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Identification, establishment and management of seed sources

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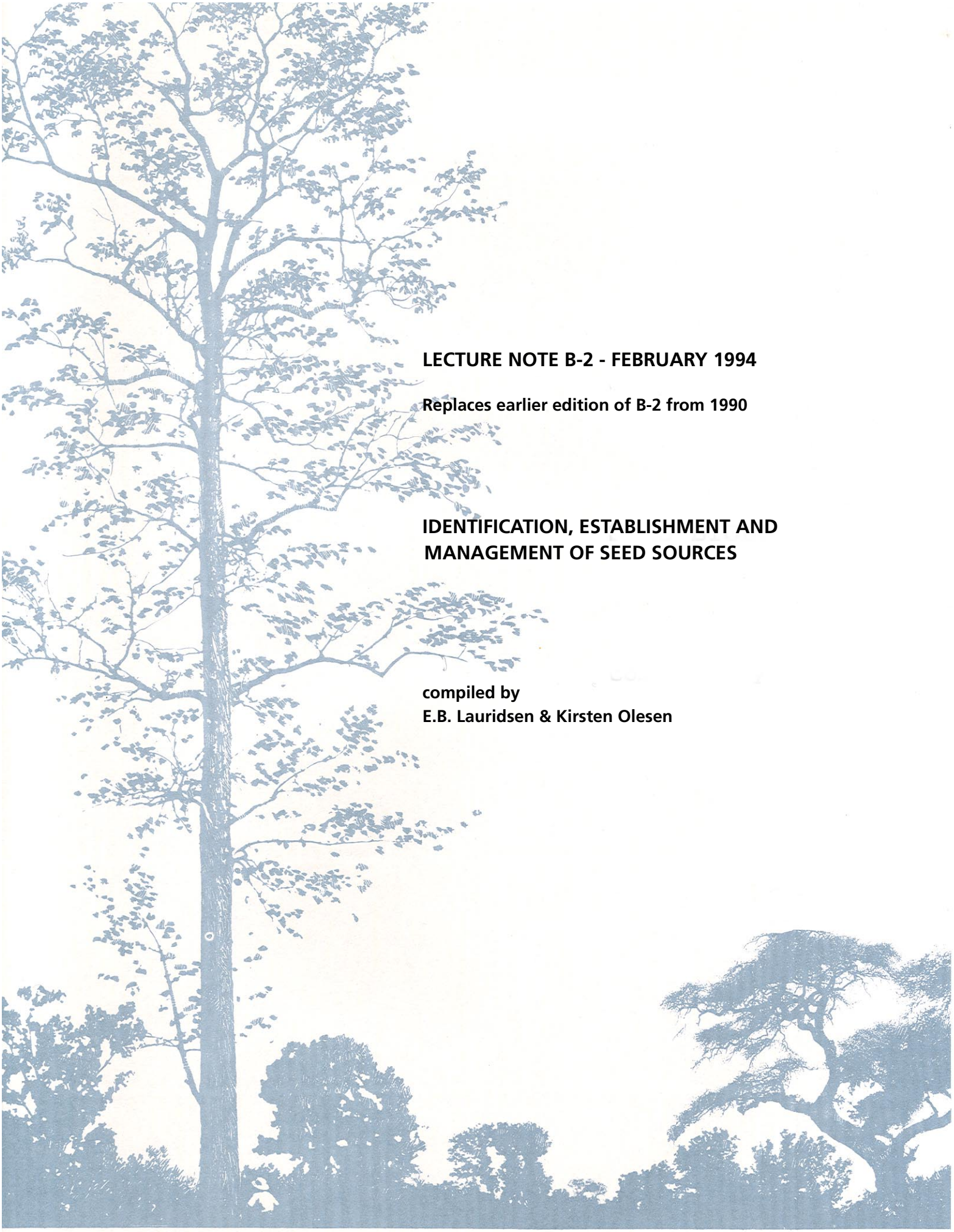

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IDENTIFICATION, ESTABLISHMENT AND MANAGEMENT OF SEED SOURCES

compiled by
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DANIDA FOREST SEED CENTRE

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CONTENTS

1. INTRODUCTION 1

2. STEPS IN THE PROCESS OF SEED SOURCE IDENTIFICATION 1

3. PREPARATORY DESK WORK 2
- 3.1 Size and Location of Planting Areas 2
- 3.2 Estimation of Seed Source Areas to be Identified 3
- 3.3 Location of Potential Seed Production Areas and Seed Suppliers 4
  - 3.3.1 Compilation of available information 4
  - 3.3.2 Mapping of seed sources already in use 5
  - 3.3.3 Mapping of potential seed sources 5
  - 3.3.4 Identification of seed suppliers and sources outside the country 6
  - 3.3.5 Matching seed demand and estimated supplies 6

4. VISIT TO AND DESCRIPTION OF CANDIDATE SEED SOURCES 7
- 4.1 Accessibility 7
- 4.2 Condition of Stand 7
- 4.3 Number of Trees and Size of Seed Source 8
- 4.4 Flowering and Fruiting 8
- 4.5 Phenotypic Appearance 9
- 4.6 Description and Sketch Map of Seed Source Candidates 9

5. IDENTIFICATION OF SEED SOURCES 12

6. ESTABLISHMENT OF SEED SOURCES 13
- 6.2 Siting of Stands 14
- 6.3 Size of Area 17
- 6.4 Registration of Selected and Planted Seed Sources 17

7. MANAGEMENT OF SEED SOURCES 18
- 7.1 Demarcation 18
- 7.2 Protection 19
- 7.3 Weeding 19
- 7.4 Thinning 19
- 7.5 Isolation 20
- 7.6 Fertilization 20
- 7.7 Conservation 20

8. REFERENCES 21

1. INTRODUCTION

The identification and establishment of seed sources is a continuous process throughout the existence of a tree seed programme. Seed sources will be selected, improved and discarded depending on the level and progress of genetic improvement required for the different species. It is important to start the process at the earliest possible stage of the programme, even if the currently available information is incomplete.

The immediate objective is to find seed sources to cover the current seed demand adequately, in respect of quantity and as far as possible in respect of genetic quality, and at the same time incorporate long-term measures for an improved seed supply for the future, e.g. through selection, conservation, and establishment of breeding populations and improved seed sources.

Surveys for seed-sources will take place both in natural forests and in plantations. A seed source may be a pure stand or one species in a mixed (usually natural) stand.

Most often it will not be possible to identify enough ideal seed sources and it will initially be necessary to include less desirable sources. It is, however, important to recognize and register the status of such seed sources for future improvement. The establishment of additional seed sources will also have to be considered.

Even when sufficient seed sources have been identified to cover current demand, new surveys, identifications and establishments will follow, so that good seed sources may be substituted by still better ones.

For more details on definitions and classification of seed sources, see Lecture Note B-1.

2. STEPS IN THE PROCESS OF SEED SOURCE IDENTIFICATION

The process includes the following major steps:

Preparatory Desk Work (section 3)

- Quantify and localize planting areas
- Quantify and localize corresponding seed source demand
- Localize and map potential seed production areas and seed suppliers
- Quantify potential seed production and supplies

Survey and Identification (sections 4 and 5)

- Visit and describe candidate seed sources
- Select final seed sources
- Visit and describe selected sources
- Reiterate as necessary

3. PREPARATORY DESK WORK

3.1 Size and Location of Planting Areas

The very first step in the process is to compile and use existing information on actual and future planting areas. This should be in the form of a species- and locality-wise register which also includes organization in charge of planting, size of annual planting area, and period of planting.

Seed sources may be located differently for easy access depending on whether seed collections are arranged centrally or locally. Seed sources may be used for seed supply to certain ecological areas or uses only, and would thus have to be located in specific ecological situations (see below under species).

Choice of species

The selection of priority species may be politically determined or determined by central forest authorities. This means that they cannot always be freely chosen by any individual planting programme.

Priority species according to planting purpose

It is always necessary to evaluate the required end use of the trees to be included in the programme. The end uses may for instance be timber, fuelwood, leaves and fruits for fodder for domestic animals, and protection against erosion. Species are then given priority according to the importance and extent of the required end uses, and in accordance with previous experience with the species in the country and local area, as well as with experience from their use in other areas.

Priority species within seed zones

Over the last half century evidence has accumulated that, within a botanical species, significant genetic variation in forest trees is frequently associa-ted with ecological differences between the places where they are growing. Natural selection

takes place through the generations, favouring those that are best suited for the area and thus leaving individuals that are adapted to the local environment. This means that the greater similarity there is between future planting sites and the site where the seed is collected, the greater is the possibility that the plants will survive, grow and remain healthy.

Some countries are naturally divided into ecological regions because of great differences in climate and other conditions important for vegetation formation.

Such ecological regions may be used as a basis in the establishment of a seed-zoning system of the country. It is expected that seed harvested and used within one such zone is better adapted to the environmental conditions than seed from other seed zones. Seed zoning systems have been made in a number of countries, viz India, Tanzania, Ethiopia, Thailand.

When planting programmes have been effective for some years, and when results from provenance trials become available, it will be possible to revise the borderlines between seed-zones according to the experience gained.

When information has been obtained on the species to be planted under the planting programmes in different locations (ideally seed zones) of a country, then the size of the planting area of each species in each location has to be determined.

3.2 Estimation of Seed Source Areas to be Identified

Based on (1) the number of hectares expected to be planted with the different species within each seed zones, (2) the spacing of the trees, and (3) the expected rate of replanting in the field, the number of plantable plants can be calculated. From there the amount of seed to be collect can be calculated taking into account (1) losses and culls in the nursery stage, and (2) germination percentage.

In order to be able to calculate the necessary area of seed source, one must know the average number of seed bearing trees per hectare and the average annual seed crop per tree and take into account the fact that good seed years occur more or less irregularly.

If the quantity of seeds needed is 500,000, and if the average seed production per seed bearing tree e.g. is 15,000, then seed will have to be collected from at least 33 trees. If the number of seed bearing trees per 2 ha is say 1, then the necessary area for annual seed production will be about 66 ha.

If it is assumed that only every third year is a good seed year, then 3 x 66 ha = about 198 ha of seed stand is required for this species and seed zone. Seeds for three years should then be collected in one year with a good seed crop on condition that the seeds of the concerned species can be stored safely for two years.

In reality it is difficult to predict how many hectares of seed sources are necessary

to cover the demand, because the magnitude of seed crop will vary from year to year and will, also in good seed years, depend on the development, condition, and age of the seed source, as well as on the germination capacity of the seed. The quantity that it is possible to collect will also depend on the skill of the collection crew and available equipment. Therefore, particularly in the initial phase of seed source survey and identification, it is advisable to attempt a liberal registration of seed source candidates.

More details are found in Lecture Note C-1 and C-3 and in Willan (1985).

When the seed source area required for each species and seed zone has been determined, three situations regarding type of seed source are to be considered: 1) Some seed sources may already be in use (within or outside the country), 2) new seed sources are to be identified (within or outside the country), and 3) seed sources may have to be planted inside the country.

3.3 Location of Potential Seed Production Areas and Seed Suppliers

The following steps are involved:

(a) Obtain information from institutions regarding occurrence and situation of different species, forests, and tree populations. (3.3.1)

(b) For each species and seed zone, map existing seed sources on maps of a relevant scale; attempt to estimate seed production capacity. (3.3.2)

(c) Map new potential and relevant seed sources on maps of a relevant scale; attempt to estimate seed production capacity. (3.3.3)

(d) For each species, map and register relevant international potential seed suppliers and their seed sources; estimate need for seed from such sources. (3.3.4)

(e) Check if estimated potential supplies roughly balances with demand; otherwise revise and choose alternatives. (3.3.5)

3.3.1 Compilation of available information

The information mentioned under item (a) could be obtained from institutions such as:

Forest departments: e.g.inventories, national working plans with expected planting targets, forest maps, forest reserves.

Forest district officers: e.g. knowledge of good stands; knowledge of the origin of plantations; experience with plant production.

Forest research institutes: e.g. species and provenance trials.

Other national seed centres, international seed centres or national seed centres in other countries.

Botanical institutes of universities: e.g. species distribution; knowledge of seed biology.

Survey departments: e.g. up-to-date maps, maps showing vegetation cover.

Local residents with knowledge of certain areas.

Cooperation with these institutions may save much time and greatly improve the subsequent survey.

3.3.2 Mapping of seed sources already in use

Mapping of seed sources in use covers both stands in plantations and areas in natural forests, inside as well as outside the country.

Any information that is available about stands inside the country that are used for seed collection should be obtained and recorded at the earliest possible opportunity and include observations made during surveys, seed collections, seed handling and nursery operations. The information would include information on the origin of the stand, the size of the stand, the production capacity, its quality, collection periods etc.

The seed sources should be located on a map and the seed zone in which it is located should be recorded.

The information obtained should be evaluated, and a decision made if the seed source would be worth a visit or if it may be discarded off-hand.

3.3.3 Mapping of potential seed sources

Much of the information needed for selection of areas to be surveyed may already be available from the institutions and organizations mentioned in 3.3.1. Some of it may be found through the registration (and evaluation) of seed sources already in use, some of it may be sought in publications or reports.

As for existing seed sources, the potential seed sources should be located on a map and the seed zone in which it is located should be recorded.

The information obtained should be evaluated, and a decision made if the seed source would be worth a visit.

3.3.4 Identification of seed suppliers and sources outside the country

For many species exotic to the country, previous experience and research work may have indicated that it could be feasible to buy seed of specific provenances from abroad rather than having the trouble of establishing and maintaining own sources. This would for example be the case if the size of planting area was modest, or if conditions were not favourable for local seed production, or if severe contamination of local sources with pollen of inferior types was unavoidable.

Where seed has been (or is likely to be) imported, as much information as possible should be obtained about the seed sources. It is generally out of the question to make visits to such stands, and hardly feasible if only reliable suppliers are contacted.

Today a number of reliable and well functioning seed centres and suppliers exist, from where seed can be ordered and timely delivery of seed of good genetic and physiologic quality is assured.

It is necessary to obtain information regarding the possibility of supplies of seed of the right provenances in the right quantities. Most suppliers are issuing good seed catalogues, and several international agencies will issue lists of seed suppliers. If possible, contracts for long term supplies of seed should be formulated.

3.3.5 Matching seed demand and estimated supplies

Much effort and time can be saved if the field survey for seed sources is covering approximately the needed demand for seed sources, though with a balance towards a larger area than immediately envisaged. Although seed production potential can initially be estimated only very inaccurately, an attempt should nevertheless be made to make such estimates, and to check them against the estimated demands for each locality.

4. VISIT TO AND DESCRIPTION OF CANDIDATE SEED SOURCES

The following aspects should be noted when seed source candidates are visited and evaluated

accessibility
condition of stand
number of trees and size of seed source
flowering and fruiting
appearance of the trees

If field visits and evaluation of seed sources in use have not already been made, then these seed sources should be visited, evaluated and described in the same way as described for candidate seed sources.

4.1 Accessibility

For seed sources located in remote areas or with poor access roads accessibility plays an important role as time and resources spent on reaching the seed source for repeated collection, supervision and management may weigh heavily on the budget.

However, the survey should not be limited to areas close to the seed centre or field stations, but cover the areas likely to comprise the required seed sources; perhaps without including the most in-accessible areas in the first survey.

4.2 Condition of Stand

It may happen that a stand of trees or a forest disappears or has degraded to the extent that it cannot serve the purpose of seed production. It is an easy decision to discard such stands.

Stands may also be in a condition, where there may well be many trees of the concerned species, but obviously it has been exposed to long term dysgenic felling, i.e. the best trees have been systematically felled. Or stands may appear unhealthy, in which case the surveyor should try to find the cause, i.e. poor site conditions, fire, humans, animals, insects or pathogens. There may still be a good quantity of seed produced. If there are no other suitable stands or alternative seed supplies, such stands (apart from the ones affected by insects or pathogens) may be considered as candidates, but their possible final selection as seed sources need a thorough scrutiny.

The trees should have reached a stage where they are reproductively mature and

where flowering and seed production are found in most trees. They should not be too old with risk of decline or deterioration of seed production.

4.3 Number of Trees and Size of Seed Source

The size of the seed source candidate may be from about 25 trees, provided these are unrelated, and to areas of up to 100 ha or more, but where possible, the size must reflect the demand for seed from that particular source.

In small natural seed sources, trees may be closely related (for some species as *Ficus sp.* and *Prosopis cineraria* a stand may be made up of one clone), which will lead to inbreeding, making the seed source inappropriate for future seed production.

Small stands may be uneconomical to collect from, whereas very large areas have the disadvantage of being more difficult to supervise and manage; it is also more likely that the growth conditions will not be uniform for the whole area, and it may be considered to sub-divide the area.

Trees that occur naturally scattered over a large area may constitute a seed source if the ecological conditions are uniform. Actual demarcation in the field of the boundaries of such a seed source is not possible, so the area must be clearly and accurately indicated on good maps.

Of endangered species, however, even very small groups should be considered in order to secure the gene resource. Such small groups or populations should not be selected as candidate seed sources, but a note should be made of their location, and efforts should be made to secure their continued existence, in-situ or ex-situ.

Natural boundaries (like streams, roads, tracks, and borders to agricultural lands) will help to demarcate the area and may be decisive for the size of the seed source.

4.4 Flowering and Fruiting

In natural stands, flowering and fruiting will usually take place in adequate amount; but in plantations, particularly of exotics, development of flowers and seed should be examined, as the area may be all right as to production of the required product, but unfavourable for flowering and fruiting.

In already established seed sources, seed crop in one season may have been registered earlier. This may help to estimate the crop to be expected in other areas when the number of trees are compared.

4.5 Phenotypic Appearance

It is assumed that good phenotypes are to some extent genetically determined, which means that desirable characteristics, at least to some extent, are passed on to the offspring. So, if a choice between stands is possible, the best should be chosen; but very often there is no alternative, and improvement by thinning may be considered.

Selection criteria (i.e. the characteristics of the trees that are considered of importance for the selection) should be limited to a few important phenotypic traits estimated to have a relatively high heritability (the ability of the parents to transmit their characteristics to the progeny) such as stem straightness, branching habit. Growth rate is greatly dependent on the environment and is therefore of low heritability.

The right type of trees to choose depends on the expected use and is therefore a variable concept to be defined for each group of species. For instance, timber trees should have tall straight stems, very different from fodder trees with wide crowns with many leaves or fruits.

If the stand gives the immediate impression of being a nice usable stand likely to produce the wanted product (timber, fuelwood, protection etc.), it should be described as a seed source candidate.

The surveyor should spend enough time in the stand to get a good general impression of it by walking around in the area.

4.6 Description and Sketch Map of Seed Source Candidates

When a stand has been nominated a seed source candidate, a sketch map (figure 1) and description must be made.

See the suggestion for a type of form for a seed source candidate in figure 2. It should be filled in with the information immediately available. If the seed source candidate is later selected, a seed source registration form with more details is filled in, see figure 3.

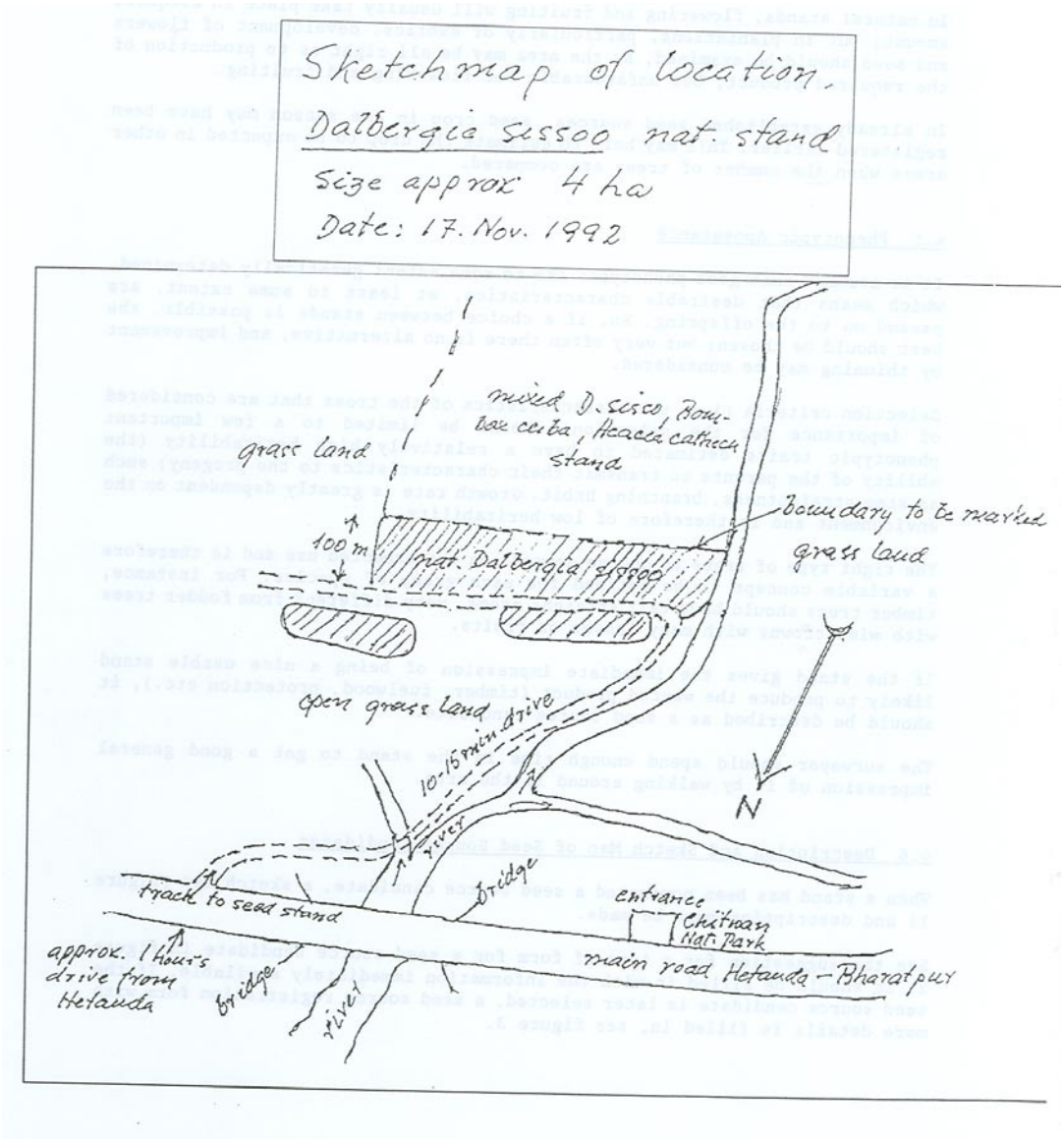

Figure 1: Example of a Sketch Map.

MINIMUM INFORMATION OF CANDIDATE SEED SOURCES

TENTATIVE REF. NO: _____

SPECIES latin name: _____
Local name: _____

OWNER/CONTACT PERSON: _____

REPORT AUTHOR: _____ DATE: _____

LOCATION

Latitude: _____ Longitude: _____ Altitude:_____
State/Province: _____Forest Circle: _____
Name of Forest: _____ Cpompart./Block: _____
Detailed location: _____
_____
_____

Map ref.: _____
Seed zone/ecological zone: _____

ACCESS ROAD DESCRIPTION: _____
_____

NATURAL BOUNDARIES: _____
_____
_____

STAND DESCRIPTION

Total area: _____ Establishment year: _____
Establishment method: Natural / Planted /sown with seed from: _____ Unknown _
Associated important species: _____
Present codition of stand (incl. uniformity of spacing or grouping of trees:_____
_____
_____

SEED TREE DESCRIPTION

Selected for: Timber/Pulp/Fuel/Fruits/Fodder/Wood extractives/Other extractives/Wind breaks
Other protection/Other specify: _____
Is stand superior or average for trait selected for: _____
Approx. age: _____ Crowm development:: Dominant / Co-domin. / Suppressed
Health -"- : + +/- - Approx. height of dominant/co-dominant trees: _____m
Remarks: _____
_____

DISTANCE TO NEAREST STAND OF SAME SPECIES: _____
SEED COLLECTION: Collection permit required: YES by _____ NO UNKNOWN

Flowering period: _____ Fruiting period: _____
Percentage trees flowering/fruiting: _____%
Seed production capacity: _____
_____

GENERAL REMARKS _____
_____

(SKETCHMAP ON REVERSE)

Figure 2. Example of a form for the description of a seed cource candidate

It is important to try to obtain any local knowledge of the origin of the seed source during the survey and to include this information in the description. This applies both to natural forests and plantations.

Proper maps, together with information on origin, are the most essential parts of the description. Often it will be necessary with more than one map, for example, a country map showing approximate location in the country, a map showing seed source in relation to some well known major cities, road junc-tions, mountains, and the like, and finally a sketch map showing sufficient details to reach the stand and to identify its boundaries in the field.

It is essential that the sketch map gives enough information to enable also other staff members than the surveyor himself to find it again and identify the seed source. The sketch map should therefore include indications of:

- approach from clearly distinguishable landmarks, e.g. the closest villages, a temple or church, road, path, river, giving some locally acknowledged names.

- approximate distances either in time of driving from forest station or overnight quarters or in distance in kilometres plus possible walking distance.

- the direction of north. It will often be more convenient to draw the outlines of the seed source in relation to tracks, river or other landmarks first and afterwards indicate the north-south direction by means of a compass.

- possible natural, or preliminarily made, demarcations should be indicated too.

- names of surveyors and possible local contacts.

5. IDENTIFICATION OF SEED SOURCES

After the survey for seed source candidates, the information obtained has to be compiled. Some kind of summary of seed source candidates according to end uses, species, and ecological zones should be made to give a survey of the situation. Particularly seed production has to be held against the estimated demand for seed for the different groups. If there is a great imbalance, further candidate seed sources would have to be selected.

The surveyor or the one who finally decides which seed sources to select may in some cases be the same person; then some of the activities of the survey and identification may be integrated.

But in most cases the final selection will be made by more experienced seed-centre or forestry-staff members, who will base their decisions on previous experience and information received from the surveyors.

The final choice of seed sources rests upon the evaluation made when selecting seed source candidates. The main things to consider in addition may be for example to choose among several alternatives, or evaluate if sources are inferior in respect of phenotypic appearance of trees due to dysgenic fellings and there are no alternatives, or whether the source as the only choice is too small to produce the needed quantity.

It should be remembered that new surveys and identification should follow so that good seed sources may be substituted by even better ones.

6. ESTABLISHMENT OF SEED SOURCES

A ESTABLISHMENT OF SEED SOURCES IN NATURAL FORESTS

When a candidate seed source has been finally selected, mapped and described, it is established. The further processes of possible boundary demarcation, protection etc. are considered to be part of management. Specifically, it should be mentioned that it is rarely feasible to establish and maintain proper boundary demarcations, which few seed centres can afford. Boundaries established and maintained around forest reserves should be utilized as far as possible. Otherwise efforts should be made to see that existing features in the landscape are utilized as boundaries, as described above.

Seed Source Registration Forms are filled out, see Figure 3 and section 6.4.

B ESTABLISHMENT OF PLANTED SEED SOURCES

New establishment of seed sources by planting will almost invariably be part of a continued seed-procurement and tree-improvement programme. The most obvious reason is that there is not enough seed available from existing sources. Other reasons may be related to possibilities for improvement or needs for protection and conservation, or a combination of both.

6.1 Seed and Plants for Seed Source Establishment

Some general rules for sampling should be followed:

(a) To represent a population adequately, seed from a minimum of 25 trees should be collected and preferably in good seed years;
(b) Seed trees should be sufficiently apart to avoid likelihood of common parentage;
(c) Each seed tree should be equally represented in the established stand;
(d) Criteria for selection of seed trees should be formulated according to the purpose:

For improvement purposes, seed will only be collected from the better phenotypes (provided they bear seed).

For conservation of genetic resources, as many genotypes as possible should be represented. Therefore in principle no deliberate selection of seed trees should take place.

6.2 Siting of Stands

The following conditions may be observed:

(a) Access should be adequate for establishment, protection, management, and for collection and transport of seed;

(b) Legal rights to use the site for the purpose should be clearly stated and rest with the managing authority. For this reason government forest reserves may be preferred;

(c) The location should preferably be a type of site similar to where the seed source has performed best in respect of growth and seed production, and also similar to the type of site where the major planting activities are expected to take place;

(d) Proper isolation measures against contaminating pollen should be taken, i.e. provision of sufficient distance from undesirable sources of the same species, and separation from botanically closely related species, e.g. conifers protected by broadleaved species;

The present and planned use of other tree species in the area should be investigated before a site is approved for seed source establishment. This is particularly relevant for wind pollinated species, for which the recommended minimum distance for isolation is 300-500 m;

The effect of isolation will also depend on the size and the shape of the seed source. The larger and more compact the area, the less the effect of outside pollen. A seed source of an oblong shape will be less affected if the larger axis is oriented in the direction of the prevailing wind in the flowering season;

(e) Soil condition may influence flowering and seed bearing. Usually heavy soils with poor drainage are cold and considered unfavourable for flowering. Sandy loam and loamy sand of moderate fertility are considered favourable;

(f) To secure a seed source from obliteration (fire, windfall, pests etc.) it is advisable to plant the seed source on two or more sites.

DETAILED INFORMATION ON IDENTIFIED SEED SOURCE

SOURCE REF. NO: _____ SEED ZONE: _____
PROVENANCE NAME: _____
SPECIES (botanical) : _____SPECIES CODE: _____
(vernacular): _____
OWNER/CONTACT PERSON: _____
_____
_____

LOCATION

Latitude: _____o _____ ' North Lontitude: _____o _____ ' East. Altitude: _____m.a.m.s.l.
Country: _____ State: _____
Forest circle: _____ Forest: _____
Detailed description of how _____
to reach location _____
_____
_____
Map ref: _____

ACCESS ROAD DESCRIPTION:_____
_____
_____

NATURAL BOUNDARIES: _____
_____
_____
_____

SITE DESCRIPTION:
Topography, Aspect:: _____
_____
_____
Soil Type: _____
Structure: _____
Drainage: _____
General: _____
_____
Climate: Rainfall (mm): min. _____ mean _____ max. _____
Months of dry season: _____

Figure 3A. Seed Source Registration Form. Example of the front page.

STAND DESCRIPTION

Total area: _____ Establishment year: _____

Establishment method: Natural /Planted/sown with seed from: _____

Unknown / Associated important species: _____

_____

Trees pr hectare (all species):_____

Description of uniformity of spacing or grouping of trees: _____

_____

_____

Age uniformity: Even un-even very un-even Branching habit: Tree Bush

Health -"- : healthy some disease unhealthy Crown development: Dominant Co-domin. Suppressed

Stem straightn: most straight medium most poor Mean height of dominant/co-dominant trees: _____

General condition: _____

_____

Remarks _____

_____

DISTANCE TO NEAREST STAND OF SAME SPECIES: 0-150 m 200-500m 500-1000 m > 1000 m

SEED PRODUCTION:

Collection permit required by: _____ None required: Flowering period:

Fruiting period: _____Percentage trees flowering/fruiting:_____%

Seed production capacity per tree and total in stand: _____

LABOUR AVAILABILITY:

Name(s) of nearest village, camp, etc: _____

_____

Distance to nearest village/camp, etc: _____

Nos. and kind of labourers available: _____

PROTECTION AND MANAGEMENT NEEDS: _____

_____

EXTENSION OF SEED SOURCE: _____

_____

SEED SOURCE CLASSIFICATION:

Unclassified ____ Seed zone _____ Identified stand ____ Selected stand _____

Seed production area _____ Provenance seed stand _____ Seed orchard _____

DETAILS OF ORIGIN:

For identified stands, selected stands, seed production area & provenance seed stand:

Natural regeneration _____ Planted Indigenous _____ Planted Exotic _____

If known provenance, describe material:

- area representation in collection: whole = 2/3 = 1/2 < 1/3 unknown
- selection: positive neutral negative - characters selected for:
- selection intensity: - testing: Untested Tested

If tested, give details/references: _____

For seed orchards:

- Age of testing: _____ - Characters Evaluated: _____
- Trial report(s) ref:. _____
- Give reference and _____
  details of tree _____
  improvement programme _____

Firgure 3B. Seed Source Registration Form. Example of the back page

6.3 Size of Area

The area should be sufficiently large to provide enough pollen for adequate fertilization and intercrossing between individual trees and to contain enough seed trees at seed-bearing age to render seed collection economical and to avoid too narrow genetic representation in the offspring.

The area will vary with tree species, but a lower limit of about 5 ha with a final stocking of 500-750 seed trees will usually be required.

6.4 Registration of Selected and Planted Seed Sources

Detailed descriptions should be made on a Seed Source Registration Form (see example in figure 3) and final sketch maps will have to be made.

Part of the information can be entered on the seed source registration form immediately while other parts of the form will be filled in subsequently as the information becomes available.
As to more details on registration and records, reference is made to Lecture Note C-13, Seed Documentation.

A register of seed sources according to species or end use should be made to give a general idea of the situation, see example in Table 1.

Table 1: Example of a Register of Seed Sources According to Species

Species	Location	Age	Size (ha)	Seed production (nos)
Gmelina arborea	Gum Gum	14	0.8	400,000
	Kolapis	11	1.2	600,000
	Umas Umas	11	0.3	160,000
	Apas Rd. Mile 9	12	0.2	100,000
Albizzia falcataria	Gum Gum	12	0.9	360,000
	S.T.C. Mile 6	14	0.1	40,000
	Umas-Umas	12	0.1	40,000
Eucalyptus deglupta	Gum Gum 5 K	12	0.2	400,000
	Kolapis 72 A	8	15.0	12,000,000

7. MANAGEMENT OF SEED SOURCES

Management in this context is the execution of activities considered necessary to attain one or more of the following objectives:

1. maintain good conditions for abundant flowering and a healthy seed crop
2. make seed collection easier and more economical
3. secure continuous protection against damage and destruction
4. maintain isolation against contamination from undesirable pollen.

The management required will vary with different types of seed sources. As described in Lecture Note B-1, seed sources may be classified as (1) identified stands, (2) selected stands, (3) seed production areas, (4) provenance seed stands, and (6) seed orchards.

There is an increasing degree of selection and information from (1) to (6). Also the intensity of management will increase from (1) to (6): in identified stands, management is usually limited to undergrowth clearing in connection with seed collection; in seed orchards management is very intensive, and the position of each individual family or clone is known. The management procedures for the intermediate types of seed source follow more or less the guidelines given below.

A prerequisite for effective management of seed sources is regular supervision. Therefore such factors as access to and concentration of seed sources play an important part. By 'access' is understood that a location can be reached thoughout the year by car or truck in reasonable safety and preferably within a day from a seed station. For natural stands, provided a choice is possible, the least remote stand should be selected.

7.1 Demarcation

Marking of boundaries serves the purpose of easy recognition of the area in which seed collection, maintenance and protection will take place. It also indicates the limits for trespassing and unwanted exploitation of the area (grazing, tree felling, etc.). The extent of demarcation varies with the importance and size of the seed source.

Material for demarcation should be of a kind that will last for many years, but for economical reasons best found locally; it could be cornerstones, concrete or wooden posts, or border trees could be marked with painted rings.

The boundaries must also be indicated on maps in connection with seed source description.

For very large seed source areas, demarcation in the field is not possible, making careful mapping essential.

7.2 Protection

The most common risks are fire, illegal felling, and encroachment by people and cattle. Protection may be exercised through firebreaks, regular supervision, and creation of good relationships with the local population. Clearing borderline undergrowth may serve both demarcation and reduction of fire risk.

Fire lines should be cleared and maintained round the stand, particularly in grassland areas and monsoonal climates with a marked dry season. For some species, controlled burning may be possible and desirable within the stand after a certain age.

Protective measures againt pests and diseases affecting development of flowers and seed may occasionally be required, either by removal of affected trees or by spraying or powdering. Some harmful pests and diseases have symbiosis with local plants, thus a protective measure is the removal of host plants.

Fencing will be required where browsing of cattle or wild herds and exploitation by the local population is a threat.

7.3 Weeding

This is often one of the most serious calamities during the early stages of development of a seed source. Undergrowth and climbers will have to be removed regularly, in certain places several times a year.

It may be a temporary problem until the seed trees suppress the weeds, but it may be of long lasting effect if not handled rigorously.

Slashing of undergrowth may also be necessary for easier traffic during seed collection.

7.4 Thinning

Thinning has the dual purpose of improving flowering and seed production of individual trees by giving them sufficient space to develop deep crowns, and of removing the least desirable phenotypes.

It may be difficult to fully achieve the dual purpose, and compromises will have to be found. For example in teak, when a terminal bud develops into a flower, the apical growth is terminated. Which means that desirable trees with long straight stems are usually late and sparsely flowering.

An exact prescription for rate of thinning is difficult to give as it depends on species, site, and need for suppression of undergrowth; but as a general rule, a somewhat heavier thinning is practised in seed stands than in ordinary production stands (about 10 % heavier). Thinning of seed stands differs from thinning of wood production stands in the way that the former must promote the develop-

ment of fruit-bearing branches, whereas the latter usually aims at minimizing the number and size of branches thus limiting flowering potential.

It should be stressed that delay or neglect of thinning may reduce the seed crop considerably and that tree crowns may take a long time to recover from suppression.

7.5 Isolation

Management should keep a watch for possible changes in isolation measures and take necessary action, e.g. stop using a seed source if undesirable material of the same or closely related species is planted in the neighbourhood.

7.6 Fertilization

Fertilizers are only feasible in the more intensively managed seed sources, i.e. provenance seed stands and seed orchards. Fertilizers should only be applied if they have proved to be effective and the cost can be counter-balanced by additional quantity of seed.

7.7 Conservation

Seed sources in danger of extinction may be conserved in two basically different conservation stands:

In situ (on site) stands, where the species are protected and maintained in the ecosystem in which they occur.

Ex-situ (off site) stands, where the genetic resources of the species are protected and maintained away from their original environment as e.g. production stands, breeding populations, or seed stands.

The difference between the two categories is basically that in-situ conservation of plant genetic resources allows evolution to continue within the area of original environment. Special requirement of pollinators in complex ecosystems is also met in in-situ conservation.

Ex-situ conservation may have the advantage that the stands can be established in areas particularly favourable for seed development, protection and other managerial procedures. But from a purely conservational point of view, in-situ conservation is to be preferred where possible.

8. REFERENCES

Lecture Note B-1	Classification and Selection of Seed Sources. H. Barner, Kirsten Olesen & H. Wellendorf. Nov. 1988.
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