Forestry Technology #1

Seed Collection

by Norman Jones
1 Bradfield Avenue, BRIDGEND, Mid-Glam CF31 4HL, United Kingdom
Tel [44 16560] 656726; Fax [44 1656] 768369;
e-mail: njones18@compuserve.com

Why work hard to collect good seed?

In agriculture, collecting seed from superior parent stock has been practiced for thousands of years. This technique results in higher yields and environmentally durable plants. This concept, however, has yet to gain widespread acceptance in forestry practice. To maximize yields and quality of trees for plantations, agroforestry, and other uses, the following principles for collecting seed should be observed.

One program, two benefits

In forestry, as in agriculture, the quality of offspring plants improved populations will result if the seed used to produce them was collected from superior individuals, stands or orchards. Seed quality is measured in two ways. One, by the physical quality of the seed and secondly by the desired physical traits of the resultant mature tree. The benefits of using quality seeds, chosen from selected parent trees, are twofold: improved survival and greater economic returns.

Improved Survival

Seeds from healthy, well-formed trees provide greater assurance that resulting stock will have good form, survive and better resist stressed conditions due to marginal sites, frequent cutting, or harsh climates. These adverse conditions typically weaken all but the strongest trees, making them vulnerable to insects, fungi, parasitic plants, and diseases. More important, because of the long-term resource investment and land and labor commitment in forestry, high survival rates of good quality trees is a must. In agriculture, farmers can recoup their loses after a poor season, or even two. Trees, however, occupy a site for years. Therefore, any reduction in growth or quality from planting inferior stock represents a lost opportunity, which can be measured in time and capital, for as long

as a tree occupies a particular site.

Higher product yields

For the second benefit, economic return, the investment in selection will be more than compensated for by higher product yields over shorter rotations. Better yields result in more building materials, higher fruit production and quality, faster fuelwood growth, and quicker and more prolific regrowth after lopping.

Simple measures are most effective

Effective seed selection can create success, even though sophisticated techniques may not be used. Any attention given to seed source will be a measured improvement over current practices. In addition, careful seed handling practices must be included as part of the seed collection program. Such practices include transport, seed preparation, handling, cleaning, grading, and seed testing. Disregarding these practices will result in damaged seed or allow the inclusion of unwanted or excessive amounts of foreign materials, which may hinder germination and plant production.

The following sections in this bulletin describe how to develop a system of proper seed collection and handling practices.

Where to get started

Planning the seed collection strategy

Too often in large planting programs the task of seed collection is an afterthought, typically left until the last minute and done hurriedly by unskilled or untrained labor while final nursery preparations are being made. Small-scale planters usually have access to left-over seeds from large programs. In either case, little consideration is given to seed quality, form, or location of the parent stock. Sometimes, to satisfy the requisite seed volume, nursery managers purchase bulked seed from villagers. However, villagers tend to collect from the nearest trees or stands, which generally include immature, diseased, distressed and otherwise inferior seed. And, if seeds need to be collected from the crown, villagers will choose the easy-to-climb trees, which are typically small and misshapen. Such trees would not normally be chosen as prime seed source candidates. Also, in some species a single tree will produce a large amount of seed in some years. Such a harvest may satisfy the bulk requirement, but would be genetically dangerous because only one phenotype is represented. This technique causes problems for both large- and small-scale planters.

Careful planning avoids wasted time, effort

Either approach, using untrained labor or collecting seed from a single tree, can be a critical mistake. Such practices often result in low survival, substandard trees, and a poor economic return for the time and work invested, for example, nursery and site preparation costs. Instead of an impromptu search or purchase from unknown sources, any seed collection, both large-scale and small-scale, should be a developed program of scheduled activities overseen by knowledgeable individuals. This is especially true for those involved in large-scale planting programs. Those involved in small-scale plantings can often request advice from nearby large-scale planters. These essential activities include selection of preferable parent trees; preparation of equipment including provisions for handling, transport, extraction, testing, grading, and storage; recruitment and training of workers and; seed sampling and quality monitoring. A timeline and workplan for the collection itself must be developed in conjunction with overall nursery operations. More important of these is the selection of preferable parent stock. This can be accomplished by an able person who can distinguish between desired and inferior seed sources. This person, in turn, can supervise field collection crews during harvest. Incorporating many of these activities often requires the level of funding available to large-scale operations. Nevertheless, even the small-scale planter should apply the principles as best possible whenever collecting seed.

"The choice of seed source is one of the most important decisions faced by the forest manager. An error in judgment can lead to crops with poor stem and branch form or prone to pests and diseases. Within the genetic constitution of the seed is the potential for either good or poor tree growth, and since even small increases in growth rate or improved timber quality can lead to a much enhanced return on investment, the advantages of using the best available seed from which to grow the planting stock are considerable." Hibberd, P.G. (Forestry Commission Handbook 6: Forestry Practice) HMSO London, 1991.

Genetics provides the basis for seed selection

Why is it necessary to collect only from certain preferable trees?

Tree improvement programs worldwide have shown that seed collected from trees with particular traits tends to produce trees with similar traits. One can correctly assume that if good parent trees are selected, then most of the resultant offspring will be of desirable quality. Yet despite this concept's proven value and wide understanding, it is seldom applied in the field. To correct this shortcoming, simple parent tree selection guidelines should be developed. These would identify the desired traits and specify the parent trees that reflect those traits. Such traits might include straight trunks, fast growth, and better form. These guidelines are normally met in national or company research programs, but following them will benefit all planters who are careful about the source of their seeds. The traits in turn are chosen to reflect the ultimate desired use of the tree, including building materials, windbreaks, shade, fuelwood, or

erosion control. At the same time, these guidelines should not be made cumbersome. For the benefit of those individuals collecting seeds, the guidelines could be a condensed set of simple criteria. Indeed, immediate benefits can be derived from using even the most basic concepts, such as selecting trees of good form and vigor and avoiding trees that are poorly developed, diseased, dying, or are isolated from others of the same species. These simple methods should be applied to large and small programs.

Collection strategy includes area, number, and spacing.

While it is important to collect seed from the best parent trees it is also important to gather seed from several parent trees. Collecting seed from several parent trees assures a diversity among seedlings being planted. Whether the program is large or small, maintaining diversity is important and will help guard against pest epidemics. To obtain adequate diversity, seedlots should be collected from a number of trees within a species' range. Researchers have yet to determine an ideal number of trees per seedlot.

In plantations and along roads more emphasis should be placed on collecting from the best trees. In all cases care should be taken to collect seed from several trees representative of the best parent stock. Researchers have yet to determine an ideal number of trees per seedlot, i.e., those seeds that will be used in one planting. However, most agree that collection should not rely on only one or two individual trees. According to some sources, a minimum of 15 to 25 mother trees per bulked seed source is preferred. Furthermore, collection should cover a broad geography, including the environmental extremes at the edge of the range. Seed selected from a narrow sampling of trees should be avoided as this will limit genetic diversity. Keeping a proper distance between selected parent trees is also vital. During natural regeneration of some species, seeds fall near the parent stock. In time, inbreeding may occur, which will result in lower quality individuals. To reduce the chance of collecting a seedlot predominated by half-siblings, a 100-meter distance between collection trees of the same species is recommended. This practice is especially critical to species that are lopped or coppiced as a method of harvest and regeneration. The temptation to forego a minimum number and spacing strategy is perhaps greatest during years of abundant seed production. Here, a large seed quantities are available from relatively few trees. At such times, an even greater effort should be made to ensure genetic variety. Even better, abundant seed years can be opportune. When properly cleaned and prepared, seeds can be stored for several years. Stored volumes of good seed will help ensure supplies during leaner production cycles. Where possible, all large-scale planting programs should have at least two years' seed supply in storage. Conversely, leaner seed years present other challenges. During such years shortfalls will occur and the urge will be to collect for quantity, without regard to quality. If at all possible, seed collection during lean production years should be minimized.

Proper scheduling is vital to quality

Aside from genetic and site qualities, other considerations must be factored into the collection strategy. For instance, only mature seed from ripened fruits should be gathered. Harvest schedules must account for the different times at which fruits from various species ripen. Depending on species, maturation can last between two to six months. To help determine ripening, periodic surveys of the selected stands is suggested. Surveys should begin after flowering, as is the practice with cocoa. To prevent any false readings, specific sample trees should be marked and used throughout the process. The surveys will also serve as an early indication of the season's expected seed volume and quality. In addition, field surveyors can detect early infestations of insects, disease, or other seed predators. With such information, the harvesting strategy and schedules can be adjusted to accommodate any foreseen hindrances.

Take note of growing sites

Aside from desired end-use traits, the tree must adapt to its growing site. In particular, it must withstand periodic harsh conditions, such as drought, and be able to grow in poor soils. Physical traits alone may yield few clues as to site adaptability. Here, environmental distinctions may help.

The collection staff should note even the slightest variation throughout a species' range. Topography, soils, microclimate, associated vegetation, and man-caused factors such as perennial grazing may all influence how a species conforms to its surroundings. In overall location, a species typically grows best in the middle of its range and fares less well at the edges. However, seedlots should reflect all site variations, thus assuring that no one habitat is relied on too heavily. But some cautions are needed when sampling for habitat. When associated plants are used as site indicator species, one must discern between natural conditions and man-made alterations. For example, continual grazing can heavily degrade a site, even to the point where it changes the vegetative makeup. In addition, extreme dry or wet areas should be excluded if not within the normal bounds of a species' requirements. During collection of particular stands, efforts should concentrate on trees that comprise the stand's perimeter. These individuals produce better quality seed. Aside from natural areas, man-made stands should be reviewed carefully before selection as a seed source. For example, early reforestation efforts may have given little thought to seed collection, thus producing inferior parent trees to those found in natural stands. Or, the species planted on the site may not be well suited for the area. Whenever possible, historical data or records should be referred to for such stands.

A short list of collection tactics

- Collect seedlots from between 15 and 25 individuals that are spaced at least 100 meters distance from any other collection tree of the same species.
- Choose trees in vigorous health and avoid any that are diseased, suppressed, deformed, environmentally stressed, or in otherwise poor health.

- Collect from trees that are well formed and either dominant or co-dominant in the canopy.
- Avoid individuals that are isolated from others of the same species.
- Harvest only mature seed from ripened fruits.
- To ensure genetic variation, collect fruits equally from all parts of the crown--top, sides, and bottom--as these parts may have been pollinated at varying times from different sources.
- Collect throughout a species' normal habitat, noting variations in site.
- Man-made stands, including live fencing, plantations, or windbreaks, should be carefully reviewed as to their establishment before being selected as a seed source.

A field strategy. How to select good trees

Parent tree selection in the field is best done as a planned team effort coordinated by a trained person. This selection of preferred trees serves to eliminate errors that would otherwise be produced by last-minute collection efforts. In addition, a planned, timely program allows for the full use of available people and resources. Development of the collection strategy includes a series routine screenings of potential parent stock. The series is broken into three progressive phases.

Phase one is done well before the onset of flowering. Given simple guidelines for site selection and appearance, general laborers search for appropriate stands. Locations of such are recorded, along with general descriptive information.

Phase two involves technical staff. Here, the identified stands are reviewed for their potential as a seed source. The review includes analysis of the site makeup including soils and topography, species composition, volume and spacing, and age, size and health of the trees. Initial selections are made as to potential parent stock. These trees are marked for further study in phase three.

In *phase three*, trained professionals examine the marked individuals for a final selection. The trees are analyzed for their physical characteristics, including their form, branching, growth rate, dominance, crown cover, health, and any clues as to their seed productive capabilities. Before the final candidates are chosen, additional criteria are again considered. This includes the previous mentioned spacing preference of at least 100 meters between individuals of the same species. And, preference will be given to those trees located in the stand's perimeter. Finally, selected trees are marked and their location noted. Monitoring will increase as flowering begins and continue through the seed harvest period. Monitoring includes volume and quality of the seed as it matures, in addition to any indications of pest infestations including insects and disease.

Seed handling and preparation

Seeds are rarely taken directly from the collection site for immediate planting in the nursery.

Instead, they must first undergo a preparation that will ensure proper

germination and help eliminate bad or damaged seed. Preparation includes all activities from collection to sowing. These activities cover transport, sorting, extracting, cleaning, testing, and grading. In addition, seed harvesting and sowing periods are often months apart, which requires adequate storage facilities. The facilities must protect the seed stock from the weather and intrusive pests such as animals, insects or molds. In some instances, proper temperature control may also be required. This is especially true if seed is to be kept over a number of years.

Handling in the field

Once the fruits are picked or collected, they must be transported directly for seed processing. Any lag time in the field could cause desiccation or predation by various seed pests. The seeds must also be well-protected from the weather to prevent excessive contact with moisture, which may prompt early germination. In addition, because of the variation in harvested fruits, handling techniques must flexible. Those in charge of collection must have adequate knowledge as to each species' requirements and limitations during transport. For example, while the hard coated seeds of most leguminous species travel well, other seeds are more fragile and require greater handling care.

Proper conditioning limits seed degradation

The nursery manager must have facilities readied for seed preparation at the time of collection. Such facilities should be located at the nursery site, thus eliminating the need for further transport before sowing. Seed extraction should occur as the fruits arrive from the field. Again, any lag between collection and preparation will cause the seed to degrade or spoil. Depending on species, equipment for both dry and moist extraction may be needed. Dry extraction requires appropriate sorting and drying areas, tumblers, and screens for sieving. Moist extraction calls for a method of macerating the fleshy fruits, followed by drying and cleaning of any remaining foreign materials.

In either case, all inert materials must be removed as these can result in poor germination or hamper storage ability. Also, the rate of drying and moisture content must be carefully monitored during the drying process. Seeds dried too quickly may become damaged. While small-scale planters may not have access to sophisticated equipment for drying and cleaning seeds, they should aim to remove as much foreign material as possible. After extraction, the pure seed is then graded. Grading helps ensure a more homogenous seed set, which in turn will produce more uniform growth in the nursery. Grading is done either by seed size, weight, or a combination of both. Actual seed size within the same species will vary due to a number of factors. The goal is to eliminate undersized, immature, or deformed seed. This usually can be done by hand if great quantities are not required. However, graders must be provided samples of the desired well-graded product to use as a guide. In

addition to grading, seeds are tested for germination rates, and are examined for phytosanitary concerns and species purity. Using these factors, the forester must develop criteria for consistent seed certification. No matter how carefully done, collection efforts in the field will be nullified if inconsistent methods of grading and testing are used from one seed lot to the next.

Proper storage is essential

If the prepared seed is not used within a reasonable amount of time, adequate storage must be provided. As noted, most leguminous seeds store well in normal conditions, provided they are properly cleaned, dried, and protected. Such prepared, intact seed can be handled and stored without fear of damage. However, if storage is required for several years, special facilities, such as cold storage, may be needed for some species. On the other hand, if germination begins, different measures must be taken. Here, the seed ceases dormancy and begins to use stored nutrients for survival. At this point, its shelf life is drastically reduced. Thus, it is important to closely observe the condition of the stored seed and monitor it periodically to ensure the storage environment remains intact.

Why collect seed from several provinces?

Differences in how trees adapt to environments is often more important with a species than among species. There can be important differences in growth between seed sources from different geographical areas and environments. The areas and environments in which stands have developed through natural selection are call provenances. The growth, measured in height, in tropical hardwoods of the most vigorous provenances can be 30 to 50 percent greater than the growth in the least vigorous provenances. Unfortunately, there are very few tree species that have been adequately explored in their center of origin and studied in provenance and progeny tests on multiple sites, leaving much uncertainty about provenances which are intended to represent an entire species. Perhaps the most striking example of this comes form the use of *Acacia mangium* in Sabah, Malaysia, where ultimately thousands of hectares were planted from seed collected from one tree. As a result, growth rates of third generation were one-half those of the first generation.

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Agroforestry Net, Inc.
PO Box 428
Holualoa, Hawaii 96725 USA

Contact us: email@agroforestry.net

Site comments and suggestions

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