Multiplication, that's the name of the game

Guidelines for seed production of agroforestry trees

The demand for tree seed of species and provenances that are particularly suited for specific agroforestry practices can be very high — and often demand outstrips supply. When this happens, farmers either do not plant trees or use whatever seed is available, even if it is inferior. This article by ***Ian Dawson*** *and* ***James Were*** *suggests useful guidelines for producing good tree seed. The guidelines are geared to extension organizations, researchers and others involved in spreading agroforestry techniques.*

The leguminous tree *Gliricidia sepium*, from central America, is a good example of an agroforestry species whose demand is greater than the supply of good quality seed. Gliricidia is planted throughout the tropics for various uses including fodder, firewood and green manure. It has been widely collected by the Oxford Forestry Institute and others, and tested in field trials. One particular provenance, Retalhuleu from Guatemala, has consistently performed significantly better than all others tested. Its superiority has been widely advertised, resulting in a current demand of several tonnes of seed yearly. However, the natural stand of Retalhuleu gliricidia is small and produces only a few kilograms of seed annually – meeting less than 1% of the demand — and many farmers have had to use inferior seed, often collected from poorly performing local trees. In cases like this, the only way to provide enough seed is through planting stands of trees specially to produce seed ('seed multiplication stands'). Recently, this has been done with Retalhuleu.

It is important that good quality seed is available at the start of a planting programme, because once poor seed has been widely planted, it is very difficult to replace it with a better source. Ideally, therefore, it is important to try and anticipate future demand for seed through the early planting of seed multiplication stands. Then, when the demand arises, good quality seed is already available to fulfil it.

Getting the seed you need for your area

Find out the species and provenances (if known) best suited for your planting purpose and region. Look at local species or provenance trials. Ask for recommendations on what to plant from national forestry or agriculture services, from organizations involved in international trials — such as the Oxford Forestry Institute, the Australian Commonwealth Scientific and Industrial Research Organisation and ICRAF — and from tree seed suppliers.

See if there is a need to establish seed multiplication stands to meet the demand for a chosen species/provenance by looking at the current sources of seed supply. For large-scale tree planting activities which have reached the dissemination phase, it is usually necessary to establish multiplication stands. Even if it's possible to buy smaller amounts of seed, it may still be worthwhile to establish multiplication stands because commercial suppliers often ask a high price for quality seed. For indigenous species, it may be possible to collect sufficient seed from wild sources, but collection sites are often distant and inaccessible — it is often more convenient to establish local stands.

Get seed of the species/provenance you need from a well-reputed supplier, even if it costs more than

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Healthy nursery seedlings are an essential part of a successful seed multiplication stand.

getting it elsewhere. Adequate documentation on the origin of seed should be provided, because stands should only be established from material which has an identified source. Seed should be from a wide genetic base (that is, with high genetic variation) to give the most flexibility to changing user requirements and environmental conditions. Since most trees are predominantly outbreeding (they produce seed by the transfer of pollen between individuals, rather than self-pollination), a wide genetic base provides protection against a future loss in performance through inbreeding depression (a decrease in vigour common to outbreeding species when the genetic base is too narrow). If possible, multiplication stands should be established from seed initially collected from at least 30 mother trees.

Finally, seed must breed true. Hybrid seed should not be multiplied, as progeny will not be true-to-type. Farmers should not normally be encouraged to plant hybrid tree seed, because these cannot then produce their own seed. Nationally, potential suppliers of seed are tree seed centres and forestry or agriculture services. Internationally, seed suppliers for more than 4000 tree species are listed by Kindt and others (1997), although information on particular provenances is not included and must be requested directly. If you collect seed yourself to establish a multiplication stand, follow the collection guidelines of Dawson and Were (1997).

Choosing a good spot for a seed stand

Choose a site with suitable ecological conditions for seeding, or your efforts might be unsuccessful. Factors such as temperature (which is influenced by altitude), fluctuations in day length, annual rainfall and length of dry seasons, soil fertility and pollinator availability all determine whether a species will flower and fruit at a particular site. In some species, flowering is stimulated by a combination of decreasing temperature, reduced day length and moisture stress. Generally, fertile well-drained soils, an abundance of appropriate pollinators (where relevant) and dry conditions after flowering all help seeding. You can gather information on the likelihood of good seeding of a particular species from observing locally planted trials or other stands. Most species will seed under ecological conditions similar to their native environment. Salim and others (1998) list these conditions for a range of tree species. Occasionally, you can influence seed production — for example, by introducing suitable pollinators if these are not normally available (such as using beehives for bee-pollinated species). Finally, a site close to base will be easier to manage and to collect seed from.

Stand design

Before planting, plan the layout and management practices for the multiplication stand, considering the following:

Tree spacing and management Trees need to be widely spaced so that light can penetrate crowns to stimulate flowering, pollination and seed ripening. Wide spacing also allows easy access to trees for seed collection. Actual spacing will depend on the biology of the species (tree form, age before flowering and fruiting, and pollination mechanism). For legumes such as calliandra, gliricidia, leucaena and sesbania, which should flower within two years of planting, 4 x 4 m between trees should ensure satisfactory seeding. However, trees may be planted more closely to maximise initial seed production from a stand and then thinned later as the canopy closes. Thinning can be systematic (for example, every second tree is removed from a stand) or selective (based on tree growth, form, or seed production). Systematic thinning is normally recommended, since selective thinning can lead to a significant loss in genetic base (see above). For some species, coppicing can increase crown density, leading to more flowering and fruiting sites, and if trees are smaller, it's easier to collect seed.

Number of trees Production stands should consist of sufficient trees to fulfil the predicted seed demand of users. Annual seed yield per tree can be roughly estimated for most species, and this will give an idea of how many trees are needed to produce a certain amount of seed. The extent of planting is also influenced by economic factors, such as the costs of stand maintenance and seed collection. To determine if sufficient resources are available for a project, costs should be budgeted before planting. To ensure a wide enough genetic base, a production stand should consist of at least 50 trees.

Isolation distance To ensure genetic purity, a multiplication stand should be isolated from any other stands it might cross with by at least 100 m. The actual distance might have to be greater if neighbouring stands are extensive or pollination can occur over long distances. In some cases, adjacent stands can be managed (for example, by coppicing) so that they do not flower while pollination is occurring in the multiplication stand.

Information on the design of stands for particular species may be available from the national and international institutions mentioned above.

Planting and looking after your tree seed stand

Before they are planted out, nursery seedlings should be the right size for transplanting. Therefore, seed must be planted in the nursery at the correct time to coincide with planting out seedlings at the onset of the rainy season. Before planting, the chosen

site should be well cultivated and marked out.

After planting, ensure the stand is properly managed, including protection from browsing animals and control of weeds. Weeding in the early stage of establishment prevents competition. Alternatively, a cover crop may be planted to choke weeds and reduce labour costs. A cover crop also reduces soil erosion and conserves soil moisture. Coppicing and other management practices need to be undertaken at the correct time. Coppicing should be done at the start of the rainy season, to minimize tree moisture stress and allow rapid regrowth.

Seed harvesting

When multiplication stands reach maturity, ensure that seed of high physiological quality is harvested. The following should be considered:

Seed maturity Seed should be collected when mature, as immature seed has low viability and storage life. The interval between flowering and seed maturation varies for species and in different environments. For legumes such as calliandra, gliricidia, leucaena and sesbania, it is normally six to ten weeks. For most species, seed is mature when it can no longer be crushed between thumb and forefinger. Seed can be cut to check on the presence of a mature embryo and endosperm. Often, the colour of seed changes on maturation (for example, from green to brown or grey for many legumes). The same applies to fruit.

Seed harvesting method Seed can be harvested directly from trees by picking fruit, or collected from underneath trees. Harvesting directly from trees is better, because pest and disease attack (for example, mammals, insects, fungi and bacteria) is less likely. If seed is harvested from the ground, spreading a tarpaulin under the tree to catch the seed can reduce attack. Specialist tools such as pruning shears may be required to harvest fruit from trees.

Seed harvesting interval Individual trees produce mature seed at different times in a season and, within trees, seed maturation varies through the crown. To get a good quantity, mature seed must be collected at several times in a stand. The interval chosen depends on the seed dispersal mechanism of the species, severity of pest and disease attack, and the labour cost of each round of collection. The interval should allow a reasonable quantity of seed to mature since the last collection, without excessive shedding. If a species sheds mature seed easily, more frequent collection will be required. For example, *Calliandra calothyrsus*, *Gliricidia sepium* and *Leucaena leucocephala* may require a collection interval of as little as two weeks. For species such as *Sesbania sesban* that shed mature seed less readily, a four- to eight-week interval may suffice. The aim of harvesting is not necessarily to collect all seed from a stand, but to collect a reasonable proportion of the seed in a cost-efficient manner, while ensuring quality standards are met.

Seed harvesting conditions Collect fruit during dry weather. Dry seed is less susceptible to pest and disease attack during the time between collection and processing. Dry conditions reduce the time required to dry seed before storage. Before processing, store fruit in cloth bags that allow air to circulate freely, as this helps drying.

Ensure that seed of high genetic quality is harvested. Collected seed should be of the widest possible genetic base and should represent the initial seed used to establish the stand. Collect approximately the same quantity of fruit from individual trees and sample throughout the crown to ensure this. In practice, the quantity of seed produced by, or the ease of harvesting from, individual trees may vary greatly. It is important not to bias sampling by collecting substantially more seed from certain trees, especially in a small stand, because this narrows the genetic diversity of

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Calliandra *trees readily shed seeds — so these need to be harvested at intervals of as little as two weeks.*

your collection. In large stands, bias is reduced because of the high overall number of trees sampled. Finally, because of variation between trees in seed maturation, seed harvested from a stand at different collection intervals within a season should be mixed before being distributed to users.

Processing the seed

After harvesting, process the seed carefully, using the following guidelines:

Seed extraction For most species, seed should be extracted from fruit as soon as possible. The method will depend on the species. For many legumes, pods can be dried in the sun for two days and then rubbed across a coarse wire mesh through which seed falls. The extraction method used should not damage seed so that a significant loss in viability occurs. During extraction, impurities (for example, diseased or partly eaten seed, contaminating seed, soil, chaff and insects) should be removed by winnowing or hand-sorting.

Seed drying After extraction, most seed should be dried further before storage. Generally, the lower the moisture of seed, the longer it can be stored. Normally, seed with a moisture content of 10% or less will maintain high viability for several years, if stored correctly. Sun drying seed for two to three days generally reduces moisture to an acceptable level, although more time is needed for large seed. Seed should be spread on raised beds to help air circulate and shaded from strong sunlight (move seed into the shade for about two hours at midday).

Seed testing During processing, the viability and purity of seed is normally tested. Viability is the percentage of germinating seed in a seedlot and is measured by germinating seed under conditions — including any pretreatments (such as scarification or hot-water treatment) — that would normally be applied during germination. This provides a reference level of germination for users. Purity is the percentage by weight of pure seed in a sample and is estimated by weighing a sample of seed before and after the removal of impurities. Particular impurities, such as contaminating seed, are recorded.

Seed documentation Seed must be properly labelled during processing and storage. An unidentified seedlot is almost worthless. As a minimum, seed should be labelled with the species name, original collection source, production location, collection date, producer, viability and purity.

Seed storage

Store seed under conditions that maintain viability. Normally, dried seed should be kept cool and dark in airtight containers (such as plastic or glass bottles with screw-tight lids). If possible, seed should be stored in a refrigerator.

Seed dispatch

When dispatching seed, give users full documentation as above, plus information on any seed treatments required for a high and uniform level of germination.

Tips for harvesting and storing tree seeds on small farms

Rather than planting special seed production stands, most farmers collect seed from trees they have planted for other reasons. Here are some simple ways of harvesting better seed from these trees:

- Harvest equal amounts of seed from a number of trees, not just from the tree with the most seed. You can also exchange seed with neighbours. This will help keep a wide genetic base in the seed.
- Harvest seed when it is mature — this seed has the best viability and storage life.
- Harvest seed by hand-picking directly from trees and not from the ground, to minimize pest and disease attack.
- Dry seed as soon as you collect it, and store it in cool, dry conditions for best viability.

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