Standards for Forest Nursery Accreditation

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&
Enhancing Livelihoods and Food Security through Forest Management (EnLiFT) in Nepal

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1. Introduction

The production of seedlings in forest nurseries commenced alongside the initiation of plantation research in Nepal in the early 1960s. Nursery related studies and researches were conducted by Silviculture Research Project under the Forest Survey and Research Office and Forestry Research Project I and II from 1981 to 1996. Seedling production stands as a crucial step in expanding tree planting activities across the country. Proper planning and implementation of nursery production and planting activities are essential. The way seedlings are produced in a nursery significantly contributes to their survival rate after planting and their subsequent growth performance (Quayle et al. 2001; Lamsal et al. 2020). There are mainly three types of nurseries in Nepal viz. government (DFO and Local government), private and community nursery. Forest nurseries produce millions of seedlings annually for plantation activities in Nepal.

Good quality seedlings cannot be produced without proper care and tending. Nursery plants must be shieldedfrom extreme environmental conditions until they gain adequate strength to endure them. Encouraging local people to establish small scale commercial nurseries would not only ensure high quality of seedlings but also offer additional opportunities, such as income and technology transfer. Accrediation and certification of the chosen high value tree species' seedlings need to meet appropriate standards to ease marketing problems. In Nepal, most plants used for afforestation are grown in polypots made of polythene or polyethylene, widely used for raising seedlings. Transparent polythene pots measuring 3 inch * 7 inches were extensively used in forest nurseries and are gradually being replaced by thicker black polypots of various sizes. Generally, black polypots are useful at higher altitudes where seedlings require a longer period (exceedingtwelve months) in the nursery.

Forest nurseries in Nepal differ in various aspects such as area or size, infrastructure, facilities, production capacity and the types of planting/nursery stock. These aspects have affected both production capacities and quality of the seedlings. However, forest nurseries are not systematically classified in Nepal. It is essential to classify the forest nurseries according to set crietria to ensurequality plantlets for plantation. Similarly, forest seedlings are produced by both forest-based nurseries and other nurseries. It is essential to differentiate between the forest-based nurseries and other horto-flower nurseries to produce quality forest seedlings for effective plantation and subsequent better growth performance and higher yield.

In Nepal, forest nurseries and other nurseries produce a large number of seedlings of forest tree species every year for plantations; however, the quality of nursery stock has always been a major issue. Generally, poor-quality seedlings have been produced, and such seedlings could not adapt to the difficult and harsh plantation sites. Consequently, the survival of seedlings has been poor

in many plantations. The Lack of standards for the types of nursery stock has compelled the use of poor-quality seedlings for plantation in Nepal. The standards set for nursery stock will obligate and guide nursery owner to produce quality planting materials for successful plantations. The Production of high quality seedlings is critical for the establishment of healthy trees in the field (Pandit et al. 2020). Slow development and death of tree seedlings arecommon in many rural development programs, leading to many farmers losing interest in tree planting out of frustration. This loss of interest results in further deforestation and the loss of valuable biodiversity, further degrading landscapes and deteriorating livelihood opportunities for people (Munjuga et al. 2013; Linyunga et al. 2015). Therefore, improvements in seedling quality will improve the rate of tree seedling establishment in the field and positively impact both the environment and rural livelihoods (Pandit et al. 2020). In light of this reality, this nursery standard book is prepared.

2. Objectives

The general objective is to develop standards for the accreditation of forest nurseries in Nepal.
The specific objectives of the study are to:

- Develop standards for forest nursery accreditation,
- Develop criteria and a rating scale for the evaluation of the nursery accreditation standards,
- Develop forest nursery accreditation protocol and processes.

3. Methodology

3.1 Desk review and analysis

Related policies, guidelines, strategies, manuals, brochures and reports were reviewed to gain insight into forest nurseries and nursery stocks.

3.2 Consultations and sharing workshops

A checklist was prepared for consultations with key informants or experts. Nursery-related experts from the Ministry of Forests and Environment, Department of Forests and Soil Conservation, Department of Plant Resources, Nepal Agricultural Research Council and Division Forest Offices were consulted. The checklist was discussed with Province Forest Research and Training Centres. Similarly, sharing workshops were conducted to collect common consensus on accreditation criteria points. Additionally, we shared the nursery accreditation criteria with participants of Nursery management and Certification training held in EnLiFT project's site in April 2022.

3.3 Nursery visit and observation

Twenty-three nurseries (government, private and community) were visited throughout the country. The checklist/questionnaire was prepared to collect the data from these nurseries to

identify the prevailing practices/status of forest nurseries. Criteria for nursery standards were assessed and verified in a DFO and private nurseries located at Banepa through a team of FRTC and EnLiFT2 staff and volunteers.

4. Source of germplasm and record keeping

4.1 Seed source

The source of germplasm and collection methods significantly affect the seedling quality. Germplasm used in both private and public nurseries in Nepal comes from various sources including seed trees, seed stands, seed production areas and seed orchards. For instance, the Tree Improvement Program (TIP) in Nepal plays the role in conserving genetic resources by supplying seeds of various tree species. The Forest Research and Training Center (FRTC) and Tree Improvement Silvicultural Component (TISC) are jointly mandated to supply seeds required for plantation activities in the country. TISC carries out identification, registration and management of natural seed stands of important tree species, as well as the establishment of breeding seed orchards from where seeds or any planting material are obtained. The breeding seed orchards have been established in different parts of the country (Pandit et al. 2020). The best quality seed is always a good investment. Good seed typically costs less than 1% of the total cost of forest plantation establishment (Quayle 2001; Munjuga et al 2013). The characteristics of good quality seed of 146 species are described in a book of Gautam et al. (2018). Poor seed quality will result in:

- Low germination percentage
- Poor emergence
- Poor survival rates
- Poor adaptability to the site
- Susceptibility to disease and pests
- Stunted growth
- Reduced productivity

4.2 Seeds, seed collection time and record keeping

4.2.1 Seeds

Seed trees are individual trees from which a seed or a wildling is collected. This is regarded as the most common source of germplasm in most parts of Nepal. Seed trees may be in natural forests or plantations and must have superior physical characteristics, including a straight and single stem, few branches, maturityto produce an ample quantity of seeds and belonging to the dominant or co-dominant trees in the site (Gregorio et al. 2010).

4.2.2 Seed collection

Seed collection time varies across different species throughout the year. Some will take a long time to ripen, while others will ripen almost overnight. Some shed their seeds quickly, whereas others will retain the seeds on the tree for months or even years. Careful observation and record keeping are therefore the key to successful seed collection. The flowering, fruiting and seed shed habits of the various species in a particular area need to be determined and recorded so that

seed collection can be efficiently programmed and opportunities will not be missed. It is essential to ensure that seed is ripe before collecting. Seed collection times for the 37 most commonly grown tree species in EnLiFT2 area are presented in Table 1 and the seed source, planting time, germination and survival record form are outlined in Annex 1.

Table 1: Seed collection time, seed types, viability, pre-sowing treatment and germination period (adopted from Gautam et al. 2018)

Species	Seed collection time	Seed types	Viability	Pre-sowing treatment	Germination period
1. *Actinidia chinensis (kiwi)*	Oct-Dec	Orthodox	1 month	Washing & …	1 month
2. *Alnus nepalensis (Utis)*	Nov-Dec	Orthodox	>1 year	No need	2-3 week
3. *Artocarpus lakoocha (baddar)*	June-July	Recalcitrant	1 week	Washing	10 days
4. *Bassia butyraceae (chiuri)*	May-June	Recalcitrant	1 week	Washing & ….	1 week
5. *Bauhinia purpurea (tanki)*	April-May	Orthodox	1 year	24 hr cold w	9-30 days
6. *Callistemon citrinus (kalkiphool)*	Aug-Mar	Orthodox	1 year	No need	2-7 week
7. *Choerospondias auxilaris (lapsi)*	Nov-Mar	Orthodox	1 year	24 hr cold w	3-4 week
8. *Cinnamomum camphora (kapur)*	Aug-Nov	Orthodox	6 month	24 hr cold w	35-55 days
9. *Cinnamomum tamala (tejpat)*	May-June	Recalcitrant	1 week	Removing flesh	15-20 days
10. *Coffee Arabica (coffee)*	Sept-Jan	Recalcitrant	1 month	Washing	1 month
11. *Citrus aurantifolia (lime)*	Aug-Sept	Recalcitrant	1 month	Washing	1-2 month
12. *Delonix regia (golmohar)*	Mar-Apr	Orthodox	>2 year	24 hr cold w	1-4 week
13. *Edgeworthia gardeneri (argeli)*	Dec-Jan	Cutting	-	-	-
14. *Elaecarpus sphaericus (beadtree)*	Nov-Dec	Orthodox	6 month	Breaking & hot water	1-9 month
15. *Emblica officinalis (amala)*	Oct-Dec	Orthodox	1 year	72 hr cold w	9-30 days
16. *Ficus auriculata (nimaro)*	Aug-Sept	Orthodox	1 year	No need	4-5 week
17. *Ficus benzamina (sami)*	Apr-June	Orthodox	2 year	No need	4-9 week
18. *Ficus semicordata (raikhanayo)*	July-Sept	Orthodox	6 month	No need	1-6 week
19. *Flemingia congesta (bhatamase)*	Oct-Jan	Orthodox	2 year	Hot water	10-15 days
20. *Juglans regia (Okhar)*	Nov -Dec	Recalcitrant	2 year	48 hr cold w	10-60 days
21. *Leucaena diversifolia (ipil ipil)*	Nov-Jan	Orthodox	5 year	Hot water	10-20 days
22. *Malus domestica (apple)*	Dec-Jan	Orthodox	6 month	No need	1-3 months
23. *Mangifera indica (mango)*	July-Aug	Recalcitrant	7 days	Washing	1-2 week
24. *Melia azedarach (bakaino)*	Nov-Dec	Orthodox	1 year	24 hr cold w	15-45 days
25. *Michelia champaca (chap)*	Aug-Sept	Recalcitrant	15 days	Washing with w	10-45 days
26. *Moringa oleifera (saijan)*	Feb-Mar	Orthodox	6 month	24 hr cold w	20-30 days
27. *Morus alba (kimbu)*	Dec-Jan	Cutting	-	-	-
28. *Pinus species (pine)*	Nov-Dec	Orthodox	3 year	48 hr cold w	2-4 week
29. *Prunica granatum (anar)*	Sept-Oct	Orthodox	6 month	24 hr cold w	1-2 months
30. *Persea americana (avocado)*	Aug-Sept	Recalcitrant	1 week	Washing & cold	10 days
31. *Prunus cerasoides (painyu)*	March-Apr	Orthodox	2-3 year	No need	15-20 day
32. *Pyrus communis (pear)*	Dec-Jan	Cutting	-	-	-
33. *Paulownia tomentosa*	May-June	Orthodox	1 year	Cocopit	1-2 months
34. *Saurauia nepalensis (gogan)*	Mar-Apr	Orthodox	4 month	No need	3 week
35. *Tephrosea spp (mendula)*	Dec-Feb	Orthodox	2 year	24 hr cold w	7-10 days
36. *Texus baccata (loathsalla)*	Nov-Dec	Recalcitrant	6 month	Store in cold	45-80 days
37. *Zanthoxylum armatum (timur)*	Nov-Dec	Orthodox	2 year	Washing with W	1-6 month

5. Nursery Accreditation

5.1 Rationale for Accreditation

In Nepal, there are many types of nurseries that lacks adequate quality assurance procedures. Instances of mislabeled species and the sale of seed from incorrect sources have been observed.

There are evidences that some nurseries have entered the market without assurance of the quality seedlings. On the other hand, why should anyone buy seedlings from an established nursery instead of a new nursery that is selling a less expensive seedling? Nursery accreditation would be one way for a reputable nursery trying to follow correct practices to distinguish themselves from those lacking the quality standards. Accreditation may also assist in supporting claims a nursery wishes to make concerning its products. For example, a nursery may produce seedlings in elevated pots and grow them in a hardening bed before planting, which does not require root pruning, and the roots of which are not curled. Accreditation is one method that can be used to certify that the seedlings produced with inoculation (rhizobia, mycorrhiza, azotobactersetc) have the ability to be established properly in new sites. One nursery might seek certification for products developed and grown for use within a particular state or region, while another may wish for certification for superior timber production.

5.2 Benefits of accredited/ or certified nursery seedlings

- It servesas the basis to raise overall industrial quality and capacity of their organization
- With accreditation, the seed source is guaranteed and known.
- It would help to support established programs, continuing good practices (keeping them in business) and serve to educate newly organized nursery businesses.
- Accreditation would encourage effective management. We would be cautious in our operation if we know someone is going to observe our nursery.;
- Accreditation sfacilitates recognition within our own organizations for producing quality seedlings. This, in turn, can reasonably justify training for personnel as well as having good facilities.
- Accreditation can help focus on priorities; what gets counted gets done.
- The records mandated by an accreditation process will prepare a nursery to address challenges observed in nursery work. Every nursery manager has to face customer complaints from time to time. A completely documented program from seed source identity to sowing through pack and ship will put the manager in a position to objectively answer any questions raised from outside the nursery concerning seedling quality.
- It helps maintain the availability of High quality seed of different tree species to the farmers through certification.
- It helps achieve the objective of plantation
- It provides information about the place of origin and the quality of the mother plant
- It helps determine the vigor of the growth, sturdiness and the degree of suitability to that site of plantation.
- It plays an important role in risk minimization

5.3 Pre-condition/ or eligibility criteria to apply for forest nursery accreditation

a) The applicant should have adequate information about seed or planting materialsources (Annex 1).
b) The applicant should provide proof of producing a minimum of 10,000 seedlings annually on two ropani (1000 M^2) of land (Annex 2)

c) Certificate of attendance to trainings, workshops or lectures on Nursery Development and Management conducted by Forest Research and Training Center (FRTC) or Division Forest Offices (DFOs) or other recognized agencies providing high quality training activities;
d) Recommendation from the local government
e) Certificate of registration from the respective agencies
f) Recent Tax Clearance certificate (within the last a12 months)
g) The nursery operator is applying the prescribed standard practices depictedin **Section 6** below for nursery operation;

5.4 Who would participate in the accreditation program?

Any individual nursery operator, local government unit, academic institute, government including DFOs, non-government organization, cooperative, corporation/ company, small and cottage industry, Forest User Groups (CFUG, LFUG) and others with an existing forest nursery can apply for nursery accreditation. In the case of any forest nursery operator who has been managing a forest nursery at least for the last 6 months prior to application, they may also apply for accreditation.

The accreditation of the nursery would be strictly voluntary and open to any nursery or seed plant wishing to participate. No one would be prevented from selling seedlings from an unaccredited nursery or seeds from an unaccredited seed plant, but the supporting or certifying agencies would certainly recommend the costumers to buy seedlings from accreditated nursery.

5.5 Accreditation body

The accreditation body is the organization that reviews the criteria and standards; and then conducts the evaluation and, finally, issues the accreditation certificate (Karrfalt 2005). One possible accrediting body in Nepal for forest nursery accreditation could be composed of five members/ representatives of the following organizations at the local level. The last 4^{th} and 5^{th} members will only be invited by the DFO in case there is need for any further information on the applicant nursery.

1. Divisional Forest Officer or officer designated by DFO- Chair
2. Sub-division Assistant Forest Officer/ designated by AFO- Member secretary
3. FRTC representative within the Province
4. Local government-related representative equivalent to officer- Member
5. District Agriculture Knowledge Center - Member

This committee will be named the **Quality Nursery Verification Committee (QNVC)** and will use the above criteria and standards (section 6) for accreditation. This committee would provide voluntary conformity assessment and accreditation services for those who applied for accreditation. This committee is an independent committee that strives to provide services in accordance with accepted nursery practices and internationally recognized nursery guidelines.

All services are provided on a cost-recovery basis, with fees as nearly equal as possible to the actual cost of providing the service.

5.6 Accreditation process and issuance of accreditation certificate

1. The nursery owner who meets the eligibility criteria (section 5.3) can apply to the DFO for its accreditation using the format (Annex 3).
2. The proposed application fee is NPR 1500 and the renewal charge is NPR 1000.
3. The DFO, in consultation with the QNVC members, may form a small team (two to three members). In case of DFO nursery, the Regional Director will form the nursery accreditation team, including a representative from the Provincial FRTC office, for inspections and verification.
4. The designated Team reviews the submitted documents and conducts field verification and assessment according to the prescribed rating scale of the applicant nursery to be accredited and submits the report to QNVC.
5. The applicant nursery needs to secure an average of at least 50% marks to be qualified for accreditation (Section 6).
6. The QNVC approves or disapproves the application based on the rating scales for accreditation and promptly informs the applicant.
7. The duration of accreditation will be for 1 year and is renewable for another year.
8. Regular monitoring of accredited nursery shall be conducted either by the committee members or assigned technical personnel of DFO. The report will be the basis for continuous operation, suspension or cancellation of the accreditation permit.
9. Official shields, stamps, logos, or other marks may then be used on certified nursery certificates, correspondence, advertising and promotional material to signify that the nursery has been accredited for the claims it makes for its products.
10. DFO will issue a license to the applicant. (Note: Any nursery business within the district must pay annual nursery licensing fees and be subject to DFO inspections. The costs of licensing and any other authority-mandated certifications must be included in the operational costs of the applicant nursery).

6. Standards and their Criteria for Accreditating Forest Nurseries

6.1 Criteria for defining a forest nursery and a high-tech nursery

6.1.1 Forest nursery

A forest nursery is a place where seedlings, especially of forest tree species are raised either from seed or from any other part of the plant for eventually planting out. A nursery is said to be a forest nursery if: at least 60% of the total number of different species raised in the nursery must be trees and/or shrubs and/or fuelwood and/or foddef and/or NTFPs species such as *Terminalia belerica, Terminalia chebula, Azadirachta indica, Phyllanthus emblica, Sapindus mukorossi, Elaeocarpus sphaericus* etc. and/or ornamental tree species such as *Jacaranda mimosifolia*, *Lagerstroemia* sp. The remaining 40% of the production can be fruit, flower or other species including medicinal and/or aromatic plants.

6.1.2 High-Tech Nursery

The next step is to decide whether you are going to establish a simple locally operated nursery or a high tech nursery. The level and types of technologies (simple-seedlings are grown in natural environment; medium-plastic and green net used and high- iron structure and sprinkle water used) differ between nursery types and investment capacities. Therefore, a High-tech forest nursery is the combination of a poly green house and agrinet house where the following four standards, including temperature control, humidity control, light intensity control and misting facility or micro-irrigation are fulfilled.

6.2 Basis for accreditation of forest nurseries

A set of four standards are developed as a basis for accreditating forest nurseries as below:

1. Standards for human resource requirements
2. Standards for basic nursery set up and facilities
3. Standards for general seedling physical quality
4. Standards for specific seedling stock quality

A total of 14 indicators have been developed for the assessment of the quality of the forest nursery seedlings. More weightage (maximum 4 points) is given to the indicators (3, 5, 6, & 7) for the assessment of basic nursery set up and facilities, followed by general seedling quality standards (Indicators- 8, 9, 10 & 12). The remaining 6 indicators (1, 2, 4, 11, 13, 14) have maximum allocated point of 3 each. Altogether, there are 50 points, of which a nursery should obtain a minimum of 25 points (50%) to pass the examination (for certification). The final results are graded as from 25-30 points is grade- C, 31 -40 points is grade- B, and more than 40 points is grade-A.

6. 3 Standards and Criteria for Forest nursery accreditation

6.3.1 Standards for human resource requirement

Standards for human resource requirement are judged on the basis of individual skills/knowledge and experience in nursery operation and quality seedling production. Here four basic criteria are developed for evaluating the human resource involved in the nursery operation and management.

1. Nursery manager and/ or supervisor should have at least a basic Diploma in forestry training to a BSc or master's in forestry level qualification and possess one to two years of experience in supervising nursery work.

Criteria description	Points
Neither obtained an academic degree nor any nursery related training	0
Not have an academic degree but participated a nursery training from a recognized institute with one year of experience in nursery work supervision	1
Not have an academic degree but participated in a month nursery training from a recognized institute with one year of experience in nursery work supervision.	2
Completed a BSc in forestry, nursery training from a recognized institute with one year of experience in nursery work supervision	3

2. The nursery operator should have participated in at least one nursery related training and should have minimum of three years of working experience for producing high quality seedlings

Criteria description	Points
Not received any nursery related training and not any working experience in seedling production	0
Have participated in one nursery related training and one year of working experience in forest nursery	1
Have participated one nursery related training and two years of working experience in forest nursery	2
Have participated at least one nursery training and working experience of at least three years.	3

6.3.2. Standards for a basic nursery set up facilities and outlook

3. Infrastructure: The nursery should have access to road/transport & market with sufficient space for tools/equipment storage, as well as facilities for electricity and fencing

Criteria description	Points
Nursery has space required for poly bag nursery but not for other facilities (only for nursery bed)	1

Have facility of water supply and road /transportation facilities (including above criteria)	2
Have enough facility forwater supply and space for equipment and tool storage (Have space for equipment and tool storage room including above)	3
Have reliable facility forwater supply, equipment, electricity, fencing and market facilities(Have facilities of electricity, fencing, market, rest room including above criteria)	4

4. Facilities- There should be **the p**resence of necessary nursery facilities such as seed beds, seedling beds and or hardening beds with soil sterilization and seiving facilities for quality seedling production

Criteria description	Points
Not having separate seed, seedlings and hardening beds	0
Have three types of basic beds (seed bed, transplant bed and hardening bed)	1
Have a soil, sand and compost sieving facilities including above facilities	2
Have soil sterilization facilities including above facilities	3

5. Seedling container: nursery uses different sizes of polybags and hyko (elevated) trays for root training

Description	Points
Nursery uses makeshift materials (can, juice packs and plastic cups)	1
Nursery uses polybags	2
Nursery uses different sizes of polybags based on species requirements (duration-years, seedling size etc)	3
Nursery uses hiko trays (high density plastic used in forest nurseries) or elevated containers which is used for root training	4

6. Potting mixture: nursery uses forest top soils with drainage enhancers in the mixture

Description	Points
Pure clay soil	1
Clay soil with drainage enhancers (sand, leaf/forest peat, rice husk, saw dust) and fertilizer	2
Top soil from forests with high organic matter	3
Top forest soil with drainage enhancers	4

7. General outlook of the nursery in terms of grading (according to the size of the polybags, age and type of the species) and cleanliness (weeding & hoeing) seems to be appropriate, attractive and appealing.

Description	Points
Nursery lacks appropriate grading and have poor sanitation	1
Nursery seedlings are graded based on species, age and sizes of poly pots	2
Have appropriate nursery seedling grading and good sanitation facilities	3

In addition to above nursery signboard is placed on a place that can be easily noticed from the outside	4

6.3.3. Standards for general quality seedling stocks

8. Sturdiness: seedlings should have robust stem

Criteria description	Points
All samples have sturdiness quotient value of more than 10	1
10-16 samples have sturdiness quotient value more than 6 but less than 10	2
5-9 samples have sturdiness quotient value more than 6 but less than10	3
< 5 samples have sturdiness quotient value more than 6 but less than 10	4

Note: Sturdiness quotient: *It refers to the ratio of the height of the seedling in cm to the root collar diameter in mm and expresses the vigour and robustness of the seedling. A small quotient indicates a sturdy and stouter plant with a higher expected chance of survival, especially on windy or dry sites (Jaenicke 1999). A high ratio indicates a relatively spindly (thin) seedling (Haase 2007). The ideal value for a seedling to be considered sturdy is less than six (Jaenicke 1999 cited by Takoutsing et al. 2013). In the prevailing context of planting materials production in Nepal's forest nurseries, the sturdiness quotient of up to 10 or less is suggested for selecting nursery stock for planting.*

9. Health: Seedlings should be free from pest & diseases, no mechanical or physical injuries and no stem rottening

Description	Points
All samples (16) are affected by pests and diseases, but no mechanical injuries	1
10-15 samples are affected by pests and diseases but no mechanical injuries	2
5-9 samples are affected by pests and diseases but no mechanical or physical injuries	3
<5 samples are affected by pest and diseases and or no mechanical or physical injuries	4

Note*: Any plant or seedling is said to be healthy when it is free from pests and diseases, and at the same time, it should not have any mechanical injuries and physical damage.*

10. Colour of foliage: The colour of leaves and foliage should be dark green/ green deep colour and no dark, pale-green foliage

Criteria description	Points
Almost all samples (>15) have pale green color foliage and leaves	1
10-15 samples (9) have pale green color foliage and leaves	2
5-9 samples (6) have pale green color foliage and leaves	3
< 5 samples have pale green color foliage and leaves	4

Note*: Colour of foliage or leaves of seedlings is a general indicator of seedling quality and can vary by species and time of the season. Yellow, brown, or pale-green foliage indicates lower vigour than dark green foliage (haase, 2007).*

11. Stem form: Good quality seedlings should have straight stem

Description	Points
All samples (>15) have two or more stem leaders and bent shoots	0
10-15 samples have two or more stem leaders and bent shoots	1
5-9 samples have two or more stem leaders and bent shoots	2
<5 samples have two or more stem leaders and bent shoots	3

Note: *Any seedlings selected for planting in the field should have straight stem and a single stem leader*

12. Root form: Quality seedlings should have well-developed root system and no evidences of root deformations

Criteria description	Points
All 16 samples have j-pot bound and curled roots and primary roots growing out from the container and penetrating into the ground	1
10-15 samples have j-pot bound and curled roots and primary roots growing out from the container and penetrating into the ground	2
5-9 samples have j-pot bound and curled roots and primary roots growing out from the container and penetrating into the ground	3
<5 samples have j-pot bound and curled root and primary roots growing out of container and penetrating into the ground	4

Note*: The root system of plants can be assessed easily in bare-root seedlings and plants for stump production. A deformed root obstructs the uptake of water and nutrients from the soil and a bent or looped primary root does not provide a strong base for the anchorage of the growing plant (Harrison et al. 2008 cited by Takoutsing et al. 2013).*

6.3.4. Standards for specific types of nursery stocks (Annex 4)

13. Container raised single year seedlings of 4”x7” should have a min ht of 25 cm & root collar diameter 2.5 mm.

Description	Points
All 16 samples (4 samples /bed of 10 m length) fall under the minimum standard of at least 4”x7” pot size, 25 cm ht., and root collar diameter 2.5 mm	0
Only 1-5 samples meet the minimum standard of least 4”x7” pot size, 25 cm ht., and root collar diameter 2.5 mm	1
6-10 samples meet the minimum standard of least 4”x7” pot size, 25 cm ht., and root collar diameter 2.5 mm	2
More than 10 samples meet the minimum standard of least 4”x7” pot size, 25 cm ht., and root collar diameter 2.5 mm	3

14. Container raised or a large ball rooted multi- year seedlings of 5”x10” or 14” polipot size should have a min ht of 50 cm to 1 m & root collar diameter 5 mm.

Description	Points
All 16 samples fall below the min pot size of 5”, ht 50 -100 cm and root collar diameter >5 mm	0

Only 1-5 samples have min pot size of 5", ht 50 -100 cm and root collar diameter >5 mm	1
5-9 samples have min pot size of 5", ht. 50 -100 cm and root collar diameter >5 mm	2
>10 samples have min pot size of 5", ht. 50 -100 cm and root collar diameter >5 mm	3

7. References

Aldhous, J. R. and Mason, W. L. (Eds.). 1994. Forest Nursery Practice Forestry Commission Bulletin 111. The Forestry Authority, Research Division, Alice Holt Lodge, Wrecclesham, Famham, Surrey GU10 4LH.

American Hort. 2014. American Standard for Nursery Stock. American Horticulture Industry Association, USA.

AVRDC. 2015. Healthy Seedling Production Training Course Guide. World Vegetable Centre.

Campbell, M.W. 1983. Plant Propagation for Reforestation in Nepal. Revised Edition. Technical Noite 1/83. Nepal Australia Forestry Project, Kathmandu, Nepal.

Chaturvedi, OP., Handa, AK., Uthappa, A.R., Sridhar, KB., Kumar, Naresh, Chavan, SB. and Rizvi, Javed. 2017. Promising Agro forestry Tree Species in India. Jointly published by the Central Agro forestry Research Institute (CAFRI), Jhansi, and the South Asia Regional Programme (based in Delhi, India) of the World Agro forestry Centre.

Dharmasena, P.B. 2016. Nursery Management: Handbook for Beginners

Gautam L, Paudel RB, Pokhrel YR. 2018. Tree seeds information book. Ministry of Forests and Environment, Government of Nepal.

GoN. 1997. The Seeds Regulation. Government of Nepal, Kathmandu, Nepal.

Gregorio, NO., Herbohn, JL., and Harrison, SR. 2010. Guide to Quality Seedling Production in Smallholder Nurseries. VISCA Foundation for Agricultural Research and Development, Inc. and College of Forestry and Natural Resources, Visayas State University, Visca, Baybay City, Leyte, Philippines.

Haase, Diane, L. 2007. Morphological and physiological evaluations of seedling quality. In Riley, L. E.; Dumroese, R. K.; Landis, T. D., tech. dub. 2007. National proceedings: Forest and Conservation Nursery Associations—2006. Proc. RMRS-P-50. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. Online: http://www.rngr. Net/nurseries/publications/proceedings.

Harrison, S., Gregorio, N. and Herbohn, J. 2008. A critical overview of forest seedling production policies and practices in relation to smallholder forestry in developing countries. *Small-scale For* **7** (3–4): 207–223.

HMGN. 1988. The Seeds Act. His Majesty's Government of Nepal, Kathmandu, Nepal.

HMGN. 2000. Nursery Management Act- His Majesty's Government of Nepal, Kathmandu, Nepal

Jackson, J.K. 1994. Manual of Afforestation in Nepal. Volume 1. Forest Research and Survey Centre, Ministry of Forests and Soil Conservation, Kathmandu, Nepal.

Jaenicke, H. 1999. Good Tree Nursery Practices: Practical Guidelines for Research Nurseries. International Centre for Research in agroforestry

Khanna, L.S. 1984. Principles and Practice Silviculture. Khanna Bandhu. Tilak Marg Dehradun, India.

Krishnan, P. R., Kalia, R. K., Tewari, J. C. and Roy, M. M. 2014. Plant Nursery Management: Principles and Practices. Central Arid Zone Research Institute (Indian Council of Agricultural Research), Jodhpur – 342 003 (Rajasthan).

Karrfalt R.P. 2005. Needs and benefits of nursery accreditation. USDA Forest Service
National Tree Seed Laboratory, Purdue University, 195 Marstellar Drive, West Lafayette, IN 47907.

Lamsal, RP., Pandit, BH., Pokhrel, D., Paudel, NS., Cedamon, E., and Nuberg, I. 2020. Current Practices and Suggested Management Modalities of Government Forest Nurseries in Nepal, Research Paper Series on Improved Forest Management in Nepal, 2020-04: 1-28.

Liege, LH and Venator, CR. 1987. A Technical Guide for Forest Nursery Management in the Caribbean and Latin America. Institute of Tropical Forestry, Southern Forest Experimental Station, Rio Piedras, Puerto Rico.

Lilleso, Jens-Peter Barnekow, Poulstrup, Erik and Thapa, Hasta B. 2001. Species Leaflets for 131 Woody Species. Ministry of Forests and Soil Conservation, HMG/Nepal, Natural Resource Management Sector Assistance Programme (NARMSAP), Tree Improvement and Silviculture Component (TISC), Kathmandu, Nepal.

McCracken, IJ and Shrestha, ML. 1992. Common Tree Species. Field Manual for Community and Private Forestry in Nepal Part I. Field Document No. 19. HMG/UNDP/FAO, Community Forestry Development Project (Phase II), Kathmandu, Nepal.

Munjuga, MR., Gachuiri, A N., Ofori, DA., Mpanda, M M, Muriuki, JK, Jamnadass, R H and Mowo JG. 2013. Nursery management, tree propagation and marketing: A training manual for smallholder farmers and nursery operators. Nairobi: World Agroforestry Centre.

Napier, I and Robbins, M. 1989. Forest Seed and Nursery Practice in Nepal. Nepal-UK Forestry Research Project/National Tree Seed Project.

Napier, IA, and Willan, R.L. 1983. Nursery techniques for tropical and subtropical pines. Technical Note no. 4. University of Copenhagen.

NCFD. 2020. Annual Progress and Statistics Report (in Nepali). National Centre for Fruit Development, Kirtipur, Kathmandu.

Pandit, B.H., Chapagain, R., Cedamon, E., Paudel, N.S., Pokhrel, D.C. and Nuberg, I. 2020. Choosing best practice nursery: A way forward for a successful plantation project, Research Paper Series on Improved Forest Management in Nepal, 2020-02:1-31.

Quayle S, Arnold RJ, Gunn B, Mohns B. 2001. Tree nursery manual for the Sri Lankan Plantation Industry. A project report of the Estate Forest and Water Resources Development Project, Kandy

Sarolia, D. K., Samadia, D. K., Choudhary, B.R. and Singh, D. 2018. Production of quality seed and planting materials. CIAH/Tech./Pub. No. 75. ICAR-Central Institute for Arid Horticulture, Bikaner, Rajasthan.

Singh, Balraj and Sirohi, N.P S. 2002. High-tech nursery raising technology for vegetables. *Indian Hort.,* **47** (3): 22-24.

Takoutsing, Bertin, Tchoundjeu, Zacharie, Degrande, Ann, Asaah, Ebenezar, Gyau, Amos, Nkeumoe, Frederick and Tsobeng, Alain. 2013. Assessing the Quality of Seedlings in Small-scale Nurseries in the Highlands of Cameroon: The Use of Growth Characteristics and Quality Thresholds as Indicators. Small-scale Forestry DOI 10.1007/s11842-013-9241-7.

Thompson, BE. 1985. Seedling morphological evaluation–what you can tell by looking. In Duryea M.L., editor. Evaluating seedling quality: principles, procedures, and predictive abilities of major tests. Proceedings of a workshop held October 16-18, 1984. Corvallis (OR): Oregon State University, Forest Research Laboratory, 59-71.

YCMOU. 2012. Resource Book on Horticulture Nursery Management. Yashwantrao Chavan Maharashtra Open University (YCMOU). Developed under National Agricultural Innovation Project, Indian Council of Agricultural Research, New Delhi – 110012.

WBFBCP. 2015. Nursery Site Selections, Layout and Development. Nursery Manual Volume II. West Bengal Forest and Biodiversity Conservation Project. Directorate of Forests, Government of West Bengal, India.

Westwood, S. 1986. Results of Experiments Conducted at Hetauda Forest Research Nursery 1984-1985. Publication No. 45. Forest Survey and Research Office, Kathmandu, Nepal.

Annex 1: Seed source, date and germination and survival records

Species	Date of collection	Amount in kg	Source of germplasm	Planting date	Germination %	Survival %	Remarks

Annex 2: Calculation for space requirement for 10000 seedlings

Step 1: Measure the size of the pots or bags to be placed in the nursery.

Step 2: Measure the area taken up by the pots or bags. For example in a standard shed (6mx10m = 60 M^2) for transplant beds, a minimum of 10,000 poly bags of a 4"x7" size can be placed.

Step 3: Calculate the area assuming 50 % seedlings (5000) are smaller size and 50% are larger size (5000) = Area required for smaller size poly pots = 30 M^2+ area for larger size poly pots = 60 M^2 = 90 M^2

Step 4: Add 25 percent to the number of seedlings or poly pots (i.e., to allow for unexpected loss such as poor germination or death) = (90 + 25% = 112.5 M^2).

Step 5: Multiply by 2.5 for the space between beds, seedlings, walk ways and paths = 112.5x2.5 = 281 M^2

Step 6: Estimate the size of storage house (6x4), water tank/ reservoir (5x3), Germination bed (6x4), Hardening bed (6x4), mother plant area (10x25) and compost pits (2.5x2) and toilets (7x5) = 377 M^2 that will be needed.

Step 6: Double this figure to allow for space between the structures (377 x2 =754M^2).

Step 7: Add results from steps 5 and 6 to give an estimate of the total area that will be needed for the nursery (281 + 754 = 1035 M^2 = Approx. 2 *ropani*).

Annex 3: Application form for nursery accreditation

(*To be completed by the applicant*) adopted from Grigorio et al 2010

Name of the Nursery: _____

Name of the Nursery Operator/ manager: _____

Address: _____

Telephone: _____Email:_____

Enclose the following:

1. Photograph of the nursery
2. Proof of seeds and planiting material sources (from where seed was purchased or collected)
3. Land area available and production capacity
4. Certificate of attendance to trainings related to nursery seedling production
5. Nursery set up and facilities
6. List of seedling species registered for production and trade
7. Business permit from the local government where the business is located
8. Authenticated tax clearance
9. An accreditation/administrative fee of NPR 500.00 shall be paid to the DFO upon application for individual applicant and NPR 1,000 for cooperative, corporation, small and cottage industries, NGO, private group and academic applications.

Annex 4: Specific standards and criteria for seven types of nursery stocks

	Polypot size, color, thickness	Height in cm/m	Root collar diameter in mm	Production period & purpose	Species and purpose
Container raised single year	3"x7" to 4"x7", black and 200 gauge	≥25 - 30 cm	≥2.5 - 3.0 cm	3 months to 1 year- for **patch or block or irregular** planting	Ipil, tanki, bakaina, lapsi, utis, pine, Flemingia, Moringa
Container raised multi-year	5”x8” or (6"-10", 10"-14"), black pots; at least 200 gauge	≥50 cm to 1 m	≥5 mm to 10 mm	2 to 4 years for **urban/avenue, road side, ceremonial & canal** planting	Champ, Tejpatta, kapur, timur, walnut, F religiosa, F. bengalensis, F benjamina and any fruit trees
Large ball rooted seedlings	NA	≥50 cm to 1 m	≥5 mm to 10 mm	6 months to 2.5 years depending upon the species and purpose (urban, roadside, canal and ceremonial)	*Terminalia arjuna, Syzygium cumuni, Mangifera indica, Albizia lebbeck, Albizia procera* etc
Stump (3-5 cm stem & 20-25 cm root portion)	Spacing in beds – 10 cm to 30 cm based on species	1 m to 2.5 m	8 mm to 25 mm	1 to 2 years	*D. sissoo, T. grandis, Grewia optiva*, *Cassia siamea*, *Leucaena* spp, *Azadirachta indica*
Cutting	5”x8” or (6"-10", 10"-14"), black pots; at least 200 gauge	15-25 cm length and 30 cm for rooted plants	8mm to 25 mm depending upon species	4- 5 months or 18 months	*Populus deltoids, Daphne, Morus alba, pear, Taxus baccata*
Bamboo seedlings	No of shoots or buds/ cutting = 3	≥ 1 m -2 m	≥ 4 cm diameter	18 months to 3.5 years depending on species and altitude	*Abundent lateral roots with dense fibrous roots*
Grafted fruit seedlings	Min 5”x8 to 10”x14” and > 200 guage thickness	≥ .5 m -1 M	≥ 10 mm	> at least > 2 years	*Mango, Litchi, Orange, Avocado, Apple*