Tree Seed Source Re-classification Manual
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ICRAF has been engaged in research on Tree seed source surveys, tree seed production and distribution with a wide range of local, national, regional and international partners for more than 6 years to understand tree seed systems in various countries

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Tree Seed Source Re-classification Manual

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Front Cover photo: Prunus africana plantation seed source (one of the sources used in field testing of the new seed source classification) in Meru around Mt. Kenya

Cover page back photo: Natural Farmland seed source of Melia volkensii in Eastern Kenya at Kibwezi in Joel Mungoloti’s farm. The trees are considered to be relicts/remnants from the original forest vegetation. (This source was used during the field testing of new class sources classification)
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Introduction

A seed source classification system is a practical tool in seed documentation which is an essential tool in quality assurance and marketing. Different seed source classes have been used from the early stages of tree improvement to rank the genetic history of plantation seed (Zobel and Talbert 1984, Wright 1976).

Definitions of tree seed sources have been developed and applied in many countries, and standardised (slightly differently) by OECD, EU, FAO, DFSC, GTZ and others (for convenience we call it the OECD system). These guidelines generally rank seed sources into unclassified and selected sources and for selected sources, into tested and untested reproductive material (e.g. OECD, 2007, Albrecht, 1993, Barner et al., 1988). The OECD system has been developed and is accordingly most suitable for plantation species in temperate industrialised countries.

However, the OECD system fails to include the majority of seed sources used by smallholders in the tropics. Most of these seed comes from trees scattered on farmland or from natural forests. Introduction of the class ‘farmland seed sources’ is an attempt to include this large and important category of seed sources. The ‘farmland seed sources’ may be remnants of natural vegetations or planted trees. Only a very small part of the reproductive material utilised for agroforestry is from selected, let alone tested sources, and the currently used definitions therefore disregard options for applying simple principles that can widen the genetic quality considerably and minimise the risk of inbreeding. Furthermore the terms ‘selected’ and ‘unclassified’ sources presuppose that central authorities have the capacity to establish, maintain, protect and evaluate improved sources of relevance to the consumers (smallholders), which is rarely the case. We suggest that it will be more fruitful to apply common sense criteria of quality to the bulk of reproductive material that is used by smallholders than to uphold strict criteria that are difficult to apply.

The simplified system used in this manual was first introduced in Nepal by Dhakal et al. (2005). The present document is mainly been an attempt to cover the seed flow system with a major component of agroforestry species in the tropical East Africa. However, the principles applied do not have geographical restrictions but can in practice be applied anywhere. Compared to the OECD seed scheme the main change is the introduction of farmland seed sources, and the elimination of the terms selected and identified. These terms may still be used as quality ranking in seed documentation. Some ‘classes’ have been eliminated as distinct classes e.g. Seed Production Areas and Seed Stands. It has therefore been necessary to re-classify these sources in the present system. Each category of the five new tree seed sources classification (Natural, farmland, plantation, Tree seed orchard and vegetative propagules) were tested in the field.
1. Use of seed sources and classification

A seed source refers to the source of seed for planting. The term ‘seed’ in this connection may be a bit misleading, since in reality we need source identification for any type of planting material, be it seed or vegetative propagules, so in practice the term means germplasm source.

Seed sources should represent the best available genetic material for planting as exhibited by the parental material. The real genetic value can only be verified through genetic test, which are long term, expensive and only available for some fractions of some species. However, experience from genetic testing allows us to give some general rules for seed sources:

i) Site-source matching: Well matched source are sources that match the environmental conditions of where the seeds are collected (source) and the site of where the seeds are to be planted (this is in reference with altitude, rainfall, temperature and soil characteristics). The source should provide tree seeds that are well adapted to the environmental conditions of the planting site. Populations that have regenerated and survived on a particular site for many generations have most likely adapted to the prevailing soil, terrain and climate at that particular site (eco-types). Plants from local seed sources or sources growing under similar conditions will thus often have an adaptive advantage compared to introduced material from different ecological conditions. Or: a particular seed source can only be used for a restricted part of the potential planting range of the species (= planting zone). Climate and soil data together with information about prevailing natural vegetation at the source and planting site respectively help to make the ‘best match.

ii) Provenance identification: Different populations have different genetic makeup, and some populations show significantly better performance than others under the same set of ecological conditions. In practice it is very difficult to assess genetic quality at population level without prior field test because populations are exposed to very different growth conditions.

iii) Genetic base / diversity: Any one seed is a cross between one male and one female i.e. in outbreeding two individuals. For some species selfing may play a role, but this is not common for trees. Bulked seed should represent a broad genetic base because genetic diversity gives more adaptation options, allows selection and reduce the risk of inbreeding in future generations. Although the issue of ‘optimal’ level genetic diversity is not an easy one, as many factors must be taken into account, we say as a rule of thumb that a seed source that is not part of a designed breeding programme should in general consist of many individuals and seed should be collected from at least 30-50 unrelated seed trees.

iv) Outcrossing: Trees are predominantly outcrossing. Self pollination results in inbreeding which is usually negative in trees as it may lead to inbreeding depression. The chances of inbreeding is increased when individual trees are isolated making out crossing difficult. In natural forests related trees occur in clusters of families and gene exchange within such groups or family may also lead to problem associated with
inbreeding. The best seed sources are those where outcrossing can occur i.e. where there are unrelated neighbouring trees flower at the same time. The distance between individual trees must be short enough to allow cross pollination. Generally not more than 100 metres.

**v) Genetic superiority:** It is measured by the level of genetic diversity within and between populations as well as suitability for intended use among other desirable characters. Some genotypes are more attractive than others for tree users, if they include genes that lead to trees with attractive phenotypes. For example genes that enhance superior production (yield) and product quality. However, the genetic variation may be blurred by age and environment, and only where the relative impact of these factors are reduced (or can be accounted for statistically) does selection of superior individual mother trees make sense (= give genetic gain). Accordingly, the first steps of domestication and selection in natural forests are entirely on population level, while individual selection belongs to a more advance stages. It should be noted however, that some traits can be under fairly strong genetic control. Stem form for example often seems to be under stronger genetic control than growth rate.

Seed source classification is employed to group seed sources into types where similar criteria for evaluation of genetic criteria are utilised: Natural forests sources represent a group of seed sources with similarities e.g. in relation to adaptability and regeneration; a natural forest and a seed orchard represent two different types. Seed source classes are practical tools in the seed documentation system, which has a practical application when selecting seed and plant material for planting programmes and activities. In addition it is often practical to categorise seed sources during domestication and breeding.
2. Summary of traditional seed source classes (the FAO, DFSC, OECD schemes)

Revising and simplifying the seed source classification system imply that some of the previous used classes be transferred into other classes. In this section we suggest a ‘translation’ of the former categories into the simplified system.

a. **Natural forests.** These represent some original vegetation type that is the result of natural processes such as dispersal (pollen and seed), natural regeneration and succession. Most natural forests in the tropics consist of many species. Single or few species natural forests do occur. Some pioneer forests are dominated by one or few species, and environments exhibiting strong stress phenomena e.g. salt (tidal areas), wind (coastal areas), cold (highland) or draught (dryland) are often dominated by one or few species. Natural forest category is maintained in the revised system and most seed sources previously classified as natural forests will be placed in the same category in the revised system. Exceptions are those sources that are fractioned, e.g. in farmland and which are now categorised as farmland sources.

b. **Plantations.** These normally referred to all categories of planted stands, established for commercial forest production and/ or environmental purposes of any kind, but without a seed production purpose. Although it has mostly referred to traditional block plantations, most previous systems included for example boundary plantings and shelterbelt plantations in this category. In the revised system some small plantations, woodlots, boundary plantings and shelterbelts will be placed under farmland sources.

c. **Seed Production Areas.** SPAs are plantations or (rarely) single species natural stands that have been genetically upgraded and managed for improved seed production by culling of poor phenotypes. Culling may also lead to some degree of genetic refinement and drift. Although rouging may give some genetic gain for desirable characters that are highly heritable, SPAs are, in terms of evaluation and seed collection, similar to their base source viz. plantations (or in rare cases natural forests). SPAs will thus in the present system typically be classified as plantations.

d. **Seed Stands.** The category is used for different types of sources whose main function is seed production for forest plantations. Sometimes it refers to a plantation established from selected material in a natural forest or a commercial plantation. Sometimes it refers to a plantation (or rarely a natural stand) that has been upgraded by culling i.e. above mentioned SPA. Seed stands could, dependent on the character i.e. selection intensity and genetic base of parent material, be categorized as plantations or bulked BSOs.

e. **Provenance seed stand.** The pre-fix ‘provenance’ refers to a known authentic location, but is otherwise the same as seed stand. In Australia the term ‘provenance resource stand’ is used in the same connection. Provenance seed stands are in the revised system usually classified as plantations, sub-category provenance plantation. Provenance seed stands known to be based on a broad
and selected parent material from defined location could also be classified as bulked BSOs.

f. **Extensive Seedling Seed Orchard (ESSO).** The class refers to some intermediate level between seed stand and seed orchard. Mother trees (plus trees) have been selected according to pre-decided characters, but seeds and plants have not been kept separate and planted with family design as in normal seed orchards. ESSO seed sources follows closely the class bulked BSO in the revised system.

g. **Identified stand.** In the OECD seed scheme concept an identified stand is an accepted or ‘candidate’ seed source i.e. a natural stand or plantation that has a sufficient size, diversity and phenotypical performance not to be disqualified (OECD 2004). Identified stand would in this system be re-classified according to genetic history and information, i.e. natural forest, plantation or farmland.

h. **Selected stand.** This is also an OECD seed scheme concept, which refers to a seed source that has been selected or approved according to its superior general quality (OECD 2004). Selected stands are, as identified stands, re-classified as natural forests, plantations or farmland seed sources.

i. **Seed Orchard.** These are established seed sources i.e. sources with a documented parental history or pedigree. In seed orchards seed lots, i.e. mother trees, are kept separate and the identity maintained in order to do family selection and breeding as part of advanced seed production. Seed orchards can be established by seeds (SSO) or clones (CSO). In both cases the product is seed. A new concept, breeding seed orchard (BSO) has been introduced as a special sub-category of the seedling seed orchards. BSOs are based on a high number of families (mother trees), which permit selection for breeding during several generations without introduction of new material. Seedling seed orchards may thus be classified as ordinary seed orchards or BSOs dependent on their base material. The term Clonal Seed Orchard (CSO) is maintained in the revised system.

- **Seedling Seed Orchard (SSO) cum progeny trials.** ‘Cum’ (= with) progeny trials means that genetic evaluation is integrated in the SSO. Cf. the arguments above these could be BSOs or ordinary SSOs. The SSO may be classified as ‘tested’/ ‘qualified’ if the test results support superiority of the seed source progenies either before or after genetic thinning
- **Seedling Seed Orchard (SSO) w/o progeny trial means** that a parallel progeny trial is established away from the SSO (maybe on a potential plantation ground with more realistic growth conditions than found in a seed orchard). Results from the progeny trial determine the genetic thinning. The SSO may be classified as ‘tested’/ ‘qualified’ if the test results support superiority of the seed source progenies either before or after genetic thinning
- **Clonal Seed Orchard (CSO) is established by clonal material** (usually scions) from selected mother trees, which is raised by
(usually) grafting. The offspring from the clones in the seed orchard may be tested in separate progeny trial. If such trials prove that clones in general are superior, the CSO may be classified as ‘tested’/ ‘qualified’. The CSO can also be classified and ‘tested’/’qualified’, if only superior clones (based on results of the progeny trial), are left and other clones removed (=genetic thinning).

j. Clonal garden, cutting orchards, clone propagation archives, vegetative propagules source (several names are used). This special category became necessary as vegetative propagation became a common way of raising trees. The source is mother source of vegetative material which is used for vegetative propagation of plants for bulk production. The term clonal garden is sometimes confused with clonal (seed) orchard. However, although the parent material is often (but not always) clonal material the distinction is that the harvested material from clonal garden is vegetative material and not seed. Vegetative material may be cuttings or explants for micro-propagation / tissue culture. The class remains unchanged in the present revised system; we use here the class name ‘vegetative propagules source’.
3. General criteria for seed source classification

The aim of the revised classification is to make it simpler, here by using 5 main categories, with some logic sub-categories where precision is necessary or where the main class include more than one distinct type. With a precise definition of the categories it should also be possible to place any potential seed source into a class.

We have applied 6 simple rules for the classification;

a. Sources are delineable. That means that sources are within a distinct geographical location i.e. a theoretical ‘line’ can be drawn around them.

b. Classes represent major differences. Smaller differences e.g. upgrading from a plantation to a seed production area by phenotypic thinning is here, due to its probable minor genetic gain, considered to be source management and does not merit a special category.

c. Categories reflect a distinct genetic history. Genetic history refers to natural or man-made selection and distribution. Man-made selection and distribution have an aim of genetic improvement of the planting material. The genetic ‘class’ thus determines the next step in the improvement process.

d. Individual sources are consistent. Although fractioning of, and intercropping in natural forest may result in a re-classification as a farmland source, the seed sources are generally not reclassified as a resource of management or external impact.

e. Class’s names are descriptive on use / design / material. The term ‘natural’ refers to process without influence by man; the term ‘plantations’ refers planting, the term ‘clonal’ to vegetative material etc. Despite the aim of making precise classes, transition types are unavoidable. There are naturalised exotic species mixed in indigenous forests, and there are transitions between abandoned farmland and fallow. In both examples classification could be subject to discussion.

f. Ranking seed sources according to their relative genetic quality may also not always be straightforward as genetic quality is relative, and in particular for untested sources, quality is assessed in rather general terms. Whether a farmland seed source is better or worse than a natural forest depends to a large extent on species, density, pollination and base population.
The description below of seed source classes includes these reservations with comments on transition forms and relative genetic quality respectively.

<table>
<thead>
<tr>
<th>Main seed source class</th>
<th>Sub-class</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Natural forest</td>
<td></td>
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</tbody>
</table>
| b. Plantation          | b1. Plantations with unknown origin  
                        | b2. Provenance plantation |
| c. Farmland seed source | c1. Natural  
                         | c2. Planted |
| d. Seed orchard        | d1. Ordinary seed orchard  
                        | d2. Bulked BSO  
                        | d3. Family BSO  
                        | d4. Clonal seed orchard |
| e. Vegetative propagules source | |

**Table 1.** Summary of system of revised seed source classification
4. List of seed source classes (5 types) and sub-classes

a. Natural forest seed source
   i. Description. Natural forests are natural populations of trees occurring in forest or woodland that is utilised for seed production. It includes all types of forests that originate from the original forest cover, i.e. a forest reproduced naturally without or with minor influence of man. Natural forests consist of indigenous species, which has spontaneously generated themselves on the location for many generations. Natural forests include both edaphic and climatic climax types and pioneer forests. Natural forests can be more or less influenced by culture, e.g. by logging or regeneration techniques, but the forests must not have been subject to regeneration by sowing or planting. However, enrichment planting and sowing using local material will still be considered natural forest.

   ii. Examples. Natural forest types range from high multi-species rain forests to forest types dominated by few species e.g. dry bush land / savannah, highland forest mangrove forest and pioneer forest types.

   iii. Transition forms to other sources. Natural forests as seed sources should be several hectares of coherent mature forest where the target species has a reasonable density that will allow out-crossing. Protected forests like national parks, Kenya Forest Service natural forests typically belong to this category. As a rule of thumb natural forests should have a size of minimum 4 x tree height (large size trees occupy bigger space) and contain at least 50 seed trees. Smaller, non-coherent scattered remnants of natural forests, where the individual piece is not sufficient size to make up a genetic diverse seed source are defined as farmland seed sources under sub-category ‘natural’. A transition type is secondary forest of fallow, which, with long periods between cropping cycles, may form a type of natural forest. Forests consisting of naturalised introduced species with relative short history should be considered plantations even if they have regenerated in situ by natural means.

   iv. Relative genetic quality. Natural forests are the base material for all other seed sources and must generally be expected to represent an ‘average’ quality. Trees growing in natural forests must be expected to show a high degree of adaptation to the prevailing environmental conditions of the site. Pollination is usually effective in natural forest. However, due to seed dispersal, there is in natural forests a risk that trees form family groups i.e. neighbouring trees are related or in extreme cases inbred. This will normally be broken in next generation plantation seed source. To assure genetic diversity is advised that seeds from natural forest be collected from widely separated trees. Seed sources in natural forests should accordingly typically be larger than plantations. Selection of mother trees / seed trees in natural forest usually gives little, if any, genetic gain since environment and age difference conceal or veil possible genetic variation. However, relatively
even-aged natural forests exist for example as pioneer forest after land slide, burning, shifting cultivation or other disaster events. Many types of natural forests are nowadays protected forests bounded by cultivated land. Even if the total distribution of the forests may be large, some individual species could have a limited distribution within the forest. Natural forests are typically used to ‘mobilise’ the genetic reserve.

b. **Plantation seed source**

i. **Description.** Plantations are forests that have been established by planting or direct sowing, usually with production aim e.g. timber but for some species, non-wood forest products for example resin. They could also be established for environmental purposes such as watershed management. Plantations should be minimum one hectare which, provided the plantation has been established from well mixed seeds of a good representative collection, should be sufficient to ensure possibilities of collecting from 50-100 seed trees at sufficient spacing (10-14 meters) even after thinning.

ii. **Examples.** Many timber species (teak, pines, cypress, gmelina, Meru oak, eucalyptus etc.) are grown in plantations. Non Wood Forest Product (NWFP) plantations are for example *Pinus caribaea* (resin) and *Acacia senegal* (gum). Environmental plantings are e.g. watershed areas, rehabilitated mining areas and rehabilitated grassland. While the former usually consist of one single
species, with trees grown at narrow spacing, environmental plantings often include a mixture of several species.

iii. **Transition forms to other sources.** Small plantings of less than 1 hectare are considered farmland seed sources because the individual stands are too small to form a coherent seed source. Where plantations are established with a main aim of future seed production, they represent an upgrading of the production plantation, since there has normally been a selection of parent tree phenotypes. With a strong selection of parent trees from production plantations or natural forest (where this makes sense), the source would be upgraded to a bulked seed orchard.

iv. **Relative genetic quality.** Plantation sources based on a sufficient genetic base are often better than natural forests because seeds and plants from different parents are mixed and the family structure thus broken. That gives a better chance of outbreeding. In addition, even-aged plantations grown at even spacing allows for some selection of ‘plus trees’ for seed production. The genetic history of plantations is crucial for their relative genetic quality. Some plantations are based on a narrow genetic base, e.g. early introduction of exotics. For many plantations the origin (provenance) and genetic base is unknown. This implies a certain risk in the use of planting material from the source. Plantations, especially those that have been grown on the site for more than one generation, may have been subject to some natural or managed selection, for exotics often referred to as land races. Plantations based on vegetative material (cuttings, tissue culture) may consist of one or few clones. Such plantations should for obvious reasons be disqualified.

b1. **Plantation with unknown origin.**

A plantation raised from plants with unknown origin and without documentation.

b2. **Provenance plantation**

A plantation raised from plants with known and documented origin from a broad genetic base.
**Plantation seed source:** seed trees which are planted in blocks (minimum one hectare) for other purposes other than seed production. These could have been established with plant materials from known origin which is documented or from plant materials of unknown origin which is not documented.

c. **Farmland seed sources.**
   
i. **Description.** Farmland seed sources consist of scattered trees, shelterbelt plantings, groups of trees and small woodlots interspaced in the cropping areas. Trees could be remnants of former coherent (natural) forest or it could be trees established by plantings. Often such species are rejuvenated by natural regeneration or planted. Sometimes the density of remnant trees is increased by additional planting of the target species. The distinction between the two types is thus not always clear.
ii. **Examples.** Most farmland seed sources are to be found on farmland i.e. agroforestry trees. However, the character of scattered trees and small groups of trees also exists in some urban areas e.g. parks or roadside plantings. Trees in new farming areas, which are remnants of former natural forest, may have been left because they have some production, ornamental or occasionally spiritual importance. Examples are *Ficus natalensis, Erythrina abyssinica, Melia volkesii, Faidherbia albida, Acacia seyal* and *Adansonia digitata* in parkland agroforestry systems.

iii. **Transition forms to other sources.** Farmland seed sources are derivatives of natural forests or plantations depending on origin. Where trees grow at high density i.e. not in combination with crops and the individual stand is more than 1 hectare they would be categorized as either plantations or natural forests. A theoretical transition to seed orchards may exist if seedlings of selected progeny have been planted in farmland with testing and seed production as an integrated purpose.

iv. **Relative genetic quality.** Reduction of stand density compared to natural forests and plantations may most reasonable cause degradation of the average genetic quality both due to the risk of removing the best trees and the risk of impeded outbreeding because of distance and changed environment for pollinators. However, ‘old’ systems may also have practiced some positive selection of good producing trees and stand density of selected useful species could be higher than in natural forest. Where planting is practiced it could have resulted in more diverse population structure. Special care should be exerted where trees have been distributed for plantings by organizations. Some species like eucalypts are occasionally propagated by tissue culture and distributed to farmers. Such sources should obviously be disqualified as seed sources.

c 1. **Farmland seed source, natural**

Farmland seed sources consisting mainly of remnant trees from former forest vegetation. These sources frequently consist of long-lived trees.

c 2. **Farmland seed source, planted trees**

Farmland seed sources consisting of mainly planted trees of local origin or introduced trees planted on farmland as intercropping, shade trees, boundary trees, small homestead woodlots, home gardens, ornamental or roadside trees.

**NB:** In practice it could be difficult to distinguish between natural and planted trees on farmland, especially in settlement with long history of farming, often consist of a mixture of remnants of former natural forest and planted trees.
Farmland seed source - could be remnants of former coherent (natural) forest or planted trees on farm for other purpose other then seed production. These trees consist of scattered trees, shelterbelt plantings, groups of trees and small woodlots interspaced in the cropping areas, along the road, in towns which are also utilised for seed.
d. Seed orchard

v. **Description.** Seed orchards are seed sources established from a known source, with a broad genetic diversity (many seed mother trees), usually with phenotypic or, in case of advanced generation seed orchards with genetic tests available, genotypic selection. Seed orchards are also called ‘established seed sources’ because they are planted with the prime and often only objective of seed production. Genetic test is sometimes an integrated part of the seed orchards; sometimes the test is kept separate at a different location. Advanced generation seed orchards are typically referred to with a generation number. 1\textsuperscript{st}, 2\textsuperscript{nd}, 3\textsuperscript{rd} generation seed orchards thus refer to orchards established after 1, 2 and 3 selection and breeding generation.

vi. **Examples.** Seed orchards exist of timber trees e.g *Pinus patula*, *Eucalyptus grandis*, *Cupressus lusitanica*, *Grevillea robusta*, *Markhamia lutea*, *Tectona grandis*, *Calliandra calothyrsus*. Seed orchards are usually part of a breeding or improvement programme where progeny is under testing or has been tested. Note that fruit orchards are mere production orchards and should not be confused with seed production in a seed supply context.

vii. **Transition forms to other sources.** Seed orchards with bulked seed (formerly called Extensive Seedling Seed Orchards, ESSO) are a transition to provenance plantations, where the only difference is the selection intensity of the base population. Seed orchards are highest category of seed sources. Some seed orchards may look as farmland sources because the space between trees can be used for cultivation or grazing, but the selection and establishment will place them in the seed orchard category.

viii. **Relative genetic quality.** Tested seed orchards (SO) would normally represent the highest genetic quality and thus potential performance of the offspring. This is provided that testing is performed under conditions comparable to real plantation conditions both in relation to growth site and cultivation practice (spacing, rotation length, mono-culture contra intercropping etc.). Tested seed orchard with family selection allows stronger selection resulting to higher genetic quality than bulked SOs. Bulked SOs is thus typically the first generation of a breeding programme or represents the first phase of domestication. Clonal seed orchards represent the ‘exact copy’ of mother trees.

d1. Ordinary Seed Orchard

Seedling seed orchards, which do not fulfil the criteria of Breeding Seed Orchards in terms of number of families and seed orchards where progeny trials are separate from the Seed Orchards, are classified as ordinary SOs.
d2. Bulked Breeding Seed Orchard (bulk BSO)

Seed for multiplication is collected from a number of (phenotypically) selected, unrelated mother trees. Bulked BSOs are established from the bulked seed lot (i.e. no family control). Each family should be represented by approximately the same quantity of seed in order to assure a reasonable balance between family representations in the seed orchard.
d 3. Family Breeding Seed Orchard (Family BSO)

Family BSOs are seed orchards established from a large number of families (60-100) with family control throughout the whole process of seed handling, nursery propagation and planting design in the seed orchard. Progeny of each mother tree (family) is planted in a plot consisting of 3 or more trees. Each family is established in several plots (replications). The overall selection thus combines within family and between family selections. Family plots must be thinned before seed collection can start because otherwise there would be a great risk of pollination within the family.
d 4. Clonal seed orchard

CSOs are seed orchards established from clonal material of selected mother trees. Clonal orchards are established with clonal control throughout the collection and establishment process. The cloned trees are usually multiplied by grafting, which generally gives an earlier seed production than seedlings, cutting and micro-propagated plants. Since clonal trees usually have low branching (‘a tree without a stem’), stem habits and growth rate must be evaluated on a parallel genetic test. Clones are planted in 1-tree plots in CSO because there is no ‘within clone’ variation.
e. Vegetative propagules source

i. **Description.** These are sources of vegetative propagation material (not seed), which can be cuttings, scions, buds or explants for micro-propagation / tissue culture. The mother plants are kept low by continuous harvesting of material. They are also called clonal gardens or hedged gardens.

ii. **Examples.** Vegetative propagation is, for most species, practiced for selected high bred material and often for hybrids where there is no or poor quality seed production. Much mass production is linked to clonal plantations. Examples are *Ocotea usambarensis*, *Polyscias fulva*, *Melia volkensii* and hybrid *Eucalyptus camaldulensis* x *E. grandis*. Most domesticated fruit trees (mangoes, apples, guava) are propagated vegetatively (grafting, budding, air-layering / marcotting), both to maintain
desired superior production and taste of fruits and to assure production at a younger age and size than seedling trees.

iii. **Transition forms to other sources.** Vegetative propagule source makes up a special category without transition forms to seed sources. The class must not be confused with a clonal seed orchard whose product is seed and not vegetative propagules.

iv. **Relative genetic quality.** This is a source of clonal propagation and the quality thus a direct copy of the parent plant. The quality of offspring in terms of production is often high but diversity is low. The latter could affect adaptability to adverse and variable environments.
Table 2. Summary of translation of formerly used seed source classes into a simplified system

<table>
<thead>
<tr>
<th>Present seed source class</th>
<th>Translation in present system</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural forests</td>
<td>Natural forest</td>
<td>Any type of natural forest regardless of species composition and successional stage. Degradation and fractioning will tend to be classified farmland types.</td>
</tr>
<tr>
<td></td>
<td>Farmland seed source, natural</td>
<td></td>
</tr>
<tr>
<td>Plantation</td>
<td>Plantation</td>
<td>Rule of thumb: Block plantings of &gt; 1 hectare is categorised as plantations while smaller plantings are categorised farmland sources.</td>
</tr>
<tr>
<td></td>
<td>Farmland seed source-planted, natural</td>
<td></td>
</tr>
<tr>
<td>Seed Production Area</td>
<td>Plantation / Provenance plantation</td>
<td>Thinning / phenotypic rouging may be performed in all seed source types and is thus not considered a specific class.</td>
</tr>
<tr>
<td>Seed Stand</td>
<td>Plantation / Provenance plantation</td>
<td></td>
</tr>
<tr>
<td>Provenance seed stand</td>
<td>Plantation / Provenance plantation</td>
<td></td>
</tr>
<tr>
<td>Identified stand</td>
<td>n.a.</td>
<td>Identified and selected stands can be placed under any of the categories natural forest, plantation or farmland source.</td>
</tr>
<tr>
<td>Selected stand</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>Seed Orchard</td>
<td>Seed Orchard</td>
<td></td>
</tr>
<tr>
<td>Extensive Seedling Seed Orchard (ESSO)</td>
<td>Bulked Family Breeding Seed Orchard (BSO)</td>
<td>ESSO where base material comes from natural forest with very small gain for selection of seed trees should be placed under provenance plantation.</td>
</tr>
<tr>
<td>Seedling Seed Orchard (SSO) cum progeny trials</td>
<td>Family BSO</td>
<td>Seed orchards established from a base material of more than 60 families are classified as BSOs</td>
</tr>
<tr>
<td>Seedling Seed Orchard (SSO) w/o progeny trial</td>
<td>Ordinary seed orchard</td>
<td>The term ‘ordinary’ here means to distinguish it from the special category of seed orchard, the BSO.</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Clonal Seed Orchard (CSO)</td>
<td>Clonal Seed Orchard (CSO)</td>
<td></td>
</tr>
<tr>
<td>Clonal garden</td>
<td>Vegetative propagule source</td>
<td>Plant material harvested are vegetative i.e. cuttings, scions, explants etc.</td>
</tr>
<tr>
<td>Cutting gardens</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clonal propagation archives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hedged garden</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Documentation of quality (qualified, tested, selected, identified …)**

Genetic quality can only be documented from analysis of well designed genetic tests such as provenance trials (test on population level), progeny test (test on family level) and clonal test (test of individual genotype). However, such tests are available for only a fraction of seed sources. Testing is a very slow and expensive process and for the majority of species less accurate yet valid evaluation may be extracted from systematic assessment:

1. Non-established seed sources such as natural forests and plantations may be evaluated based on their phenotypic appearance, growth performance and genetic diversity, or secondary information from offspring established from seeds from the seed source. Seed sources, where such evaluation has shown superior quality may be termed ‘selected’.

2. During establishment of seed orchards, phenotypic (or in advanced generation genotypic) selection has taken place, which are likely to make them better than the bulked original source, yet the quality is not yet documented. Such seed sources may be classified as ‘qualified’. When test results are available they will be upgraded as ‘tested’.
References and selected readings


OECD 2007. OECD scheme for the certification of forest reproductive material moving in international trade. OECD Forest Seed and Plant Scheme. OECD


987-87-7903-316-0 (Internet)
Guidelines for filling in the Seed Source Registration Form

Introduction

This document contains explanatory guidelines for filling in seed source inventory or registration and most of the information to use when filling the collection forms used by KEFRI, ICRAF and other major seed distributors in Kenya. The seed source information is compiled into a database called Seed Source Inventory in ICRAF and KEFRI.

A seed source should be selected using the following criteria e.g. growth performance, size of the source or number of mother trees, age, health, and suitability of the species in the climatical zone where the seed is to be planted. The best tree seed sources meet certain standards, which ensure a wide genetic variation or good seed quality. The source should also match the environmental conditions of where the seeds will be planted.

1. Species information

Seed source reference number: This number consists of a prefix of two digits referring to the seed collection centre’s code (in case of KEFRI) followed by two digits referring to seed zone (Defined as an ecological zone with relatively uniform genetic (racial) composition) or ecological zone in Kenya, which may normally be from 01-25 (as defined by Albrecht ed. 1993 “The forest seed zones of Kenya)) and 3 digits referring to the species code, followed by 1 digit referring to seed source type ( can be 1-5).

Seed zone: Defined as an ecological zone with relatively uniform genetic (racial) composition or ecological zone in Kenya, which is numbered from 01-25 (as defined by Albrecht ed. 1993. The forest seed zones of Kenya).

Provenance name and origin: The provenance name is the location where the trees grow. It should be named after, for instance the nearest village, town, hill, lake or other definite geographical area.

Origin: Is the original source of planting material (e.g. provenance and country for exotics) and hence pertains only to planted seed sources. For natural stands origin is the same as provenance (write ‘same’). For plantations write original source or tick ‘unknown’ if there is no information about the origin.

Species: For established plantation seed sources there will usually be only one species for a particular seed source. However, natural forest or farmland sources may be within a limited area, a seed source for several species. In that case a form should be filled for each species, but the seed source reference number may be the same.

Common name: Normally refers to English, Trade name, Swahili or Local name (please specify).

Species code: Is a 3 digit numerical code used by KEFRI, please refer to special list.
2. Location description

The exact location is indicated with geographical coordinates DMS (conjugate: Degrees, Minutes and Seconds) or Universe Transverse Mercator (UTM). Coordinates can be read on Geographical Position System (GPS, a satellite based position system) or read from detailed maps. When reading positions in coordinates from maps it should be remembered that the distance between two latitudes (e.g. 1° and 2°) is 111 km, and that 1 degree is divided into 60 minutes. Only one measurement is usually necessary for each seed source. It should preferably indicate the centre of the seed source. Altitude is conveniently measured by an altimeter or read on GPS and is indicated as 'meters above sea level (m.a.s.l.)' (pls. avoid older measure ‘feet’). In hilly or mountainous terrain, altitude may be indicated as a range, e.g. 950-1000 m.a.s.l.

3. Seed Source Classification

Seed sources are classified according to official classification:

a) Natural forest seed source: Natural populations of trees occurring in forest or woodland that is utilized for seed production. These are normally trees growing naturally (not planted). Depending on species and location natural forests may be high closed canopy forest, scattered trees in woodlands or savannahs, or shrubs of dryland; situated in a state land e.g. on government/public land or trust land. As a rule of thumb the size should be at least one hectare and the population consist of more than 50 trees (smaller patches of fractioned natural forests may be classified as farmland seed sources).

b) Plantations. Plantations are trees planted in plantations, blocks or woodlots to provide wood, services or other end products, but not aimed at seed production. Plantation seed sources are divided into two categories;
   i. Plantation with unknown origin - trees planted in a block or as woodlot but planted with plant materials of unknown origin and no documentation
   ii. Provenance plantation. Plantations which has been established from seed of a known and documented seed source, often a selected superior provenance with the prime or secondary purpose of producing seeds

c) Farmland seed sources: Trees on farm or public land that have been planted or retained (remnants of indigenous trees) in farms to provide other end-products (e.g. fuelwood, fruits, fodder or services) apart from providing seed. This could be trees in a group, in a line, along the boundary or scatted on farms, in towns, around schools, churches or factories. In most cases individual populations are small and a farmland seed source thus typically consists of several farms and other stands (ideally seeds should be collected from 30 trees minimum).

*The two types of farmland tree seed sources are:*
i. **Natural farmland seed source** These are tree remnants (left out after clearing) natural vegetation located in agricultural landscape or in towns, which may be scattered or in groups or in a line from natural vegetation. These are trees of local origin representing the original population in the area.

ii. **Planted farmland seed source** These are planted trees of local origin or exotic (introduced), which may be planted within the farm, intercropped, scattered, along the borderline, on roadside or planted in towns, churches, schools for other purposes (e.g. for ornamental, shade or to provide fodder, timber) other than seed production.

d) **Seed orchards.** A seed source established from selected clones or families, isolated and managed for high quality seed production. These sources are defined as “established seed sources” purposely for seed production. The genetic identity is normally (but not always) maintained. Seed orchards are further divided into 4 groups:

i. **Ordinary seed orchard:** Seedling seed orchards that have been established by a smaller number of families than BSO and where breeding is not an integrated part of the SO.

ii. **Bulked breeding seed orchard (BSO) (formerly Extensive Seedling Seed Orchards (ESSO)):** Seed orchard established from a large number of selected trees (> 60) from one or more known provenances where seeds have been bulked and family identity is thus not maintained.

iii. **Family Breeding Seed Orchard (BSO) (formerly Seedling Seed Orchards (SSO)):** Seed orchard raised from seeds from selected plus trees, which have been tested / are under testing in progeny trials and inferior genotypes removed / to be removed before seed collection. Family identity is maintained and the orchard is designed so as to minimize inbreeding.

iv. **Clonal Seed Orchards (CSO):** Seed orchards raised from clonal material such as grafting, budding or air-layering. Clonal identity is maintained and the orchard is designed so as to minimize inbreeding. CSO is normally combined with a separate progeny trial. Cloning is done to stimulate early flowering by transferring the age of a mother tree (through scion) to a new plant.

e) **Vegetative propagation seed source.** These are sources for clonal propagation material only e.g. cuttings, scions and tissue culture (micro-propagation).

The main category and, if possible, one of the sub-categories should be ticked.

Genetic evaluation has 4 categories. Not evaluated or selected means either that there has not been an evaluation of the seed source or that the evaluation results were too poor to qualify for grading it “selected”. Selected means that the seed source has been evaluated and found better than average based on some defined selection criteria. Selection must typically be done by an official selection board, whose name is indicated. Qualified are Plantations and Seed Orchards where test results are not yet available (e.g. young seed
sources) but where there has been some selection of mother trees. The category tested is only used where genetic evaluation and rogueing has been accomplished. Type of test (e.g. provenance test, progeny test) is indicated.

4. Ownership and Protection
The main types of forest protection categories in Kenya are:

- **National Parks and Nature reserves** are natural forests with strongly restricted use, they are normally managed to sustain wildlife and biodiversity of plants. The parks are owned by Kenya government and administered by Kenya Wildlife Service (KWS)
- **The Natural forests and planted forests** for example planted shelterbelts, watershed belts or gene conservation areas are managed and protected by State or Government (e.g. Kenya forest Service)
- **Local Authority Forests**: any forest situated on trust land which has been set aside as a forest by a local authority pursuant to the provision of the trust land Act and also all lands in towns
- **Private forests/trees**: any forest or trees in farmland, privately or company owned
- **Communal forests/trees**: any trees in communal land or land set aside for a group of people to use for various purpose

Ownership categories follow the hierarchy of public ownership, cooperative or private tenure.

Owner of seed source refers to the tenure right; name of person or authority is indicated.

5. Climatic records
All information to be filled into this part should be obtained from official weather records from central meteorological station in Nairobi. The weather station best representing the climate at the site of seed source is selected; that is usually the closest station, but in case of hilly or mountainous terrain a distant mountain station may better reflect the climate at the site than a closer lowland station. Climate information from a number of stations is also available at [www.globalbioclimatics.org](http://www.globalbioclimatics.org). Kenyan climate is strongly influenced by the Inter-tropical Zone of Convergence (ITCZ) which passes north and south with seasons. Equatorial locations typically have bi-modal climates with two rainy seasons, while station to the north and south have more pronounced seasonality with distinct rainy and dry season. Rain occurs during two season’s viz. March-April and October-December in many parts of the country. Dry season is defined as months with less than 60 mm rainfall. The months with dry season are January-February, August-September.

6. Site description
Terrain/Topography is classified in three types.

- **Flat** describes terrain with no or small protrusions, e.g. savannah planes, river deltas, mangrove areas or highland planes.
- **Hilly** is small slopes and protrusions normally not larger than 50 meters relative altitude.
• Mountainous are high elevations with usually large difference between valley and top.

Slope. Indicated in percentage, i.e. number of meters raise or fall in elevation per 100 meters horizontal. Slope is classified in four types: None or gentle, Medium, Steep and Very steep

Soil type: The main soil type is indicated in common terms, e.g. limestone, alluvial soil etc. or, if available, in scientific terms such as Vertisols, Arenosols, Ferralsols, Nitosols, Andosols, Fluvisols, Gleysols, and Phaeozems. Texture is classified in categories according to the size of particles, the most coarse grained is sand and the most fine-grained is clay. pH is measured on a representative soil samples and is indicated as a range e.g. 4.3-5.0. Soil samples may be collected in the field and analyzed in the laboratory.

Natural vegetation: Type of natural vegetation typically reflects a long time adaptation of a vegetation type to a particular combination of climate and soil. Vegetation type may be recognized in terrain from existing or remnants of natural vegetation or information may be retrieved from vegetation maps.

According to the Potential Natural Vegetation Map of Kenya; Examples of natural vegetation types are Alpine (-), Mountain scrubland and moorland (scrub- and moorland), Bamboo woodland and thicket (bamboo), Moist montane forest (MM forest), Dry montane forest (DM forest), Moist intermediate forest (MI forest), Dry intermediate forest (DI forest), Upland Acacia woodland, savanna and bushland (upland Acacia), Broad-leaved savanna-evergreen bushland mixtures (mixtures), Lowland Acacia-Commiphora woodland, bushland and thicket (Acacia-Commiphora), Moist Combretum-Terminalia savanna (moist Combretum), Evergreen and semi-evergreen bushland (evergreen bushland), Semi-evergreen thicket (-), Papyrus and swamp (swamp), Open grassland areas on clay plains (open grassland), Acacia and allied vegetation on soils with impeded drainage (impeded Acacia, Mangroves forest).

7. Seed source description

Total area of the seed source is indicated in hectares for plantations and seed orchards. Number of trees per hectare is calculated based on main spacing. Total number of trees in the stand is calculated by multiplying the two figures. In stands consisting of more species (typically natural stands/farmland) the measure of stand density of the target species will be different from the stem density of all species together. Therefore, the two figures are indicated. Height range of mature trees is indicated for 10 average size trees. Diameter range is indicated for the same trees.

Maturity of the stand is categorized in three types;

• Young stands are stands largely under mature size and with small seed production.
• Mature aged stands have reached almost full production capacity in terms of seed.
• Over mature stands are stands with small production due to senescence
For plantations, seed orchards or vegetative propagules sources, the age of the stand can be assessed by indicating the year of planting.

Species composition: Plantations, seed orchards and vegetative propagules sources typically consist of one species only. Natural and some farmland seed sources may consist of more. Main 2-3 associated species should be indicated.

Genetic base pertains to established seed sources only, i.e. Seed orchards. Initial number of families is based on establishment records whether the family identity has been maintained or not. Number of families after thinning/culling can only be indicated if family identity is known, i.e. not applicable to provenance seed stands. Number of clones pertains to Clonal Seed Orchards (CSO) only.

8. Assessment of trees in seed source
The average phenotypic appearance of the trees in the stand is assessed for 3 main characters viz. stem form, branching, and growth. Where other characters are relevant, they should be added under 'others'. The characters should be scored on a scale from 1 to 5. For grafted clonal seed orchards, assessment of phenotype is not applicable (n/a.), or it may be based on secondary information from a progeny trial, which should then be indicated.

9. Seed production
The phenological periods (months) of flowering and fruiting is indicated. Records on earlier fruit collection or crop assessment data form the basic for crop production estimates.

10. Accessibility
Of primary concern is the accessibility during seed collection. If this is during the rainy season, access may be impeded by flooding, which should be noted on the form. Under 'other information' should be a short description of how to reach the seed source and the type of road should be indicated.

11. Other information (recommendations, observations etc.)
Observations could be degree of general or selective logging, threat from local communities, recent burning, attack by insect's, of the species etc. Recommendation could be on e.g. protection and management (e.g. thinning necessary, weeding necessary or fertilization Write also any other relevant information pertaining to seed sources which has not been indicated on previous forms e.g. contact person or office with more information of the source.
**SEED SOURCE INFORMATION SHEET**

a) **Species information**

<table>
<thead>
<tr>
<th>Seed source reference No.</th>
<th>Seed zone:</th>
</tr>
</thead>
<tbody>
<tr>
<td>_________________________</td>
<td></td>
</tr>
</tbody>
</table>

Provenance name: __________________________

<table>
<thead>
<tr>
<th>Origin:</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>_______</td>
<td>_______</td>
</tr>
</tbody>
</table>

**Species Name (botanical):** _______________________________

**Common name (s):** _____________-___________

**Species code:** _____________

b) **Location description**

<table>
<thead>
<tr>
<th>Seed source location: Sub-location</th>
<th>Location</th>
<th>District</th>
</tr>
</thead>
<tbody>
<tr>
<td>_________</td>
<td>_________</td>
<td>_________</td>
</tr>
</tbody>
</table>

**Province:** _________

**Country:** _________

**Geographical coordinates:**

Conjugate, DMS: Latitude: ‘ ‘ (Pls. indicate N or S) , longitude: , ‘ ‘”E or W

**Universal Transverse Mercator (UTM):** X: ___________, Y: _____________

**Altitude:** m. a. s.l

c) **Seed source classification**

<table>
<thead>
<tr>
<th>Natural forest seed source</th>
<th>Seed orchard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmland seed source</td>
<td>Ordinary seed orchard</td>
</tr>
<tr>
<td>Natural farmland seed source</td>
<td>Bulked breeding seed orchard (bulk BSO)</td>
</tr>
<tr>
<td>Planted farmland seed source</td>
<td>Family breeding seed orchard (family BSO)</td>
</tr>
<tr>
<td>Plantation forest seed source</td>
<td>Clonal seed orchard (CSO)</td>
</tr>
<tr>
<td>plantation established with plant material of unknown Source (origin)</td>
<td>Vegetative propagules source</td>
</tr>
<tr>
<td>Provenance plantation</td>
<td>Genetic evaluation</td>
</tr>
<tr>
<td></td>
<td>Not evaluated or selected</td>
</tr>
<tr>
<td></td>
<td>Selected, pls. indicate authority: __________________________</td>
</tr>
<tr>
<td></td>
<td>Qualified</td>
</tr>
<tr>
<td></td>
<td>Tested, Indicate type of test ____________________</td>
</tr>
</tbody>
</table>

d) **Protection and ownership**

<table>
<thead>
<tr>
<th>Protection category: National park or reserve, Natural forests/planted forest under Government forests, National forestry Research Institute, National Agriculture Research Institute Community forest, Private, Local authority Others pls. indicate: __________________________</th>
</tr>
</thead>
</table>

**Seed source owner:** State /public, Community, Private, Other

**Name and address of owner / administrator:** ________________________________
Collection permit: Not required, Required, pls. indicate authority: _______________

e) Climatic records

Nearest weather station: ________________________
Geographical coordinates:
Conjugate, DMS: Latitude: ‘ ‘ (Pls. indicate N or S), longitude: ‘ ‘ ‘’E

Universal Transverse Mercator (UTM): X: ___________, Y: _____________

Altitude: m.a.s.l, Distance of weather station from site-seed source (km)_________,
Number of years recorded: ____________

Rainfall regime: Two seasons, Bimodal, Unreliable

<table>
<thead>
<tr>
<th>Month</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>July</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pick Rainfall (mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mean annual rainfall (mm): ______________ Mean annual temperature (°C):
Length of dry season (<60mm) (indicate months): __________________________
Temp coldest month _______ Temp hottest month __________
Absolute min. temperature, °C: ______ Absolute max. temperature, °C: ______
Other information:
_____________________________________________________________________

f) Site description

Terrain/Topography: Flat, Hilly, Mountainous, Ridge top
Slope: None or gentle (<5%), Medium (5-10%), Steep (11-50%), Very steep (>50%)
Soil type: pH: ______
Texture: Sand, Loam, Clay,
Other information:
_____________________________________________________________________

Soil Depth: Deep, Medium, Shallow
Stoniness: None, Low, Medium, Rocky
Soil Drainage: Well drained, Poor drainage

Natural vegetation: According to the Potential Natural Vegetation Map of Kenya
Alpine, scrub- and moorland, Bamboo, Moist montane forest, Dry montane forest, Moist intermediate forest, Dry intermediate forest, Upland Acacia woodland, Broad-leaved savanna-evergreen bushland mixtures, Acacia-commiphora forest, Moist Combretum forest, evergreen bushland, Semi-evergreen thicket, swamp, open grassland, Acacia and allied vegetation on soils with impeded drainage

g) Seed source description

<table>
<thead>
<tr>
<th>Total area: hectares</th>
<th>No. of trees per hectare</th>
<th>No. of trees in the stand</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>or target species only: No. of trees per hectare</td>
<td>No. of trees in a source</td>
<td></td>
</tr>
<tr>
<td>Height range m</td>
<td>Diameter range cm</td>
<td></td>
</tr>
<tr>
<td>Maturity of stand:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Young, Mature, Over mature</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Species composition: One species, Mixed species, (Associated species), pls. Indicate:

Genetic base (for family/clonal seed sources only):
Number of families before thinning
Number of families after thinning
Number of clones before thinning
Number of clones after thinning
h) Assessment of trees in seed source

Stem form: _________, Branching: __________, Growth: ________, Others, pls. indicate:

_______________________________________________________________________

_______________________________________________________________________

_______________________________________________________________________

Phenotypic thinning Done Not Done

i) Seed production

Flowering period _________________ Fruiting period (collection):

______________________________

Harvestable fruit production (estimated): ______ Kg, or seed production (estimated):

______ Kg

j) Accessibility

Distance to nearest forest station/town/Divisional HQs: ___________
Road accessibility, Remarks: ________________________________

Walking distance from nearest road accessible by vehicle: ______ Km
Other information:

_______________________________________________________________________

_______________________________________________________________________

k) Labour availability

Name(s) of nearest village: ________________
Distance from seed source to nearest village: _______________________
Available labourers: _______________________

l) Other Information (management recommendations, observations etc.)