Report
A Study of Forest Management Systems of Productive Forests in Lumbini Province, Nepal

Submitted to

Ministry of Forest, Environment and Soil Conservation

Province Government

Lumbini Province

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१. इरेगुलर सेल्टरउड प्रणाली अबलम्बन गरिएका वन तथा प्लटहरुमा छनौट प्रणाली र काट्दै नकाटेका प्लटहरुमा भन्दा बढी प्राकृतिक पुनरुत्पादनको राम्रो रहेको पाईयो,

२. इरेगुलर सेल्टरउड प्रणाली अवलम्बन गरीएका प्लटहरुमा नियमित वन उपचार (टेन्डींग अपरेशन) का कार्यहरु जस्तै : झाडी सुधार, पतकर संकलन गरिएका स्थानहरुमा लक्षित तथा रुचाइएका प्रजातीका पुनरुत्पादनहरु बृद्धी भएको पाईयो,

३. पूर्ण बयस्क र बुढा रुखहरु मात्र काटिएकोले तिनीहरुको पुनरुत्पादन गर्ने क्षमतामा ह्रास आएकोले कटान भएका रुखको ठुटाबाट मुना (स्टूल कपिस) र रुट सकर बाट पुनरुत्पादन देखिएन। ९० प्रतिशत भन्दा वढी पुनरुत्पादन रुट स्टक (सिड्लिङ्ग कपिस) बाट भएको पाईयो ।

४. पुनरुत्पादन भएका प्लटहरुमा वयस्क रुखका प्लटहरुमा भन्दा प्रजाती संख्या कम पाइयो। शुरुमा प्रकाशार्थी प्रजातीहरु मात्र उम्रिने हुदा पुनरुत्पादन तह मात्र भएको अवस्थामा वयस्क रुख सहितको बहुतह भएका प्लटमा भन्दा कम प्रजाती संख्या देखिनु प्रक्रियागत नै रहेको पाइयो ।

वन व्यवस्थापन पद्धति

१. सबै ठाउँमा एकै किसीमको वन सम्वर्द्धनका उपचार विधिहरु अवलम्वन गरिएकोले कतिपय स्थानमा भौगोलिक र सामाजिक अवस्थाको कारणले वन सम्वर्द्धन विधिहरुले आशातित प्रतिफल प्राप्त हुन सकेको देखिदैन ।

२. प्रचलित / विद्यमान निर्देशिका र कार्य विधिहरु वन सम्वर्द्धन प्रणालीमा आधारित व्यवस्थापनको लागि उद्देश्य अनुरुप पूर्ण छैनन् ।

कोष परिचालन

१. उत्पादनशील वन व्यवस्थापनमा लाग्ने उच्च लगानी (कार्ययोजना निर्माण र कटानी खर्च) ले आवश्यक खर्चको व्यवस्थापनको लागि कतिपय उपभोक्ता समुहहरु अनौपचारिक श्रोतहरुमा निर्भर रहन बाध्य छन् ।

२. उत्पादनशील वन व्यवस्थापन सगै उपभोक्ताको आम्दानीमा पनि वृद्धि भएकोले लेखा प्रणाली थप जटिल बन्दै गएको छ ।

३. आर्थिक व्यवस्थापन कौशलता कमिका कारण वन उपभोक्ता समुहरुको आर्थिक लेखा प्रणाली कार्य चुस्त दुरुस्त बन्न सकेको देखिदैन,

४. कोष परिचालनको ठोस योजनाको अभावमा उपभोक्ता समुहहरुको कोषको परिचालन प्रभावकारी हुन सकेको छैन । जसकारण कतिपय समूहको बैंक मौज्दात बृद्धि हुन गई बचतमा समेत कर तिर्नु पर्ने अवस्था रहेको भन्नेपाइएको छ ।

प्रमुख सुझावहरु

पुनरुत्पादन प्रवर्द्धन

१. प्राकृतिक पुनरुत्पादन प्रवर्द्धन तथा रुचाइएको प्रजातीको प्रजातिलाइ प्रोत्साहन गर्न ईरेगुलर सेल्टरउड प्रणालीको अवलम्वन सगै झाडी सुधार तथा पतिगंर संकलन कार्यहरुलाइ नियमित गर्नु पर्ने देखिन्छ।

२. 'वीउबाट भएको पुनरुत्पादन प्राथमिकता दिन तथा डाईब्याक' प्रकियालाई कम गरी रुट स्टकबाट हुने पुनरुत्पादन (सिड्लिङ्ग कपिस) घटाउन आगलागि तथा चरिचरण नियन्त्रण जस्ता कार्यहरु प्रभावकारी रुपमा गरिनु पर्ने देखिन्छ ।

वन व्यवस्थापन पद्धति

१. भौगोलिक अवस्थिति र धरातलिय अवस्थाको आधारमा उपयुक्त वन सम्वर्द्धन प्रणाली र वन सम्वर्द्धनका उपचार विधिहरुलाई परिस्कृत गर्दै लैजानु पर्दछ । जस्तै समथर, चूरे क्षेत्र, भूक्षय सम्बेदनसिल क्षेत्रमा व्यवस्थापन कार्यहरु गर्दा अबलम्वन गरिने वन सम्वर्द्धन प्रणाली र वन सम्वर्द्धनका उपचार विधिहरुमा ध्यान दिनुपर्ने देखिन्छ ।

२. पुनरुत्पादन प्रवर्द्धनलाई वाधा पुरयाउने सम्भावित खतराहरु जस्तै मिचहा प्रजाती, भौगोलिक स्थिति, वनको अवस्थिति र अवस्था हेरेर वन सम्वर्द्धनका उपचार पद्धतिहरु अवलम्वन गर्नु पर्दछ ।

३. उत्पादनशील वन व्यवस्थापनलाई प्रभावकारी बनाउन तत्काल 'वन सम्वर्द्धन प्रणाली कार्यविधि' र 'थिनिङ्ग कार्यविधि' तयार गरी लागु गर्नुपर्दछ ।

कोष परिचालन

१. अनौपचारिक ऋण प्रवाहलाई निरुत्साहन गर्न वन उपभोक्ता समुहहरुलाई वित्तिय संस्थानहरुबाट ऋण लिने प्रावधान मिलाउन मन्त्रालयले सहजिकरणको व्यवस्था मिलाउनु पर्दछ ।

२. डिभिजन वन कार्यलयहरुले वन उपभोक्ता समुहहरुलाई लेखा प्रणली सम्वन्धि तालिम वा कोचिंग कक्षा नियमित रुपमा संचालन गर्नुपर्ने देखिन्छ ।

३. साथै, आर्थिक रुपमा सबल केहि उपभोक्ता समुहहरुलाई समन्वय गरि एकलै वा समुहमा लेखापालको व्यवस्था गर्न प्रोत्साहन गर्नु पर्ने देखिन्छ ।

४. कार्ययोजना निमार्ण सगै बृहत रुपको कोष परिचालन योजना तयार पारि लागु गर्नु पर्ने देखिन्छ।

५. कार्ययोजना निर्माण खर्च कम गर्नको लागि ''सा व मापन निर्देशिका'' मा परिमार्जन गर्नु पर्ने देखिन्छ।

Main results

Regeneration promotion

- Irregular shelterwood system ensures more promising regeneration than conventional management and no-harvest.
- Irregular shelterwood system accompanied by regular tending operations ensure promising regeneration of the intended tree species while discouraging that of unintended species ultimately contributing to species diversity.
- Harvesting only the mature and over mature Sal trees that might have lost their ability to produce shoots are unlikely to promote stool coppice. More than 90% regenerations are from root stock.
- Plant species richness in the regeneration layer found lower than the matured forests. This is expected since regeneration layer has light demander species only. When forest grows and contains multiple layers, multiple species such as light demander and shade tolerant species.

Forest management systems

- A blanket approach of applying similar silviculture treatments is not producing expected outcomes due to the unsuitability of the treatments;
- Existing guidelines are not sufficient to facilitate silviculture-based production-oriented forest management in the field; there is a need to develop “Silviculture System Guidelines” and “Thinning Guidelines”.

Fund mobilization and benefit sharing

- Higher costs associated with the productive forest management i.e. higher initial investment in operational/management plan preparation and harvesting plan implementation is forcing forest users’ groups to secure loan from the informal sector.
- The accounting system of the forest users’ groups is becoming complex with the increasing income with the productive management of forest.
- Forest users’ groups do not have adequate capacity to manage account and keep record systematically.
- Absence of proper fund mobilization plan is hindering effective mobilization of fund for improvement of socio-economic outcomes. Some have saving in bank, which forced them to pay tax on saving.

Main recommendations

Regeneration promotion

- Irregular shelterwood system should be accompanied by regular tending operations to ensure promising regeneration of the intended tree species while discouraging that of unintended species i.e. to ensure intended species diversity.
- Regeneration protection from fire and grazing through fencing and regular cleaning may contribute to protect seedlings and reduce the root stock,

Forest management systems

- There is a need to define silviculture treatments based on the geographical location and conditions.
- The potential risks such as invasion of exotic species, geographic fragility, forest location and conditions should be evaluated before prescribing forest management systems and silviculture treatments.
- There is a need to develop “Silviculture System Guidelines” and “Thinning Guidelines” to facilitate silviculture-based production-oriented forest management in the field.

Fund mobilization and benefit sharing

- Ministry of Forests, Environment and Soil Conservation should facilitate to make a provision for loan to forest user groups from financial institutions,
- Divisional Forest Offices should have annual program to support forest users’ groups, through training and/or coaching, for accounting and record keeping.
- Similarly, the forest users’ groups with adequate savings should be encouraged to appoint accountant and forest technician. This could be done in a cluster basis.
- The forest operational/management plans should have a clear plan for fund mobilization so that the forest users’ groups can mobilize their fund effectively to improve socio-economic outcomes.
- Revise Community Forest Inventory Guidelines to make CFOP preparation cost effective

1. Introduction

1.1 Forests in Nepal

Forests cover 41.69% (6,166,766 ha) of the total area of Nepal (FRTC, 2022). Nepal's forests can broadly be categorized into two types from ownership perspective, i.e., national forests and private forests. National forests mean forests owned and managed by the Government of Nepal (GoN) whereas private forests mean forests planted and nurtured or conserved by any private landowner (GoN, 2076). Most of Nepal's forests are national forests provided that the extent and coverage of registered private forests is not very encouraging in Nepal (Amatya & Lamsal, 2017). Currently, Nepal's national forests are being managed under seven management regimes, namely, collaborative forests, community forests, forest conservation areas, government managed forests, leasehold forests (including pro-poor and pro-business leasehold forests), protected areas (including national parks, wildlife reserves, hunting reserves, conservation areas and their buffer zones), and religious forests (GoN, 2076). However, forest management in Nepal has been primarily conservation oriented. This not only applies to protected areas and their buffer zones and forest conservation areas but also to other management regimes. Most of the management prescriptions have been limited to harvesting and use of 4-D (i.e. dead, dying, diseased and deformed) and fallen trees. The terms "sustainable", "scientific" or "active" management have been mentioned in connection where harvesting of live trees is prescribed, but these are limited to isolated small-scale trials.

1.2 Forest management systems

From system perspective, forests in Nepal were or are being managed under four systems namely, conventional management, irregular shelterwood, clear-felling, and no-harvest. Conventional management system also known as annual allowable harvest (AAH) based forest management system is being commonly applied in the

forests (CF Resource Inventory Guideline, 2003). Irregular shelterwood system also known as silviculture-based production-oriented forest management system and more generally known as scientific forest management was applied in the selected collaborative, community and block forests. Clear-felling system is being practiced in the plantation forests of Sagarnath Forest Development Project. Unfortunately, until date, most of the forests under other management regimes in Nepal are left without any management interventions i.e. no-harvest.

1.3 Forest management in Lumbini Province

Lumbini Province is a pioneer in adopting production-oriented forest management in Nepal. The Collaborative Forest Management Groups (CFMGs), the Community Forest User Groups (CFUGS) and the Block Forests (BFs) in the province were among the first ones to adopt silviculture-based production-oriented forest management system that aims at developing close to normal forest i.e. irregular shelterwood system generally known as scientific forest management (GoN, 2071). The approach was initially applied in Sal (*Shorea robusta)* and Teak (*Tectona grandis)* forests. Since most of the forest patches were overstocked, overmatured and under-utilized, the main objective of the silviculture-based production-oriented forest management was to increase the production and productivity of forests through the implementation of a silviculture-based production-oriented forest management (Poudel, 2018). Currently, the productive forests of Lumbini Province are being managed under three management regimes namely, collaborative forests (8), community forests (>228) and block forests (2). From system perspective, these forests are being managed under three systems namely, irregular shelterwood, conventional management and no-harvest (DFO records).

However, right from the beginning, the forest management systems that were or are being practiced in Nepal, including the most recent silviculture-based production-oriented forest management, have remained contested. The critiques of the conventional management have raised concerns about decreased forest product supply, increased forest degradation and increased contribution to forest based carbon emissions (Poudyal et al., 2019b). Additionally, the conventional management has also been criticized for promoting negative selection regime where only the 4-D (i.e. dead, dying, diseased and deformed) and fallen trees were harvested (Cedamon et al., 2018). Similarly, the critiques of the silviculture-based production-oriented forest management have blamed it for promoting monospecific stands i.e. monospecific Sal stands and have also raised concerns about the governance issues in benefit sharing (Basnyat, 2021). In response to such criticisms, the Government of Nepal has discontinued the silviculture-based production-oriented forest management and has suspended the forest management activities (Decision of the Council of Ministers held on 2077/10/11 BS). Nevertheless, another group of practitioners, researchers and academicians believe that without silviculture-based production-oriented forest management, Nepal will be losing millions of dollar every year (see also (Poudyal et al., 2019a). They also believe that the effects of the forest management have remained largely unexplored and an in-depth technical assessment could only reveal actual prospects and challenges of the forest management. In this background, this study is designed to undertake an in-depth technical assessment of forest management systems of productive forests in Lumbini Province.

2. Objectives of the study

The general objective of this study is to undertake an in-depth technical assessment of forest management systems of productive forests in Lumbini Province.

The specific objectives are to:

- Assess and compare the regeneration status including plant species diversity among the forests managed under different forest management systems (irregular shelterwood system, conventional management system, and no-harvest)
- Assess the origin of regeneration
- Assess the relationship between stand species composition and species composition of regeneration
- Understand the motives of forest user groups to participate in different forest management systems
- Identify the issues and challenges in fund mobilization and benefit sharing in the forests
- Assess the existing productive forest management approach

3. Methodology

3.1 Study area

This study focused on the productive forests of Lumbini Province. Currently, the productive forests of Lumbini Province are being managed under three management regimes namely, collaborative forests (8), community forests (>228) and block forests (2). From system perspective, these forests are being managed under three systems namely, irregular shelterwood, conventional management and no-harvest (DFO records). Of which, two collaborative forests, 11 community forests and one block forest were selected for the study in close consultation with the major stakeholders at province (i.e. Ministry of Forest, Environment and Soil Conservation; Division Forest Officers, academicians and Federation of Scientific Forest Management User Groups; Figure 1; Table 1). Species composition (Sal dominated forests), geographic coverage (wider geographic coverage) and forest management regimes (collaborative forests, community forests, block forests with/without silviculture-based production-oriented forest management) were taken as criteria for the selection of study forests. The elevation and slope maps of Lumbini province are presented in Figure 2 and Figure 3 respectively.

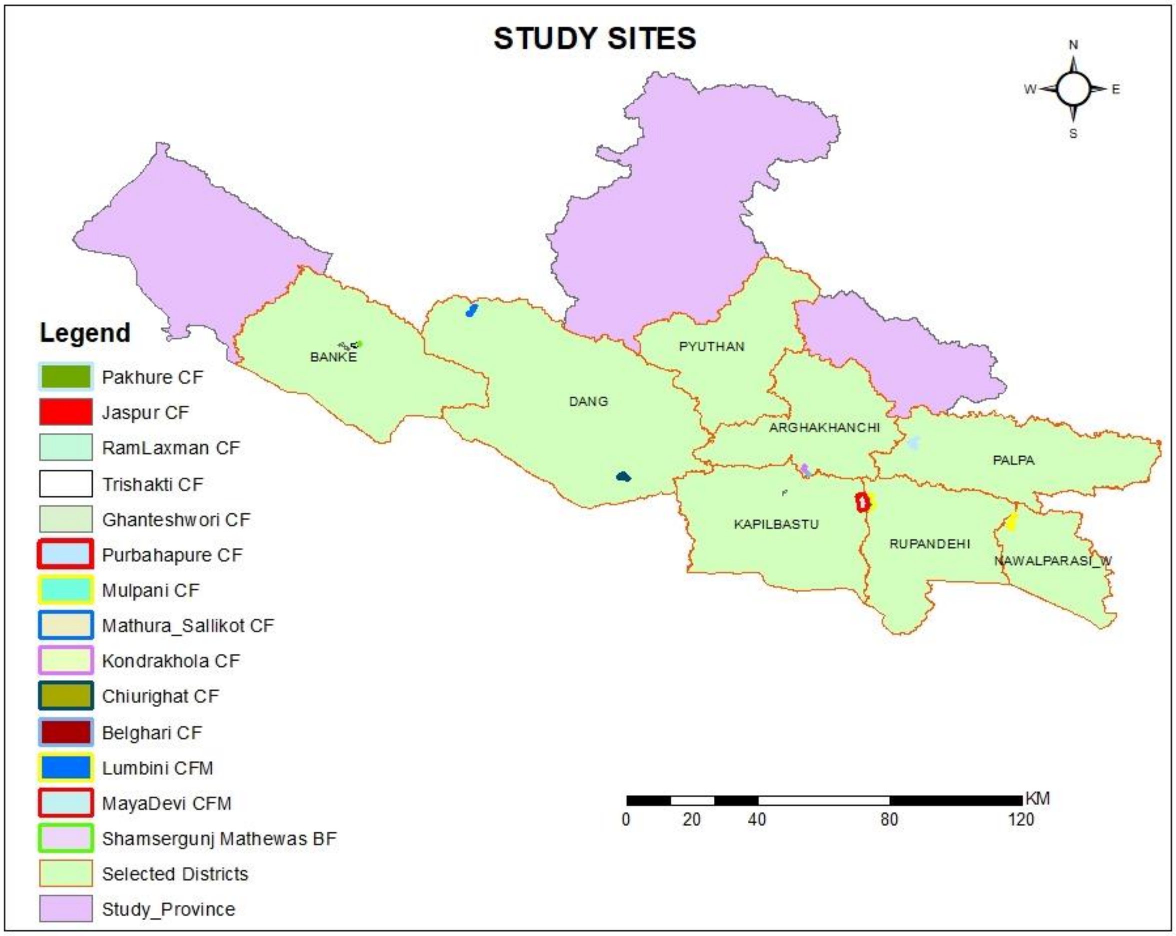

Figure 1. Study area map with complete list of collaborative, community and block forests selected for regeneration survey.

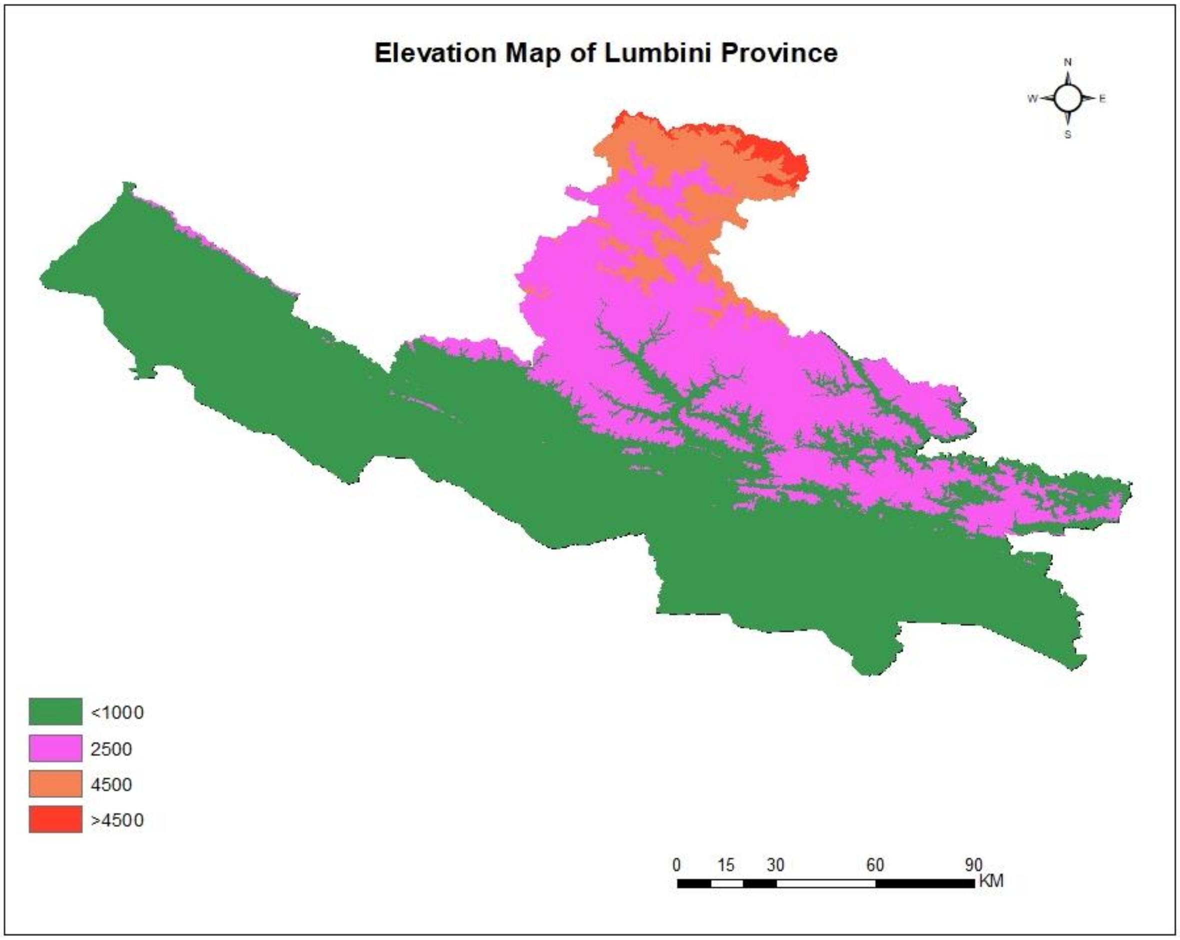

Figure 2. Elevation map of Lumbini province.

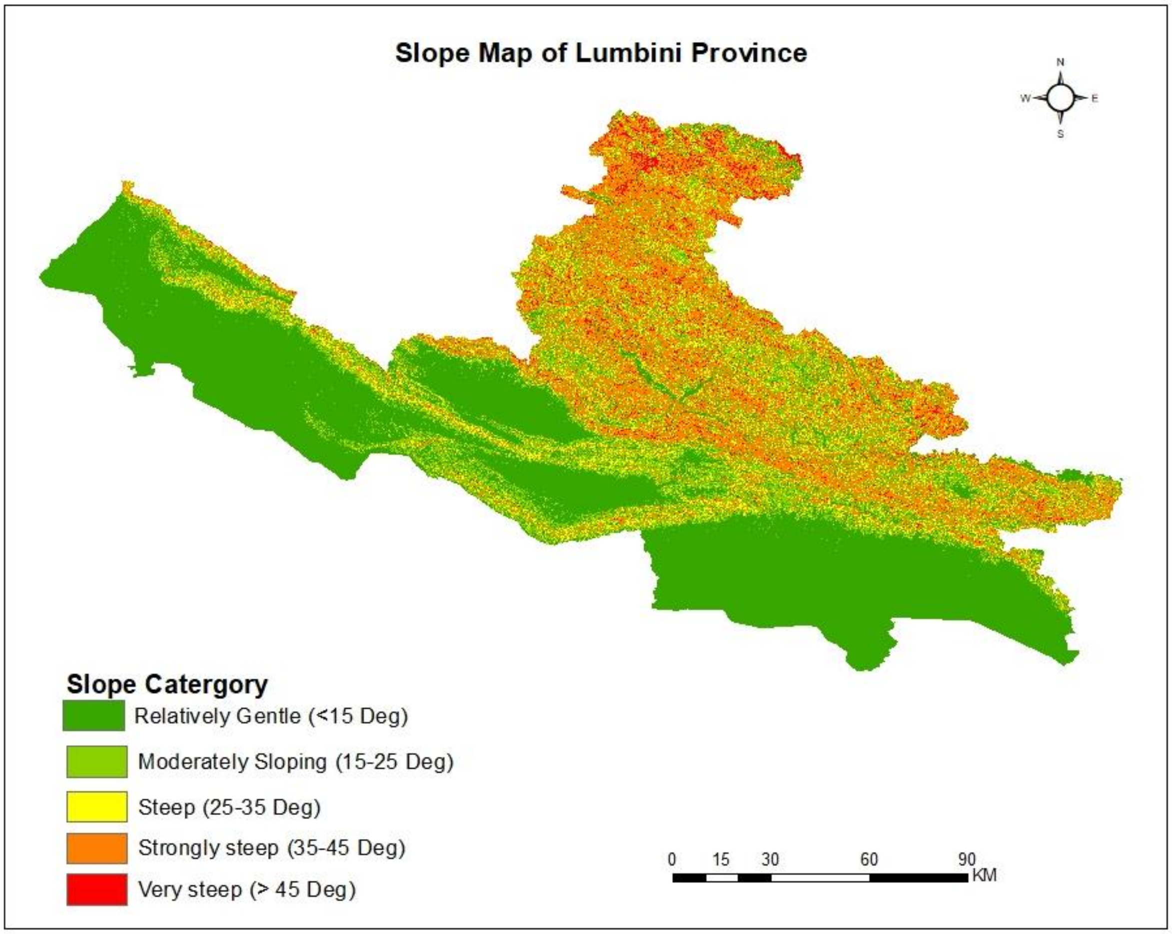

Figure 3. Slope map of Lumbini province.

3.2 Data collection

3.2.1 Desk study

Forest Management/Operational Plans and periodic (progress) reports were reviewed for collection of information on management interventions, stand species composition prior to the implementation of management interventions, motives of forest user groups in participating in different forest management systems, and existing practices on fund mobilization and benefit sharing.

3.2.2 Regeneration survey

Ground based regeneration survey was used for collection of regeneration [seedling (regeneration < 1 m in height) and sapling (regeneration > 1 m in height and < 10 cm in DBH)] related data: number of regenerations per species per unit area, regeneration species richness, regeneration species diversity and origin of regeneration. Regeneration survey focused only on tree species and was undertaken in forests managed under irregular shelterwood system, conventional management and no-harvest. The later was treated as the control.

Table 1. List of collaborative, community and block forests selected for the study. Names of the forests, their district and number of sample plots by forest management systems are shown.

SN	Name	District	Number of sample plots by forest management systems			
			Irregular shelterwood	Conventional management	No harvest	Total
1	Belghari CF	Arghakhachi	20	0	20	40
2	Chiurighat CF	Dang	20	0	20	40
3	Ghanteshowri CF	Banke	0	20	0	20
4	Jaspur CF	Pyuthan	20	0	0	20
5	Kundrakhola CF	Arghakhachi	0	20	0	20
6	Lumbini CFM	Rupandehi	20	0	20	40
7	Mathura Sallikot CF	Dang	0	20	0	20
8	Mayadevi CFM	Kapilvastu	20	0	20	40
9	Mulpani CF	Nawalparasi	20	0	20	40
10	Pakhure CF	Palpa	20	0	0	20
11	Purba Hapure CF	Dang	20	0	20	40
12	Ram Laxman CF	Kapilvastu	20	0	0	20
13	Samsherjung Mathewas BF	Banke	20	0	0	20
14	Trishakti CF	Banke	20	0	20	40
	Total		220	60	140	420

3.2.2.1 Sampling

For the regeneration survey, 20 samples plots per forests were laid out systematically (20 - 50 m apart from each other in a straight line depending on the size of the sub-compartments). In this way, a total of 420 sample plots (220 in sub-compartments managed under silviculture-based production-oriented forest management; 60 in forests managed under AAH based forest management and 140 in no harvest forests) were laid out (Table 1). Plots were numbered and mapped. Rectangular plots of 5 x 5 m were used for regeneration survey (Figure 4).

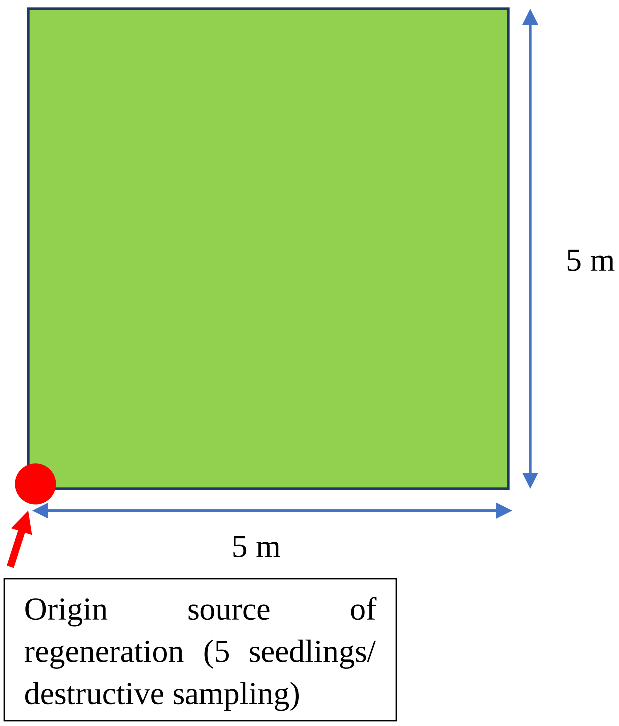

Figure 4. Layout of the sample plot that was used for regeneration survey.

3.2.2.2 Measurement

All seedlings and saplings in the sample plots were identified to the species level and their count were recorded. Additionally, the site characteristics, such as elevation (m a.s.l.), slope (degrees), aspect, canopy openness, and intensity of disturbance were also measured and recorded. Topographic elevation was measured using Garmin GPS. Slope and aspect were measured using Silva compass with clinometer. Canopy openness was used to determine light availability and was measured using smartphone positioned in the center of each sample plot. Intensity of disturbance was be measured using the presence – absence method. This means that if the signs of disturbance were present in the sample plots, it was scaled as one, and if absent, it was scaled as zero.

To check the origin of the seedling, a disturbance sampling method was used. For these few seedlings located closest to the starting point of plot were dug out and examined for their origin (seed or coppice). Origin of seedlings was examined only for Sal species. The sample of the form used for regeneration survey is presented in the Annex I.

Photo 1: Seedling Inventory

3.2.3 Species composition survey

To assess the relationship between stand species composition and species composition of regeneration, Tilaurakot CFM was selected. Stem mapping data prepared as the part of initiation of the irregular shelterwood system was obtained from the DFO. It was used as source of data for stand species composition. Regeneration survey was carried out for collection of regeneration species composition data. For this, four rectangular plots of 5 x 2 m per felling year per sub-compartment were established as shown in Figure 5. In this way, a total of 115 sample plots were established (only 3 sample plots for felling year 1 in sub-compartment B6C7S5 (Table 2).

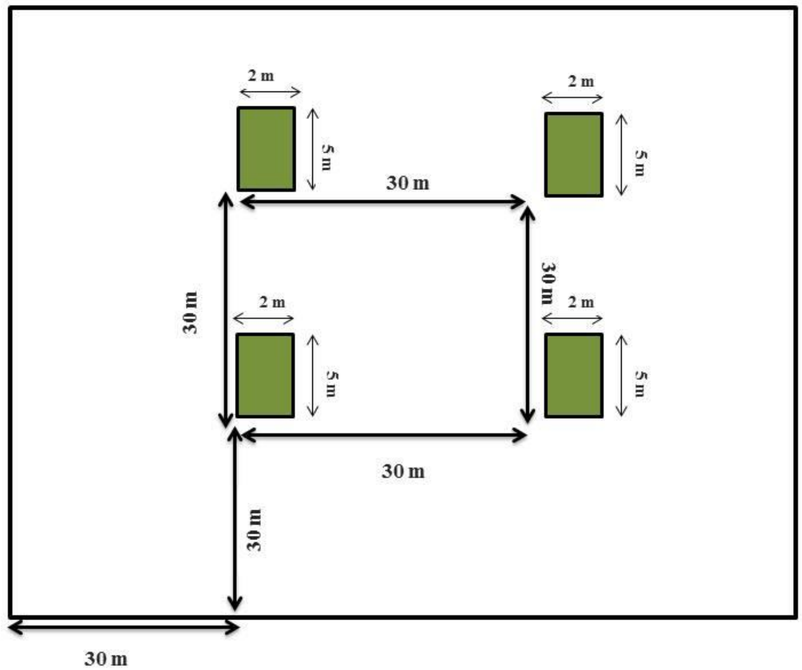

Figure 5. Layout of the sample plot that was used for species composition survey.

Table 2. Sample plots used for species composition survey.

Sub-compartments	Number of sample plots by felling years					Total number of sample plots
	1	2	3	4	5	
B6C1S1	4	4	4	4	4	20
B6C2S1	4	4	4	4		16
B6C3S4	4	4	4	4		16
B6C4S7	4	4				8
B6C5S3	4	4	4			12
B6C6S5	4	4				8
B6C7S5	3	4	4			11
B6C8S6	4	4	4			12
B6C9S2	4	4	4			12
Grand total	35	36	28	12	4	115

3.2.3.1 Measurement

All seedlings and saplings in the sample plots were identified to the species level and their count were recorded.

3.2.4 Social survey

Consultation with forest users (Photo 2) and telephone interviews were carried for collecting data required for assessing the motives of forest user groups in participating in different forest management systems and identifying issues and challenges in fund mobilization and benefit sharing associated with different forest management systems. Representatives of 48 community forests from eight districts (Arghakhachi, Banke, Dang, Kapilvastu, Nawalparasi, Palpa, Pyuthan, Rupandehi) were interviewed in person and telephone. All interviewed representatives were forest users committee officials mainly Chairperson, Secretary and Treasurer. Of the 48 community forests selected, 40 were practicing irregular shelterwood system for productive management of their forests whereas 8 are managing their forests using operational plans with the conventional forest management based on annual allowable harvest (Annex 2). Checklist that was used for interviews is presented in the Annex 3.

Photo 2. Consultation with the representatives of community forest.

3.3 Data analysis

3.3.1 Regeneration per species per unit area

Regeneration per species per unit area was calculated using the following equation:

$$Number\ of\ seedlings\ of\ a\ species\ per\ ha = \frac{Total\ number\ of\ seedlings\ of\ a\ species}{Total\ number\ of\ sample\ plots * Area\ of\ a\ sample\ plot\ in\ sq.m}\ x\ 10000 \text{.......................Eq}^{n}\ 1$$

$$Number\ of\ saplings\ of\ a\ species\ per\ ha = \frac{Total\ number\ of\ saplings\ of\ a\ species}{Total\ number\ of\ sample\ plots * Area\ of\ a\ sample\ plot\ in\ sq.m}\ x\ 10000 \text{......................Eq}^{n}\ 2$$

Sums of regeneration per species per unit area gave overall regeneration per unit area.

3.3.2 Species diversity

Species richness, Shannon-Wiener index and Simpson's index were used as measures of species diversity and were calculated using the following equations:

$$Species\ richness\ of a\ forest\ stand\ (S) = Total\ number\ of\ species\ recorded\ in\ a\ forest\ stand \quad ....Eq^n\ 3$$

$$Shannon - Wiener\ index\ (H') = -\sum_{i=1}^{S} p_i\ x\ ln p_i \quad ....Eq^n\ 4$$

where,

S = species richness

p_i = proportion of species i

ln = natural logarithm

$$Simpson's\ index = 1 - \frac{\sum_{i=1}^{S} n_i(n_i - 1)}{N(N-1)} \quad ....Eq^n\ 5$$

where,

S = species richness

n_i = number of individuals of species i

N = total number of individuals of all species

3.3.3 Species composition

The similarity in tree species composition of the stand before management intervention and tree species composition of regeneration following management intervention was calculated using Jaccard's Similarity Coefficient as follows:

$$SJ = \frac{a}{(a+b+c)} ....Eq^n\ 6$$

where,

a = number of tree species common to the stand before management intervention and to the regeneration following management intervention

b = number of tree species unique to the regeneration after management intervention

c = number of tree species unique to the stand before management intervention

The values of SJ range between 0 and 1, 0 indicates complete dissimilarity and 1 indicates complete similarity in species composition.

3.3.4 Origin of regeneration

The origin of regeneration ratio of a species was calculated as:

$$Origin\ of\ regeneration\ ratio\ of\ a\ species = \frac{Number\ of\ regeneration\ of\ the\ species\ from\ seed}{Number\ of\ regeneratin\ of\ the\ species\ from\ vegetative\ parts} \quad ....Eq^n\ 7$$

Wherever applicable, the difference between plots with irregular shelterwood system, conventional management and no-harvest was tested using ANOVA.

4. Results and discussion

4.1 Characteristics of the study forests

4.1.2 Canopy cover

Forests managed under irregular shelterwood system (38%) were found to have significantly lower canopy cover than the forests managed under conventional management (69%) and no-harvest (66%; Figure 6). This suggests that intensive regeneration felling is bound to create large canopy openings in the forests managed under irregular shelterwood system.

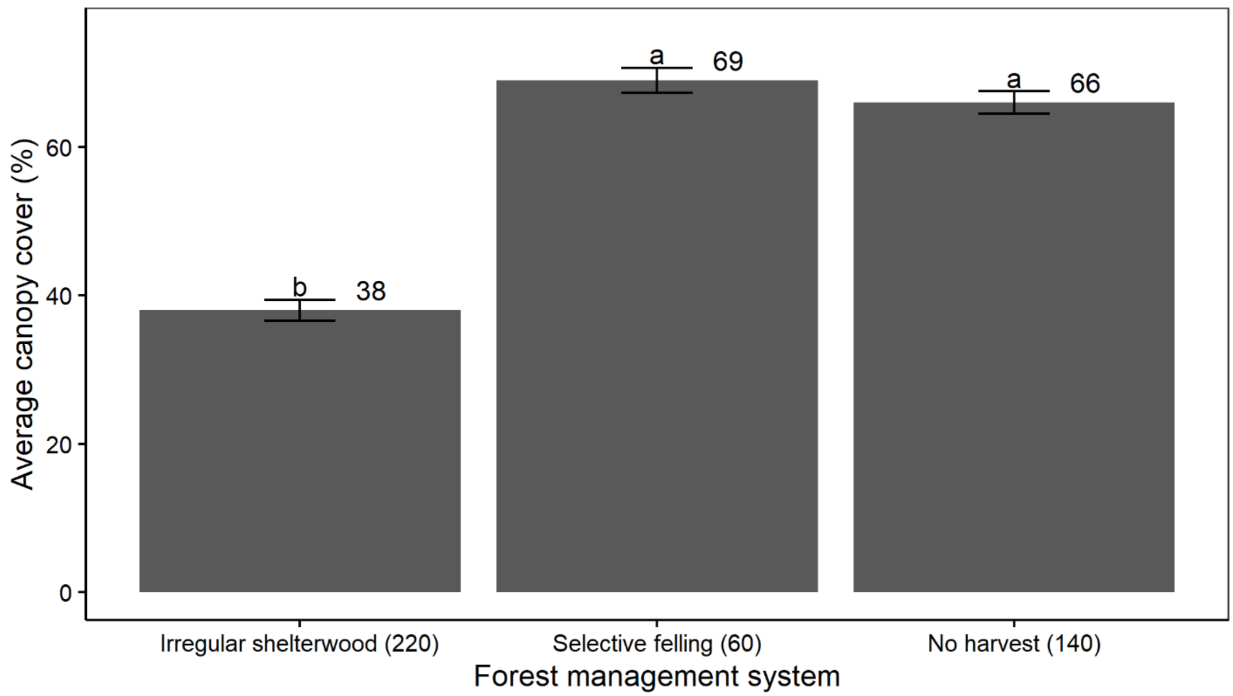

Figure 6. Average canopy covers of the forests managed under irregular shelterwood system, conventional management and no harvest.

Note: Differences among forest management systems were tested using ANOVA. Error bars show mean ± 1 SE. Bars with same alphabets at the top of error bars are not significantly different while those with different alphabets are significantly different (post-hoc Tukey test, $p < 0.05$). Numbers in parenthesis next to the forest management systems indicate the number of sample plots in the group.

4.2 Regeneration status

In general, regeneration status was good (seedling >5000 and sapling >2000; CF Resource Inventory Guideline, 2003) in all the studied forests. This study focused only on regeneration because only regeneration felling has been undertaken in the forests managed under irregular shelterwood system. Intensive regeneration felling is bound to create large canopy openings in the forests managed under irregular shelterwood system. Indeed the forests managed under irregular shelterwood system were found to have significantly lower canopy cover than the forests managed under conventional management and no-harvest (Figure 3). Must be because of such lower canopy cover, seedling and sapling densities were found to be significantly higher in the forests managed under irregular shelterwood system (seedling = 12698 and sapling = 6064) than in the forests managed under conventional management and no harvest (Figure 7, Photo 3). This suggests that irregular shelterwood system ensures more promising regeneration than conventional management and no-harvest (cf. Awasthi et al., 2015, 2020).

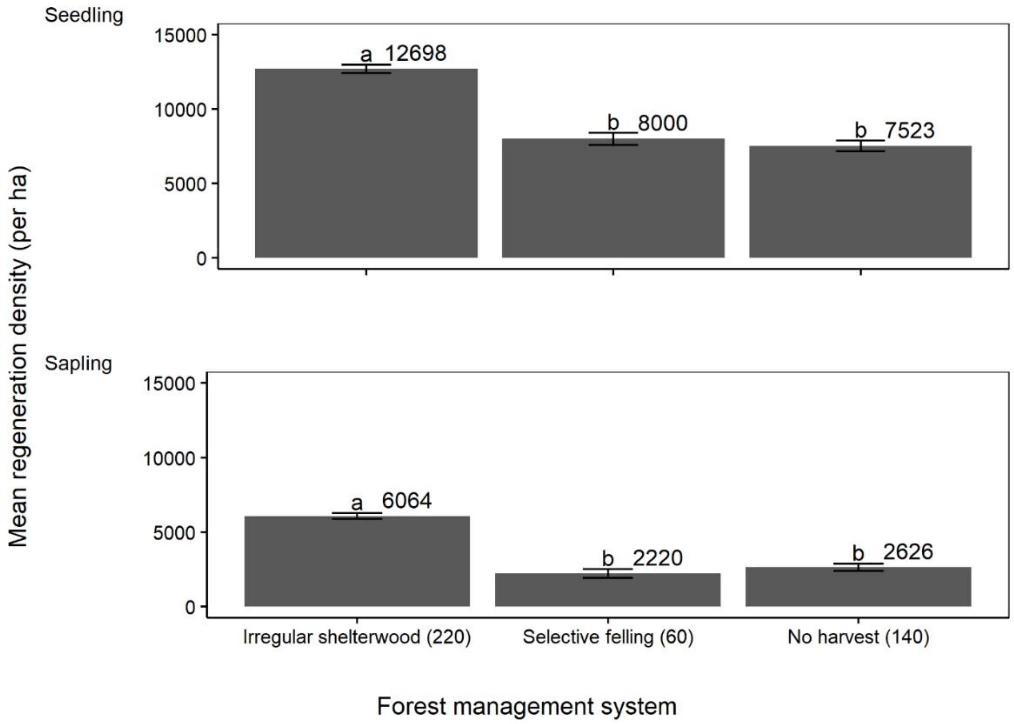

Figure 7. Mean regeneration densities of the forests managed under irregular shelterwood system, conventional management and no harvest.

Note: Top panel shows mean regeneration densities for seedlings whereas bottom panel shows that for saplings. Differences among forest management systems were tested using ANOVA. Error bars show mean ± 1 SE. Bars with same alphabets at the top of error bars are not significantly different while those with different alphabets are significantly different (post-hoc Tukey test, $p < 0.05$). Numbers in parenthesis next to the forest management systems indicate the number of sample plots in the group.

Photo 3. Regeneration in Kanchan CF after the regeneration felling under irregular shelterwood system.

Photo 4: Regeneration under unmanaged matured Sal Forest Plot - Lumbini CFM

4.3 Species diversity

4.3.1 Species richness

In this study, we focused only on tree species diversity. Altogether seedlings of 50 tree species (Table 3) and sapling of 33 tree species (Table 4) were recorded during the regeneration survey.

Table 3. List of tree species recorded during the regeneration (seedling) survey. Common names, scientific names and families of the tree species are shown.

SN	Common name	Scientific name	Family
1	Amala	*Phyllanthus emblica*	Phyllanthaceae
2	Asna	*Terminalia alata*	Combretaceae
3	Bakaino	*Melia azedarach*	Meliaceae
4	Bakledo		
5	Banj		
6	Banjhi	*Terminalia anogeissiana*	Combretaceae
7	Barro	*Terminalia bellirica*	Combretaceae
8	Bel	*Aegle marmelos*	Rutaceae
9	Bhakumlo		
10	Bhalayo	*Semecarpus anacardium*	Anacardiaceae
11	Bhorla	*Bauhinia vahlii*	Fabaceae
12	Bidipatta	*Diospyros sp.*	Ebenaceae
13	Bilaune	*Maesa chisia*	Myrsinaceae
14	Birea		
15	Bot dhairo	*Lagerstroemia parviflora*	Lythraceae
16	Chilaune	*Schima wallichii*	Theaceae
17	Chiuri	*Diploknema butyracea*	Sapotaceae
18	Dabdabe	*Garuga pinnata*	Burseraceae
19	Dhauti		
20	Dudhe		
21	Dumri	*Ficus racemosa*	Moraceae
22	Ghutuk		
23	Harro	*Terminalia chebula*	Combretaceae
24	Jamun	*Syzyzium cumini*	Myrtaceae
25	Kadipatta	*Murraya koenigii*	Rutaceae
26	Karma	*Adina cordifolia*	Rubiaceae
27	Katus	*Castanopsis indica*	Fagaceae
28	Khair	*Acacia catechu*	Fabaceae
29	Khaltu		
30	Khamari	*Gmelina arborea*	Verbenaceae

SN	Common name	Scientific name	Family
31	Koiralo	*Bauhinia variegata*	Fabaceae
32	Kumbi		
33	Kusum	*Schleichera oleosa*	Sapindaceae
34	Kutmero	*Litsea monopetala*	Lauraceae
35	Kyamuna	*Syzygium nervosum*	Myrtaceae
36	Maail		
37	Mahuwa	*Madhuca longifolia*	Sapotaceae
38	Piyari	*Buchanania latifolia*	Anacardiaceae
39	Rohini	*Mallotus philippensis*	Euphorbiaceae
40	Rajbriskh	*Cassia fistula*	Fabaceae
41	Sadan	*Ougeinia oojeinensis*	Fabaceae
42	Sal	*Shorea robusta*	Dipterocarpaceae
43	Salla	*Pinus roxburghii*	Pinaceae
44	Satisal	*Dalbergia latifolia*	Fabaceae
45	Sisso	*Dalbergia sissoo*	Fabaceae
46	Tantari	*Dillenia pentagyna*	Dilleniaceae
47	Tendu	*Diospyros sp.*	Ebenaceae
48	Teju	*Diospyros malabarica*	Ebenaceae
49	Tilka		
50	Tooni	*Toona ciliata*	Meliaceae

Table 4. List of tree species recorded during the regeneration (sapling) survey. Common names, scientific names and families of the tree species are shown.

SN	Common name	Scientific name	Family
1	Amala	*Phyllanthus emblica*	Phyllanthaceae
2	Asna	*Terminalia alata*	Combretaceae
3	Bakaino	*Melia azedarach*	Meliaceae
4	Bakledo		
5	Banj		
6	Bhakumlo		
7	Bhalayo	*Semecarpus anacardium*	Anacardiaceae
8	Bilaune	*Maesa chisia*	Myrsinaceae
9	Birea		
10	Bot dhairo	*Lagerstroemia parviflora*	Lythraceae
11	Chilaune	*Schima wallichii*	Theaceae
12	Dabdabe	*Garuga pinnata*	Burseraceae
13	Dudhe		
14	Jamun	*Syzyzium cumini*	Myrtaceae

SN	Common name	Scientific name	Family
15	Kadipatta	*Murraya koenigii*	Rutaceae
16	Kafal	*Myrica esculenta*	Myricaceae
17	Karma	*Adina cordifolia*	Rubiaceae
18	Khaltu		
19	Koiralo	*Bauhinia varigata*	Fabaceae
20	Kusum	*Schleichera oleosa*	Sapindaceae
21	Kutmero	*Litsea monopetala*	Lauraceae
22	Maail		
23	Mahuwa	*Madhuca longifolia*	Sapotaceae
24	Piyari	*Buchanania latifolia*	Anacardiaceae
25	Rohini	*Mallotus philippensis*	Euphorbiaceae
26	Rajbriskh	*Cassia fistula*	Fabaceae
27	Sal	*Shorea robusta*	Dipterocarpaceae
28	Salla	*Pinus roxburghii*	Pinaceae
29	Simal	*Bombax ceiba*	Bambacaceae
30	Sissoo	*Dalbergia sissoo*	Fabaceae
31	Tantari	*Dillenia pentagyna*	Dilleniaceae
32	Teju	*Diospyros malabarica*	Ebenaceae
33	Tilka		

Studies (Awasthi et al., 2015, 2020) have shown that intensive regeneration fellings have severely affected species diversity in the natural forests managed under irregular shelterwood system. In contrast, we found that mean species richness for seedlings for the forests managed under irregular shelterwood system was comparable to that for the forests managed under conventional management and was slightly higher than that for no-harvest forests (Figure 8 top panel). Likewise, we found that mean species richness for saplings for the forests managed under irregular shelterwood system was slightly higher than that for other forests (Figure 8 bottom panel).

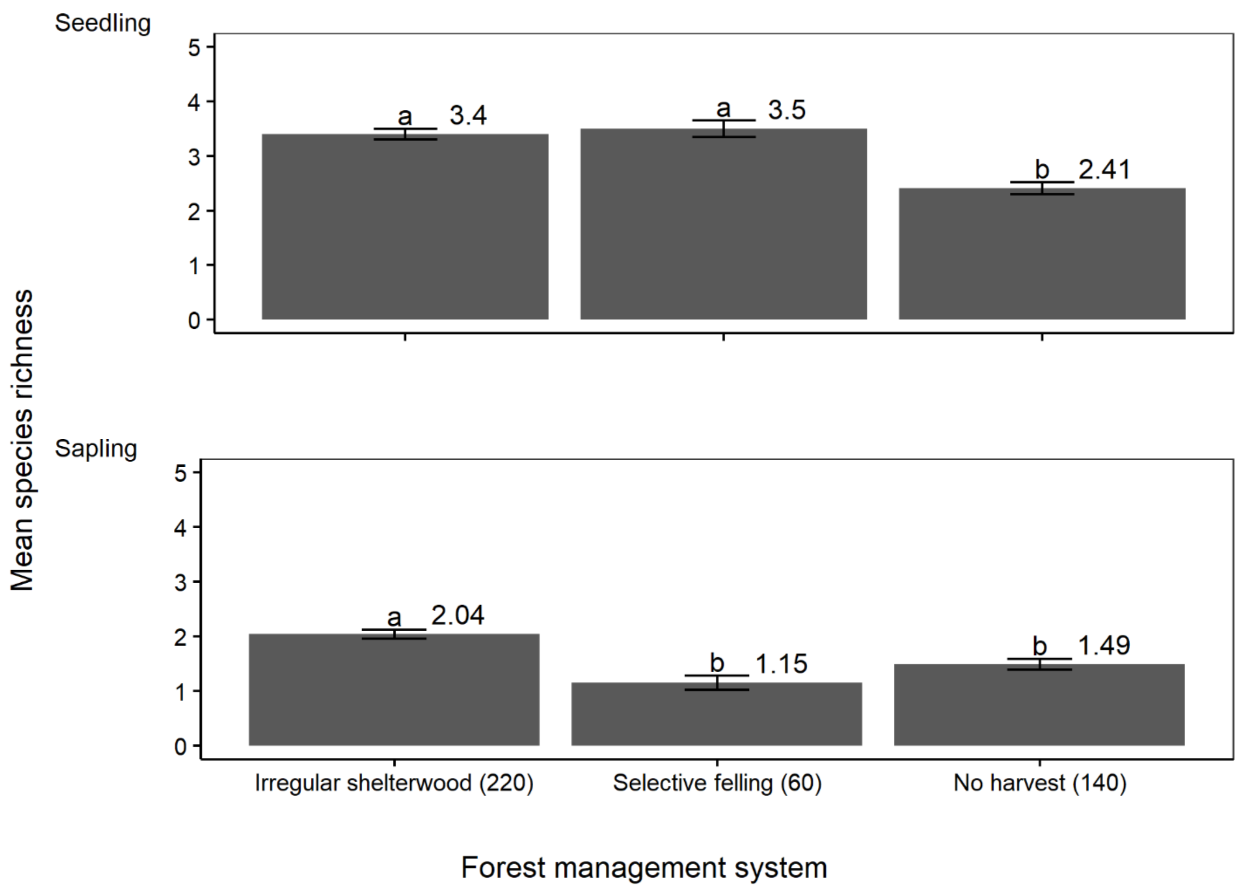

Figure 8. Mean species richness of the forests managed under irregular shelterwood system, conventional management and no harvest.

Note: Top panel shows mean species richness for seedlings whereas bottom panel shows that for saplings. Differences among forest management systems were tested using ANOVA. Error bars show mean ± 1 standard error of mean. Bars with same alphabets at the top of error bars are not significantly different while those with different alphabets are significantly different (post-hoc Tukey test, $p < 0.05$). Numbers in parenthesis next to the forest management systems indicate the number of sample plots in the group.

4.3.2 Shannon-Wiener index

Unlike species richness, Shannon-Wiener Index for seedlings was found to be significantly higher for the forests managed under conventional management than that for the forests managed under other systems (Figure 9 top panel). Whereas we didn’t find significant difference in Shannon-Wiener Index for saplings among forest managed under different systems (Figure 9 bottom panel).

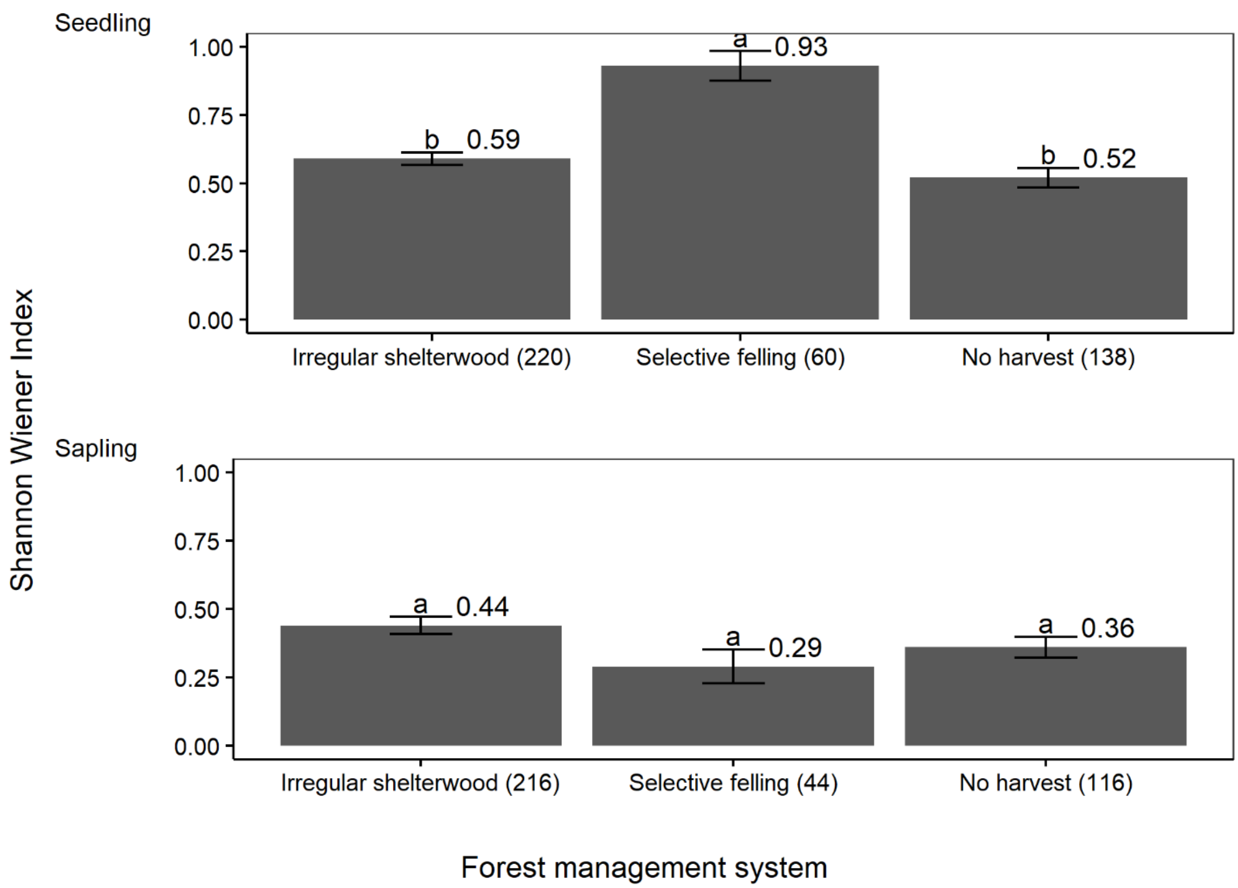

Figure 9. Shannon-Wiener Indices for seedlings (top panel) and saplings (bottom panel) for the forests managed under irregular shelterwood system, conventional management and no harvest.

Note: Differences among forest management systems were tested using ANOVA. Error bars show mean ± 1 standard error of mean. Bars with same alphabets at the top of error bars are not significantly different while those with different alphabets are significantly different (post-hoc Tukey test, $p < 0.05$). Numbers in parenthesis next to the forest management systems indicate the number of sample plots in the group.

4.3.3 Simpson's index

Similarly, Simpson's Index for seedlings was found to be significantly higher for the forests managed under conventional management than that for the forests managed under other systems (Figure 10 top panel). Whereas we didn't find significant difference in Simpson's Index for saplings among forest managed under different systems (Figure 10 bottom panel).

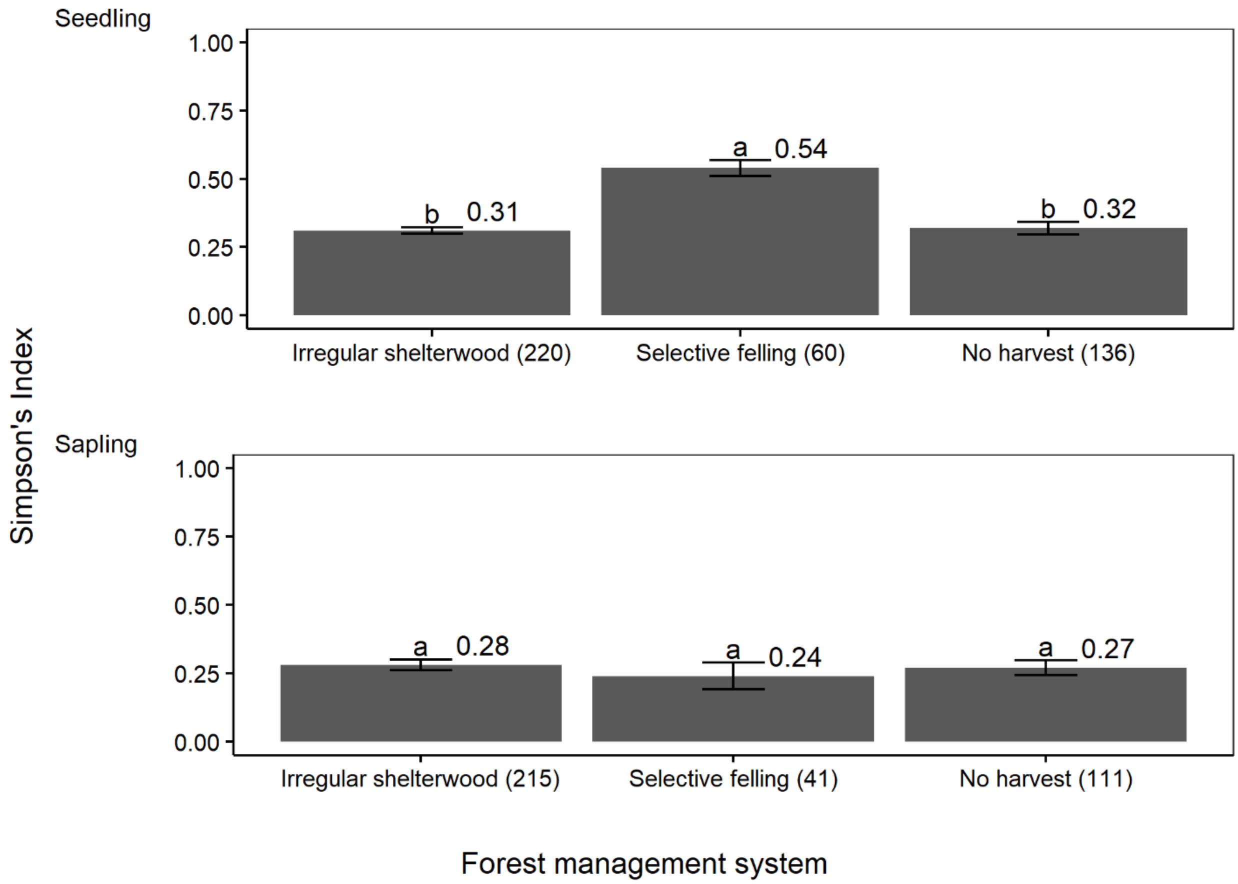

Figure 10. Simpson's Indices for seedlings (top panel) and saplings (bottom panel) for the forests managed under irregular shelterwood system, conventional management and no harvest.

Note: Differences among forest management systems were tested using ANOVA. Error bars show mean ± 1 standard error of mean. Bars with same alphabets at the top of error bars are not significantly different while those with different alphabets are significantly different (post-hoc Tukey test, $p < 0.05$). Numbers in parenthesis next to the forest management systems indicate the number of sample plots in the group.

This suggests that intensive regeneration fellings open canopies and make growing spaces available for new tree species but usually such growing spaces are reoccupied by few vigorous existing tree species. More precisely, irregular shelterwood system was practiced in Sal dominated productive forests of Lumbini Province and Sal being a strong light demanding species could readily take advantage of open canopies and reoccupy growing spaces before other species could do so. Provided this, irregular shelterwood system accompanied by regular tending operations could ensure promising regeneration of the intended tree species while discouraging that of unintended species.

4.4 Origin of regeneration

Origin of seedlings was examined only for Sal species. The seedlings and young plants of Sal are well-known for their capability to produce shoots after having been cut back or died back (Jackson, 1994; Ojha et al., 2008). However, the studies examining the origin of Sal seedlings are limited. Therefore, in this study, we examined for the origin of Sal seedlings. Of the 266 Sal seedlings dug out and examined for their origin (seed, root stock or stool coppice), more than 90% of the seedlings were found to have root stock origin. Close examination of the seedlings of root stock origin showed that they had gone through dieback process and the existing seedlings were actually sprouts from the root stock of died-back seedlings of seed origin (Photo 5). The seedlings from seed and stool coppice were negligible in the study area (Figure 11). This might the case because we are focusing on harvesting only the mature and over mature Sal trees that might have lost their ability to produce shoots.

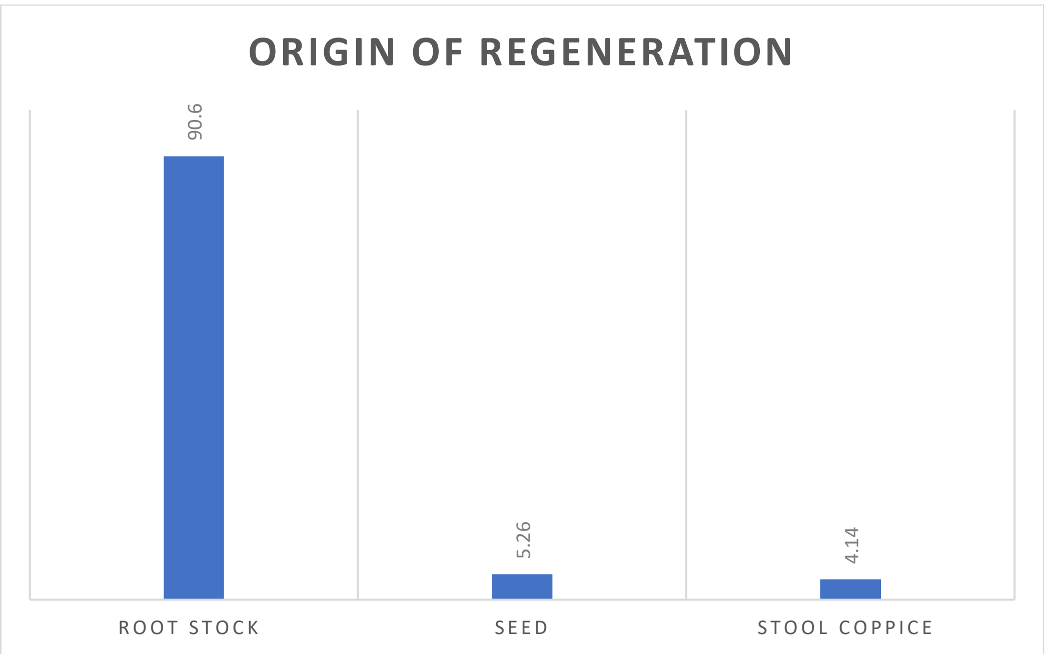

Figure 11. Origin of seedlings. Numbers at the top of bars show percentage of seedlings of different origin.

Photo 5. Research team examining the origin of Sal seedling.

4.5 Relationship between stand species composition and species composition of regeneration

To assess the relationship between stand species composition and species composition of regeneration Jaccard's Similarity Coefficient (SJ) was calculated. Normally, the values of SJ range between 0 and 1, 0 indicates complete dissimilarity and 1 indicates complete similarity in species composition. Here, we found SJ values ranging from 0.26 – 0.50 suggesting that there was less 50% similarity between stand species composition and species composition of regeneration. We also found that species unique to regeneration were consistently lower than those unique to stand (Table 5) suggesting that only few new tree species arrived in the study while many tree species were lost following the intensive regeneration felling. This might be the case because intensive regeneration felling open canopies and make growing spaces available for new tree species but usually such growing spaces are colonized by few vigorous existing tree species. Provided this, irregular shelterwood system should be accompanied by regular tending operations to ensure promising regeneration of the intended tree species while discouraging that of unintended species.

Table 5. Jaccard's Similarity Coefficients for different sub-compartments of Tilaurakot CFM. Number of tree species common to stand and to regeneration, unique to regeneration and unique to stand and Jaccard's Similarity Coefficients are shown.

Forest sub-compartment	Number of tree species			Jaccard's Similarity Coefficient (SJ)
	Common to stand and to regeneration (a)	Unique to regeneration (b)	Unique to stand (c)	
B6C1S1	11	2	14	0.41
B6C2S1	10	4	20	0.29
B6C3S4	13	6	10	0.45
B6C4S7	12	5	12	0.41
B6C5S3	12	7	5	0.50
B6C6S5	8	7	11	0.31
B6C7S5	6	7	9	0.27
B6C8S6	5	6	8	0.26
B6C9S2	8	3	8	0.42

4.6 Motives of forest user groups to participate in forest management systems

Initially, forest users' groups in Banke were managing their forests based on operational plans prepared following conventional AAH based approach or conventional management system. Since the timber and fuelwood production was limited, they were facing pressure of increased demand of forest products. Then they heard about the silviculture-based production-oriented forest management approach being practiced in Kapilvastu district. They visited the collaborative forests in Kapilvastu district to observe the productive forest management approach. After their visit, they requested the Division Forest Office Banke to revise their operational plans following the productive forest management approach. They realized that after the implementation of the productive forest management plan, timber production increased and demand of forest products gradually decreased. The forest users' groups stated that Divisional Forest Office organized orientation programs about the productive forest management approach and supported them to prepare their operational plans following the productive forest management approach. They heard about the success of this approach in Kapilvastu district. They also came to know that it was a primary program of the Government of Nepal then. Therefore, they decided to adopt the approach.

These forest user groups unanimously agreed that there is an increase in regeneration in the plots where they have carried out regeneration felling. There was also increase in timber and fuelwood production, local employment generation and income of the groups. Therefore, they were able to invest on pro-poor activities, organize capacity-building programs and fund social development activities.

The forest users' groups that have not adopted the productive forest management approach stated that they are not convinced with the approach. They think that the approach will destroy their forests and biodiversity. They also admitted that they have not got opportunity to directly observe their neighboring CF or CFM that were practicing the productive forest management approach.

Following the decision of the Council of Ministers held on 2077/10/11 BS to do away with the Scientific Forest Management Work Procedures 2071 BS, forest users' groups with the operational plans adopting the productive forest management approach are left with no choice but to do nothing. These forest users' groups are worried that their income has come down to zero but their expenditure on forest protection and tending operation like cleaning are ongoing. They are also worried that users' participation in forest management has decreased and they are not even allowed to collect fallen trees forcing them to leave them to decay in the forests. Following the decision of the Council of Ministers to do away with the Scientific Forest Management Work Procedures, 15% (6) forest users groups stated that there is no change in forest condition, 8% (3) stated that there is increase fire incidences whereas the remaining 77% stated that the condition their forests are degrading.

4.7 Issues and challenges in fund mobilization and benefit sharing in the forests

The forest users' groups shared their experience that the productive forest management system is expensive than the conventional management system though it has a high return. It requires higher initial investment in operational plan preparation and the implementation of harvesting plan. Most of the forest users' groups did receive financial support from the Government, through different programs. However, the financial support was not adequate. Some forest user groups had to secure loan from informal sources to cover the expenses.

However, the productive forest management system has helped forest users' groups to improve their accounting system, as it was mandatory for them to submit audit report annually. However, they did not have professional accountant to handle accounting system that become complex with increased income. Many of them did not have systematic record keeping and accounting system in place that further complicated the situation. The forest users' groups realized that increase in timber harvesting increased the number of interest groups with in the forest users' groups. This made it challenging to follow the "user first" principle while distributing the forest products.

Last but not the least, in absence of proper fund mobilization plan, many forest users' groups were not able to mobilize their fund effectively to improve socio-economic outcomes. Most of them kept their fund in their bank account. This tendency, on the one hand, reduced the potential of increasing social and economic outcomes of forest users' groups; and on the other hand, forest users' groups were forced to pay tax on their saving amount.

4.8 Assessment of the existing productive forest management approach

The existing productive forest management system seems to be effective in terms of increasing production and productivity of the forests. However, there are several aspects to be improved to make forest management more efficient. For instance, there is a blanket approach of irregular shelterwood system regardless of the forest and geographical condition. There are two approaches of defining annual coupe such as area based and volume based. But they are same in the hills as well as in Terai. There is a provision of leaving 15 - 25 mother trees per hectare. But in some cases, where advance growth is sufficient, leaving that many mother trees is not an efficient way. Besides, the field observation showed that Sal seed could dispersed to distance as far 130 m (respondents stated that it could disperse even further). Therefore, from seed dispersal point of view also number of mother trees per hectare needs to be revised. In some cases, post-regeneration felling activities are not adequate. Post-regeneration felling activities such as fencing to protect regeneration from grazing; weeding and cleaning to promote regeneration; and removal of mother trees after the establishment of regeneration must be made mandatory. Timely and proper harvest of mother trees could also generate considerable income for forest users' groups. In addition, there is also a need of finding a balance between regeneration felling and restoration of the degraded areas. The latter part has remained in shadow in many cases.

5. Conclusions and recommendations

6.1 Conclusions

- Must be because of lower canopy cover resulting from the intensive regeneration fellings, seedling and sapling densities were found to be significantly higher in the forests managed under irregular shelterwood system in comparison to those managed under conventional management and no harvest suggesting that irregular shelterwood system ensures more promising regeneration than conventional management and no-harvest.
- Species richness for seedlings for the forests managed under irregular shelterwood system was comparable to that for the forests managed under conventional management and was slightly higher than that for no-harvest forests. Unlike species richness, species diversity indices (Shannon-Wiener Index and Simpson's index) for seedlings were found to be significantly higher for the forests managed under conventional management than that for the forests managed under other systems. This suggests that intensive regeneration felling open canopies and make growing spaces available for new tree species but usually such growing spaces are colonized by few vigorous existing tree species. Provided this, irregular shelterwood system accompanied by regular tending operations could ensure promising regeneration of the intended tree species while discouraging that of unintended species.

- More than 90% of the seedlings were actually sprouts from the root stock of died-back seedlings of seed origin. The regenerations from seed and stool coppice were negligible in the study area. This might the case because we are focusing on harvesting only the mature and over mature Sal trees that might have lost their ability to produce shoots.
- Similarity between stand species composition and species composition of regeneration was found to be less than 50% and species unique to regeneration were consistently lower than those unique to stand suggesting that only few new tree species arrived in the study while many tree species were lost following the intensive regeneration felling. Provided this, irregular shelterwood system should be accompanied by regular tending operations to ensure promising regeneration of the intended tree species while discouraging that of unintended species.
- Motives of participation in silviculture-based production-oriented forest management system:
  - i) realization that silviculture-based production-oriented forest management system increases production and productivity of the forests
- Motives of sticking to conventional AAH based management system:
  - i) doubt that silviculture-based production-oriented forest management system will destroy their forests and biodiversity
- Issues and challenges in fund mobilization and benefit sharing:
  - i) higher initial investment in operational plan preparation and implementation of harvesting plan
  - ii) lack of professional accountant to handle accounting system that become complex with increase in income
  - iii) increase in the number of interest groups within the forest users' groups with increase in timber harvesting
  - iv) absence of proper fund mobilization plan hindering effective mobilization of fund for improvement of socio-economic outcomes
- Silviculture-based production-oriented forest management system is effective in terms of increasing production and productivity of the forests. However, there are several aspects to be improved to make forest management more efficient such as applying context specific approaches instead of blanket approach; making post-regeneration felling activities to protect and promote regeneration mandatory; and finding a balance between regeneration felling and restoration of the degraded areas.

6.2 Recommendations

Regeneration promotion

- Irregular shelterwood system should be accompanied by regular tending operations to ensure promising regeneration of the intended tree species while discouraging that of unintended species i.e. to ensure intended species diversity.

- Regeneration protection from fire and grazing through fencing and regular cleaning may contribute to protect seedlings and reduce the root stock,
- Plant species richness in the regeneration layer found lower than the matured forests. This is expected since regeneration layer has light demander species only. When forest grows and contains multiple layers, multiple species such as light demander and shade tolerant species.

Forest management systems

- There is a need to define forest management system based on the geographical location and conditions. This may facilitate different forest management units within a forest. Such as a forest spread in Terai and Siwaliks region can be treated as two blocks with different forest management strategies. Or, forest patches with different species composition can be treated as different management units.
- There is a variation within a particular silviculture system too, this need to be considered. For instance, shelterwood system could have preparatory and final felling; or preparatory, seeding and final felling.
- The potential risks such as invasion of exotic species, geographic fragility, forest location and conditions should be evaluated before prescribing forest management systems and silviculture treatments. In the area where the risk of invasive species is high, then gradual opening is required with no canopy opening operations in the border. Similarly, no preparatory/seeding felling in along the highway or roadside to maintain scenery or maintain green belt. Felling operations can be carried out only during the final felling in those areas.
- If there is a sufficient advance growth necessity of *seeding felling* should be considered. Such plots may require preparatory and final felling. In addition, it is important to keep mature trees for biodiversity conservation, particularly in the border of the plots. This helps to balance trade-offs between biodiversity conservation and production.
- There is a need to develop “Silviculture System Guidelines” and “Thinning Guidelines” to facilitate silviculture-based production-oriented forest management in the field.

Fund mobilization and benefit sharing

- Ministry of Forests, Environment and Soil Conservation should facilitate to make a provision for loan to forest user groups from financial institutions,
- Divisional Forest Offices should have annual program to support forest users’ groups, through training and/or coaching, for accounting and record keeping.
- Similarly, the forest users’ groups with adequate savings should be encouraged to appoint accountant and forest technician. This could be done in a cluster basis.
- The forest operational/management plans should have a clear plan for fund mobilization so that the forest users’ groups can mobilize their fund effectively to improve socio-economic outcomes.

- Revise Community Forest Inventory Guidelines to make CFOP preparation cost effective such as use *Basal area* instead of *Volume*, so that there is no need to measure height of trees during forest inventory.

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Annex

Annex 1: Form that was used for regeneration survey

Regeneration Survey

General Description of the Forest

CFUG / Forest Name:	**Plot No:………………….**	**Team Leader:**
GPS: X= Y=	**Aspect: N / S / E / W / NE / NW / SE / SW**	**Slope:**
Altitude:…………………..	**Date: / / 2022**	**Time: ………to ………**

PLOT INFORMATION

Forest Type: Natural / Plantation (If any)	**Species Dominance: ………………………**	
Fodder Collection: YES / NO	**Firewood Collection: YES / NO**	**Timber Harvesting: YES / NO**
Grazing: YES / NO	**Fire: YES / NO**	**Encroachment: YES / NO**

Cover (Personal Judgement): **Crown=............ %** **Ground:............%** **Ground Surface:** **Dry / Moist / Wet**

Other Additional Information (if any):

A. PLOT (25 m^2: 5 m * 5 m) PURPOSE: Sapling (1.3 m height to <10cm dbh) - DBH & height measurement (for height measurement bamboo pole having label can be used as best option)

SN	Species	DBH (cm) at 1.3 m	Tree height (m) (use bamboo pole)	Remarks

*** Slope correction will not be needed if bamboo pole is used while measuring height. Apply appropriate slope correction if needed while establishing the plot (bamboo pole can be used for slope correction).**

*** Measure all trees within the plot with 1.3 m height to <10cm dbh**

*** Record species of unidentified trees as Sp 1...Sp 2 likewise, and note distinguishable characteristics as comment**

B. PLOT-I: (25 m^2: 5 m * 5 m)   PURPOSE: Seedling Count (all seedling <1.3 meter height)

SN	Species (Local name)	Tally	Total Count		SN	Species (Local name)	Tally	Total Count
1					6			
2					7			
3					8			
4					9			
5					10			

C. PLOT-I (25 m^2: 5 m * 5 m)   PURPOSE: Origin source of Seedling Count (5 seedlings <1.3 meter height nearest from the starting point)

SN	Species	Origin source			SN	Species	Origin source	
		Seed	Coppice Type (a=stool, b= root stock, c=seed)				Seed	Coppice Type (a=stool, b= root stock, c=seed)
1					6			
2					7			
3					8			
4					9			
5					10			

D. PLOT-I (25 m^2: 5 m * 5 m)   PURPOSE: Crown / ground cover measurement

Note: Densiometer or smart mobile phone can be used to take crown and ground cover (photograph).

Annex 2: List of community forests selected for in-person and telephone interviews. Names of community forests, their districts and their initial and current management systems are shown

SN	Forest	District	Forest management system	
			Initial	Current
1	Adarsha CF	Kapilvastu	Conventional management	Irregular shelterwood
2	Amrite CF	Kapilvastu	Conventional management	Irregular shelterwood
3	Baijalpur CF	Kapilvastu	Conventional management	Irregular shelterwood
4	Ban gadi CF	Pyuthan	Conventional management	Conventional management
5	Barasthan CF	Pyuthan	Conventional management	Conventional management
6	Basantapur CF	Kapilvastu	Conventional management	Irregular shelterwood
7	Belghari CF	Argakhachi	Conventional management	Irregular shelterwood
8	Bhrikuti CF	Kapilvastu	Conventional management	Irregular shelterwood
9	Birpur Jankalyan CF	Kapilvastu	Conventional management	Irregular shelterwood
10	Buddha CF	Rupandehi	Conventional management	Irregular shelterwood
11	Chiurighat CF	Dang	Conventional management	Irregular shelterwood
12	Gaidea CF	Argakhachi	Conventional management	Irregular shelterwood
13	Ghanteshowri CF	Bake	Conventional management	Conventional management
14	Ghauwa Mahila CF	Argakhachi	Conventional management	Irregular shelterwood
15	Hari Om Khola CF	Kapilvastu	Conventional management	Irregular shelterwood
16	Janjagaran CF	Kapilvastu	Conventional management	Irregular shelterwood
17	Jaspur CF	Pyuthan	Conventional management	Irregular shelterwood
18	Jayban Shakti CF	Kapilvastu	Conventional management	Irregular shelterwood
19	Jhim Jhimiya Bhulke	Rupandehi	Conventional	Irregular shelterwood

SN	Forest	District	Forest management system	
			Initial	Current
	Pani CF		management	
20	Kalika CF	Kapilvastu	Conventional management	Irregular shelterwood
21	Kanchan CF	Rupandehi	Conventional management	Irregular shelterwood
22	Khadak CF	Pyuthan	Conventional management	Conventional management
23	Khojipur CF	Kapilvastu	Conventional management	Irregular shelterwood
24	Khutkhute CF	Kapilvastu	Conventional management	Irregular shelterwood
25	Kondra Khola CF	Argakhachi	Conventional management	Conventional management
26	Kotihawa CF	Kapilvastu	Conventional management	Irregular shelterwood
27	Lal Matiya CF	Kapilvastu	Conventional management	Irregular shelterwood
28	Madane CF	Pyuthan	Conventional management	Conventional management
29	Madhuban CF	Kapilvastu	Conventional management	Irregular shelterwood
30	Manakamana CF	Kapilvastu	Conventional management	Irregular shelterwood
31	Mathurasallikot CF	Dang	Conventional management	Conventional management
32	Mul pani CF	Nawalparasi	Conventional management	Irregular shelterwood
33	Namuna CF	Kapilvastu	Conventional management	Irregular shelterwood
34	Nawa Prabhat CF	Kapilvastu	Conventional management	Irregular shelterwood
35	Pakhure CF	Palpa	Conventional management	Irregular shelterwood
36	Pragat CF	Rupandehi	Conventional management	Irregular shelterwood
37	Prativa CF	Kapilvastu	Conventional management	Irregular shelterwood
38	Purba Hapure CF	Dang	Conventional management	Irregular shelterwood
39	Rajapani CF	Rupandehi	Conventional management	Irregular shelterwood

SN	Forest	District	Forest management system	
			Initial	Current
40	Rajkuda CF	Kapilvastu	Conventional management	Irregular shelterwood
41	Ram Laxman CF	Kapilvastu	Conventional management	Irregular shelterwood
42	Saljhandi CF	Rupandehi	Conventional management	Irregular shelterwood
43	Samaithan CF	Kapilvastu	Conventional management	Irregular shelterwood
44	Shanti CF	Kapilvastu	Conventional management	Irregular shelterwood
45	Sarepani CF	Kapilvastu	Conventional management	Irregular shelterwood
46	Trishakti CF	Bake	Conventional management	Irregular shelterwood
47	Trishakti CF	Kapilvastu	Conventional management	Irregular shelterwood
48	Wagale CF	Pyuthan	Conventional management	Conventional management

Annex 3: Checklist that was used for in-person and telephone interviews

प्रश्नावली

(Irregular Shelterwood System मा आधारित वन व्यवस्थापन गरेका समुदायहरुसँगको छलफलको लागि तयार पारिएको)

१. तपाईहरुको वन समूह कहिले गठन भयो ?

२. सुरुमा तपाईहरुले आफ्नो वनको व्यवस्थापन कसरी गर्ने गर्नु हुन्थ्यो ?

३. हालको वन व्यवस्थापन पहिलेको भन्दा फरक छ ? (साच्चै, तपाईहरुले अनियमित रक्षिवितान प्रणाली (Irregular Shelterwood System) शुरु गर्नु भएको त छैन ? यदि छैन भने प्रश्न ७ मा जाने)

४. यसरी छनौट प्रणाली (Selection/Selective/Conventional System) बाट अनियमित रक्षिवितान प्रणाली (Irregular Shelterwood System)मा जाने निर्णय के-कति कारणले गर्नु भयो ?

५. अनियमित रक्षिवितान प्रणाली (Irregular Shelterwood System)मा गइसके पछि तपाईहरुको वनको हैसियत र तपाईहरुले वनबाट पाउँदै आउनु भएको काठ दाउरा र अन्य सेवा सुविधाहरुमा के-कस्तो फरक पाउनु भएको छ ? कि उस्तै छ?

६. अझ ठ्याक्कै भन्दा, अनियमित रक्षिवितान प्रणाली (Irregular Shelterwood System)मा गइसके पछि तपाईहरु समूहको आम्दानीमा केही फरक पारेको छ ?

७. तपाइको वनको कार्ययोजना बनाउदा लागेको खर्च कसरी व्यवस्थापन गर्नु भयो? आफै, सरकारको सहयोग, वाह्य व्यक्ती वा संघसंस्था बाट प्राप्त गर्नु भयो?

८. तपाइको वनको व्यवस्थापन कार्यहरु जस्तै कटानमा लाग्ने खर्च कसरी जोहो गर्नुहुन्छ ? आफै, सरकारको सहयोग, वाह्य व्यक्ती वा संघसंस्था बाट

९. अनि यसरी अनियमित रक्षिवितान प्रणाली (Irregular Shelterwood System)बाट उपलब्ध हुने काठ दाउरा र अन्य सेवा सुविधाहरु तथा आम्दानीको बाँडफाड कसरी गर्ने गर्नु भएको छ ?

१०. अहिले सम्मको तपाईहरुको अनुभवमा अनियमित रक्षिवितान प्रणाली (Irregular Shelterwood System)का राम्रा पक्षहरु के-के हुन ?

११. अनियमित रक्षिवितान प्रणाली (Irregular Shelterwood System) गर्दा तपाइले सामना गर्नका चुनौतिहरु के-के हुन ?

धन्यावाद ।