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MEMORANDUM

FOR : The Regional Directors
Regions 2, 3, 4A, 5, 6, 9, 12, 13, NCR and NIR

FROM : The Director

SUBJECT : **FMB TECHNICAL BULLETIN NO. 22-I : KEY SUCCESS FACTORS WITH SEED GERMINATION**

APR 05 2017

I. This Technical Bulletin

Seed germination is one of the critical stages in the life of the seedling. This Technical Bulletin covers the basic principles of seed sourcing, seed upgrading or cleaning, storage, pre-sowing treatment and environmental factors affecting seed germination as a general reference.

II. Users of the Technical Bulletin

The users of the Technical Bulletin are the Nursery Managers, Growers, Assistant Growers and readers who plan to start and operate a nursery for native plants as well as exotic plants in the tropics.

III. Introduction

The majority of forest and conservation species are propagated from seed to preserve the wide genetic adaptation that is critical to successful seedling establishment and growth in the natural environment. The seed source is important because it affects seedling growth in the nursery but, more importantly, seedlings must be adapted to the outplanting site. Nursery Managers and Growers should insist on the proper seed source when purchasing seeds. High seed quality is essential to consistently produce crops of superior seedlings. The seeds of many forest and conservation species become dormant after they mature, therefore, most need treatment before sowing to increase percentage of germination.

IV. Importance of seed source

The concepts of seed source are of paramount importance when propagating forest and conservation plant species from seeds, and refer to the geographical area (seed zone) in which the seed was collected. A **seed zone** of a species is defined as the area or groups of areas, with uniform ecological conditions, in which stands show should always be collected from the same seed zone in which the seedlings are to be outplanted. For example, seeds collected along the Zambales-Tarlac-Bataan mountains should be outplanted in the same mountains and vicinities. It is also suggested that there should be seed production areas (SPA) in every seed zone.

Seed source affects seedling performance in 2 ways: growth rate and heat tolerance. In general, seedlings grown from seeds collected from lower elevations will grow slower but tend to be more heat hardy during the summer than those grown from seeds from higher elevations. For example, Benguet Pine that grows well at 1,000 meters above sea level or higher can grow in the lowlands but at a slower rate, heat tolerant and will produce smaller cones. The Country Report (Philippines) on the state of the world's Forest Genetic Resources published by ERDB and FSO particularly Appendix Table 7. *Potential seed production areas/Seed Sources by region* can be used as a seed zone guide.

V. Obtaining High-Quality Seeds

The key to producing seedlings of high quality is speedy and uniform seed germination and vigorous early seedling growth, and therefore the quality of seeds is very important. Even the best nursery practices cannot overcome the cultural problems that result from poor seed quality. In fact, the development of container nurseries has highlighted the importance of seed quality. Nursery managers who sow cheap seeds of unknown quality will pay for their false economy. Seed costs are only about 1 % of total seedling production costs. Thus, the cost of purchasing high-quality seeds from reliable sources or seed companies can easily be justified when compared to the costs of maintaining a growing stock with many empty cells and weak seedlings for the remainder of the growing season.

Quality seed should have good genetics and physical properties. Seeds from healthy trees with good genetics grow well in the field. Physical properties refer to clean seeds free from pest and disease damage and uniform seed size, age, weight, color, and seed coat conditions.

VI. Considerations when purchasing seeds

Many Nursery Managers grow seedlings from seeds purchased from commercial dealers, or suppliers. Nursery Managers must insist on the proper seed source when purchasing seeds and it is a good idea to ask seed dealers which seed sources of a particular species they have in stock. Some unscrupulous dealers always seem to be able to come up with whatever seed source is needed just to make a sale. It is always a good idea to find out the names of reputable seed dealers.

Next, always make sure that seeds have been tested for quality. In particular, a germination test, percentage purity, and seed weight will be needed to properly calculate seed sowing rate.

VII. Upgrading seed quality

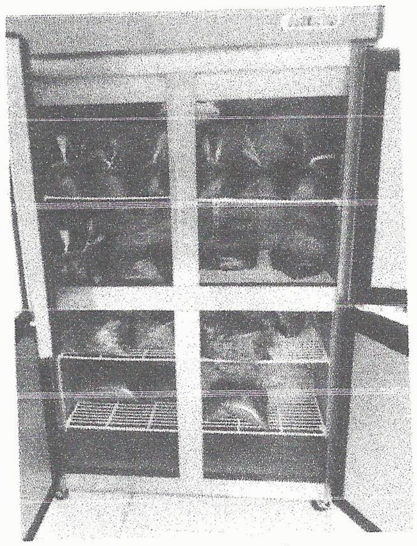
Nursery managers who purchase seeds should expect clean, pure seeds of high quality. If nurseries purchase seeds that need upgrading before they can be sown, the following techniques are useful.

Nurseries may have to re-clean some seeds before they can be sown, especially if precision seeders (automatic seeders) will be used. Although most nurseries typically do not have the full range of seed-cleaning equipment, there are some simple procedures to upgrade seeds. The basic seed-cleaning procedure is *winnowing* which uses a fan to remove hollow seeds (light weight) and debris. Most heavy, good seeds will drop near the base of the fan but hollow seeds, wings, and lighter impurities will blow farther away. A good seed should be firm, with no apparent decayed or insect-damaged spots.

Another simple and quick way to remove empty seeds for some species is by *flotation*. Just like winnowing, the principle is that heavier filled seeds will sink in water and the lighter, empty or damaged seeds will float. A good target for most species is 90% or more germination rate.

VIII. Seed Storage

Most container nurseries only need to store seeds for short periods of time, such as from the time of collection or purchase until sowing. Sometimes, it may be more economical to buy larger quantities of a popular seedlot and store it from one year to the next. The cold storage equipment being used by DENR is a chiller or cooler.



Chiller or cooler

A. Critical storage conditions: moisture content and temperature

Moisture content is the most important factor that influences seed storage. The recommended seed moisture contents for storing tropical seeds species is 4 %.

Temperature is the other important consideration when storing seeds. In general, the lower the temperature is the slower the seed deterioration rate. Most seeds in the tropical recalcitrant category will last long at relatively cool temperatures of 3 to 5 °C with humidity of 20 to 40%.

B. Storage containers

Seed storage containers must be rigid enough to provide physical protection during storage and handling. Plastic bottles with screw tops, plastic bags, and cardboard boxes lined with plastics can be used. Although rectangular containers are more space efficient, round ones assure necessary air spaces. The recalcitrant species must have constant dry air exchange.

The basic information in the seed container should be: species name (botanical or local name), date of collection/processing, testing date, germination percentage, purity percentage, origin or seed source (location), climatic type, number of trees collected from, weight of the seed and name of the seed collector.

Different seeds should be placed in different bags rather than putting them all into one bag. Large quantities are also best split into several small bags. This method would restrict to only some seeds in case of fungal attack or outbreak. If no fungicide is used, closely check the seeds, and remove any contaminated or infected seed.

In the event of fungal outbreak, remove the seeds and re-apply fungicide, then place them in a new bag. Always keep the bag sealed. The seeds should be checked on a regular basis for either fungus or germination.

C. Seed longevity in storage

Under natural conditions, most hardwood seeds have a life span of less than 3 years. When conditions are carefully regulated in refrigerated storage, viability can be maintained much longer up to 10 years. Recalcitrant species can be stored for a period ranging from a few months to a couple of years.

IX. Pre-sowing Treatments to Overcome Seed Dormancy

Unlike seeds of horticultural crops, which have been bred to germinate immediately after sowing, those of many forest and conservation species become dormant after they mature. Seed dormancy refers to a physiological state in which otherwise viable seeds will not germinate even when placed in growth-conducive environments. Dormancy is an ecological adaptation that ensures that seeds will only germinate when weather conditions, especially moisture and temperature, are favorable to the survival of the seedling.

A. Seedcoat dormancy

This condition is often called external dormancy because the restricting factor is the tissue surrounding the embryo (seedcoat). The degree of seedcoat hardness varies between species but also depends on the ecotype (habitat) and weather conditions during the seed ripening process. Several treatments can be used to soften the seedcoat. The objective is to increase the permeability of the seedcoat to water and gases. Keeping accurate and detailed notes of the treatment method and timing allows nurseries to develop a seed treatment guide for each species.

1. ***Hot water soaks.*** This is the traditional treatment for many legume seeds or those with waxy seedcoats. A volume of water that is approximately 4 to 6 times the volume of dry seeds should be brought to a boil. Then, the seeds are immersed for a few minutes and the container is removed from

the heat and allowed to cool. The embryo of some seeds can be damaged by high temperatures and so for these species, the water should be heated to only 65 to 70 °C. One problem with hot-water-treated seeds is that they stick together, making them difficult to use in mechanical seeders. One remedy for this is to place treated seeds in moist peat moss for a few days.

2. ***Scarification.*** The process of scarification involves weakening the hard seedcoat called "testa" just enough to allow the uptake of water and air by the seed (imbibition).

   a. Mechanical abrasion. Seedcoats of small quantities of relatively large seeds can be treated by hand: nicked with a triangular file or sharp knife, rubbed against coarse sandpaper or any form of abrasion to open the seed coat. Scratch the seed just enough and not to go deep into the seed itself.

   b. Acid soaks. Another scarification method is to soak the seeds in a strong acid solution. Concentrated sulfuric acid is preferred but growers must be aware that this is an extremely caustic material and that worker safety always must be a foremost consideration. When properly done, acid scarification is a very effective way to remove hard seedcoats and stimulate quick germination.

   Seeds should be clean and dry. They should not be used directly out of cold storage because they may be covered with condensed moisture. After placing seeds in the treatment container, the acid is slowly poured over them, and they are left to soak for a period of 15 to 120 minutes.

   Operational procedures for acid scarification:

   1) Place one volume of seed in a clean, dry container, and carefully add twice that volume of acid. Put the treatment vessel in another container of cold water to reduce the resultant heat build-up.
   2) Stir the seeds at regular intervals to prevent them from sticking to one another and amend the heat buildup in any one location.
   3) While the seeds are soaking, fill another container of equal volume with a 5% solution of sodium bicarbonate (baking soda) to use as an acid neutralizer bath.
   4) When the treatment time is completed (about 15 minutes), carefully pour off the acid, move the seeds to the neutralizing bath and stir.
   5) Remove the seeds from the neutralizer and rinse them thoroughly in clear, cold water.

Although acid scarified seeds can be stored for a few days, it is best if they are sown immediately. The best scarification treatment will depend on the requirements of the species and the skill and experience of the grower.

c. Bleach Seed Treatment - Seed may be treated by soaking for 40 minutes with continuous agitation in 1 part Clorox liquid bleach (5.25% sodium hypochlorite) to 4 parts water (i.e. 1 liter Clorox plus 4 liters water). Rinse seed in clean water immediately after removal from the Clorox solution and promptly dry. Germination may be compromised if soaking time exceeds 40 minutes.

X. Determining sowing rate per container.

For a container nursery to reach maximum production efficiency, empty cells must be avoided. Unfortunately, seeds of most forest and conservation species will rarely have germination percentages higher than 90%. For most species, however, growers sow several seeds per cavity to make sure that they have no empty containers.

Growers use several strategies to achieve maximum container occupancy when direct seeding:

- Sow 1 seed per cavity but sow some extra containers (oversowing)
- Single-sow and transplant emergents from additional seed trays
- Multiple-sow and thin to 1 emergent per container

The decision will depend on seed availability and cost, germination test results, container type, labor costs, and available growing space. If the grower has extra space the oversowing option works well if the sowing of another species can be delayed for a month or so. The second option of single-sowing with subsequent transplanting of emergents that are grown in separate seed trays is viable if labor costs are not prohibitive.

XI. Factors affecting Seed Germination

For seeds to germinate and grow well, the environmental conditions need to be favourable in respect of temperature, light, moisture and aeration.

1. ***Temperature*** - The average temperatures in the tropics normally permit germination to occur without supplementary heating, unlike in cooler parts of the world. However, temperature is still an important factor because:
   a. at a maximum temperature of 40-44°C, seed will not germinate;
   b. at a minimum temperature of 0-4°C, seed will not germinate; and
   c. the desired optimum temperature of most species is 18-27°C.

2. ***Light*** - The germination and early growth of seedlings depend on substances stored in the seed. Only a little light is needed while there are no expanded leaves for photosynthesis. A few species with *light-sensitive* seeds will generally

not germinate unless some light reaches the embryo, penetrating through the covering materials and the seed coat. All other kinds of trees will germinate in the dark, but they will need some light as soon as they emerge, or the seedlings will stretch and become weak.

3. ***Moisture*** - Containers must be watered frequently to keep the surface of the medium moist. The moisture content of the medium near the surface should remain near field capacity. However, care should be taken to avoid overwatering, which can lower germination and promote disease problems. Water sparingly but do not allow the growing media to dry.

4. ***Air or oxygen*** – The growing media must be porous to contain air or oxygen. Air must reach the germinating seed for respiration. If the soil is too hard (no pore space), air retention will be dramatically reduced.

FOR INFORMATION AND GUIDANCE.

NONITO M. TAMAYO, CESO IV

Annex A

Seed Collection Calendar

A. Indigenous Species

Species/Scientific Name	Month	Place
Agoho (*Casuarina equisetifolia*)	June - August	R2-Isabela; R3-Bulacan; R4A-Laguna; R4B-Palawan;R5-Albay; R8-Leyte
Alibangbang (*Bauhinia malabarica*)	February - Juy	R1–Ilocos Norte, Ilocos Sur, La Union, Pangasinan; R2 – Nueva Vizcaya; R4A-Laguna; R8 - Leyte
Almaciga (*Agathis philippinensis*)	August-October November	R8 – Samar CARAGA
Bagalunga (*Melia azedarach*)	January-May	R2-Nueva Vizcaya; R4A-Laguna; R8-Leyte; R9-Zamboanga City
Bago (*Gnetum gnemon*)	June-July	R1-Ilocos Norte; R3-Bataan; R4A-Laguna,Quezon,Batangas; R4B-Mindoro,Palawan; R5-Camarines Provinces; R6-Panay
Bignay (*Antidesma bunius*)	July-August	CALABARZON
Dapdap (*Erithyma orientalis*)	January-March	R2-Regionwide; R4A-Quezon, Laguna, Cavite, Batangas; R3-Regionwide; R1-Regionwide; R5-Regionwide
Datiles (*Muntingia calabura*)	All year round	Nationwide
Fringon (*Bauhinia purpurea*)	April-May	CAR-Benguet; R2-Nueva Vizcaya; R4A-Cavite, Batangas, Laguna,Quezon
Ilang-ilang (*Canaga odorata*)	June-October	CAR-Benguet; R1-Pangasinan; R2-Regionwide; R3-Tarlac; R4A-Cavite, Batangas, Laguna,Quezon; R6-Capiz; R7-Cebu
Molave (*Vitex parviflora*)	January-April; June-December	Regionwide
Balitbitan (*Cynometra sp*)	July-September	R4A-Laguna
Banaba (*Lagertroemia speciosa*)	March-April	R1-Pangasinan; R3-Tarlac; R4A-Batangas, Laguna, Quezon
Batino (*Alstronia macrophylla*)	March-April;July-December	R4A-Laguna, Quezon, Cavite R4B-Palawan
	July-October	R4A-Lucban, Cavinti, Sta. Maria, Infanta

	November-December	Region 7
Benguet Pine (*Pinus kesiya)*	December-January	CAR-Regionwide
Katuray (*Sesbania grandiflora*)	December-March	R1-Pangasinan; R3-Tarlac; R4A – Laguna, Batangas, Quezon
Makaasim (*Syzygium nitidum)*	Juy-August	R4A - Laguna, Quezon
Narra (*Pterocarpus indicus)*	March-April; June-October	R1-Ilocos Norte, Ilocos Sur; R4A – Laguna, Quezon; R5- Masbate, Camarines Sur; R6-Capiz; R7-Cebu; CARAGA

B. Exotic species

Wattle (*Acacia auriculiformis*)	December-January	R2; R4A;R3 – Nueva Ecija, Bulacan
	November-December	R3 - Zambales
African tulip (*Spathodea campanulata*)	All year round	R4A – Laguna, Batangas, Quezon; R3 - Tarlac
Anchoan dilau (*Cassia spectabilis)*	All year round	R3; R4A
Caballero (*Caesalpinia pulcherima*)	February - May	R4A; R4B
Fire tree (*Delonix regia*)	December - April	R2; R4A; R4B; R5
Golden shower (*Cassia fistula)*	March - April	R2; R4A; R4B
	September - November	R3 – Zambales; R5 - Albay
	December	R6 - Capiz
Indian tree (*Polyalthea longifolia)*	August - December	R4A – Laguna, Quezon
Neem *(Azaderachta indica)*	July – September; December - January	R1 – Pangasinan; R3; R4A; R4B; R12
Rain tree (*Samanea saman)*	August - December	R1; R2; R3; R4A; R4B
Mangium (*Acacia mangium)*	June - September	R7- Negros Oriental; CARAGA

Adapted from DENR-ERDB

Dry Season Crop vs Wet Season Crop

We want to find out what would be the cost of raising the planting stock during rainy season and during dry season. For example, during rainy season there could be more pesticides used due to more incidents of diseases and more fertilizers used due to the leaching effect of constant rain and more seedlings damage from rain.

During dry season, there could be more power used from electric pumps due to more watering and less watering during the rainy season, hence, less power used.

There could be more labor during the dry season because it is the usual propagation time in the tropics and less during the rainy months because it is outplanting time or vice versa.

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