PLANTATION FORESTRY SEEDS AND PLANTING MATERIAL STANDARDS

General standards

In Bhutan, plantation forestry is relatively significant and tree improvement program has not taken off in a big way. However, with social forestry gaining importance, work on tree planting and tree improvement is becoming essential in order to enhance productivity of community forestry and other forestry plantations. This development will warrant for exchange/procurement of quality reproductive material. In order to ensure that identity of material is maintained while handling there is a need to set a minimum standard through certification process during collection, seed conditioning and propagule production.

Species eligible for certificate

The certificate standards are for forest tree species, including shelterbelts and windbreaks in fields and farms. The certification standards provide minimum requirement for the handling of forest reproductive material to guarantee that genetic identity and purity is maintained. The term “reproductive material” is generally referred to seeds, nuts, seedlings, cuttings and other types of materials that will be used to grow new trees.

Classes and Sources of Seeds

Depending on the precision with which the material is procured, four classes of materials can be identified for certification. Only the material, which meets the standards, listed below for the various classes of certification shall be eligible for certification. These classes are defined as follows:

The source-identified material requires the least precise collection procedure. Such material can be collected from seed collection stands (natural forest stand or plantation stands), several stands in an area, a geog, a group of geogs, or and other defined geographic region. The source must be accurately described but cannot be more precise than the actual area of collection. For example, blue pine seeds collected from stands across Gidakom valley and then bulked into a single lot could be identified as Gidakom Source but not as Thimphu Dzongkhag source.

Selected material can be collected from an identified seed production area or from a selected individual tree (plus tree). It should show promise of phenotypic superior traits, identifiable traits or both when compared with other material of the same species.

Untested seed orchard material can be collected from seed orchards that satisfy all the basic requirement for fully developed seed orchards except progeny testing and subsequent roguing is not done. A “seed orchard” is plantation established primarily for production of seed of proven genetic quality. Material in untested seed orchard should be known genetic identity that show promise of superior traits, identifiable traits, or both, as compared to other material of the same species.

Tested material is obtained from a known tree with proven genetic traits. Material can be collected from tested or rogued seed orchards or from individual tested trees. Selection criteria and supporting comparative data are required. Progeny testing is required to prove the traits of interests are heritable.

Establishing the source

Geographic location of the sources of all classes shall be given by the country and legal description. If known, stand or tree history shall be provided to the certifying agency on request.

Height and age (or site index if known) of the parent trees shall be included for selected material.

1. In case of seeds derived from seed orchards containing selected stock from a number of geographic areas, the location of the orchards shall be given and the original geographic sources of individual components (clones of families) shall be maintained in file and furnished on request. A map of the seed orchard which show the lay out and tree identification will be prepared and made available on request.

2. In case of material originated from planted or otherwise artificially established trees, the geographic origin of the parent material must be known.

Certification Labels

All certified materials must have an official label properly fixed to each plant, container, bale, bundle or package. Grower must follow procedures for administering Certification.
The certification label attests to the genetic identity of the material contained therein. The label shall contain the information on cones or seeds or propagules. Other information as needed by certification agency will be informed to the producers or growers and no information will be put on the label without approval from certification agency.

Field Inspections

Four different types of inspection are necessary to ensure adherence to the standards.

Approval inspection

Seed production areas, selected trees and seed orchards must receive one-time approval inspection to conduct thorough examination of the trees and sites for confirming compliance with field standards. Approval inspection must be made prior to flowering and pollination. In case of clonal reproductive material, approval inspection must take place before collection of materials.

Annual inspection

Annual inspections are used to confirm adherence to standards for propagation facilities and seed conditioning facilities

Periodic inspection

Periodic inspections are used to confirm adherence to standards for seed orchards and tested material at the time of material collection. Periodic inspections are required when certified material is being produced.

Spot inspection

Inspection may be done without prior notice at any time during the production of certified reproductive material.

Field Standards

Units of certification

A tree, an area or a portion of area may be certified. Plant material that may be used to produce the certified seed are as follows:

Seed collection stands
Seed production areas
Source-identified natural stands
Plantations of known source
Selected trees, including hybrids
Seed orchards, clonal or seedling from
Family lines or individual trees derived from open-pollinated origins
Family lines or individual trees from control-pollinated origins

Specific Requirements for Seed collection stands

Seed from seed collection stands may be identified as Source –identified provided that it meets the regulation pertaining to source of seed described above. No isolation zone is required.

For seed production area, the following criteria should be met to pass approval inspection:
The stand in seed production areas should contain full stocking of desired species to allow adequate rouging of inferior phenotypic quality trees and still maintain enough trees to ensure genetic diversity and adequate pollen supply.

Before approval inspection, the stand must be rouged leaving behind dominant and co-dominant trees that are insect and disease free and are superior in vigour, form and crown characteristics.

A minimum of 200 meters surrounding the seed production area should be free of inferior trees producing contaminated pollen.
Specific Requirements for a Single Tree

Each selected tree shall be permanently marked with identification numbers. The record of each tree will contain information that explains the basis for selection and map showing its exact location. Seeds or vegetative propagules must come from a single tree.

Tested material (from a single tree): each tree shall be permanently marked with identification numbers.

The record of each tree will contain information that explains the basis for selection and map showing its exact location.

A selected tree must possess superior characteristics in growth, form etc that can be distinguishable from other trees of the same species on the same site. Seeds collected from a selected tree must undergo progeny testing while vegetative propagules must be clonally tested.

Specific Requirements for Seed Orchards

1. For all species, a minimum of 200 meters surrounding the seed orchard must be free of all inferior trees producing contaminating pollen. The identity of each tree must be known and the record of known parentage must be provided. The arrangement of individual trees in the orchard should facilitate out-crossing.

2. Untested seed orchard material: Prior to completion of progeny tests seeds produced in seed orchard may be certified as untested seed orchard material

3. Tested Seed orchard material: A minimum of 200 meters surrounding seed orchard must be free of all inferior trees producing contaminating pollen.

4. The identity of each tree must be known and the record of known parentage must be provided.

5. The arrangement of individual trees in the orchard should facilitate out-crossing

6. At least 90% of the clones or family lines in a seed orchard must be progeny tested according to the testing standards. The orchard must be rogued based on the results of the progeny test.

7. Field inspection: Approval inspection is necessary for all productive material collection sites for production of selected material, untested seed orchard material and tested material.

8. Reproductive material handling: All reproductive material shall be handled so as to prevent contamination and to maintain the identity of the seed lot from time of collection through out conditioning,

Certification label

The productive material at the time of collection and when sent for certification must show the following:
- Certification class, Year of seed crop, Genus and Species, Variety (if applicable), Seed origin, Collection lot identification.

The certified reproductive material which is fixed to each seed container supplied by certification authority (BAFRA) should show the following:
- Certification class, Year of seed crop, Genus and Species , Variety ( if applicable), Seed origin, Producer seed lot number, Label serial number ( given by certification authority).

Field standards for propagation (nursery)

Units of certification

All certified seedlings must be grown from certified seeds of the respective class. The unit of production for bare root seedlings is the nursery while the unit of production for containerized seedlings is a seedlot grown in a single crop.

All certified vegetative propagules must be produced from selected trees, including hybrids. The unit of production for vegetative propagules is propagules produced from a single cone at one time.
**Propagation facility inspection**

Annual inspection of each inspection lot will be carried out between sowing, planting or micro-propagating and lifting of propagules.

**Specific Requirements for seedlings and vegetative propagation**

1. Each certified lot (e.g. seed lot, clone) must be handled separately during all stages of production.
2. Written record must be maintained that can be used to verify the identity of certified lots.
3. Bare-root Seedlings or vegetative propagules: Each bed area or row must be identified as to production lot with a marker. Genetic lots may not be mixed and must be separated by at least ½ meter parallel path to the sides of the bed and on the ends. Any portion of seed bed that is contaminated by chance windblown or waterborne seed from other sources and cannot be rogued must be removed from the seed lot.
4. Containerized Seedlings and Propagation: Only one lot may be grown in each container “block”. Each block must be identified as to production lot with a marker.
5. Laboratory Propagules: Each propagule unit (e.g. rooting tray, culture flask/container) must be identified all the times.

**Minimum germination and purity standards**

The seeds of all classes must conform to the standards as assessed using the national rules for seed testing. Since, we have not carried out any research on forest seed technology, we cannot set standards based on actual field experience. However, the following standards of forest seeds are based mainly on the studies carried out in the United States, by School of Forestry, Yale University (Toumey and Stevens 1928, Korstain 1927) and on certain experiences of field foresters in Bhutan while undertaking tree planting program (DoF 1995). These will be modified as when more field information is available. These standards will be applicable to the seeds and planting stock collected from the Source Identified Material and Selected Material only.

### Main tree species for timber and industrial plantations

<table>
<thead>
<tr>
<th>Tree species</th>
<th>Germination</th>
<th>Purity</th>
<th>Seed weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinus wallichiana</td>
<td>65%</td>
<td>97%</td>
<td>15,000-20,000 Kg⁻¹</td>
</tr>
<tr>
<td>Pinus roxburghii</td>
<td>80%</td>
<td>98%</td>
<td>8-12,000 Kg⁻¹</td>
</tr>
<tr>
<td>Abies densa</td>
<td>40%</td>
<td>90%</td>
<td>16,000-20,000 Kg⁻¹</td>
</tr>
<tr>
<td>Picea spinulosa</td>
<td>65%</td>
<td>90%</td>
<td>64,000 Kg⁻¹</td>
</tr>
<tr>
<td>Tsuga dumosa</td>
<td>75%</td>
<td>86%</td>
<td>400,000 Kg⁻¹</td>
</tr>
<tr>
<td>Juglans regia</td>
<td>65%</td>
<td>99%</td>
<td>35-120 Kg⁻¹</td>
</tr>
<tr>
<td>Quercus semecarifolia</td>
<td>60%</td>
<td>98%</td>
<td>140 Kg⁻¹</td>
</tr>
<tr>
<td>Acer campbellii</td>
<td>75 %</td>
<td>70 %</td>
<td>15,000-20,000 Kg⁻¹</td>
</tr>
<tr>
<td>Alnus nepalensis</td>
<td>70 %</td>
<td>50 %</td>
<td>400,000 -57,000 Kg⁻¹</td>
</tr>
<tr>
<td>Cupressus corneyana</td>
<td>50 %</td>
<td>70%</td>
<td>290,000 Kg⁻¹</td>
</tr>
<tr>
<td>Albizia procera</td>
<td>65%</td>
<td>55%</td>
<td>15,000-21,000 Kg⁻¹</td>
</tr>
<tr>
<td>Cryptomeria japonica</td>
<td>80%</td>
<td>60%</td>
<td>250,000-300.00 Kg⁻¹</td>
</tr>
<tr>
<td>Gmelina arborea</td>
<td>13-50%</td>
<td>-</td>
<td>1600 kernel Kg⁻¹</td>
</tr>
<tr>
<td>Exbucklandia populnea</td>
<td>75%</td>
<td>70%</td>
<td>270,000 Kg⁻¹</td>
</tr>
<tr>
<td>Michelia champaca</td>
<td>70%</td>
<td>70%</td>
<td>14,000-17,000 Kg⁻¹</td>
</tr>
<tr>
<td>Terminalia belerica</td>
<td>80%</td>
<td>90%</td>
<td>400-520 Kg⁻¹</td>
</tr>
<tr>
<td>Daubanga grandiflora</td>
<td>30%</td>
<td>70%</td>
<td>24,000,000 Kg⁻¹</td>
</tr>
</tbody>
</table>

### Important multipurpose trees for Social Forestry Program

<table>
<thead>
<tr>
<th>Tree species</th>
<th>Germination</th>
<th>Purity</th>
<th>Seed weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aesandra butyracea</td>
<td>50-80%</td>
<td>-</td>
<td>450-600 Kg⁻¹</td>
</tr>
<tr>
<td>Exbucklandia populnea</td>
<td>75%</td>
<td>-</td>
<td>27,000-71,000 Kg⁻¹</td>
</tr>
<tr>
<td>Ficus nerifolia</td>
<td>40%</td>
<td>-</td>
<td>100,000-600,000 Kg⁻¹</td>
</tr>
<tr>
<td>Ficus roxburghii</td>
<td>75%</td>
<td>-</td>
<td>3000-8000 Kg⁻¹</td>
</tr>
<tr>
<td>Toona ciliata</td>
<td>60%</td>
<td>70%</td>
<td>350,000 Kg⁻¹</td>
</tr>
<tr>
<td>Cheropondias axillaries</td>
<td>60%</td>
<td>90%</td>
<td>300 Kg⁻¹</td>
</tr>
<tr>
<td>Melia azedarach</td>
<td>70%</td>
<td>85%</td>
<td>1200-1500 Kg⁻¹</td>
</tr>
<tr>
<td>Syzigium cumini</td>
<td>90%</td>
<td>95%</td>
<td>1000-1300 kg⁻¹</td>
</tr>
<tr>
<td>Tree Species</td>
<td>Germination (%)</td>
<td>Survival (%)</td>
<td>Seed Weight (Kg)</td>
</tr>
<tr>
<td>----------------------</td>
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<td>------------------</td>
</tr>
<tr>
<td>Quercus griffithii</td>
<td>93%</td>
<td>90%</td>
<td>1800 Kg⁻¹</td>
</tr>
<tr>
<td>Robinia pseudocacia</td>
<td>80%</td>
<td>85%</td>
<td>35,000-80,000 Kg⁻¹</td>
</tr>
<tr>
<td>Persea fructifera</td>
<td>50%</td>
<td>95%</td>
<td>29 Kg⁻¹</td>
</tr>
</tbody>
</table>

Standards for seedlings and stumps of forest tree crops

All planting materials (e.g. seedlings, stumps) of the above tree species for all types of planting purposes should meet following criteria. Seedlings should:

1. be 20-30 cm in height, to the base of the newest leaf or buds
2. have straight, undamaged and un-forked stems
3. have stem well lignified for at least half their length
4. have root collar diameter of over 4 mm
5. be of healthy deep green color
6. be quite free of insect and fungal disease

Stumps should:

1. have root collar diameter between 7 and 20 mm, and a root diameter of at least 7 cm
2. have no forked roots and stems
3. be undamaged and straight
4. be free from pests and diseases

Standards for Some Specific Species

1. **Abies densa** (Fir)
   - Seeds are to be collected during October- November.
   - Seeds should be stored in gunny bags.
   - Seeds must be exposed to sun at regular intervals to prevent fungal attack.
   - Soak the seeds for 12 hours before sowing.
   - Seedlings should be grown in raised nursery beds under shade to prevent damage from rain, hail and snow, and should be protected from fungal attack.
   - Seedlings raised in polypot or bare root should be planted when they attain 20-30 cm in height.
   - Preferable altitude for planting this species is between 2600m – 4000m (asl).

2. **Picea spinulosa** (Spruce)
   - Seeds are to be collected during September- November.
   - Clean and dried seeds should be stored in sealed container for 1-2 years.
   - Soak the seed in cold water for 6-12 hours.
   - Seedlings should be raised in poly pot in the nursery.
   - Seedling should be planted in planting sites when they attain 25-30 cm in height.
   - Young seedlings should be protected from fungal attack (*peridermium piceae*) by applying fungicides or spraying ash.
   - Seedlings should be planted within the altitudinal range of 2300-2600m (asl).

3. **Pinus wallichina** (Blue pine)
   - Seeds are to be collected during September – November.
   - Seeds should be stored after cleaning and drying.
   - Soak the seed in cold water for 6-12 hours before sowing.
   - Seedlings should be raised in polythene bag or poly pot and should be raised under shade when young.
   - Direct sowing in shallow pit is also possible.
   - Seedlings should be planted when they attain a height of 25-35 cm.
   - Young seedlings should be protected from rust disease (*Cronartium ribicola*).
   - Seedlings should be preferably be planted between 1800 to 3000m altitude.

4. **Pinus roxburghii** (Chirpine)
   - Seeds are to be collected during January –March
   - Seeds should be stored in sealed container.
• Soak the seeds in fresh water for 12-24 hours before sowing.
• Seeds should be treated with red lead before sowing to protect from pests.
• Direct sowing in *thalis* (*prepared bed for direct seed dibbling*) is also recommendable.
• Seedlings should be protected from rust disease (*Cronartium himalensis*).
• The preferable planting size of seedlings is 20-30 cm
• Seedlings should be preferably be planted between 900-1800 m (asl) altitude.

5 *Cupressus spp* (Cypress)
- Seeds are to be collected during October – January.
- Seeds should be stored in well-ventilated store up to 6-12 months but should be preferably sown fresh.
- Soak the seed in fresh cold water for 6-12 hours before sowing.
- Seeds should be sown in mother bed and pricked out in poly pot.
- Seedlings should be planted when they attain 25-45 cm.
- Seedlings should be preferably planted between 1800 – 2700m (asl) altitude.

6 *Acacia catechu* (Khair)
- Seeds are to be collected during November – March.
- Seeds should be dried thoroughly and stored in well-sealed polythene bags and should not be stored for more than 8 months, as it will become susceptible to insect attack.
- Seeds should be pre-treated in cold water for 12 hours before sowing.
- Direct sowing of seeds in patches or strips with worked out soil is recommended.
- Seedlings can also be raised in poly pot in nursery.
- Seedling should be planted when they attain 20-30 cm in height.
- This species prefers riverbed and edges along river channel and the seedlings should be planted up to 900 m (asl) elevation.

6 *Acrocarpus fraxinifolius* (Mandaney)
- Seeds are to be collected during April-May.
- Dried seeds should be stored in gunny bags or in airtight tin.
- Seeds should be pre-treated in fresh cold water for 6-12 hours before sowing.
- Direct sowing in patches or *thalis* is commonly practiced.
- Seedlings are also raised in polythene bags.
- Seedlings of this should be planted in sub-tropical area up to 1300 m (asl) altitude.

7 *Alnus nepalensis* (Utis)
- Seeds are to be collected during December-March.
- Dried seeds can be stored in sealed plastic bags for few months, it is preferable to sow fresh seeds as it loses viability when stored for long period.
- Seedlings are raised in poly pot in nursery.
- Seedling can be planted when they attain 25-40 cm in height.
- Seedlings are also be propagated by direct sowing.
- Seeds broadcasted directly in freshly eroded slopes also do well.
- It is sub-tropical to temperate species, which grow in between 1200-2300m (asl) elevation.

8 *Bombax ceiba* (Simul)
- Seeds are to be collected during March –May.
- Seeds should be collected along with floss and should be separated from floss manually or by threshing with stick.
- Seeds can be stored in sealed container or plastic bags for 1 year.
- Seeds should be pre-treated in cold water for one day before sowing.
- Bare root seedling can be grown in nursery.
- This species is good for cutting and stump planting prepared from nursery-raised seedlings.
- This is a tree of mixed deciduous forest grown between 200-1400m (asl) altitude.

9 *Chukrasia tabularis* (Chekrasi)
- Seeds are to be collected during March-June.
- Clean dried seeds can be stored up to 5 months in gunny bags.
Soak the seeds in fresh water cold water for 1-2 hours before sowing.
- Bare root or nursery-raised seedlings are planted.
- Direct sowing in patches or terrace also gives good result.
- It is subtropical species and grows in well-drained soil up to an elevation of 1000m (asl).

10 **Dalbergia sissoo (Sisoo)**
- Seeds are to be collected during March-May.
- Clean dried seed can be stored in sealed tin or gunny bays for about 6-12 months.
- Pre-treatment with soaking in water for 6-12 hours before sowing.
- This species is propagated by direct sowing method; seedlings can also be raised in nursery, stumps and by root suckers are also used for planting.
- Sisoo seedlings to be protected from weeds, cattle and fungal infection.
- This species prefer alluvial soil adjoining rivers and can grow up to 1000 meters (asl) elevation.

11 **Gmelina arborea (Gamari)**
- Seeds are to be collected April-June.
- Seeds are collected by de-pulping and dried in sun for 2-3 days.
- Seeds can be stored in dry ventilated room for about 6-12 months.
- Seeds collected from animal droppings are better.
- Seeds should be soaked in water for 2-3 days before sowing.
- Seedlings are raised in mother bed and transplant in secondary beds.
- Stumps are prepared for planting out when seedlings attain thump size girth.
- Directly sowing also gives good result.
- It is species of moist sub-tropical zone, prefers moist, fertile and well-drained soil up to 1200 m (asl) elevation.

12 **Juglan regia (Walnut)**
- Seeds are to be collected during September-December.
- Walnut seed loose viability when dry out, therefore it must be kept moist, cool and aerated. It can be buried them in pits since this species require cold stratification.
- It is advisable to sow them immediately after collection.
- Seedlings can be raised in shaded nursery beds and pricked out in polythene tube and placed them under shade.
- Seedlings attain plantable size within one year (25-35 cm height).
- Walnut species can also be propagated by grafting.
- It prefers moist deep and well-drained soil, grown between 1200 –2500 (masl) elevations.

13 **Melia azedarach**
- Seeds/stones are to be collected during November – March.
- Seed/stones are dried and stored in gunny bags or in sealed tins for about one year.
- Soak the stones in warm water for 5-6 hours or in cold water for 12 hours before sowing.
- Poly pot seedlings can be grown in nursery.
- Direct sowing in plantation site is also done.
- Propagation can also be done through stumps planting.
- Seedlings should be kept free from over head shade.
- The preferable planting size of seedling is 20-30 cm
- Seedlings of this species can grow up to 2500 m (asl) altitude.

14 **Michelia species (Champ)**
- Seeds are to be collected during July- August (*Michelia champaca*) and August-September (*Michelia doltsopa*).
- Fruits are collected from standing healthy mother trees.
- Seeds are extracted by gentle threshing, wash it with water and dry under shade (never dry it under direct sun) for 2-3 days.
- Seeds loose viability while storing, most be sown after collection.
- Soak the seeds in fresh water for few hours before sowing.
- Seedlings are raised in mother beds and then transplanted to poly pot under shade.
- Seedlings attain plantable size in one year (30-45 cm)
- *Michelia champaca* can grow in moist subtropical zone up to 1500m (asl) whereas *Michelia doltsopa* can grow between 900–2500m (asl) elevations.

**15 Quercus spp (Oak)**
- Seeds are to be collected during November–February (*Q.griffithii*) and June-August (*Q.semicarpifolia*).
- Seeds loose viability while storing.
- Seeds to be sown immediately after collection.
- Soak the seeds in cold water for 6-12 hours before sowing.
- Seedlings are raised in polypots.
- Direct sowing can also be done.
- Seedling most attains at least 20cm tall before planting.
- *Quercus griffithii* can grow between 1500–2500m (asl) on drier sites while *Q.semicarpifolia* can grow between 1700–3800m (asl) on moist and shady area.

**16 Shorea robusta (sal)**
- Wing seeds are to collected during May-June.
- Sal seeds cannot be stored as it loose viability rapidly.
- Fresh fallen winged seeds should be sown before or within 7 days.
- Direct sowing in plantation site (terrace or lines) with wings upward.
- Plantation site should be ready before collection of seeds for immediate sowing.
- This species occurs in southern foothills up to 1000m (asl) elevation.

**17 Tectona grandis (Teak)**
- Seeds are to be collected during December-February.
- Seeds (bony drupe) can retain viability for long period and can be stored in well-aerated sack.
- One-year-old drupe gives better result than fresh one.
- Alternative soaking and drying under concrete sun for 2-3 weeks before sowing.
- Seeds can be treated by light burning of drupe.
- Seeds are sown in mother beds and pricked out in secondary beds when leaves appear.
- Stumps are prepared for planting out when seedlings attain thump size girth.
- Direct sowing can also be practiced.
- Seedlings of *Tectona grandis* should be grown about 600m (asl) altitude & below and should not be planted in steep slopes as it deteriorate soil because of large foliage system.

**18 Thuja spp**
- Seeds are to be collected during October–December.
- Soak the seeds in cold water for 6-12 hours before sowing.
- Seedlings should be raised in shaded nursery beds and pricked out in poly pot when they attain 2-3” height.
- Seedlings are ready for planting after 12-18 months.
This species can grow between 700 - 2000m (asl) altitude.