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Government managed Forest Nursery, Tanahun Nepal, and picture taken by Dr. Bishnu Hari Pandit, Activity Coordinator, Private Forestry, EnLiFT2 Project

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Ministry of Forests &
Environment Government of Nepal

Current practices and suggested management modalities for promotion of forest nurseries in Nepal

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ACRONYMS

AFO	Assistant Forest Officer
AKC	Agriculture Knowledge Center
CFUG	Community Forestry User Group
CIFOR	Center for International Forestry Research
CCP	Churia Conservation Project
DFO	Divisional Forest Office
DOFSC	Department of Forests and Soil Conservation
EnLiFT2	Enhancing Livelihoods from Improved Forest Management in Nepal
FAO	Food and Agriculture Organization
FECOFUN	Federation of Community Forestry Users Nepal
FRTC	Forest Research and Training Center
GON	Government of Nepal
ICRAF	World Agroforestry Center
INGOs	International Non-Government Organizations
LG	Local Government
MOALD	Ministry of Agriculture and Livestock Development
MOFE	Ministry of Forests and Environment
MSFP	Multi Stakeholders Forestry Program
NAF	Nepal Agroforestry Foundation
NAFSCOL	Nepal Agroforestry Seed Cooperative Limited
NGO	Non-Government Organization
NTFPs	Non-timber Forest Products
POMITFE	Provincial Ministry of Industry, Tourism, Forests and Environment
SDFO	Sub Divisional Forest Office
SWOT	Strength, Weakness, Opportunity and Threats
TCFP	Terai Community Forestry Project
TISC	Tree Improvement Silvicultural Component
WB	World Bank

SUMMARY

Considering the current problems and issues on forest tree seedling production and distribution system in Nepal, this paper examines gaps and challenges faced in government, community and private managed nurseries and suggests strategic guidelines and modalities for promotion of forest nurseries. All nursery types are important interlinked components of national seedling supply systems and reforestation and also for private tree planting programmes. This study reviewed literature on seedling production and nursery operations mainly from government documents and project technical reports, books, nursery manuals, newspaper and journal papers. SWOT analysis provided important insights in recommending possible strategies and modalities to the Government of Nepal for implementation. The study estimated that a total of 1.37 billion seedlings were produced in the entire country in the last four decades (1978 to 2017). The production volume varies with types of nurseries (government, community and private) across Nepal ranging from few hundred up to thousands. Government nurseries produce seedling based on government tree planting targets while private nurseries are oriented towards meeting demand of private landholders. In general, the level of nursery technology used is basic and low-tech although few nurseries have adopted state-of-the-art technology in the recent years supported by projects. Both indigenous and exotic species are produced in the nurseries, but their seed sources are not verified except from some local collections. The seedlings from government nurseries are given for 'free', while those seedlings in private nurseries are for sale. Mostly government nurseries are permanent types unlike others.

The current nursery operation processes include annual planning and budgeting, implementation schedule, identification of nursery site and establishment, seedling production, distribution and planting, and record keeping. The existing gaps and weaknesses include lack of coherence in the policy and implementation, weak coordination mechanism, poor quality planting stock, limited availability of preferred seedlings, inadequate skill and technical knowledge, inadequate resources (land, water, funds and information), poor access to seedling sources, low level of entrepreneurship capacity and low germination and seedling survival. Similarly, threats and challenges include climatic disasters (drought, hailstorm, and erratic rainfall), free seedling distribution, change in political preferences, competition between nurseries, community dependency on external funds, focus on big plantation project and threat of extinction of local and indigenous species. Based on these gaps and challenges (highlighted in SWOT analysis), strategic interventions are proposed. The recommended strategic interventions are divided into five groups that include (1) reforming policy legal and regularity framework (2) enhancing institutional development and capacity for commercialization of private and community nurseries (3) enhancing support services for innovative technologies, quality germplasm and planting materials (4) strengthening nursery operators' capacity in nursery development and management and (5) formulating resource mobilization framework to increase funding for nursery programme. Details of each of the 30 action points are discussed briefly in each of the strategic interventions and the roles of three tiers government, private sector and communities are clearly outlined at the end of the report.

INTRODUCTION

Background

The history of nursery management in Nepal dates back to 1965 where the objectives on its management and operation were clearly defined. However, due to various institutional, technical and procedural factors, levels of operations of government nurseries have been heavily reduced and production practice standards had declined (GON 2017). Despite of a long practice, nursery management skill of nursery operators suffers from various institutional deficiencies like weak commitment from both government and non-government agencies, skilled human resource, and consultation from policy to implementation, unclear budgetary arrangements and difficult nursery equipment procurement system of the government. Similarly the data of seedling production and plantation have not been kept properly and updated at both district and national level which shows a fundamental gap in nursery management policy in Nepal (Pandit et al. 2020). In view of the above problems, this paper documents the current practices and gaps/challenges, proposing strategies and management modalities for the promotion of government nurseries. This paper may be a valuable guide for policy makers and nursery practitioners to implement the best nursery modalities in Nepal.

This demands for a national level policy or guideline for an effective implementation of seedling production and plantation projects. Because of lack of such policy or guideline, the nursery management practices vary across country and the supporting data are inadequate and controversial, and much is fragmentary and tentative. Although, the official records overestimate the true extent of seedlings and plantation, unsupported sources suggest that more than 50 per cent of seedlings have not been used in plantation.

The quality seedlings determine the success forest plantations, afforestation and reforestation programmes, enrichment plantings, agroforestry (GON 2017). Tree nurseries play crucial role in propagating seedlings of desired quality and species and age with minimum input. However, existing nurseries in Nepal like in many nurseries elsewhere, are not meeting expectation of forestry plantation programmes due to unavailability of quality planting materials, shortage of required species, lack of coordination between the seedling production and plantation time and mismatch of location (Roshetko et al. 2010; Cedamon et al. 2017; Pandit et al. 2020). Most tree nurseries overemphasise mass seedling production to the expense of seedling quality, thus result in overall poor performance of plantation (CIFOR 2006).

The forest nurseries in Nepal is comprised of three interacting groups of nurseries, namely the private, community and government nurseries, which are operating within a policy environment largely administered by the government (Pandit et al. 2020). Under the government category, there are two types, namely local government and Division Forest Office managed nurseries.

METHODOLOGY

This paper is mainly based on review of various project documents of the Department of Forests and Soil Conservation (DOFSC) and lead author's experiences in implementation of forest nursery and plantation programmes in Nepal. The reviewed materials include mid-term and final evaluation report of various projects associated to the DOFSC, Government progress report as well as the report of the Auditor General related to initial projects in hills on community forests and watershed management, Terai-Community Forestry PProject (TCFP), Sagarnath Project, Ratuwa and Nepalganj Forestry Development projects, Resource Conservation and Utilisation Projects, Operational Forest Management Plan, project supported by the World Bank, Danida, the Multi-Stakeholder Forestry Programme (MSFP), the Churia Conservation Project (CCP) and various other projects supported by the Government. Beside these documents, project technical reports (Jayasawal and Bishowkarma 2016; CIFOR 2006), research or network paper series of EnLiFT and Nepal UK Community Forestry Project (Pandit et al. 2020; Robinson and Thompson 1989), Technical reports of FAO, ICRAF and World Bank, nursery management manual, guide and source books (Gregorio et al. 2010; Reshesko et al. 2010; Wilkinson and Landis 2014), publications and research Paper Series, journal and newspaper (Cidamon et al. 2017; Mandal 2019) were reviewed.

RESULTS AND DISCUSSIONS

Trends in seedling production

The record of seedlings production and distribution of various forestry projects and programme documents of DOFSC for periods 1978 to 2017 is provided in Table 1. Records show that a total of 1.369 billion seedlings (in minimum) have been produced with an annual average of 34.2 million, highest level of production of 87 million in 1989 and the lowest level of 3.65 million in 1978, during the initial years. Overall Nepal's seedling production was 1.37 billion in the last 40 years period. Mandal (2019) mentioned that 50 million seedlings plantation target of the last fiscal year (2019/20) in Nepal has encouraged the development of several DFO managed nurseries. These records are not however exact as they were pulled from various sources of project documents and from newspapers.

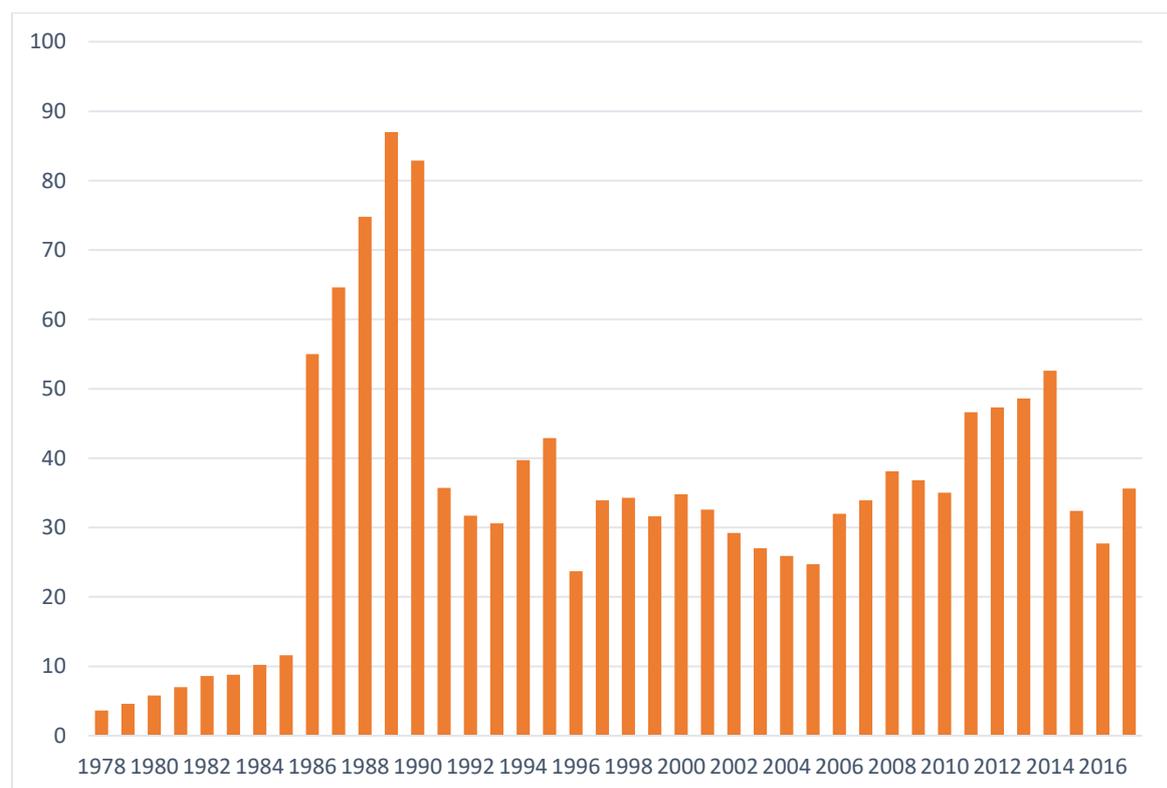
Annual seedling production of the last 40 years period is also illustrated in Figure 1. The trend shows that the seedling production was at peak (above 80 million) during early nineties (1990 to 93). The records on seedling distribution from Tree Improvement and Silviculture Component (TISC) alone during 1992 to 1998 shows that around 88 million seedlings were distributed (Tamrakar 2003).

Table 1: Seedling production in Nepal (in million)

Years (B.S)		Seedling production			
From	To	Total	Average/yr	Minimum/yr	Maximum/yr
1978	1982	29.65	5.93	3.65	8.6
1983	1987	150.2	30.04	8.8	64.6
1988	1992	312.1	62.42	31.7	87
1993	1997	170.8	34.16	23.7	42.9
1998	2002	162.5	32.5	29.2	34.8
2003	2007	143.5	28.7	24.7	33.9
2008	2012	203.8	40.76	35	47.3
2013	2017	196.9	39.38	27.7	52.6
Total		1369.45			

Note: The estimated figures are based on a rapid analysis of 17 nursery and plantation project documents related to DOFSC

Shortage of quality tree seeds and seedlings have always been a major constraint in afforestation, reforestation, agroforestry and related land restoration activities. In response to this problem, tree seed programmes were initiated to establish seed centres in many parts of Nepal to mitigate the shortage of tree seeds on quality and quantity. Tree seed procurement and distribution system for tested seeds and capacity-building activities on tree seed technologies were initiated by TISC of the government in 1992. Though these programmes were quite instrumental in supplying quality seeds, they could not fully satisfy the demand for quality tree seeds with increasing awareness on the importance of tree planting. The tree planting programme was at pick during the period of 1986-1990 (Figure 1).

**Figure 1: Seedling production (in million) in Nepal from 1978 to 2017**

Characteristics of nursery operations and seedling production systems

A wide diversity of characteristics of seedling production systems can be identified in Nepal. The purposes for establishment of nurseries are mostly for restoration of lands and not always limited to timber species, moreover they also support fruits, herbal medicine, fuelwood and animal fodder production. Nurseries in urban areas, produce a substantial quantity of ornamental plants. Listed below are characteristics of nursery operation:

- The main division of forestry nursery ownership is between government, private owners and communities. The government nursery is divided into DFO and local government managed nurseries, and private nurseries are also of two types, namely registered and non-registered as home nurseries (Pandit et al. 2019).
- Nurseries are usually located in rural areas while there are a few in urban locations.
- Types of activities conducted by nurseries are production of seedlings of timber trees and fruit trees, production of non-timber species (e.g. bamboo, rattan, and ornamentals) and fodder and grass species. In addition to producing timber, non-timber and other tree seedlings, nurseries are also engaged in providing services such as landscaping and garden management, restoration plantings and conservation of rare species.
- Production volume of nurseries ranges from a few hundred up to thousands of seedlings per year. Government nurseries produce seedlings based on its government tree planting targets, while private nurseries are oriented towards commercial production and sale.
- In most of the cases, the level of technology used is primitive and traditional. While majority of government nurseries have not used state-of-the-art technology (particularly tissue culture) yet, some are slowly trying to upgrade to a higher level of technology as such automatic temperature control, sprinkling and irrigation system, and using steel structures. The level of technology varies greatly from very simple structures made of light local materials e.g. bamboo in remote locations, to modern high-technology nurseries, of government departments and research centres, companies, and some academic institutions.
- Many of the nurseries either government managed or private grow both exotic as well as indigenous species in combination. However, the level of use of exotic species is higher in private nurseries than others. Choice often depends on whether the forest policies favour indigenous (native) or exotic species. There are some sound reasons for growing indigenous species, such as adaptation to planting sites, high timber quality, resistance to pests and diseases, and support for wildlife habitat. However, typically exotic species grow more rapidly and presents a better commercial proposition, therefore mostly grown widely.
- Seed source used in nursery is mostly not from verified sources but from the locally collected seeds and wildlings, seed merchants (drawing on seed collectors, seed orchards and seed imports). Government buys seeds either from registered companies or cooperatives.
- Seeds or wildlings were collected locally by the nursery operators from naturally growing trees and tree plantations. Sometimes, seeds are also purchased from domestically produced and imported seed. Tree Improvement Program (TIP) in Nepal played the role of conservation of genetic resources by providing seeds of various tree species. The Forest Research and Training Center (FRTC) and TISC were jointly

mandated to provide technical inputs for seed required for plantation activities in the country. TISC carried out identification, registration and management of natural seed stands of important tree species, and establishment of breeding seed orchards from where seed or any planting material was secured. The breeding seed orchards have been established in different parts of the country (Pandit et al. 2019). The extent of government nurseries using seeds from identified seed source is very minimal. This is estimated to be as much as 15 per cent (Personal communication with Tula Ram Ghimire, AFO, Sindupalchowk).

- The seedling is distributed freely and in occasional cases with the support to meet the transportation cost. The cost is usually covered by government funding, and some of the costs is borne by the projects working with DFO. Private nurseries provide seedlings with a negotiated price to users, government and industrial forestry enterprises. Sometimes relatively large private seedling nurseries operate alongside with the support from government for free seedling distribution. These nurseries are often known as contact nurseries.
- Government nurseries are stand-alone based management system, but for private nurseries they are often integrated with other enterprises.
- Government nurseries are either temporary or permanent. Private nurseries are often ephemeral based on seedlings demand. They remain dormant when there is little seedling demand but resume quickly when a seedling market arises.
- Although private seedling nurseries are a form of business which is easy to set up, there is also a high rate of failure. This is because of market uncertainty and project-specific up and down of demands.

Current processes

The diverse topographic-edaphic-climatic condition of Nepal offers scope for growing nurseries and planting a variety of species. The type of species or variety suitable for plantation in one area may or may not be appropriate in another area. The production of site-specific species and quality seedlings has the potential to increase both the production and productivity and it offers scope for sustainable forest management (Jayasawal and Bishowkarma 2016).

The National Forest Policy – 2019 calls for massive state-managed, community-based and private plantations in all available spaces such as government owned, community managed, public, private, urban and degraded and unproductive lands. The timely availability of quality seedlings during plantation, choice and type of species and accessibility of seedlings in close proximity to the plantation areas are the major challenges often associated to undertake a long-term plantation strategy in Nepal.

The nursery processes, practices and the subsequent operations are described in this section with a focus on government nurseries. The process begins with the preparation of annual plan, budget allocation and release, issuance of implementation guidelines and other key area of operations. The following major steps have been followed in the districts:

Step 1: Annual planning and budgeting

Annual plan preparation is an important initial step, which is carried out by the Ministry of Forest and Environment (MOFE) through participation of DOFSC at the federal level and Divisional Forest Office at the provincial and local level. The annual plan acts as the legal,

institutional and technical guiding document for the nursery operations. The plan and budget preparation process starts with the identification of potential nursery site and the seedlings to be produced for planting in each of the districts and integrate this into the national plan. Identification of potential area is usually carried out through discussion between planning team of the government institutions (central and provincial) according to the budget ceiling and, national and sectoral budget preparation guideline. These plans are prepared based on demand of local communities, and in some cases, government priorities.

Step 2: Implementation schedule

This step involves approval of the annual programme, budget release, issuance of the work order, areas of nursery establishment; budget estimate, and release of advance from the implementing field office. This is then aligned with previous years' practices mainly on identification of location, terrain, soil, water etc. for nursery management.

Step 3: Identification and establishment

As practiced in the districts, the establishment of nursery includes a series of activities: site selection for nursery, design and layout, nursery site preparation, management of equipment and tools, preparation of potting medium, sowing of seeds, potting management, transplanting, tending, wildling collection, preparation of stock for field planting, distribution and record keeping. The site selection is done only for the new sites, but not in the already started nursery sites. The selection of a nursery site is generally carried out based on several important factors, such as the location of the proposed site, soil, climatic factors, topography, economic factors and water supply.

In between the major interventions, some crucial activities include boundary survey and fencing, site clearance, levelling, division of areas into several parts for soil work. A close coordination is maintained with the local communities and leaders to manage water resources, shading materials and boundary stone or bricks.

The nursery land is divided into different segments. The nursery beds are mostly separated by paths in between which are usually positioned either side of the beds. Between the beds, a shallow drainage is prepared depending on local conditions. All the debris is removed from the nursery to reduce the risk of pest attack. Depending on the local conditions, protection of nursery from fire, grazing, and unwanted human entry are given high priority. The nursery infrastructure also includes sheds or buildings, water tanks, irrigation pipes and water canes. There is no any fixed recommended layout system or structures for any types of nurseries whether it is private, public or community-led. For all nurseries, the standard width is one meter and the length is dependent on the requirement of seedlings and size of the land.

Step 4: Seedling production

The production process of seedling starts from the seed procurement (selection) from registered seed cooperatives or companies located in the region, sowing or sprouting process, filling the polybag, putting seeds on the germination beds, pricking out small seedlings into the transplant beds and sorting and grading of seedlings for out-planting. Generally, orthodox¹

¹ Orthodox seeds are seeds which will survive after drying and/or freezing during ex-situ conservation, as opposed to recalcitrant seeds. Their viability will not be lost or reduced after drying in the sun. These seeds can be stored for some time before planting.

seeds (*Leucaena leucocephala*, *Pinus* species and *Bauhinia purpurea*) are sown in the late winter (January to April) and recalcitrant seeds (Such as (*Artocarpus heterophyllus* and *Artocarpus lacucha*, *Michelia champaca* etc) are planted immediately after seed extraction. The latter category of seeds generally matures during July to September. Therefore, the seedling production cycle ranges from three months to seven or eight months based on species and ecological zones. Thereafter, the process of seedling maintenance is conducted through the activities like removing the weeds, root pruning if not put on the elevated beds, observation and control of pest and disease, seedling watering and fertilization. Meanwhile, the nursery facility covers the maintenance activity on the terrace, drainage, falling field, etc.

Step 5: Distribution and plantation

The grown seedlings are distributed free to users and transported to the various sites by individuals and communities for plantation. The seedling selected for out-planting should be of desired shapes and sizes. The size of the plants should be examined by looking at its trunk, branches, leaves and roots. Trunk should be straight above the middle of root balls, branches should be balanced on trunk and should be growing at regular intervals, and leaves should be of normal size and should not show spots, blights, distorted shape or wilting (Gregorio et al. 2010). The appropriate height of the seedling ranges from 25 to 30 cm depending on the species and location. Tractors, buses and carts are used to carry the seedlings most of the way, but sometimes the trees have to be carried by hand to areas that are difficult to access by vehicle.

Step 6: Record keeping

Nursery records in Nepal are not maintained in detail except on seedlings distributed, pay worksheets and financial statements that is required by the account and audits. Nursery record keeping is essential for tracking production and precluding serious problems. Nursery record keeping includes the following (Wilkinson and Landis 2014):

- A daily Log—can be as simple as writing the day's date and putting down some notes in a notebook about observations and activities at the end of each day, by the Nursery operator. He/she needs to make a habit of entering something in the log book each day, even if the observations seem unimportant at the time.
- Plant development records (such as germination rate, seed viability, number of seeds per gram, growth rate, cultural regime like shading, water and nutritional/potting mixture requirement) for each species should be kept in an easily accessible place and a few notes should be maintained as changes occur with the species.
- Propagation protocols—show how to produce each kind of species successfully in the nursery. The protocols provide guidance for each new crop in developing the production plan and listing needed facilities and supplies and should be regularly updated and revised.
- Inventory assessment—should include all plants in the nursery by their number, current developmental stage of each species, and details of delivery (target requirements, out-planting site, name of client, seed source, and anticipated delivery date).

² Recalcitrant seeds' viability will be lost after drying in the sun. These seeds should be planted immediately after extraction.

Gaps and challenges in the current nursery operations and seedling production systems

A number of strengths, weakness, opportunities and threats (SWOT) are identified in the nursery operation and seedling production system in Nepal (Table 2). This analysis does not cover out-planting and management of planted seedlings. In this section, gaps and weakness and challenges and threats are discussed separately.

Table 2: SWOT analysis of nursery operation and seedling production in Nepal

Strengths	Weakness
<ul style="list-style-type: none"> • Locally visible • Cost effective • Creating awareness • Rely more on locally driven technology and natural ecological process rather than artificial high level technology • Covering the whole area of Nepal with different physiographic zones • Involvement of community in management as and when required • Accessible for all 	<ul style="list-style-type: none"> • Lack of coherence in the policy and implementation • Weak coordination and monitoring system • Poor quality planting stock (seedlings) • Inaccessibility to nursery • Inadequate skills and technical know how • Inadequate resources (land, water, funds and information) • Low level of entrepreneurial capacity • Low germination rate and seedling survival
Opportunities	Threats
<ul style="list-style-type: none"> • Priority of all three levels of governments • Women employment through nurseries and other trainings • Income, employment and alternative livelihood • Improvement in the farming practice in terms of agroforestry • Greening the environment • Options for fruit tree growing • Business opportunity 	<ul style="list-style-type: none"> • Climatic change issue such as droughts • Free seedling distribution system • Change in political preference • Competition between nurseries • Community dependency on external funds • More focus on big plantation project • Threat on extinction of low value and indigenous tree species because of commercialisation

Gaps and weaknesses

- **Lack of coherence in policy and implementation**

The Forestry Sector Policy and Strategy have clearly emphasised massive plantations for maximisation of both economic and environmental benefits. The DOFSC, Department of Forest Research and Survey, Regional Training Centres, Tree Improvement and Silviculture project, and some funding agencies have prepared their own guideline for nursery operation in the past. However, these guidelines have generalised nursery into a blanket approach irrespective of the quality, sustainability, ecological zone, forest conditions, and focused management objectives. This emphasis on one size fits all could potentially limit the quality of nursery and seedlings. Similarly, the current practices with extensive plantation operations are focused on the few easily grown species. Detailed plans and guidelines for other species are yet to be developed. The donors supported implementation has faced problem to expand, despite successes and the relation to local engagement and forest productivity.

Despite having the policy, plan and budget in nursery and seedling production, the gap between plan formulation and implementation is high. There is mismatch between the seedling production and plantation requirement which resulted to low survival of planted seedlings. This is due to poor capacity of both government and non-government institutions to make the best use of physical, human and fiscal resources. Moreover, constraints are posed due to procurement system, attitude and negligence to pursue for good intention and innovation. Crowding out of seedlings grown by private nurseries by competition from governments free seedling supply; inconstancy of government forest related policies and plan; problem of quality standards and no motivations for nurseries to produce high quality seedlings.

The Public Procurement Regulation-20073, revised in 2019, has only mandated the hiring of services for direct payment to labours costing not more than one hundred thousand Rupees. Since nursery management is labour intensive and costly, it requires a regular inflow of resources through all months. This has not only added ambiguities to the nursery and seedling production process but has significantly complicated and delayed the implementation.

The forest nursery industry is not well organised. The current organisation of the private, community and government nursery is not delivering high quality planting stock to users. In the past, the DOFSC and its projects had institutionalised a technical protocol governing the germplasm quality of forest trees, which was not continued. The current seedling production system is still largely quantity oriented compromising seedling quality.

³ Prior to procuring any goods, construction work or service, the chief of the public entity shall prepare, or cause to be prepared, the specifications, plans, maps, designs, special requirements or other details, referred to in Section 4 of this regulation revised in Dec 19, 2019

- **Weak coordination and monitoring system**

There is always a coordination problem among the nurseries established and managed by private farmers, community organisations and government agencies including the Department, District Forest Office and District Soil Conservation Offices and academic institutions. Lack of coordination and transparency has created unhealthy competition between nurseries. The coordination and monitoring at the local level (i.e. district) is a neglected issue and not considered as a means of improvement of operation, enhancement of seedling quality and increase in plantation performance.

- **Poor quality planting stock of species**

Many nurseries, mostly government ones, are not delivering high quality planting stock of species suitable for agroforestry and reforestation programmes. The problems in regards to the unavailability of species preferred by users, low quality of planting stock and difficulty in accessing seedlings from nurseries have been identified as reasons for the apparent failure of established plantations.

In many instances, it is observed that the planted trees are of low quality because of the following problems:

- Poor genetic base of seedlings due to lack of attention on known and improved genotype seed source or planting materials; not collecting seed from superior mother trees and not identifying quality suppliers.
- Defective seedlings because of containers placed on ground; pots without root trainers; and no regular grading and sorting.
- Slow growth of seedlings caused by poor management of nursery timing; inadequacy in irrigation; poor composition of soil organic matter and lack of fertilizer; too much or too little shading; and no measures on pest or disease control
- Poor seedling quality leading to poor plantation due to weak planting materials; improper handling, planting seedlings before developing proper root system; poor sun hardening; deformed roots; and failure to remove weak or overgrown seedlings.
- Poor nursery operation and management on seedling distribution, week time schedule, quantity driven, poor diversity of species, high reliance on exotic species and difficulties in propagating clonally.

Seedlings coming from a nursery should be of high quality such as acceptable structure, good appearance, height of seedling, and quality of stem (straight and vertical), branches, leaves (natural green) and roots (well firmed). The nursery operator therefore should focus on raising high quality seedlings rather than on the number of seedlings produced. Higher quality seedlings have numerous advantages including low mortality rate, low plantation maintenance costs, shorter rotation period and high timber quality (Gregorio et al. 2010). Most government “research nurseries” in Nepal focus on developing standards of seedling quality and evaluating species, provenances, varieties and other germplasm. This is normally integrated into tree improvement or seed source selection activities (Roshetko et al. 2010). The best available germplasm is used to support these activities. However, in Nepal, because of so many limitations and constraints to use the research outcomes in actual implementation (see Table 2), the nurseries are not producing quality seedlings.

- **Limited availability of preferred seedlings**

The scaling up of community and private forestry in Nepal is hampered by several constraints including the problems on forest nursery. Most of the community based forest users and private land holders face difficulties in reaching their plantation targets because of the shortage of planting materials. The promotion of plantation is constrained by the limited availability of preferred seedlings, a few species option resulting in site-specific mismatch, and use of low quality planting stock. There are hundreds of seedlings in the government nurseries, but they are not preferred by farmers for planting on their private lands. Generally farmers prefer fruit and non-timber forest product (NTFP) seedlings for planting on their farms for income generation. On the contrary, government nurseries mostly focus on forest tree species (Pinus, Alnus etc) that are not preferred by farmers.

- **Inadequate skill and technical knowledge**

The improved practices require updated technical expertise to maintain higher efficiency in the planning and implementation. However, such human resources are still inadequate within the sector, and there is a lively and current debate as who have the capacity to develop or provide the resources to hire sufficiently knowledgeable technical human resources. Furthermore, availability and knowledge of handling modern and efficient technology and tools, both amongst the government staff and stakeholders, poses immediate challenges to out-scaling and selection of species, propagation of resources, and management.

In general, forest nurseries in Nepal only produce one batch of seedlings a year, timed to be available at the commencement of the wet season, when the highest survival rate on out-planting can be expected. Given that the seedlings can be ready for distribution in about six to 12 weeks, this means that the nursery facilities are inactive or carrying leftover stock for most of the year.

Not only government nurseries, but also private and community nurseries are constrained by specialised technical abilities, investment, information of quality germplasm sources, responsiveness of the value of genetic quality and market help. Evidence suggests that nurseries are unlikely to evolve into commercial enterprises because of a) short nursery life for seedling production requirement, b) financial uncertainty for nursery operations, c) failure due to inadequate resources and lack of support or poor decision making. Nurseries are critically dependent on seedling demand from the government or users.

- **Inadequate resources (land, water, funds and information)**

In addition to inadequate skilled human resources, most nurseries are generally constrained by lack of other resources such as funding, suitable land availability, accessibility of nursery, and information sources and sometimes a reliable water supply. Poor land quality and inadequacy, complexity of budget, inappropriate water system and poor operation skills are also other challenges for all types of nurseries. Seed germination rates, quality of seeds, diversity, and seedling survival rates are found to be low due to insufficient technical and managerial skills. For most of the nurseries, required budget, species choice and technical abilities are the important challenges in making stride for their effectiveness. In spite of the fact that managers of government nurseries generally have information on sources of quality germplasm, but they are constrained by limited budget from using high quality germplasm and thus

creating problems to produce genetically predominant planting stock. Due to restricted financing in government nurseries, they are producing few numbers of low genetic quality exotics and indigenous planting stocks. The limitation of resource also prohibits the seedlings of government nurseries for transportation into plantation sites, which is an essential part for improving seedling distribution and uptake in plantation. Although the managers of government nurseries have mostly completed tertiary education including orientation and training on seedling generation, majority of them still need the fundamental aptitudes to create quality planting materials

- **Inaccessibility of nurseries**

The nurseries are able to produce seedlings of some of the tree species that users would like to grow. In terms of accessibility of nurseries to potential users, there may be a few large nurseries, distant from users, who lack knowledge of where to obtain seedlings and lack transport facilities to collect them. Government nurseries often provide free seedlings of a limited number of species, majority of those are exotics. This may undermine the seedling market of community and private nurseries, thereby seedlings are crowded out and unused.

- **Low level of entrepreneurship capacity**

Capacity to run efficient nursery enterprises is instrumental for providing benefits to nursery growers. However, the existing trend in growing nursery in Nepal is still not business oriented. Nursery activity is being considered as a service oriented activity rather than profit making activity. Small entrepreneurship capacity is being developed with private sector, but community and government sectors are not yet transformed to develop business nurseries. Even with private sector, the quality of seedlings has reduced their competitiveness and hampered their ability to sell the nursery stocks beyond local markets. A large number of these enterprises are informal and unregulated, and therefore are unable to take the opportunities available through linkages to proper marketing channels (Pandit et al. 2019). They are also constrained by a lack of new technology and seedling supply capacity, as well as by the absence of a supportive policy and legal framework discussed earlier. Besides this, there is limited capacity to make business planning and running the nursery enterprises.

- **Low germination rate and seedling survival**

Low seed quality or poor handling mechanism, poor technological inputs to germination, low level of water supply or watering, and weak plant protection from pests and diseases, cattle, hail and windstorms are causing low germination of seeds and subsequent seedling survival rates.

Threats and Challenges

- **Climatic change issue such as droughts and hail-storms**

Nepal's vulnerability to climate change is being alleviated day-by-day because of its fragile ecosystem, uneven topography, and high dependency on agriculture, hydroelectricity and low GDP (GON, 2017). It was seen that climate impacts many key sectors of Nepal including forestry, agriculture, hydroelectricity, food security, tourism and many others. Climate change is expected to cause many other climate induced hazards like flood, drought, and landslides. Thus, these will directly impact the economy of the country and hence livelihood of the people. Nursery activities are being disturbed in many parts of the country. Sudden and unexpected occurrence of hail storms, floods, soil erosion and erratic rainfall has damaged many nurseries in Western Nepal and also in EnLiFT project sites in the past (Pandit et al. 2019). In order to protect the nursery seedlings from frost and hail storms, green net system was fixed in some of the nurseries supported by EnLiFT project in 2019.

- **Free seedling distribution**

For many of the privately run nurseries, accessibility of market has been a challenge due to the predominant free distribution of seedlings by the government nurseries. The operational viability of private nurseries has been constrained by specialised technical abilities, investment, information of quality germplasm sources, responsiveness of the value of genetic quality and market help. In addition to this, many private nurseries have less access to reliable seed germplasm sources. It should be realised that improving germplasm can support in making strides for expanding the supply of quantity and quality; giving information on sources of superior germplasm possibly increases the production of high quality planting stock, and promoting market is likely to increase seedling demand. This has become the greatest hurdle in nursery business promotion and is also the main cause of plantation failure.

- **Change in political preferences and community conflicts**

In Nepal there is a greater risk in operation of nursery, appointment of nursery operator and seedling distribution due to change in political preferences of community members. If one person of the community who is in the leadership capacity finds other community members working with other political party, he/she would not be willing to provide support and incentives for his/her nursery development. Community conflicts will also arise as a result of use of resources.

- **Competition between nurseries**

Observations show that there has been crowding out of seedlings grown by private nurseries by competition from governments free seedling supply; inconsistency in government policies on forest seedling production; problem of quality standards and no motivations for nurseries to produce high quality seedlings. Government nurseries dominate the seedling production landscape in Nepal. However, there are a number of advantages associated with the domination of government nurseries including that it has permanent locations, continued allocation of budget and steady end users linkage through community and private tree planting campaigns. On the other hand, it includes higher operation cost, poor choice of species and limited end user access due to location may be the drawbacks.

- **Community dependency on external funds**

The sustainability of the operation of community nurseries is greatly influenced by the presence of project support. Experiences show that where funding from external agencies is absent, there is less chance that a communal nursery will sustain its operation because the participation of members of community organisations becomes minimal. Sustainability of community nurseries largely depends on flow of constant financial resources and provision of sale of seedlings can potentially serve as an alternative income source. Expanding the seedling deals for community nurseries through market showcasing offers a buffer against the negative effect of external funding. Connecting the community nurseries to a wide populace of potential seedling buyers can be a crucial step in improving their effectiveness.

- **More focus on big plantation project**

Government sometimes implement major projects, which generate high activity in seedling production to meet targets. It is commonly observed that the contracts from government to produce seedlings through support from donor projects may be found valuable for initiating nursery operation, but often resulted in short lived, and led to unexpected financial failure and disillusionment to private and community nursery operators. There are various reasons for losses of young seedlings in plantation such as natural losses, wildfires, hail and livestock damage; and low seedling quality is often a contributing factor.

- **Threat of extinction of low value and indigenous tree species because of commercialisation**

Private nurseries are now looking for species that give higher rate of return. Low value tree species such as *Alnus*, *Pinus*, *Schima* and many other forest tree species are given low priority to grow in the nursery. Therefore there is a danger of losing many forest tree species in Nepal in future. There is a fashion to grow exotic and so called improved species such as Teak, *Paulownia* etc. This has also posed threats over local and indigenous species nursery.

PROPOSED STRATEGIES AND MANAGEMENT MODALITIES

The review of gaps and challenges suggests several measures which could improve the current nursery practices for better seedling quality. The forestry sector requires a serious attention in undertaking a firm strategy and committed actions for long run to improve the seedling quality and successful plantation. The SWOT analysis of the current government nursery management and interviews with experts identified five major gaps and weaknesses in promotion of nursery programme in Nepal. These gaps include the following:

1. Lack of coherence in the policy and implementation
2. Low level of entrepreneurial capacity and weak coordination
3. Poor germination and quality planting stock (seedlings)
4. Inadequate skills and technical know how
5. Inadequate resources (land, water, funds and information)

In order to address the above gaps and weaknesses, we have come up with five main strategies (Figure 2) and 30 recommended action points that may substantially increase the performance of nurseries and will service the purpose without spending too much public money. The overall goal of developing these strategies is to ensure sufficient and appropriate supply of seedlings through reforming policy, legal and regulatory framework and proper development and management of nurseries. The SWOT analysis further suggests a major departure from the current model of nursery as a public business. The gaps in responsiveness with the changing need, poor performance and high recurring costs strongly suggests that scarce public money should be limited to research and development of nursery. The mass production and distribution should be gradually shifted to community and private nurseries as independent economic enterprise itself. In fact, there is an upsurge of private and community run nurseries in recent years. The list of possible strategic interventions and action points are presented in Table 3.

Table 3: List of possible strategic interventions and action points

Strategic intervention	Recommended actions
1. Reforming policy, legal and regularity framework	1. Develop a clear national level policy or guidelines
	2. Facilitate private entrepreneurs and Forest User Groups (FUGs) in nursery business thereby focusing DFO role in regulating, innovation and capacity building
	3. Develop a transitional strategy to facilitate the shift from current government led approach to private/community led approach
	4. Acknowledge nurseries as forestry cum agricultural enterprises and enable them to access public support schemes from all three levels of governments
	5. Promote and protect the legal autonomy of nursery entrepreneurs to enable them better respond to the local needs and market demands
	6. Develop a transparent system for accreditation, registration and operation of private and community nurseries
	7. Clarifying roles of various nursery actors

2. Enhancing institutional development and capacity for commercialisation of private and community nurseries	8. Bring-in local government as the key player in promoting and supporting local nurseries (private and FUGs)
	9. Conceive nurseries as financially profitable economic enterprises and treat them accordingly.
	10. Create a level playing field for private nurseries so that they are able to compete as sustainable enterprise.
	11. DFO provide support to private nurseries for developing business plan
	12. Sub-divisional Forest Office sign contract with accredited communities and private nurseries to produce required quantity of seedlings for sale and distribution
	13. Reduce competition between government and private nurseries for production of quality seedlings
	14. In case of FUGs, nursery should be part of their management plan (OP) that have received needed community endorsement
3. Enhancing support services for innovative technologies, quality germplasm and planting materials	15. Ensure access to high quality seeds of high-quality genotypes through management of seed trees, import regulation, testing, proper monitoring
	16. Develop guidelines, manuals for proper seed collection, storage and handling of seeds/seedlings during transport and out-planting
	17. Identification and certification of seed orchards and provenances for fruit tree species
	18. Develop market information system that enables seedling producers and farmers to access needed information on price, quality and availability of seeds/seedling
	19. Support establishment of one high tech-high production capacity nursery enterprises across all eco-zones
	20. Provide opportunity to women and poor to work in the nursery as nursery operator
4. Strengthen nursery operators' capacity in nursery development and management	21. Training and capacity building in nursery technology
	22. Establishment of pilot nurseries showcasing latest technologies and best nursery management practices such as seed storage and germination methods, improved seedling containers, raised shelving systems, watering, non-mist cloning etc.
	23. Develop a map or database of nursery operators for monitoring of all aspects of nurseries
	24. Promote networking of nursery entrepreneur for collaborative learning, sharing and other exchanges
5. Formulate resource mobilization framework to increase funding for nursery programme	25. Utilise funding opportunities available with all levels of government and other stakeholders
	26. Provision for support of materials (green net and iron structure etc) to protect seedlings from frost and hail-storm.
	27. Public financing should be continued for research, technology development and extension through goods and service taxes
	28. Create enabling environment for accessible and affordable loan, insurance, and grants for preservation of threatened species
	29. Align any government incentive/subsidies with output (number of seedling sold) not with inputs for better quality seedlings.
30. Develop criteria for good quality seedlings and guarantee the minimum support price for the seedling of main species	

Strategic intervention 1: Reforming policy, legal and regularity framework

Clear provisions are needed in policy and guidelines to improve nursery and seedling production in different ecological zones, forest types and with different management modalities. The current forest policies and guidelines need amendments to encourage this expansion rather than imposing with a blanket approach. Considering the potential, both political and bureaucratic commitments are crucial at all levels to achieve anticipated results from plantation at the grass roots level, province and to the policy level at the Ministry. A common understanding and collaborative partnership among users, private sectors, and three levels of governments are important to ensure effective implementation and increased ownership for the sustainability of nursery and seedling production. The nursery establishment is constrained by procurement system limited to use budget of prescribed ceiling of Nepalese Rupees (NRs) 1 lakh, thus require a reasonable range of flexibility in procurement system. Delays in release of fund often create uncertainty; therefore, timely release of fund is highly recommended.

Private sector and CFUGs need to be encouraged in nursery business promotion. This requires a fundamental shift from the current government led approach to private or community approach. The government needs to acknowledge nursery as forestry cum agricultural enterprises by means of which private sector could easily access to public support schemes at all levels of government. Nursery entrepreneurs do not have full autonomy to work as nursery entrepreneur and therefore local demand for quality seedlings is not fulfilled.

The government needs to accredit the nurseries so as to formalise them; and it should be crafted within the policy framework to regulate their quality. Accreditation of private nurseries seeks the nursery operators adopting best management practice to ensure the production of high-quality planting materials. The financial viability of nursery enterprise can be improved with high quality and diversity of plantation materials which can be sold at higher prices. However, the nursery operators required to possess sufficient knowledge and necessary skills for the nursery accreditation and seedling certification. For accredited nursery, there should be time limit for license to operate nursery wherein audit of the nursery will be required before the licence is renewed to make sure nurseries comply the minimum standards. For this purpose, a series of training sessions can be given to managers and nursery foremen of private, community and government nurseries.

The proposed nursery policy and guideline should clarify the roles and responsibilities of different nursery actors (discussed at the end of this report). It must support a balanced decentralization of nursery and plantation strategy, guidelines and operations, using the principles of co-existence, coordination, and collaboration among three governments, communities, private sector and other stakeholders. The identification of initiatives undertaken by communities, private sector and government, the need of their involvement, their roles and capability need to be identified so that it improves seedling production and distribution systems.

Therefore, six action points are recommended to achieve strategy 1 as follows:

1. Develop a clear national level policy or guidelines and clarifying roles of various nursery actors
2. Facilitate private entrepreneurs and FUGs in nursery business thereby focusing DFO role in regulating, innovation and capacity building
3. Develop a transitional strategy to facilitate the shift from current government led approach to private/community led approach
4. Acknowledge nurseries as forestry cum agricultural enterprises and enable them to access public support schemes from all three levels of governments
5. Promote and protect the legal autonomy of nursery entrepreneurs to enable them better respond to the local needs and market demands
6. Develop a transparent system for accreditation, registration and operation of private and community nurseries

Strategic intervention 2: Enhancing institutional development and capacity for commercialization of private and community nurseries

For any plantation and nursery programme, the institutional development and capacity building initiatives will go a long way in how the programmes perform. There is pertinent reason to ensure that the capacity to implement plantation and nursery programme is based on sound scientific and technical framework. Also, as the nursery activities cut across various institutions and partner, being able to foster collaboration and partnership is critical.

Till today, local government has not taken full responsibility to implement and monitor nursery programme within their jurisdiction. The Divisional Forest Office and all three levels of government (local, province and federal) have forest nursery development plans. However, these plans are implemented in isolation and in many cases, there is duplication of resources. Nursery activities are being run almost in isolation. Community members are dependent on external support. Therefore, it is better to integrate nursery programme of all types of institutions including DFOs and Agricultural Knowledge Center (AKC) into local government annual planning. This will also strengthen ground visibility and transparency. Respective local government should play a key role in promoting and supporting local nurseries either private or community. DFO and Civil societies' role will be to provide technical support.

In the current system, forest tree seedling production has been always dependent on government nurseries. Seedlings are being provided free of cost. Generally the seedlings produced in the nurseries are distributed based on the recommendation of senior officials or through personal contacts. Proper records are not kept for these distributions. This demands a transparent system of seedling distribution. In order to establish a more independent and operational nursery at local level, the institutional system of nursery management in future requires changes in strategic management, free of charge of seedling distribution to the professional and commercial seedling production. The alternative way of institutional management could be foreseen by changing the status of nursery management into permanent/payment based that will lead to an independent status.

The private sector nurseries are not fully capable to promote their nursery as a business enterprise. The policy should encourage the community and the private sector to produce

seedlings and sell as an alternative source of income. Therefore, other nursery types are essential to provide adequate tree seedlings to the users. The policy shift to strengthen such nurseries will result in enhanced income and increased quantity and quality of tree seedling supply. This will leverage the government budget to address tree seed source quality control and supply of particular types of species that are difficult for community and private nurseries to handle. The seedling produced in private and community nurseries are not sold and distributed to the families who are looking for quality seedling. Therefore, sub-divisional forest office could play a role for sale of seedlings. This will reduce the competition between nurseries for sale of seedlings. For community nurseries, DFO should include it in their management plan. Therefore in order to address these issues and achieve the above strategy, the following seven action points are recommended:

1. Bring-in local government as the key player in promoting and supporting local nurseries (private and FUGs)
2. Conceive nurseries as financially profitable economic enterprises and treat them accordingly
3. Create a level playing field for private nurseries so that they are able to compete as sustainable enterprise.
4. DFO provide support to private nurseries for developing business plan
5. Sub-divisional Forest Office sign contract with accredited communities and private nurseries to produce required quantity of seedlings for sale and distribution
6. Reduce competition between government and private nurseries for production of quality seedlings
7. In case of FUGs, nursery should be part of their management plan (OP) that have received needed community endorsement

Strategic intervention 3: Enhancing support services for innovative technologies, quality germplasm and planting materials

The seedlings in the nurseries seem to be of poor quality, which may be due to poor quality seeds or seed collectors are aware or not aware of mother tree selection. Access to high quality seeds and germplasm can be done through identification of superior trees, establishment of seed orchards, seed imports, certification of seeds and seedling. The germplasm improvement at the local level can be achieved through fetching high-quality seeds of high-quality genotypes. Several means in this direction have been suggested such as identification and use of superior trees, establishment and management of seed orchards, seed imports, certification of seeds and seedlings, establishment of seed banks, importing genetically superior seeds and support for a seed supply pathway. In a simpler way, to improve the supply of high quality germplasm especially for native timber species, a survey to identify the location and phenology and also an assessment of the phenotypic quality of mother trees of native timber species can be carried out. The required information of mother trees such as location, status, and phenology can be recorded through local knowledge of seed collectors and seedling producers along with available literature. However, the seed tracking system must be established consistently so that the produced and planted seedlings are well established in the field. It means that the seedling planting process should be aligned with site compatibility and seedlings produced in the nursery. Also, the result of the seed tracking system is very important information in delineating the performance of certified and uncertified sources of seeds. It gives a way forward for a good selection method to seed providers. There is a gap in information in technical management of nurseries. Therefore, there is a need to

develop a manual or guidelines for proper seed collection, storage and handling of seeds and seedlings along with certification seed orchards and provinces for fruit tree species and market information system on price, quality and availability of seeds/seedlings. The support services should include the establishment of one high tech nursery in each ecological zone. The current system has failed to involve women and disadvantaged member in the job of nursery operation. Pandit et al. (2019) revealed that in EnLiFT2 project supported nursery programme, nursery operation was dominated by men (six in eight nurseries). This situation also prevails in other parts of the country. In order to maintain social equity, all types of nurseries whether government, community or private should keep gender balance in the nursery programme. Awareness about gender and equity issues will increase the involvement of women and deprived members in the nursery management programme. Therefore, to achieve the above strategic intervention, the following six action points are recommended:

1. Ensure access to high quality seeds of high-quality genotypes through management of seed trees, import regulation, testing, proper monitoring
2. Develop guidelines, manuals for proper seed collection, storage and handling of seeds/seedlings during transport and out-planting
3. Identification and certification of seed orchards and provenances for fruit tree species
4. Develop market information system that enables seedling producers and farmers to access needed information on price, quality and availability of seeds/seedling
5. Support establishment of one high tech-high production capacity nursery enterprises across all eco-zones
6. Provide opportunity to women and poor to work in the nursery as nursery operator

Strategic intervention 4: Strengthen nursery operators' capacity in nursery development and management

A good planning of the nursery establishment and management is essential to produce quality seedlings. Most nurseries are managed by caretaker, and lack skill and capacity to manage their nursery, hence need to build their capacity. There are inadequate technical capacities of nursery workers in terms of nursery management. The Ministry must ensure a significant proportion of future support for funds and capacity building of government staffs, the private sector representatives, and community members so that an essential nursery staff to support expansion is developed. This would further contribute in reducing the dependency of users on the DFOs for technical backstopping. A number of training and extension events on best management practice can be organised to community and private nursery operators. There may be many forms of extension materials including leaflets on quality seedling production and videos can be developed and used during these training activities. In each district/local level, a demonstration cum pilot nursery can be established to showcase the best management practices (such as seed storage and germination methods, improved seedling containers, raised shelving systems, watering, non-mist cloning) to community and private nursery operators. It also serves as distribution points of germplasm and extension materials to users, private sector and business enterprises.

The government have not developed yet a database of nursery operators for monitoring of the existing nurseries. To facilitate in advertising of private and community nurseries, a database of nursery operators can be developed by the DFOs. The database should contain names of nurseries and their operators, phone numbers, addresses, species produced and price of seedlings. This information can be disseminated to users, communities, private sectors, forest

based entrepreneurs, government offices, respective municipalities and prospective seedling customers. An annual interaction or experience sharing programme of nursery operators will be of a great value. A database of nursery operators can be easily established when there is nursery accreditation. To start with, the database can be developed with accredited and registered nurseries within its political jurisdiction. This would follow by a networking of nursery entrepreneurs for collaborative learning, sharing and other exchanges.

The network establishment of stakeholders is the key for seeking support for the professional and profitable nursery management. As the core function of a nursery is seedling production and technology transfer, it requires a close relation with the universities in supporting the research and development activities on nursery management and seedling production process for university students. The network can also be established with the primary schools, junior high school and high school to support plantation programme or environmental care programmes for the students. These can be done by visiting or working practical in the available nursery location.

The four action points are envisaged to achieve the above strategic intervention.

1. Training and capacity building in nursery technology
2. Establishment of pilot nurseries showcasing latest technologies and best nursery management practices such as seed storage and germination methods, improved seedling containers, raised shelving systems, watering, non-mist cloning etc
3. Develop a map or database of nursery operators for monitoring of all aspects of nurseries
4. Promote networking of nursery entrepreneur for collaborative learning, sharing and other exchanges

Strategic intervention 5: Formulate resource mobilization framework to increase funding for nursery programme

The plantation and nursery programmes are mostly dependent on MOFE budget. Budget for the nursery is only for the establishment and no maintenance budget provided, which is the most critical action for a sustainable nursery programme. Many government and non-government agencies have funds for nursery promotion programme. The DFO, local, provincial and federal government, and some International/Non-governmental Organisations (I/NGOs) have allocated some funds for seedling production. In many parts of the country, the nursery seedlings have been damaged by climatic hazards such as frost, hail-storm and erratic rainfall. In order to protect the seedlings from these hazards, one needs to provide support green net facilities or permanent structures. There is a danger of losing some low value forest tree species with increasing commercialization. It is recommended that the provincial and federal government should allocate some funds to DFOs for providing incentives to local communities. Public financing should be granted for such activities (protection of biodiversity loss and climatic hazards) through goods and service taxes.

Similarly, DFO and local government should create environment for accessible and affordable loan, insurance and grants and align nursery growers to government subsidies. The volume of work involved in distribution of planting stock sometimes resulted delays in drying out of the seedlings before planting. Therefore, the seedlings distribution lists and requests should be prepared well before the plantation takes place. It is therefore recommended that the process

and lists are completed by the end of December each year. Moreover, there is a need for developing a guideline for the farmers about transportation of seedlings, storage and planting. It is generally observed that standards regarding plants extraction, storage and transportation in government nurseries are lower as compared to the private nurseries. It needs a proper guidance for nursery managers on the timing of plant extraction, storage and transportation to reduce losses and increase success rate of planation.

At last, nursery entrepreneurs need to be assured of minimum support prices for seedlings of main tree species. This will avoid reluctance of nursery entrepreneurs in promoting a quality nursery. The government needs to develop certain criteria for a good quality seedling and shared with each of the accredited nursery operators. Six action points are recommended to achieve the above strategy.

1. Utilise funding opportunities available with all levels of government and other stakeholders
2. Provision for support of materials (green net and iron structure etc) to protect seedlings from frost and hail-storm
3. Public financing should be continued for research, technology development and extension through goods and service taxes
4. Create enabling environment for accessible and affordable loan, insurance, and grants for preservation of threatened species
5. Align any government incentive/subsidies with output (number of seedling sold) not with inputs for better quality seedlings
6. Develop criteria for good quality seedlings and guarantee the minimum support price for the seedling of main species

ROLES AND RESPONSIBILITIES OF NURSERY ACTORS

Various stakeholders are involved in the management of tree planting and nursery programme. The main stakeholders include central and provincial government, local government, private sector and local communities. The roles and responsibilities of these actors in relation to implementation of above strategic interventions are depicted in Figure 2 and their narratives are discussed below:

Strategic interventions	Current model	Future model
<ul style="list-style-type: none"> • Policy, laws and regulations • Institutions and governance • Support services for new technology • Capacity building • Financing & Resource mobilization 	<ul style="list-style-type: none"> • DFO nurseries • Private nurseries 	<ul style="list-style-type: none"> • DFO nurseries (R&D only) • Private nurseries • Community run nurseries

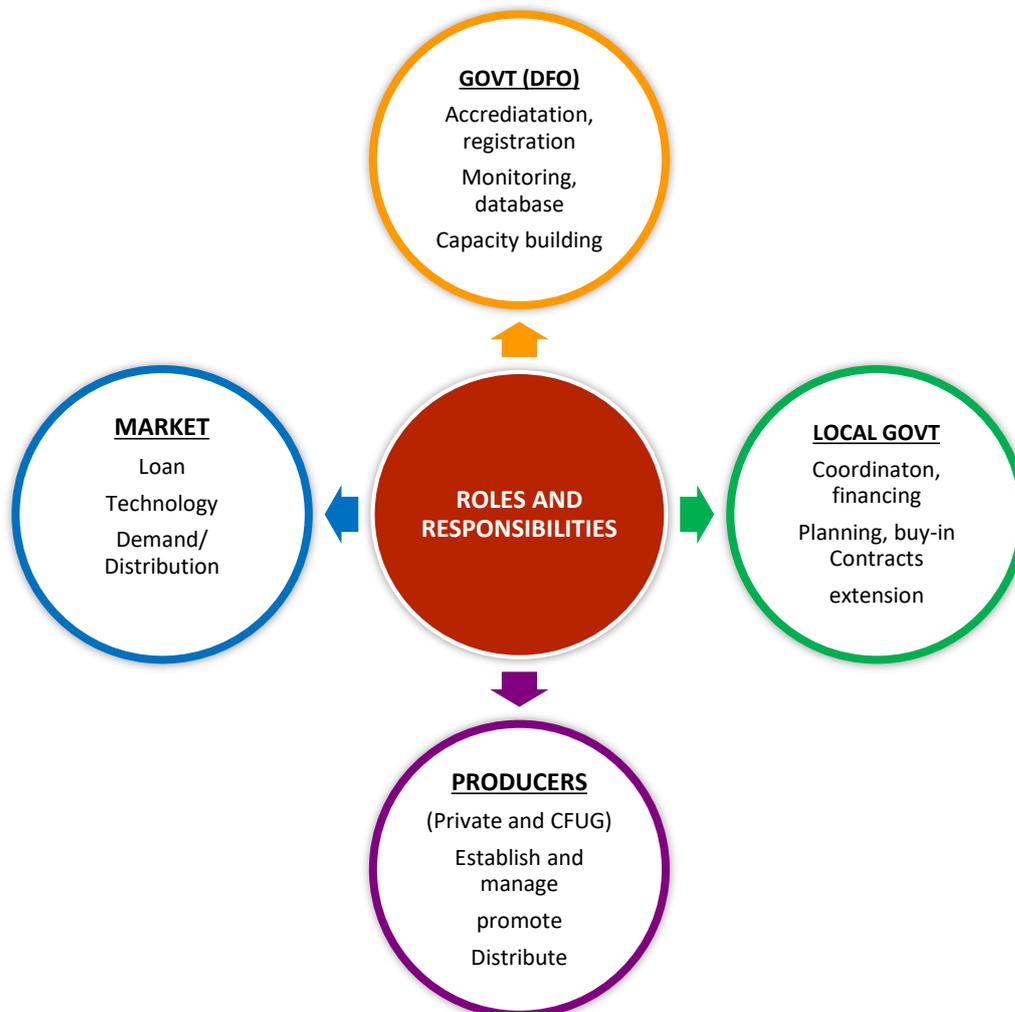


Figure 2: Roles and responsibilities of the main stakeholders for implementation of nursery strategic intervention

Role of central/provincial government in resources and high quality germplasm: As an important partner of nursery promotion, the government could play an important role in assisting private sectors and users to grow their own high quality seedlings. Availability of quality land at suitable location is often a major constraint to establish nursery, produce seedling and expand. Therefore, the government can play a vital role in assigning and making land available to nursery operators. Similarly, they can assist in providing access to finance for the community and private nurseries. Government can also play an important role in providing access to high quality germplasm including the establishment of seed orchards in farmers' field. In Nepal, well developed seedling collection and distribution system did exist in the past. Therefore, the increased scale of seedling with quality seeds may result in higher production cost but in the long run, this will compensate the return to nursery operators with higher net revenue, higher seedling demand and increased efficiency of nursery. As the private sector is not organised and lack the capability, the government can facilitate in providing guidance in development of effective seed pathways, a system which can supply high quality seed to all types of nurseries and perhaps directly to resource deprived small nurseries. In terms of species choice, differences in opinion do exist concerning the role of native tree species. In practice, the species of short-rotation age, which may not produce the highest quality timber are the most widely grown in Nepal. However, there are strong reasons for considering native tree species, many of which have higher timber quality and greater environmental benefits. Greater difficulties in seedling production may occur though.

Role of the central government would be vital in introducing a unified regulatory framework for quality accreditation and procedure on collection, distribution, sale, use and import and export of seeds and germplasm.

Role of private sector in the supply of seeds and seedlings: Private sectors can play an important role in the seed supply chain to benefit the seedling nurseries providing an access to a better quality forest products supply in the future. The individual tree growers should be encouraged by providing information on nursery practices to produce their own seedlings of high quality. Depending on local circumstances, this might be technically feasible and they can make available much larger quantities of seedlings at low cost without any distribution problems of seedling from nurseries. However, maintaining quality holds difficulties; and there is likely to be a bias over easy-to-grow exotic species. Private nursery holders should share their expertise in nursery management and development including making business plan.

Role of local communities on improvement of production methods: There is a high scope in improving the management practices of nursery seedling production by local communities. This suggests a need for promoting quality control or best management practices in nurseries. The communities may apply their traditional knowledge and skills as well as new technology in using efficient practices for production of quality seedlings, resulting to enhance their capacity and confidence as well as to fulfil community needs.

Role of the local governments: There seems to be a major weakness in nursery operation, and it may be a desirable idea to place high priority in improving seedling marketing systems. The local governments can take a greater role in working closely with private nurseries and try avoiding unhealthy competitions among them while producing and providing seedlings. One possible role for the local government is to produce seeds, seedlings or cuttings of difficult-to-grow species (often native species) and to provide reproductive materials of these species to private nurseries at low cost. Contracting out seedling production to community and

private nurseries may provide support to these nurseries in increasing their financial stability. It also may help them to be more cost-effective so that the local government may reduce seedling production costs. Under this arrangement, local government could play a guiding role in quality control. The local government can allocate the budget for financing the priority activities in nursery development. The production costs for seedlings could go down significantly along with efficient nursery management if the role of the local governments is effectively planned. In addition to this, the local governments' role is to provide a supportive policy environment for competitive nursery sector. An example here is to encourage investment from the private sector in forest nurseries by loosening regulatory hurdles or making steps of forest nursery accreditation less costly and less red tape.

CONCLUSION AND RECOMMENDATIONS

- The issues and strategies presented in this paper are an initial step in developing an understanding of current situation of nursery and seedling production and undertaking future interventions in Nepal. Despite long history, nursery practices have significant shortcomings on the quantitative and qualitative performances. The nurseries are not effective in delivering high quality planting materials of a wide species variety to users.
- Many of the problems experienced in seedling production in government nurseries and identifying these problems can be helpful in informing forest nursery policy. Forest nurseries are easy to set up in Nepal, but unfortunately they typically produce low quality seedlings and often fail technically and financially in a short time. High failure rate of plantation is a common problem, and it has not been clearly reported and reviewed. Seedling demand in plantation determines the supply of seedlings by the nurseries. The demand, however, is frequently erratic over time and thus impacts the quality and quantity of seedling production.
- Measures such as genetic improvement, provision of free seedlings, and extension activities including demonstrations and site visits can be means of promoting the interest of users in forestry. A difficulty arises where provision of free seedlings by government crowds out private nurseries. Hence, where there is potential for private nurseries to be financially viable, it may be a preferable policy for government to assist private nurseries rather than compete with them.
- Strong emphasis on number of seedlings produced can divert attention from seedling quality. In terms of promoting a sustainable nursery, it may be desirable to move away from seedling quantity to seedling quality targets. In general, there does appear to be a need for consistency of government policy with regard to seedling production, and adoption of long-term seedling quality improvement programmes.
- With the support of local government, nurseries can be centres of forest extension services, transfer of technology to local communities through engagement in planting campaigns, educational programme to schools and other groups, and hosting demonstrations of how plants grow and how they can be used. Nurseries can be a hub for forestry expertise and activities and provide the opportunity for professionals and communities to learn about multiple dimensions and many aspects of forest ecosystems at the local, provincial, and national levels.
- Improved forest nursery management facilities and practices are required to improve the quality of seedlings raised. There is also a need to educate and capacitate users to buy high quality seedlings in order to discourage the market for low quality planting materials. Policy, institutional and market environment for nurseries, seedlings and plantation forestry

is to make supportive with a focus on how the poorest people can receive benefit from this opportunity.

- It must be acknowledged that plantation contributes to balance the three pillars of sound forestry development: social, economic, and ecological aspects. However, there is a decreasing trend of plantation due to limited funding and less commitments. Seedlings production and plantation are dependent over government support. This dependency can be reduced with production of high quality and high value cash generating species that are of greater demand locally.
- Although the government organisations are not in a sound position to ensure the sustainability of the nursery operations, it is clear that the implementation of a nursery demands sustainable and significantly high financial investment as well as sound technical knowledge and skills. However, the price of seedlings if charged while distributing from nursery and introduction of performance-based incentives to tree growers, including the price they paid to seedlings may provide a strong foundation for sustainability.
- Alternatively, in terms of sustainability, the role of the local communities, private sector, local government and stakeholders is vital. Majority of them can be convinced on the importance of quality seedling production that will have higher net revenue in future plantation project and it will also enhance both the local and national economy, with assurance of their sustainability through effective government support. Moreover, sustainability also depends on the transformation of technical knowledge to the stakeholders, and this requires further training and support, especially on new technology such as improved timber and agroforestry value chain.

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