a. Improvement Felling and Enrichment Planting

All over-matured trees are removed and enrichment plantation of wildlings is done to maintain a distance of at least 5 meters. Trees other than fodder are selectively removed. Once young wildlings are established, the rest tress are removed gradually.

b. Tending Operation

As done in EnLiFT1, several operations including removal of lower and unproductive branches, removal of mosses and parasites and preserving of potential seed trees at a distance of 10-15 meters are carried out.

c. Coppicing

All the stems are clear cut to allow coppice from their stumps. In later years, coppice will be treated to maintain its reasonable number. If coppices are not sufficient, seedlings of *Quercus* are planted in the following years.

d. Control: No treatment is done

The size of the trial plot will be 50mx50m. A 10-meter buffer will be established by clearing all the vegetation. The following parameters are measured.

- Natural regeneration capacity and survival rate - planted and natural
- Fodder production

Hill Sal Forest

Most of the hill Sal forests are stunted and growth has been stagnated. Through a review of various trials conducted in the past by the FRTC and other forestry projects along with a detailed site quality survey, the project will design experiments for hill Sal forest management.

Schedule of Knowledge Generation and Management

Most of the Pine trial plots will be installed by December 2019, fodder trial in 2019 and 2020 and Sal trial plots in 2020. The EnLiFT2 will conduct follow-up treatments and measurements until the completion and will be continued by the Divisional Forest Offices and the FRTC. The research findings will be shared during the workshops as well as through research articles. The summary will be produced in Nepali language and discussed with communities for scaling-up and out.

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Community Forest Silviculture Trials on Pine Plantation

Background

A large scale plantation began in the late seventies primarily focusing on both indigenous and exotic *Pinus* species namely Chirpine (*Pinus roxburghii*), an indigenous species, and *Pinus patula*, an exotic species. As a result of the plantations, pure to mixed-species forests were established across the country. Originally, objectives of these plantations were to conserve the denudated hills and to supply the primary forest products to the community. However, restored forests provide a range of goods and services, including provisioning, regulating, supporting and cultural services. In order to maximise the yield of these goods and services (goods generally for local users whereas services are for local to global users) with adequate regeneration and meet the objective of sustainable forest management, proper silviculture interventions are required. In collaboration with the Ministry of Forests and Environment, Enhancing Livelihood and Food Security from Agroforestry and Community Forestry in Nepal (EnLiFT1) project had established a number of trial plots for management of pine plantation and natural broad-leaved forests in Kavrepalanchok and Lamjung Districts of Nepal. These trials are continued in the second phase of the project, known as Enhancing Livelihood from Improved Forest Management in Nepal (EnLiFT2).

The silviculture treatments selected for trials in EnLiFT2 follows the learnings from the silviculture trials and other related studies of its predecessor, the EnLiFT1 Project. The key learning of EnLiFT1 is that the number of regenerations of pine is directly related with the crown opening. For example, uniform shelterwood system has recorded more than 200,000 seedlings per hectare while the selection system has recorded 50,000 seedlings per ha (Cedamon *et al.* 2017). Lack of regeneration of broadleaved species was observed in the trial plots.

The aspirations of forest users in managing the mixed-species forest, prominent in forestry literature and debate on community forestry Nepal is the driver for the selection of silviculture treatments for trials. There is also an apparent need by forest users for continual forest cover for material provisions and ecological services like biodiversity and water.

With the objectives to enhance active and equitable forest management practices in community forests, the EnLiFT2 project plans to establish silviculture trials in selected community forests where government forest officers and technicians, and forest users will learn together, and scale-out the lessons learnt.

Silviculture trials conducted within the community forests demonstrate the transformation of *Pinus patula* and *Pinus roxburghii* to the multi-aged and mixed-species forests. Four experimental treatments are planned representing a varying level of canopy opening and tree stocking in different configurations. These treatments will allow evaluation of silviculture regimes that will facilitate transformation of monoculture pine forest to mixed-species (at least 25% broadleaved) and multi-age forest.

In broadleaved species, trial plots are established on stagnated hill Sal forests to increase productivity. Similarly, trial plots are established to promote fodder production from *Quercus* Forest.

Research questions

1. What is the effect of different silviculture systems on the stand development pattern of mix broadleaf and pine forests?
2. What is the effect of different silviculture systems on the growth and survival of seedlings - planted and natural regeneration?
3. What are the harvesting and reforestation cost, and revenue differentials between the different silviculture systems?
4. What is the forest structure and composition of the trial plots four years after silviculture treatments?
5. What is the effect of different silviculture systems on soil erosion and run-off using small-scale plots?
6. What are the perceived effects of different silviculture systems in terms of economic, ecological and social values and how the perception changed over four years?

Description of silviculture treatments

1. Treatments for Pines

For *Pinus patula*, the trials are established in Banepa and Chaubas of Kavrepalanchok and Dandapakhar of Sindhupalchok District while for *P. roxburghii,* are in Banepa of Kavrepalanchok District and Chautara of Sindhupalchok District. Four different treatments are carried out in 1 ha plot for each treatment on *Pinus patula* and *Pinus roxburghii* plantations.

- Treatment 1: Irregular Shelterwood System – retaining 16-20 mother trees per hectare
- Treatment 2: Dispersed Variable Retention – this treatment will develop two age classes of the future stand. Dominant trees at the spacing of 10m x 10m will be retained as a seed source and to maintain forest cover. These trees will be retained for the next rotation. The remaining trees will also provide a bio-geoclimatic condition that may favour the growth of shade-tolerant broadleaf species.
- Treatment 3: Strip Seed Tree – seed tree strips with 4 seed trees per 2000 sq.m., uncut strips to be harvested at the time of thinning of seed tree strips.
- Treatment 4: Control – business-as-usual management

To develop mix-species composition-at least 25% broadleaved, natural regeneration of both broadleaved and pine species are promoted which are complemented by plantation of desired and suitable species to establish regeneration with the spacing of 3m x 3m. The experimental layout is randomised complete block design where the 4 treatments are randomly assigned to plots in each block (community forest). The schematic layout of the four treatments is shown in Figure 1.

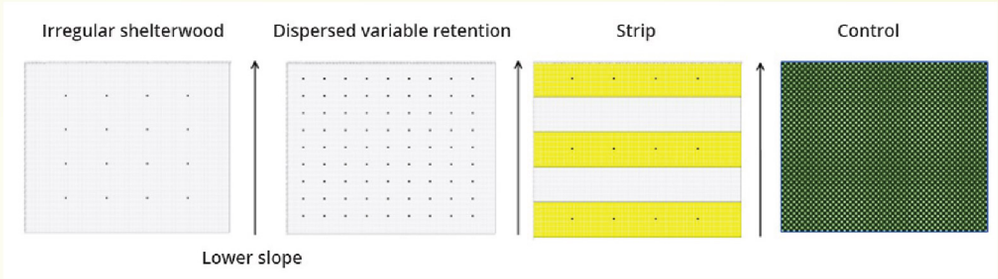

Figure 1. Schematic diagram of stand after silviculture treatments (Dots on the irregular shelterwood system and dispersed variable retention system represent the 'target leave trees', the yellow colour shows the strip to be harvested with four seed trees represented by 4 dots, while the grey strip represents the area to strip of forest to be retained (not harvested).

2. Treatments for Broadleaved

Fodder Trial

Fodder enhancement trials are carried out in Dhungkharka of Kavrepalanchowk in *Quercus* species. Tending operations of existing stagnated old fodder trees of maximum 5-10 meters heights were carried out during the EnLiFT1. The operation includes removal of lower and congested branches, removal of mosses and other parasites. The treatment also involves the marking of potential seed trees which are kept for the next 10 years. Through the initial observation and discussion with communities, it is concluded that this treatment will have the positive impact in increasing fodder yield. However, seeding is yet to be seen through mother trees. It is also realised that more treatments are necessary in this regard. Hence, four treatments are carried out at this site. The treatment will also be replicated in other sites. As treatments are jointly managed by the project team including the Forest Research and Training Center (FRTC) and the Divisional Forest Offices, they will conduct follow up activities during the EnLiFT2 and after its phase-out.