develop a procurement plan and budget for the seed that will be purchased for all projects over the course of the coming year. Once approved, this plan is to be sent to the Seed Bank Coordinator/Manager, who will add a summary of the information into the Procurement Plan Summary spreadsheet in the Seed Bank Management Booklet. This plan documents how much seed is needed for each species, the purchase price point for each, and the time of year that purchase orders should be sent, seeds collected, and seed distributed for each. This snapshot of seed procurement will assist the Seed Bank Coordinator/Manager know with procurement planning throughout the year.
2. **Update Seed Vendor List –** The list of seed vendors, found in the Seed Bank Management Booklet should be updated as needed to add new collectors, update their status (i.e. active/inactive), and add any notes on the collectors.
3. **Monitor Seed Procurement Plan** – Different species produce seed at different times throughout the year. The Seed Bank Coordinator/Manager will monitor the seed procurement plan and begin the procurement process as scheduled. Ideally seed for each species will only be purchased once per year, even if it is planted in more than one season. The seed is to be purchased to fill demand immediately following collection and processing, then stored in the seed banks until it is to be distributed for planting.
4. **Distribute Purchase Orders** – Use the Vendor List in the Seed Bank Management Booklet to determine which vendors collect the species needed, and contact them to discuss how much they expect to collect. After agreeing on the amount and purchase price, and reviewing the best practices, the Seed Bank Coordinator/Manager will issue each collector a Purchase Order to formalize the agreement and terms.
5. **Conduct Seed Source Visits –** Ideally seed source visits will occur for all collectors during collection periods, to verify that they are following best practices and provide mentoring where needed.
6. **Monitor Seed Collection –** The Seed Bank Coordinator/Manager is to follow up with collectors during collection to ensure they are able to fulfill their order commitments. If

they are not able to, the manager should reach out to other collectors to increase orders where needed to meet the shortfall.

7. **Procure Seed** – The vendors should contact TREES when the seed they collected is processed, stored, and labelled. The vendor will then either deliver the seed, or an authorized TREES representative will pick up the seed from the vendor. The TREES representative who receives the seed should check the seed to ensure it is the right species, and that it is dried and cleaned properly.
8. **Seed Bank Intake –** As soon as the seed enters the seed bank, the Seed Bank Manager will enter it into the Seed Record spreadsheet of the Seed Bank Management Booklet, following instructions on the sheet. At this point only columns B-H will be entered.
9. **Seed Testing** – As soon as possible after the seed is entered into the seed bank, the Seed Bank Manager should initiate a purity test, quality rating, moisture test, and germination test for each batch. The purity test and quality rating can be done first, then further cleaned if needed. Then the germination test can be started. As soon as the tests are complete, record the data into the Seed Record spreadsheet (columns J-L). At this time, any relevant information about the seed should be noted in the Vendor List spreadsheet, if warranted.
10. **Seed Payment** – As soon as the quality tests are complete, and assuming it performs well in testing, payment should be made to the seed collectors. If seed is found to have excessively poor germination rates, impurities, quality, or high moisture content the seed should be returned to the collector as soon as the issue is identified, with an explanation as to why it is being returned. The testing process should take no longer than 30 days from receipt of the seeds, so payment should be made to the collector within one month.
11. **Seed Storage** – After purity tests and quality ratings are complete, and while germination tests are underway, the seed should be properly stored (see SOP 5: Seed Storage). Weigh the cleaned seed prior to storage and note the weight of each batch in the Seed Record sheet (column I). The seed should then be labelled accurately (see Seed Storage Labels under SOP 8.2 Seed Labels) and stored following guidelines provided.
12. **Update Seed Inventory** – The final step that goes along with storage is for the Seed Bank Manager to fill in columns A-D in the Seed Inventory sheet in the Seed Bank Management booklet, following the instructions given.
13. **Seed Outturn** – It is the responsibility of each project's technicians or other project leadership to submit a *Seed Request Form* to the Seed Bank Manager well before the expected date of distribution to farmers (at least one month in advance). The manager should be prepared for this request well in advance, based on the procurement plan, and should have the required seed in stock, if collected through the seed bank (if the seed is to be purchased from formal vendors, or in the case of recalcitrant seed, there should also be a plan in place to procure these seeds well in advance). The seed request form should note all the species needed and totals for each project. It should also specify the number of individual seed packets that are needed for each species, and the weight (in grams) of each packet. Note: the weight of seed packets given to each farmer should be calculated as follows:
    Quantity of seeds required (kg) *= # of seedlings desired / (Purity (%) x Germination (%) x # of seeds/kg)*
14. **Run Germination tests (if needed)** – The Seed Bank Manager will check the inventory of the requested species to double-check there is enough to fill the requests. S/he will also

check the storage dates of all of the seed that will fill the order. For any batches of seed stored for more than 6 months, germination tests should be completed again, and marked on the seed labels. Remember that the oldest seed should always be used first, given it has acceptable germination rates.

15. **Fill Seed Request** – Upon receipt of a seed request from project leads, the Seed Bank Manager will prepare the seed packets as needed for distribution, ensuring that the desired seed is weighed, placed in a packet with a completed Seed Packet Label (see Seed Storage Labels under SOP 8.2 Seed Labels), and heat sealed.
16. **Update Seed Inventory** – Columns E-I in the Seed Inventory sheet (or the appropriate columns according to the Distribution number for each batch) should be filled in upon outturn of the seed. Note that the seed distributed for a given project may come from multiple batches of seed, so should be recorded accordingly to ensure good inventory management.
17. **Complete Seed Outturn Form** – When the project team takes the seed, the Seed Bank Manager should have a Seed Outturn Form prepared, to confirm the amount of seed being taken, the person taking it, the date. This form should be signed and filed for accounting purposes.

SOP 8: Record Keeping

Record keeping can be time consuming, but it is a critical element of seed bank management. There are a number of different records and documentation that are kept for seed banks, to help manage and monitor vendors, seed intake and distribution, storage, testing, and more. Record keeping involves careful information management (record entry, documentation, and labeling) on all aspects of the seed bank functions. Seed information is kept in multiple documents and spans all aspects of the seed cycle, from collection to monitoring in the field. Seed records and documentation, their use, and the information required for them, are detailed below:

8.1 Seed Documentation

The following documents will be maintained and used to keep accurate account of seeds entering and exiting the seed bank, as well as information on seed vendors, procurement, sources, quality, etc. Much of this information is kept in the Seed Bank Management Booklet. Descriptions and information kept in each of the documents is provided below.

Inventory Summary Sheet – This sheet maintains the balance of seed inventory in the seed bank. As long as the seed records are kept accurately, the inventory balances for each species in the seed bank should be filled and updated automatically.

Vendor List – Every vendor (also called a 'collector') from which TREES purchases seed should be entered into the Vendor List, found in each country's Seed Bank Management Booklet. The information to be documented in the Vendor List includes:

- *Vendor Number* – this is a 2-digit number that is entered sequentially as the vendors are added to the program. Note that if a vendor is no longer used for any reason (e.g. deemed unfit to supply seeds for any reason, decides to stop collecting seeds, etc.), they are not to

be removed from the list, but rather only labeled 'inactive' under the Status column, with a note (see below) that explains why.

- *Location* – the place where the vendor lives (village, county/district)
- Phone number
- *Trained* – mark 'yes' if the vendor has participated in the seed collection training module for TREES vendors, and 'no' if not. Note that all vendors should participate in the module(s). Initially the seed collection training will focus on dry/orthodox seeds, but more advanced training on other types of seed will be added later.
- *Bank Account or e-payment information* – write the bank account information if the vendor receives payment through a bank transfer, or e-payment (e.g. M-pesa) information if through e-payment. Only under special, pre-approved circumstances should a vendor receive payment in cash.
- *List of Species collected* – list all the species (botanical names) for which a vendor collects seeds
- *Notes on Collector* – add any notes on a collector that may be pertinent to a collector. First mark the date that the note is written, followed by the note. This should include any information on the quality of the seed provided, if there is any follow-up that is needed on a collector, when the follow up was completed, notes on the collectors' sources when visits are made, if there is any reason to not use this vendor again (in which case the vendor should also be marked 'inactive'), etc.

Procurement Plan Summary – This sheet summarizes the total amounts of seed needed to be procured each year for the entire program. It provides a quick look at key information and timelines for procurement. This information will come from the detailed procurement plan that program and project leadership will put together for each project during annual planning and budgeting. The following information is kept in the Procurement Plan Summary sheet:

- *Species Code* – found in the Species Information Sheet
- *Species* – write the botanical name
- *Quantity needed* – the total amount of seed for the species, including all projects, for the year. This should come from a detailed procurement plan developed by program/project leadership
- *Purchase price* – this denotes the purchase price that TREES will offer collectors. It should be a fair price that is consistent with what formal vendors (e.g. government seed banks or ICRAF) pay for seed collected.
- *P.O. Completion* – the month that Purchase Orders should be completed for each species.
- *Collection Period* – the month(s) that each species of tree is ready for seed collection.
- *Distribution Date* – the month that each species should be procured, tested, and prepared for distribution to projects/farmers.
- *Notes* – any relevant notes on the procurement plan for each species.

Lot Number - the seed *Lot Number* is a unique number given to every batch of seed that is brought into the seed bank. A lot number is assigned every time a new batch comes in, and is noted in the Seed Record Spreadsheet, along with the accompanying entry information in the Seed Bank Management Booklet (e.g. when entering seed intake/outturn in the Inventory spreadsheets). This number tracks that specific batch of seed and is tied to any testing done on it, and anywhere the seed goes. The lot number allows for easy tracking of seed batches and

information regarding the species, when it was harvested, and by whom, how much is in the inventory, and to where it was distributed. The lot number must also be added to the label and kept safely with the seed when stored. The lot number consists of the following:

- 2 digits for the vendor who collected the seed (found in Vendor List)
- 2 letters for the species code (found in Species Information Spreadsheet)
- 2 digits for year of harvest

So for instance, if a farmer with vendor number 07, supplies a batch of *Leucaena leucocephala* (variety code LL) that was collected in 2021, the lot number would be **07LL21**. This lot number would be placed both in the records as well as on any labels associated with this batch. At this point TREES will not be tracking the actual sources of trees, but an additional number may be added to the lot number in the future for that purpose.

Seed Record Sheet – Upon intake of the seed into the seed bank, the Seed Bank Manager will fill in the available information below, then conduct tests to determine and fill in the remaining information, including: weight of the seed (after any impurities are removed, if needed), check the physical quality and purity of the seed, and run a germination test. S/he will then input the Seed Source Information into the Seed Record Spreadsheet in the Seed Bank Management Booklet, along with some additional information:

- *Seed Batch Number* – numbered sequentially in order of intake
- *Seed Lot Number* – see above, which indicates the collector, species, and year of collection
- *Species Name* – write the botanical name
- *Date of intake* – the date that the batch of seed entered the seed bank
- *Seed source location* – the geographical location of the seed source(s), and any other relevant information, if available. This comes from the seed source information label from the vendor, that should accompany the seed.
- *Number of trees harvested from* in the seed source(s), from the seed source information label.
- *Seed collection date(s)* – from the seed source information label
- *Purchase price* – price that was paid for the seed (price/kg)
- *Seed weight (in Kg)* – this should be confirmed when weighing upon intake
- *Seed purity (%)* – entered after purity test is completed
- *Seed germination (%)* – entered after germination test is completed
- *Moisture content (%)* – entered after moisture content is determined from digital moisture meter
- *Seed quality* – entered after seed quality test is completed (see SOP section on Seed Quality Testing)

Seed Inventory Sheets – This sheet tracks the intake and distribution of seeds of all seeds that enter and leave the seed bank, aggregated by species. Each species has its own inventory sheet in each country's Seed Bank Management Booklet. The seed inventory sheet has the following information, and should be updated each time any seed enters or leaves the seed bank:

- *Batch number* – taken from seed record
- *Lot number* – taken from seed record
- *Date of intake* – taken from seed record
- *Amount (kg*) – weight of seed batch (in kg), taken from seed record
- *Date of outturn* – the date that the seed was distributed
- *Project* – the project to which the seed was distributed
- *#/size (g) of packets* – the number of individual packets/sacks of seed, and the weight of each (the individual weights will add up to the total amount distributed for the batch). This is done as the seed bank manager will often need to split the seed into packets for accurate and efficient distribution to project farmers.
- *Weight of seed distributed (in Kg)* – the total weight of seed distributed in the batch
- *2nd Distribution, 3rd Distribution* – sometimes one batch/lot of seed will be distributed to more than one project, or perhaps even to one project at different periods. These should be treated as separate distributions and marked as such. More columns can be added if required.
- *Checked out to* – Write the name of the TREES staff member who checks the seed out from seed bank
- *Sum of Distribution* – this is automatically filled and summed when the 'Amount (kg)' cells are filled under each distribution
- *Balance of Remaining* – this is automatically filled and records the running balance of each seed batch.

Species Information – This sheet maintains basic information on the species that are kept in each country's seed banks. This is mainly used for reference purposes, with information including:

- *Species code* – this is the two-letter code given to each species, that is to be included in Lot Numbers
- *Species Botanical Name*
- *Species Local Name*
- *Collection Period* – the month(s) during which seed can typically be collected for a given species in each country or region.
- *Acceptable Germination Rate (range)* – a germination rate range at which TREES will procure seed from vendors and distribute to farmers. If seed is below this rate, it should not be distributed. The range will differ by species and will be determined over time based on the germination records kept in seed banks.
- *Acceptable Moisture Content (range)* – a moisture content range at which TREES will procure seed from vendors, and at which the Seed Bank managers must maintain for storage and distribution.
- *Collection Recommendation* – any notes or recommendations on seed collection (e.g. best practices, advice, dos/don'ts, etc.)
- *Pretreatment recommendations* – note the best pre-treatment option(s) for the species
- *# of Seeds/kg* – the average number of seeds in one kilogram for the species. This (along with the germination % and purity % will help to determine how much seed to distribute to a given project.

- *Species range (masl)* – the elevation range at which a species typically grows in the country/region.
- Additional information can be added to this sheet as relevant (e.g. soil type preferences, shade tolerance, use recommendations, etc.)

Seed Distribution Form – When seeds are distributed from the seed bank, the following information should be filled in on a Seed Distribution Form, signed by the Seed Bank Manager and TREES staff member who checks the seed out, and should be filed for accounting purposes. The following information should be filled in the Seed Distribution Form:

- Name of species (botanical and local names) – there can be multiple species checked out at one time
- Amount of seed (in kg or grams) for each species
    - Total amount
    - # of packets and weight of packets
- Name of person who checks seeds out from the seed bank
- Project(s) number where seeds will be distributed
- Seed lot number(s) – from the seed inventory lists
- Date of outturn – the date that the seed is checked out
- Planned date of distribution – the planned date(s) that the seed will be distributed to farmers.

8.2 Seed Labels

Seed Source Information (Vendors' Labels) – This information should be documented by the Seed Vendor/Collector for each species and provided to TREES along with the seed when purchased. Upon intake of the seed into the seed storage facility, the Seed Bank Manager will enter this into the Seed Record Spreadsheet. Seed Source information includes:

- Seed Collector's Name
- Name of species (botanical and local names)
- Geographical location of the seed source(s)
- Number of trees harvested from in the seed source(s)
- Seed collection date(s)
- Seed weight (in Kg)
- Germination % - If tested, though this is not a requirement as it will be done by TREES
- Purity % - if tested, though this is not a requirement as it will be done by TREES

Seed Storage Labels – All seed that is brought into the seed bank should be placed in thick plastic bags and tied securely following best practices. Each bag/batch should be accurately labeled with the information below and stored safely in containers that are labelled with the species name (only one species should be stored in a given container, though the container can have more than one batch/lot of seed as long as they are each stored safely in separate bags and labelled correctly). The seed labels should be printed on thick card stock, with the information written in ink.

- Botanical and local name of the species

- Batch number
- Lot number
- Date of storage
- Seed quantity (kg)
- Purity %
- Germination %

Seed Packet Labels – these labels should be printed and inserted into each individual packet of seed that is distributed to farmers. The labels should include the following information:

- Name of species (botanical and local names)
- Amount of seed (in grams)
- Seed lot number
- Germination %
- Purity %
- Pretreatment recommendations

References

- ECHO Community: BPN #5 - Seed Storage in the Tropics
- FAO. 2014. Community Seed Banks
- Vernooy R., Sthapit B. 2017. Community Seed Banks: Concepts and Practice. Biodiversity International.
- World Agroforestry Centre, Nairobi. 2006. Tree Seeds for Farmers: A Toolkit and Reference Source.