Final Evaluation Report

Your Details	
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Project Title	Public Land Agroforestry for Biodiversity Conservation, Livelihood Support and North-South Conflict Mitigation in Nepal Terai
Application ID	26820-B
Grant Amount	£9820
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Date of this Report	August 2021

1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
To promote agroforestry in public land for biodiversity conservation, livelihood support and help reduce north-south conflict in forest resources				This is the basic goal of the project and all the activities carried under project have tried to fulfil this objective.
To aware, capacitate and institutionalise southern community for agroforestry development				The formation of local committees, development of future plan and institutional connection with local government, Division Forest Office and local forest management group: Chisapani Community Forest User group has been instrumental to achieve this objective.
To establish agroforestry demo-plot as a learning site and disseminate the learning's to wider community				A demo-plot has been established, with its management plan and a functional executive committee has been formed to carry the planned activities regularly and it has started building connection with forest offices, local government and working with their collaborations.

2. Please explain any unforeseen difficulties that arose during the project and how these were tackled.

One of the major difficulties was the COVID-19 pandemic that affected the project work continuation. Due to complete lockdown from March to July 2020, and April to July 2021 the planned project activities were entirely halted. Even after loosening of the lockdown, the surging cases of infection impacted our field activities timeline. However, we carried out the project activities when new cases for COVID-19 lowered in number. When we could not travel to the project site to carry project activities, we had regular verbal communication with the Project Management Committee (PMC) and Community Forest User Groups (CFUG) executive committee on the continuation of some activities and the possibility of initiating further project activities.

There were no other possibilities to complete the project activities, thus we completed all the remaining activities in between the COVID – 19 pandemics following the safety measures as mandated by the Government of Nepal. All the concern stakeholders were strictly requested to follow the safety measures before participating in the project activities.

Equally, there were some issues arose due to unforeseen interests of local leaders. However, we resolved them through the Chisapani community forest user group institutional process and leadership. Moreover, we provided them with the role in the project management committee and PLMG committees.

3. Briefly describe the three most important outcomes of your project.

The first and key outcome of the project is the promotion of agroforestry in southern low land of Nepal. It has increased knowledge of the local community to choose and practice appropriate agroforestry techniques for better management of their public land and their agriculture lands. We researched and shared the information about the agroforestry practices across the lowlands of Nepal to the communities regularly. In addition, we studied and conveyed the key agroforestry issues, challenges, and determinants of its promotion in the north-south conflicted region. It has helped local government and CFUG to collaborate with southern community while developing and implementing their activities.

The second outcome is the enhanced awareness and knowledge among the southern community on their present context, issues and future possibilities on agroforestry practices and their development. The minimisation of the conflict between north and south community through these awareness and knowledge sharing programmes was also achieved. Equally it has improved their capacity and institutional relation with Chisapani community forest user group and local government. Institutionalisation of southern community with community forest users' groups for resource sharing and contribution is another key outcome of the project.

Thirdly, the establishment of agroforestry demo-plot as learning site and dissemination of the learning to the wider community. We have created a demo-plot on water-vegetation-crop nexus. This agroforestry system is the combination of fish farming, timber/fuelwood, and food crops. The management plan of the demo-plot has been prepared that details the site description, plantation and harvesting periods, necessary activities of next 5-10 years, and fund arrangements for such activities. The execution of that management plan will be led by the nine-member demo-plot management committee and the CFUG will be guiding institution. For now, the committee has received the financial support from Division Forest Office and ward office.

4. Briefly describe the involvement of local communities and how they have benefitted from the project.

The local southern community from ward no. 12, 13 of Bardaghat municipality, ward no. 5, 6 of Sarawal Rural Municipality and ward no. 01 of Palhi Nandan Rural

Municipality, Chisapani community forest user groups' members and executive committee members are the primary stakeholders of the project and are the implementers of the project. They are part of project management committee, public land management groups, demo-plot management committee and direct project beneficiaries. We tried to incorporate local communities living on these wards and other committees in project committees, all project activities, training and in all programmes conducted by the project. Some of the activities and the local communities' involvement and benefits are pointed below:

- About 250 households from all five wards of southern area of Chisapani CFUG were directly involved during households' discussions, interviews and surveys on agroforestry context, practices, issues and promotions.
- More than 200 households involved in training, awareness and capacity building activities and workshops.
- About 300 Local communities from ward no. 5, 6 of Sarawal Rural Municipality are the direct beneficiaries of demo-plot.
- More than 100 students and different stakeholders including local government leaders, forest technicians, and Federation of Community Forest Users Nepal (FECOFUN) members involved in dissemination and outreach programmes.
- This involvement and collective work have enhanced their knowledge, skills and importantly the ownership towards agroforestry promotion work.

5. Are there any plans to continue this work?

Yes, The Chisapani community forest user group will monitor and facilitate the implementation of demo-plot management plan. It will further support the southern community to promote agroforestry in other public and farmlands and encourage them for agroforestry adoption through providing needed seedlings from their nursery.

On the other hand, the nine-member demo-plot management committee has been formed and they have developed their short-term and long-term plan and initiated its execution. Recently the committee has received financial support from Division Forest Office and Ward Office.

6. How do you plan to share the results of your work with others?

I have drafted the manuscript entitled "*What Determines Agroforestry Adoption in Southern Terai of Nepal*" based on the project results and learning. I will publish it shortly in international journal. It will contribute to science and practice and will be helpful to local and national policy makers and institution working in forestry and agriculture in southern Terai region of Nepal.

On the other hand, the demo-plot will act as a learning site. It is executed by a locally formed committed and monitored and facilitated by Chisapani community forest user group. Equally I will use the project results and learning at my classroom with my students.

7. Timescale: Over what period was the grant used? How does this compare to the anticipated or actual length of the project?

Due to COVID-19 pandemic there was some changes in anticipated time period of the project. Almost 60% of the project was completed before January 2021. We need to completely stop project activities for a year due to COVID 19 outbreak and complete and partial lockdown in the country. However, after vaccination started, the project team following all the safety measures continued the remaining project activities and completed it.

8. Budget: Provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used. It is important that you retain the management accounts and all paid invoices relating to the project for at least 2 years as these may be required for inspection at our discretion.

Item	Budgeted Amount (£)	Actual Amount (£)	Difference (£)	Comments
Local transportation	200	200		Primarily used for motorbike fuel and maintenance
Transportation to and from field to workplace	300	330	+30	The remaining amount from training and tea and snacks were used. Includes air fare of team leader from Pokhara to Kathmandu and back
Work plan development	490	490		Hired expert
Workshops	420	420		Two Local and two CFUG level workshop
Disseminations	410	410		School programs, community programs, sharing in IOF and publications
Demo-plot construction	200	200		
Trainings	1400	1250	-150	The number of participates were decreased following the safety measures of COVID-19. The travel reimbursement was increased to address the safety measures adopted by the participants
Tea and snacks during	700	700		In addition, we provided

plantation week				some remuneration for travel and for their time
Tea and snacks during initial meetings, reconnaissance meetings, meetings with local bodies and CFUGs	200	200		
Tea and snacks during inception workshop	150	160	+10	In addition, we provided some remuneration for travel and for their time
Tea and snacks during PLMG formations and discussions	245	245		
Tea and snacks during household surveys, group discussions and interviews with southern community and leaders	980	1010	+30	Carried 200 households' surveys, six group discussion (15-20 people), 10 key informant interviews, 15 meetings with CFUG leaders both formal and informal
Tea and snacks for PMC and CFUG meetings throughout project duration	375	375		
Stationary, printing and communication	250	220	-30	Used for DSA
DSA- field assistants	800	860	-60	Hired some additional field assistance to facilitate local processes during field works, in some cases we hired local language translators
DSA- field researcher	600	650	+50	Extra field assistances were employed during surveys and discussions
DSA- Team leader	2100	2100		
TOTAL	**9820**	**9620**	**-200**	£sterling: Nepalese rupees= 1:140

9. Looking ahead, what do you feel are the important next steps?

We have identified the key agroforestry practices adopted by the local communities, the issues and challenges and factors associated with agroforestry adoption. Based on these results, we will design a further project and activities collaborative with community forest user group and local government.

10. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?

Yes, the logo was used in all training, workshop and discussion activities. The logo was used in banners and hoarding board. Equally it will be used and acknowledged in the scientific paper.

The Rufford Foundation received lot of appreciations and thanks from all the stakeholders. The Chisapani CFUG, ForestAction Nepal thanked the foundation for its support in conservation. Similarly, local government leaders and southern community have been very grateful for the financial support to promote agroforestry in southern Terai region of Nepal.

11. Please provide a full list of all the members of your team and briefly what was their role in the project.

Prabin Bhusal – Principal invigilator, Conceptualization to final report preparation

Kavi Raj Awasthi- Forestry Graduate, research assistant, data collection and analysis, plan drafting

Naresh Shrestha – BSc Forestry Student, research assistant and field data collector

Asmit Neupane – BSc Forestry Student- research assistant and field data collector

Kamal Pariyar – Chisapani CFUG member and local field assistant

Krishna Jivan Tiwari - Chisapani CFUG member and local field assistant representing southern community

12. Any other comments?

I like to give thanks to The Rufford Foundation for the financial and moral support. Despite of the COVID-19 pandemic, the support from the foundation has encouraged me to finish the remaining activities during the pandemic.

I also would like to thank my referees who have been very supportive and for regular monitoring and inquiring the updates of the project. Special thanks go to Dr. Naya Sharma Paudel who always pushed me and put query on the progress and challenges of the project.

Similarly, I am thankful to my office ForestAction Nepal, for their support on financial management and encouragement. Thanks to Chisapani CFUGs, my project assistance and students who continuously supported in the project work in this pandemic time.

Hope to be connected with RF continuously for conservation and natural resource management.

Annex 1: Demo plot, field visit, meetings and workshop photos

Fig 1: Google map of Demo plot

Fig 2: meetings with southern and CFUG leaders


गोष्टी तया खेलफल कार्यक्रम

Fig 3: During workshops


Fig 4: Demo-plot visit and discussion with demo-plot committee

Fig 5: Discussion with school students in southern Terai, Nawalparasi

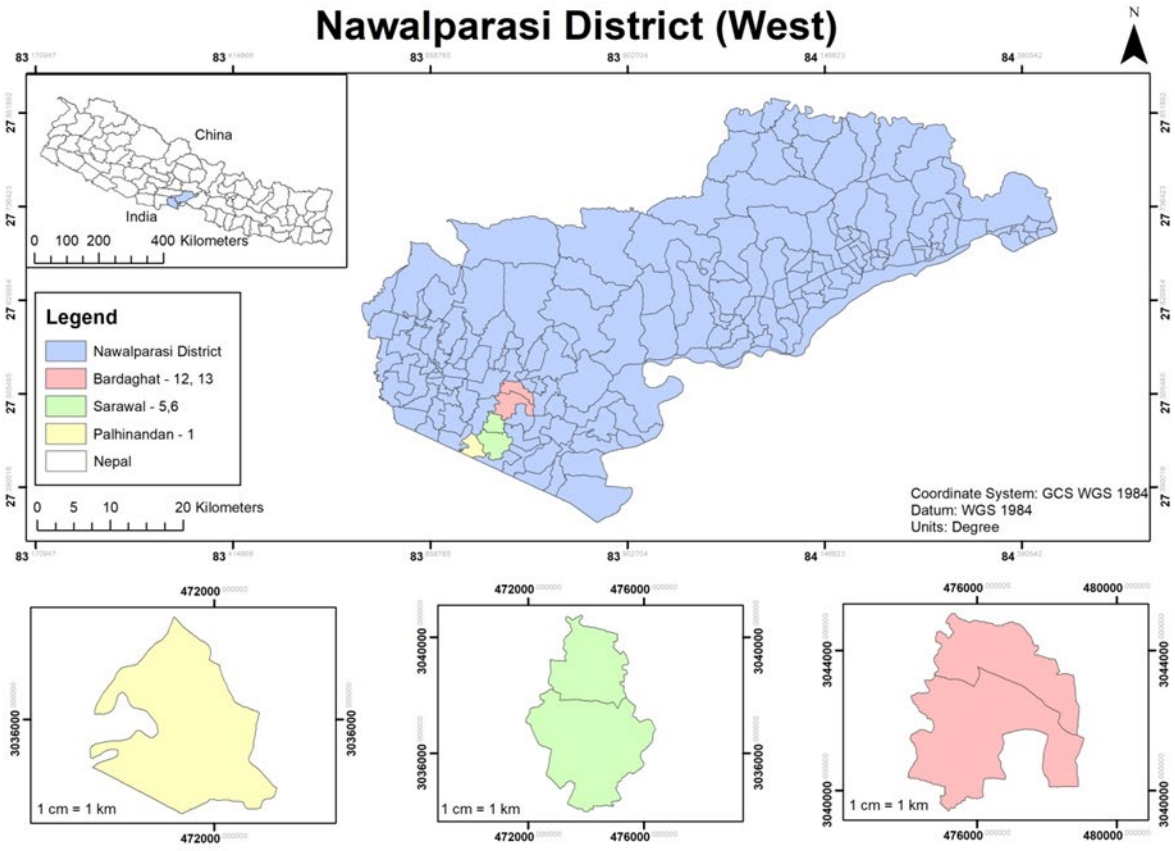

Figure 6: map of study area

Annex 2: Draft of Manuscript

What Determines Agroforestry Adoption in Southern Terai of Nepal?

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Abstract
The agroforestry promotion in southern Terai region of Nepal has been discussed as a remedy for livelihood support, biodiversity conservation and reducing resource conflict between southern and northern forest users in Terai region communities who live in distance from natural resource, especially the southern communities. While the effective role and benefits of agroforestry are undoubtedly great on conflict mitigation, the agroforestry adoption on such conflicted communities of Nepal, especially southern, is yet to be unfolded. In this context, this study aims to explore the agroforestry adoption and development dynamic in southern Terai of Nepal. Through participatory action research and adaptive learning process we employed three key instruments for data collection and analysis, i), a focus group discussion (FGDs) with the checklist (22 items), ii), a key informant interview (KIIs) guide with the checklist (13 items) and, iii), a detailed structured questioner survey (31 items). These instruments were developed to capture the socio-economic and natural resource use context, issues, challenges, practices and determinants of agroforestry adoption in southern Terai region of Nepal. We found very few households involved in public land agroforestry in southern Terai region of Nepal while majority practice some form of traditional farmland agroforestry practices like boundary plantation, home garden, and scattered tree system than the advanced knowledge systems like alley cropping. However, there is high dependency of people on farming and forests and wider prospects of agroforestry development in southern Terai region of Nepal. Besides land access and tenure, the land size also determines the agroforestry adoption in private farms. Equally, very poor ranked households and the education increase the adoption rate in public lands. However, the increasing livelihood diversification from agriculture towards remittances base have added further challenges in its adoption. We suggest institutionalization of southern community with local institutions like community forest user groups, and local governments could be instrumental in enhancing agroforestry adoption and harnessing its sustainable benefits. Further, it will act as a strong weapon to reduce tension between southern and northern communities of this region.

Introduction
The history of agroforestry adoption and development goes beyond middle age (Nair, 1993). However, its study and adoption has surged only after the last four decades (Mercer, 2004; Dagar and Tewari, 2018). People started to intermix crops on their own ways and such intermixing gave new ideas to understand about agroforestry and improve the agroforestry systems (Dagar and Tewari, 2018). These improvements have given wide range of agroforestry systems and benefits to people.

Multiple benefits – both monetary and services – of agroforestry have been documented around the world (Sollen-Norrlin et al., 2020; Tschora and Cherubini, 2020; Jose, 2009). Agroforestry has been a holistic approach to improve the sustainability of the land production (Raj et al., 2019). In addition, agroforestry has helped on biodiversity conservation (Harvey et al., 2006; Kabir and Webb, 2008) in terms of soil quality improvement (Neupane and Thapa, 2001), livelihood improvement in terms of income and food security (Dhakal, 2013), and conflict mitigation (Awazi, 2020; Sanginga et al., 2007). Even more, it is seen as a pathway for development of climate-smart agriculture (Aryal et al., 2019), carbon sequestration (De Stefano and Jacobson, 2017), and climate change mitigation (Tschora and Cherubini, 2020). These wide ranges of benefits show the importance of agroforestry.

In this context, the agroforestry implies an important aspect of livelihood support, biodiversity and reducing resource conflict between southern and northern forest users in Terai[1] region communities who live in distance from natural resource, especially the southern communities. Terai region encompasses the combination of different cultural practices. The malaria eradication program in the Terai and the rising disasters and deforestation on the mid-hills in between 1950 -1980 AD increased the permanent migration of hill communities to the Terai (Gartaula and Niehof, 2013; Dignan et al., 1989) resulting the partition of the communities into two parts. The northern (East-west highway buffer region within 18 km) communities that are descendants of hill migrants (called as "*Pahadis*") and the southern communities (living near the border of India) are comprised of indigenous communities such as Madhesi and Dalits. The concentration of remaining natural forests in the northern part and dense settlements of traditional communities in the southern belt has led to conflicts over forest use, especially after the establishment of community forestry by granting rights of access to people living close to forest areas in the northern belt (Ojha et al., 2018). This is probably the most politically charged conflict in Nepal in the present time (Ojha et al., 2018). The southern inhabitants (distant users) need timber and fuelwood as they have no alternatives for construction and cooking. However, the northern inhabitants who are settling close to the forest manage and utilize these forest resources for themselves. Thus, southern users have been forced to illegal timber and fuelwood use, often in the night for meeting their urgent needs. This reduced the resource control and use by the southern communities intensifying the forms of conflicts between the communities in Terai (Pravat Satyal and Humpreys, 2013).

Although the actions related to access on forest-based products have been tested and implemented to reduce tension between southern and northern communities of this region (Pravat Satyal and Humpreys, 2013; Ojha et al., 2018; Paudel et al., 2018), their effectiveness is yet to be seen at the community level. Most of the households of southern communities rely on conventional agriculture. The characteristic of being most productive land region across the Nepal and lack of basic qualities of life make it possible. However, in last two decades or so, agroforestry has up surged in case of multiplying production and conserving biodiversity and livelihood improvement for distant users (Dhakal et al., 2020). In addition, the role of agroforestry in reducing the

[1] Terai is the lowland in southern Nepal stretching from east to west, which is the extension of the Gangetic plain of northern India.

conflict and maximizing the benefits from forest within the shorter distance is effective around the global south (Awazi, 2020; Dhakal and Rai, 2020; Sanginga et al., 2007).

On the other hand, across Terai districts, about 20-23% of the land is underutilized and unmanaged (Deuja, 2007) and its effective management provides an important asset for southern communities not only to generate forest resources and supplement forest products but, more importantly, to reduce conflict and generate livelihood opportunities (Meena et. al. 2008). It will also help reduce the human pressure on ecologically fragile Chure forest and maintain or promote local biodiversity.

While the effective role and benefits of agroforestry are undoubtedly great on conflict mitigation, the agroforestry adoption rate on such conflicted communities of Nepal, especially southern, is yet to be unfolded. The role of agroforestry in biodiversity conservation and livelihood improvement is well accepted and proven in the midhills of Nepal (Neupane and Thapa, 2001; Cedamon et al., 2018). However, its effectiveness in agriculture-dominated livelihood of Terai is less explored. Moreover, many studies have confined the research on agroforestry adoption in farmlands of Nepal (Dhakal and Rai, 2020, Khadka et al., 2021). However, looking at the benefits and importance of public land on shaping the livelihood of Terai people (Bhattarai et al., 2020), agroforestry adoption factors of public land and their comparison with farmland seems mandatory. Public land, in case of Nepal, has been the denuded system that needs to be restored providing benefits to livelihood as well (NPC, 2015; Bhattarai et al., 2021). For this, agroforestry is a viable option, given that, the ecological and livelihood benefits it provides. Meanwhile, all these ideas and actions related to agroforestry development have been conceptualized and vocalized in the recent policies. Forest policy, 2019 has clearly identified a policy on the provision of encouraging farmers to establish, develop, and marketing of the agroforestry (GoN, 2019A). Moreover, the policy has strategic plan to provide the latest technological knowledge related to agroforestry development (GoN, 2019B).

In this context, the paper aims to explore the agroforestry adoption and development dynamic in southern Terai of Nepal. Specifically, we answer:

1. What are the adopted agroforestry practices, faced issues, and confronted challenges by the southern community of the terai region of Nepal?
2. Which factors plays vital role on determining the agroforestry adoption in the region?

For this, the paper analyses the present context and practices of agroforestry adoption in the southern Terai of Nepal. Equally, it discusses on the community knowledge, and contribution, issues, challenges and suggestion. Importantly, it tests the determinants of agroforestry adoption in southern Terai region of Nepal. Overall, the paper reflects the picture of a southern community in low land Nepal, which represents the traditional Terai population; the agriculture-based livelihood and the community who are far from the natural resources like forest but need it in their daily life.

This paper is divided into 5 sections. Section 1 introduces the agroforestry adoption with southern Terai context and the study questions. Section 2 elaborates the study site and

the methods used for data collection and analysis. Similarly, section 3 describes the results and the contextual position of the southern community in agroforestry adoption and section 4 discusses the results. At last, the paper concludes the research outputs and provides critical insights with probable pathways for future research agendas on this topic.

Method

Study area description

The study area covers ward no. 12, 13 of Bardaghat municipality, ward no. 5, 6 of Sarawal Rural Municipality and ward no. 01 of Palhi Nandan Rural Municipality under Chisapani Community Forest User Group (CFUG) of Nawalparasi District; the flat lowland Terai region of western Nepal (Figure 1). The Municipalities are adjoining with the border of India in the Southern part and with the Chure hills in the Northern part. The Chisapani CFUG was registered in 2009 with 3,350 household and 495 hectares of forest including the distant users (60% of total households) up to 18 km south to the Indian border. In our case the distant users are the Madhesi[2] community residing far from the forests up to the Indian border. The southern belt is dominated by the dense settlements of Madhesi communities up to the Indian border whereas the northern belt is inhabited by new migrants (dominated by Brahmin and Chhetri) from the Hill region of the country.

The region is home to some of South Asia's remaining natural forests on the northern belt from the east-west highway up to the foothill of Churia. Roughly 70% of forest cover consists of natural Sal *Shorea robusta* forest. The area has good fertile land for agriculture and about 34,238 ha of unmanaged public lands (MSFP, 2015). Agriculture is the main occupation of the people in the south. The flat plain and alluvial soil, temperature and rainfall pattern is favorable for agriculture production which is always the attraction for migration in this region. The people here are practicing some traditional agroforestry system mixing with the regular annual crops like boundary plantation, home garden, and small patches of fruits woodlots and scattered trees. However, the agroforestry in public lands seems negligible. The primary source of cooking of southern people is fuelwood which they have to collect travelling up to 18 km north to Chisapani CF. The use of fuelwood is equally important in most of their religious occasions and in funeral rituals. Annually southern users demand around 10,000 cft of fuelwood from Chisapani CFUG for all of these activities (Bhusal et al., 2015). As an alternative source they have to rely on cow dunk for cooking and heating and some of the well-off households nowadays use LPG.

[2] The term Madhesi generally refers to the people historically living in Madhes (Terai) who also are culturally distinct from hill migrants (also called Pahade).

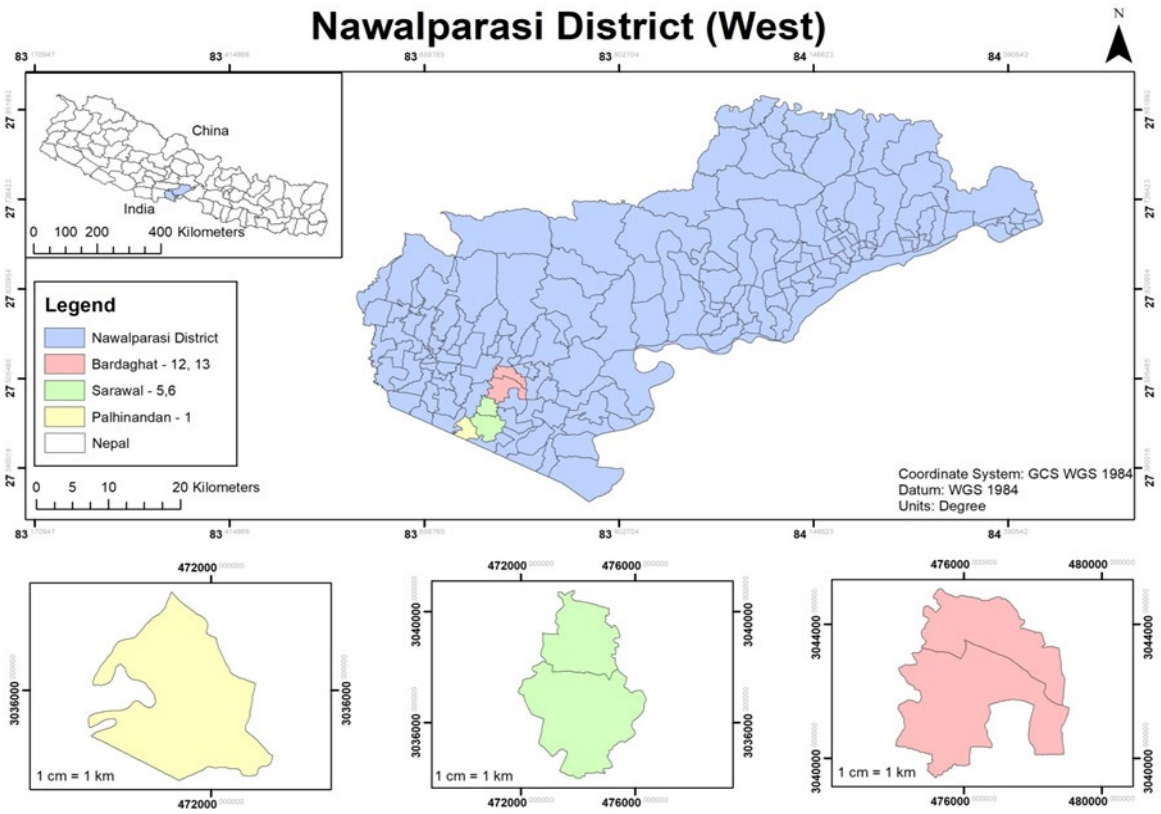

Figure 1: Map of study area

Methodological approach of the study

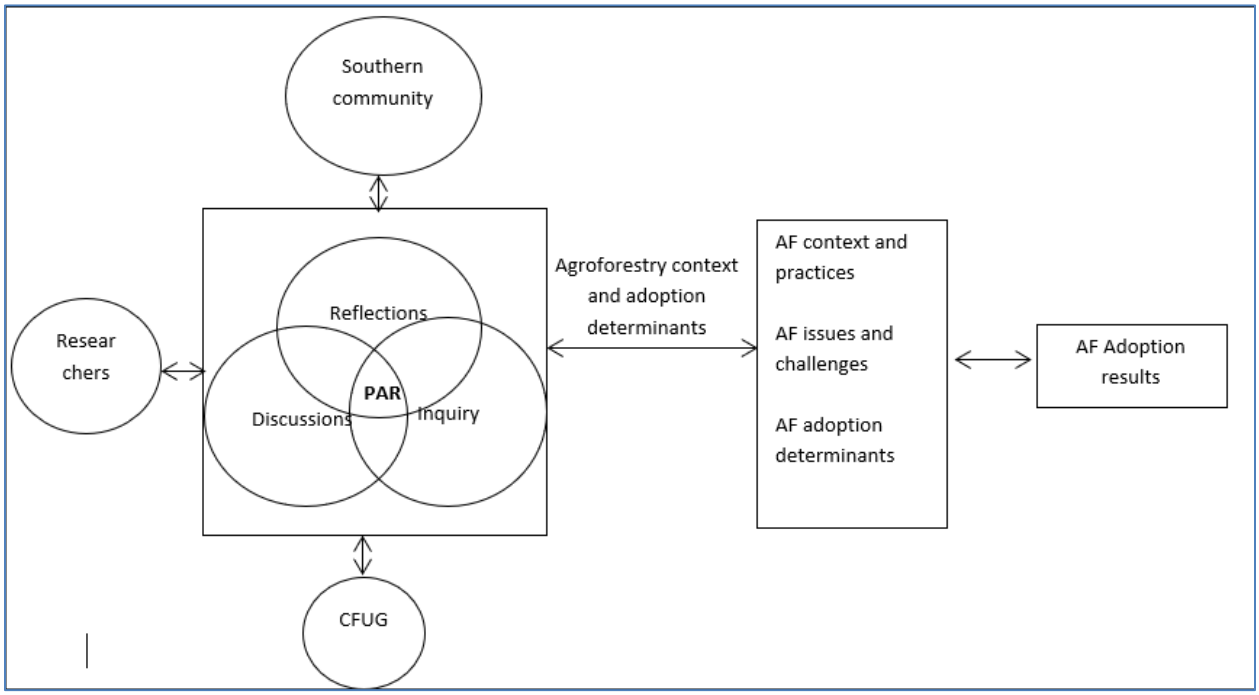

Figure 2: Methodological approach of the study (PAR = Participatory Action Research)

The approach blended participatory action research (PAR) and reflective learning process, with a formal research design including control sites and surveys to generate robust evidence. The major purpose was to assess the potential and challenges of the community to adopt the agroforestry in public and private lands and build the learning innovations in fostering suitable practices. Participatory action research is generally applied within social learning contexts, where multiple actors collectively construct meanings and work collectively toward solutions (Maarleveld and Dangbégnon 1999; Pretty and Buck 2002). Reflective learning is "learning by doing" that emphasizes the learning process in management. It is effective in developing the collective actions where the community has different need and interest and have completing claim on the limited resources (Bhusal et al, 2015).

In the natural resources management, learning processes have been recognized as a fundamental aspect of societal processes and natural systems (Ojha et al., 2018), and concepts of participatory and reflective (adaptive) learning of socio-ecological systems have been widely used to further elaborate this view (Lee, 1993). This approach takes learning as a wider socio-ecological system and beyond one dimension (Berkes & Turner, 2006; Ojha et al., 2018). It considers the reflective learning and actions processes as a part of learning and generating evidence.

These approaches consider learning, not just at the level of resource management or a particular organization, but at the level of socio-ecological systems (Ojha et al., 2018). In this research, we employed inquiry through detailed questioner surveys with the southern community, we did discussion with CFUG leaders, local leaders, farmers, and women. The reflection was carried on each issue and practices among the southern community, CFUG and local leaders and researcher. The inquiry, discussion and reflection were combined to produce a robust data and evidence. The reflective practice allowed us to bring new insights and perspectives, the collaborative inquiry between the community, local leaders and researcher helped to bring the embedded issues and concerns. Similarly, the series of discussion explored the ways to overcome the issues and enhance adoption. Our major focus was on analyzing the agroforestry context and adoption determinants. We through PAR and reflective learning processed analyzed the agroforestry context and practices, the issues and challenges and determinants of agroforestry adoption in the southern Terai region of Nepal.

Data collection and analysis

The study was conducted as part of a one-year research under the project titled, Public Land Agroforestry for Biodiversity Conservation, Livelihood Support and North-South Conflict Mitigation in Nepal Terai. It was implemented from 2019 to 2021. The time was extended due to Covid-19 pandemic. We initiated with the formation of project management committee and rapid assessment of the socio-political situation, potential public land areas, historical agricultural practices, assessment of forest resource and community dependency on forest and farm. Similarly, it involved a discussion with stakeholders particularly the CFUG executive committee, project management committee, forest officials and local government to obtain an agreement for the research work to initiate.

For data collection, three key instruments were developed and employed: a focus group discussion (FGDs) with the checklist (22 items), a key informant interview (KIIs) guide with the checklist (13 items) and a detailed structured questioner survey (31 items). These instruments were developed to capture the socio-economic and natural resource use context, issues, challenges, practices and determinants of agroforestry adoption in southern Terai region of Nepal.

In total, we conducted six focus group discussions: five discussions in each ward of study area that includes ward no. 12, 13 of Bardaghat municipality, ward no. 5, 6 of Sarawal Rural Municipality and ward no. 01 of Palhi Nandan Rural Municipality under Chisapani CFUG were carried and one with the CFUG committee members. There were 10-15 southern users including local leaders, farmers, women, Dalits and poor in each FGD. Each FGD lasted between two hours and two hours and thirty minutes. The discussions were carried out with open-structure questions, the evidence and the information obtained was recorded on field notes and used for further analysis. Discussions focused on the current status of agroforestry practices at households' level and in the public lands, the adoption of different agroforestry practices, species selections, benefits at household level, the issues and challenges in practices, the role of local institutions like CFUGs and local government in agroforestry development. Equally, we discussed on how agroforestry adoption can be developed among the southern community. From each focus group, we identified key informants and conducted in-depth interviews with them to profoundly excavate some issues that might not have been openly discussed. In total 10 KIIs was conducted with Chairperson of Chisapani CFUG, Chair of FECOFUN District chapter, Vice-Secretary of Chisapani CFUG and members of CFUG representing southern community. The key focus during KIIs was on agroforestry development and adoption context in southern Terai and the socio-economic and resource context and its role in agroforestry development. The reflections and understanding gained from FGDs and KIIs were used in developing questioners for household survey.

The detailed questionnaire survey was conducted in 200 households of ward no. 12, 13 of Bardaghat municipality, ward no. 5, 6 of Sarawal Rural Municipality and ward no. 01 of Palhi Nandan Rural Municipality under Chisapani Community Forest User Group (CFUG) of Nawalparasi District (Figure 1). The questioner was structured into four sections: (i) general information related with the socio-economic and forest resource use context, (ii) agroforestry knowledge and practices, (iii) issues for agroforestry development and implementation (iv) challenges, suggestions on agroforestry adoption. Households were categorized based on the gender of household heads, castes and well-being. In all, 200 household heads were randomly selected. The survey covered the 10% sample intensity out of total population in the southern region of the CFUG. Prior to the field interviews, the survey questionnaires were pre-tested to ascertain the reliability and validity of the instruments being used.

Further the direct observation at the households and community level was carried along with the secondary document analysis by reviewing the CFUG annual audit and forest product distribution reports, literatures on agroforestry practices related to the Terai region of Nepal and reports published by different projects were reviewed like Livelihood Forestry program (LFP), Multi-stakeholders Forestry Programme (MSFP) which

worked in the Terai region of Nepal on public land forest management and agroforestry promotions.

It was easy to organize the respondents since the first author has worked with these groups over the years. We explained the purposes behind the research to the participants, and they were assured of confidentiality. The data collected were recorded and documented in field notes. The data obtained were transcribed and coded. Based on the coded data, the qualitative information obtained were classified and arranged according to the different themes of the study as presented in the result section.

We coded and entered the questionnaire survey answers in MS-excel. The data were cleaned in order to proceed the analysis. The data collected from the respective respondents were edited to correct any missing information on the questionnaires and to ensure the accurate results. Descriptive statistics was used which include frequency distribution, percentage, mean and standard deviation to summarize the respondent's socio-economic characteristics. Data was explored and visualized using bar diagrams and pie charts were used to present the obtained information from the field survey. We used psych package in R for the descriptive statistics and ggplot2 for the data visualization. To determine the adoption factors, we ran logistic regression analysis. Before running the model, we tested independence of errors, linearity for the continuous variables, and absence of multicollinearity using variance inflation factor (VIF). The VIFs of the independent variable below 10 were taken in the model development to remove the issue of multicollinearity. In case of the two possible outcomes, the linearity of the model fails, and we have to determine the variable that might affect the probable discrete outcomes (Field, 2016). The two outcomes – yes or no – of the adoption were kept as the dependent variables while the socio-economic characteristics – age, gender, caste, education status, major income source, land size, livestock unit, and fuelwood – were independent variables. Entire analysis was conducted in R 4.0.1 (R core team, 2021).

Results

1. Demographics characteristics of respondents

We interviewed higher number of males (82%) than females (18%). Most of the household heads were males (93%) and female house heads were only 7% of total respondents. This implies the controlling patriarchy in the community where male controls and dominates the decisions (*field survey*). Janajati (36.5%) were the largest ethnic groups residing in the community followed by other (36%) groups. Most of them were the Hindu, janajati, and Madhesi. In addition, Brahmins and other ethnic communities were in minorities in the study region (Table 2). We observed the mean age (42.6 years) of the respondents well above the average of national age (CBS, 2012). This might be due to the widespread out-migration of younger ones for jobs from the community that increased our chances to meet the older respondents at higher numbers. The case is similar with mean formal education years of a respondent (5.04±4.12).

Although major income source of the households in the community was agriculture (77%) and most of them possessed agricultural land (90%), the average land amount possessed by the households was found minimal (Table 2) and the number of livestock units was also low (median = 0.5). The larger variation and range were observed in these two variables (Table 2). In case of well-being ranking, 43.5% of total respondents were found under rich class followed by medium class (20.5%), poor class (20.5%) and very poor class (12.5%).

Table 2: demographic characteristics of the respondents

S.N.	**Continuous Variables**	**Mean±SD**	**Median [Min, Max]**
1	Age (Years)	42.6±13.9	41.0 [18.0, 81.0]
2	Formal Education (in years)	5.04±4.12	5.0[0, 14.0]
3	Land amount (in ha.)	0.853±1.12	0.51 [0, 10.1]
4	Livestock Unit*	1.23±1.97	0.5 [0, 14.5]
S.N.	**Categorical Variables**	**Levels**	**Frequency (%)**
1	Gender	Male	164 (82.0)
		Female	36 (18.0)
2	Caste/ ethnic groups	Brahmin/chhetri	14 (7.0)
		Dalit	26 (13.0)
		Janajati/Adibaasi	72 (36.0)
		Madhesi	73 (36.5)
		Others*	15 (7.5)
3	Household Head	Male	186 (93.0)
		Female	14 (7.0)
4	Major source of Income	Agriculture	154 (77.0)
		Business	12 (6.0)
		Service	10 (5.0)
		Labour	18 (9.0)
		Remittance	6 (3.0)
5	Well-being Ranking	Rich	93 (46.5)
		Medium	41 (20.5)
		Poor	41 (20.5)
		Very poor	25 (12.5)
6	Land Possession	No	20 (10.0)
		Yes	180 (90.0)

**Others – include caste/ethnic people that are excluded on the brahmin/chhetri, dalit, janajati/adibasi, and madhesi groups.*

2. Agroforestry context and practices in southern Terai

2.1 Agroforestry systems adoption

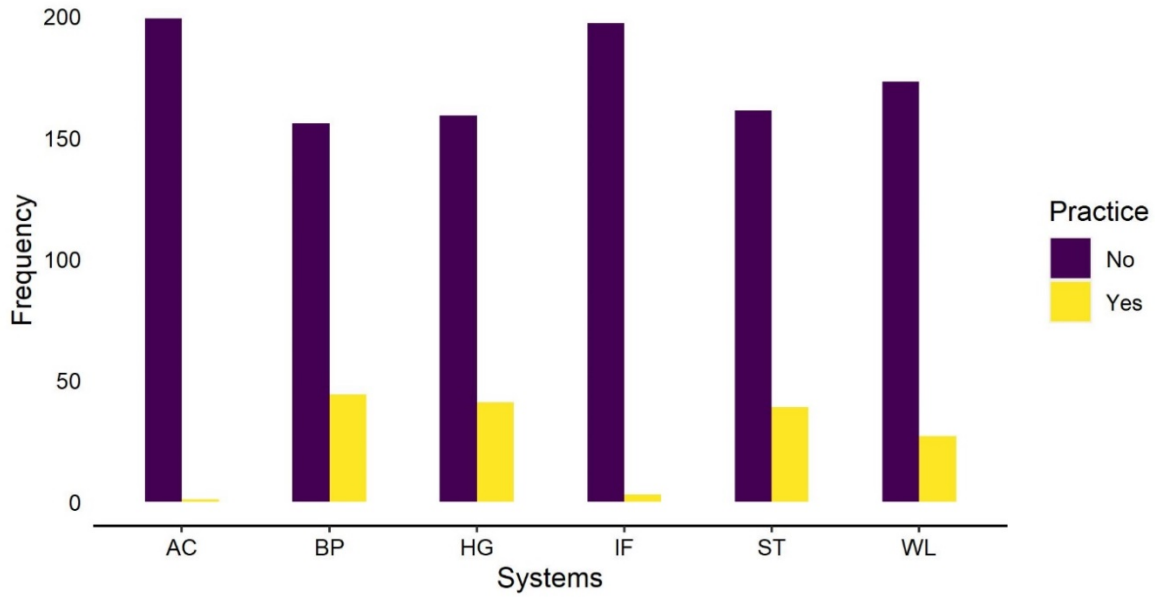

Figure 3: Agroforestry practices adopted. *(AC = Alley cropping, BP = boundary plantation, HG = home garden, IF = Improved fallows, ST = Scattered trees, WL = woodlots)*

To understand the agroforestry practices adopted in terai region, we looked for the practices based on studies conducted across terai region of Nepal. We summarized the most prevalent practices existing in terai region of Nepal (Amayta et al., 2018) especially in central terai region of Nepal. Based on this, we asked respondents about their agroforestry adoption. The majority of respondents (n=138) were not involved in any kinds of agroforestry systems in public land while 62 respondents were not involved in farmland agroforestry. We further asked the respondents who had adopted the agroforestry in farmland (N=138) about the type of agroforestry system adopted. We found that the respondents have adopted either one or more of these systems. Across 138 respondents, 44 respondents were involved in boundary plantation, followed by home garden (n= 41), scattered trees systems (n=39) and woodlots (n=27) (Figure 3). The systems like alley cropping and improved fallows have very low adoption rate among the respondents, as these systems might need larger knowledge systems.

2.2 Cropping combination with respect to AF technology

Hortosilviculture and Agrisilvicultural combination dominated larger parts of the entire agroforestry systems adopted in the southern Terai region of Nawalparasi District. In total, 32 species of trees were planted in agroforestry practices; however, many similar species were planted to different agroforestry practices (*Supplementary table S1*). Moreover, alley cropping, and improved fallows did not have any major tree or fodder species except *Leucaena* latisiliqua. This might be due to the lower adoption rate amongst the households. However, other systems comprised of several major species. Major tree species that were planted are *Dalbergia sissoo, Mangifera indica, Neolanarckia cadamba, Melia azedarach,* and *Tectona grandis* (Table 3). Surprisingly,

we observed the cropping of *Camellia sinensis* in combination with fruits: *Mangifera indica, Phyllanthus embilica,* and tree species: *Neolanarckia cadamba, Melia azedarach, Artocarpus lakoocha* (*Supplementary table S2*). Although most of the agroforestry trees were planted with the purpose of reducing timber shortage in households, numbers of high valued trees – such as *Shorea robusta* – were very less in comparison to low valued trees – such as *Neolanarckia cadamba* – in the study site. However, multipurpose – fuelwood, fodder, dry leaves – from other species, strict rules on harvesting and frequent ban on the sale of *Shorea robusta* timber might be the reason for less interest of community.

Table 3: Major species planted in various agroforestry systems (*BP: Boundary plantation; HG: Home Garden; WL: Woodlots; ST: Scattered trees*)

SN	**Tree**	**Scientific Name**	**BP**	**HG**	**WL**	**ST**
	Tree/fodder species					
1	Badahar	*Artocarpus lakoocha*	1	2	0	1
2	Bakaino	*Melia azedarach*	7	9	2	4
3	Ipil ipil	*Leucaena latisiliqua*	2	3	0	1
4	Jamun	*Syzygium cumini*	1	3	1	3
5	Kadam	*Neolanarckia cadamba*	13	27	6	17
6	Lahare Pipal	*Populus species*	1	0	0	0
7	Masala	*Eucalyptus camaldulensis*	2	1	0	0
8	Neem	*Azadirachta indica*	2	5	1	1
9	Pipal	*Ficus religiosa*	0	1	0	3
10	Sagawan/teak	*Tectona grandis*	8	2	5	3
11	Sal	*Shorea robusta*	0	0	1	0
12	Simal	*Bombax ceiba*	7	0	1	2
13	Sissoo	*Dalbergia sissoo*	27	11	20	19
	Fruit trees					
1	Amla	*Phyllanthus emblica*	1	0	0	1
2	Aanp	*Mangifera indica*	16	24	8	20
3	Anaar	*Punica granatum*	1	3	0	0
4	Belauti	*Psidium guava*	0	5	0	1
5	Katahar	*Artocarpus integra*	2	5	0	1
6	Kaagati	*Citrus limon*	1	2	0	0
	Grass/crops					
1	Baans	*Dendrocalamus spp*	2	0	7	2
2	Chiya	*Camelia spp*	1	0	0	0

2.3 Agroforestry knowledge and benefit

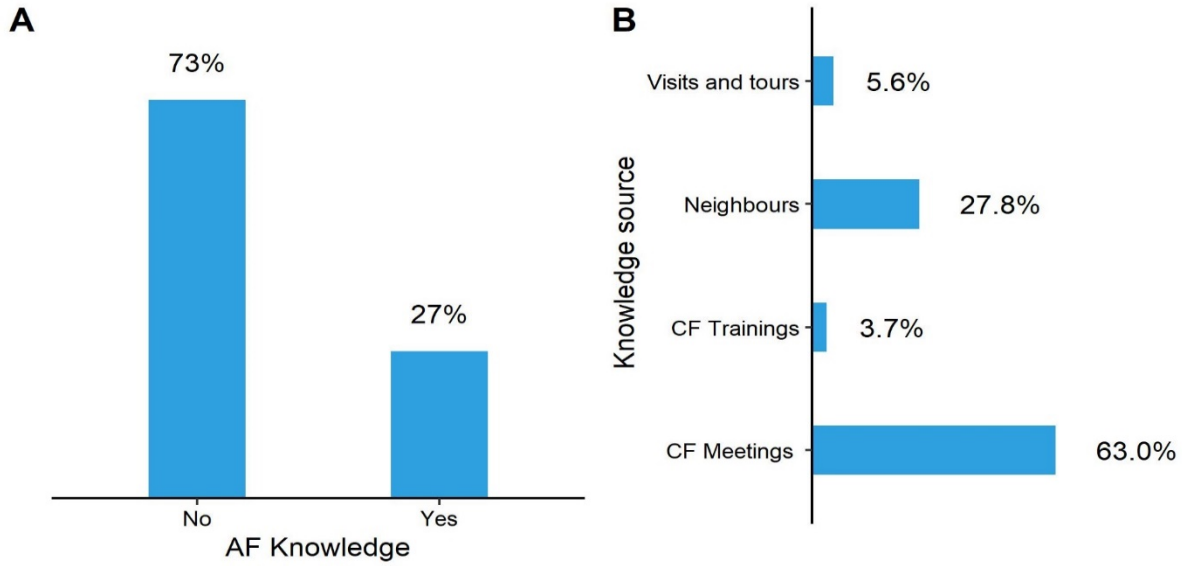

Figure 4: *(A: Knowledge of respondents; B: Source of knowledge)*

We found majority of respondents having no knowledge regarding agroforestry (figure 4A). This result resonates with the result on lower agroforestry adoption rate amongst the households. However, 27% the respondents have the knowledge about agroforestry and its systems that may be the reason for adoption of basic systems of agroforestry such as boundary plantation and woodlots. Community forest meetings (63%) and community discussions (28%) on various occasions were the major source of knowledge about agroforestry practice to the respondents. These are the major sources for knowledge dissemination to communities on masses. Moreover, yearly visits and tours to other community forests and trainings were also helpful in acquiring agroforestry knowledge (figure 4B).

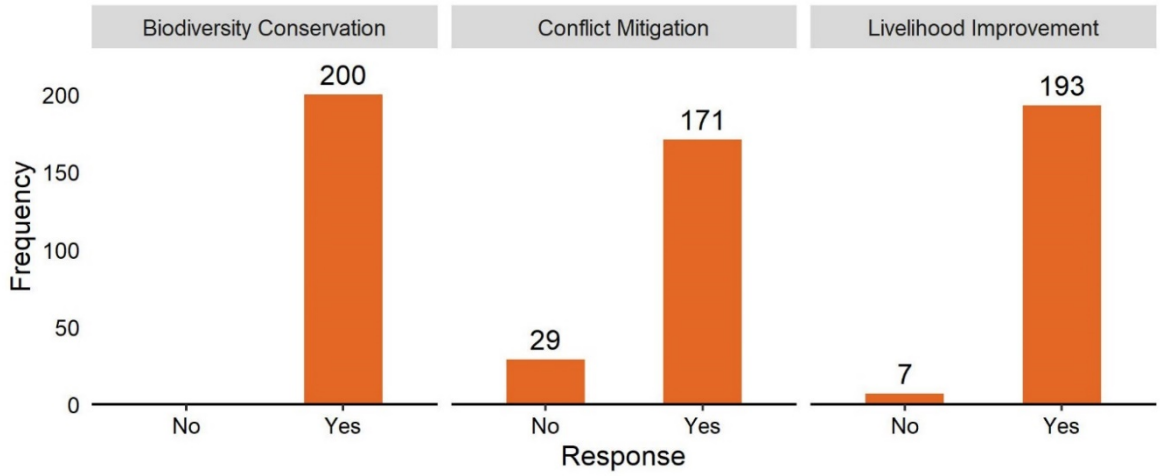

Figure 5: Benefits of agroforestry practices

We identified and categorized different benefits into three categories – biodiversity conservation in southern Terai, north-south conflict mitigation, and livelihood improvement of southern community– based on literature review and preliminary field survey. We asked southern community about the specific benefits they get from the agroforestry practices. We put the benefits like direct forest products including timber, fuelwood, leaf litter, fruits, fodder etc. in livelihood improvement category. Increased forest area, floral and faunal diversity, number of plant and animals' species in biodiversity category and reducing southern community dependency on community forest resources, decreasing the time and resources for forest product collection from community forests and receiving support for agroforestry development from community forest in conflict mitigation category. We found almost all respondents perceived that agroforestry contributes on conserving biodiversity (figure 5) if they plant diverse tree types in their surroundings. This is in line with the plantation of various trees across the agroforestry systems (*Supplementary file S1*). Similarly, out of 200 respondents, 171 and 193 respondents perceived agroforestry benefits on north–south conflict mitigation and improve the livelihood of community respectively. There are minimal respondents who shared that the agroforestry has no contribution to conflict mitigation and livelihood improvement (figure 5).

3. Issues, Challenges, and suggestions in AF adoption

3.1 Issues affecting the adoption of agroforestry

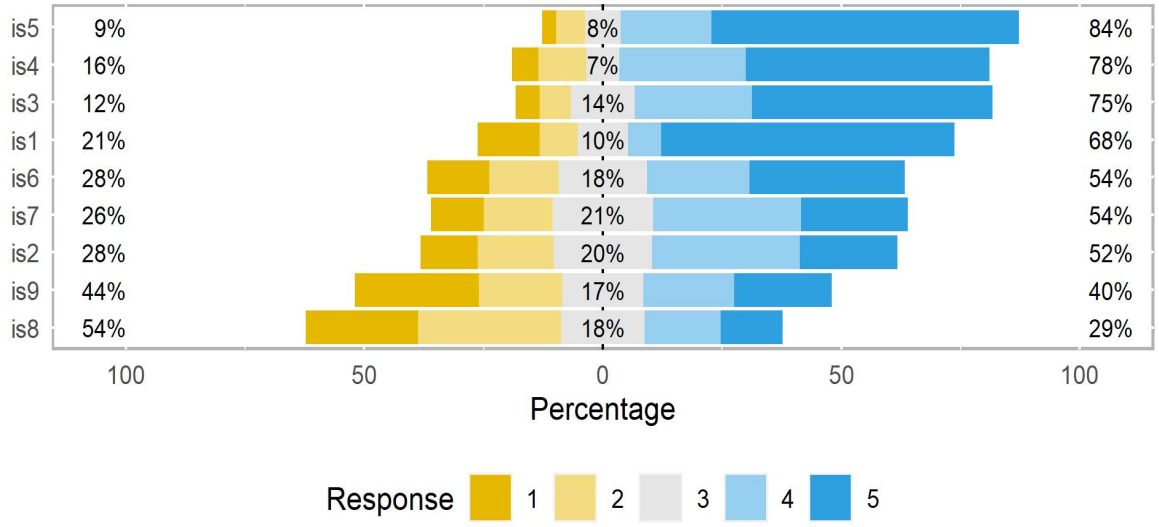

Figure 6: issues persisted on the agroforestry systems in terai region (*percentages are expressed as nearest whole number*)

(is1 = Tree Protection & Grazing, is2 = unclear rules, is3 = Lack of appropriate technology and personnel, is4 = Lack of knowledge on AF, is5 = Land and tree tenure, is6 = Social acceptability, is7 = Direct potential outputs, is8 = Farmer's gender and age, and is9 = Social beliefs and practices; 1= very low, 2 = low, 3 = medium, 4 = high, and 5= very high)

Respondents ranked nine issues based on their impact on adoption of agroforestry in the scale from one (very low) to five (very high) (Figure 7). Respondent believed land/tree tenure (high + very high = 84%) have highest negative impact on development of agroforestry and plantation of tree species (figure 6). Lack of knowledge on agroforestry practices (78%) and lack of appropriate technology/personnel (75%) were second and third on rank on having higher negative impact on agroforestry adoption and development in the region. Higher age and low formal education years might be the reason for lack of knowledge on agroforestry practices (Table 2). Furthermore, less extension programs on agroforestry practices in the region might have complemented the issue as most of the respondents expressed their disappointments on programs conducted by any organizations (source: *Field survey*). On the other hand, social beliefs and practices (44%), farmer's age and gender (54%), and unclear rules (28%) have relatively minimal impact on the agroforestry development in the region.

3.2 Challenges affecting the adoption of agroforestry

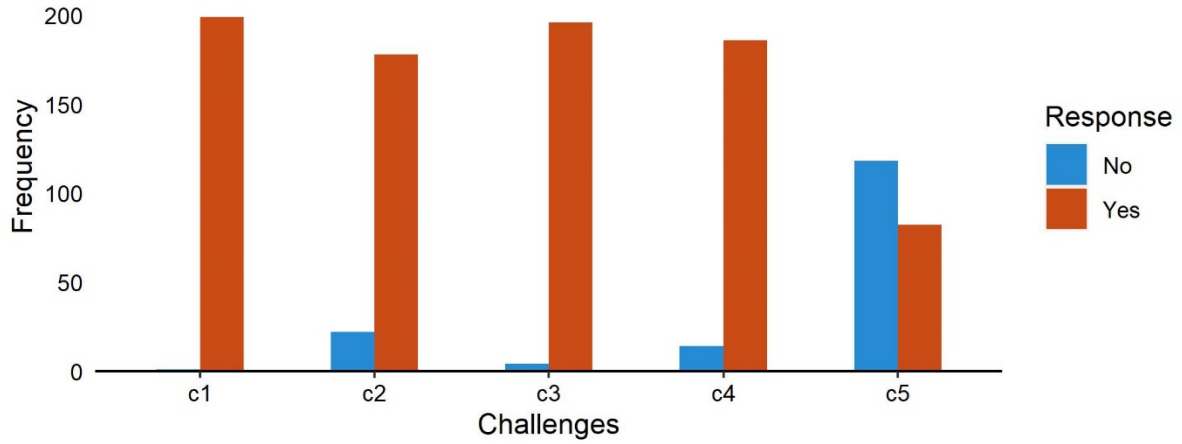

Figure 7: Persisted challenges in agroforestry development in the region
(*c1 = lack of technical skills, c2 = lack of qualified seeds, c3 = lack of capital, c4 = lack of manpower, c5 = lack of accessible market*)

Respondents believed four out of five challenges are persisted in the region for development and promotion of agroforestry (figure 7). Respondents perceived lack of technical skills amongst farmers on suitable agroforestry practices and lack of adequate capital as major challenges for agroforestry development and adoption. The poor knowledge on technical skills and low education level might be driving factor for selection of such challenges. Moreover, households believed that they have no sufficient fund or capital to invest for new practice in terms of investing in agroforestry. The income from traditional agriculture practices with weak adoption of new technology does not generate substantial return in comparison to the use of new technologies. Equally, the challenges of qualified seeds management and lack of skilled labor are also contributing to discourage households to adopt and develop agroforestry. Since the wood products such as timber/fuelwood demand is very high

and their shortage have long persisted in the region, larger portion of respondents felt accessible market as no challenge.

3.3 Farmers' suggestions to the challenges facing adoption of agroforestry

Table 4: Suggestions to improve agroforestry practice adoption

SN	Suggestions to improve AF practices	Frequency (%)
1	Availability of species	22(11)
2	Improvement of market accessibility	17(8.5)
3	Nursery establishment	2(1)
4	Skills and capacity building trainings	104(52)
5	Grants, donations, and Subsidies	7(3.5)
6	Community participation	2(1)
7	Others	46(23)
	Total	**200(100)**

More than half of the respondents suggested skills and capacity building training programs on agroforestry systems development and potentiality as a primary initiative for developing agroforestry in the region (Table 4). 23% of the respondents suggested for other activities (*supplementary table S3*). 11% and 9% of the respondents' perceived agroforestry species availability and accessibility of market on trading their agroforestry products would develop agroforestry systems in the regions respectively. The community participation (1%), nursery establishment (1%), and grant and subsidies provision (4%) were the least opined suggestions.

4. Factors affecting agroforestry adoption in southern Terai

4.1 Agroforestry adoption in farmland

Table 5: Determinants of agroforestry adoption in farmland

Variable	estimate	std. error	statistic	p.value	Odds Ratio
(Intercept)	0.90	0.89	1.01	0.31	2.47
eth.grpDalit[a]	-0.53	0.95	-0.56	0.58	0.59
eth.grpJanajati[a]	-0.89	0.89	-1.00	0.32	0.41
eth.grpMadhesi[a]	-1.77	0.88	-2.01	0.04**	0.17
eth.grpOthers[a]	-0.35	1.09	-0.32	0.75	0.7
edu.yr	0.06	0.05	1.38	0.17	1.07
incBusiness[b]	-0.23	0.79	-0.29	0.77	0.8
incService[b]	-1.20	0.81	-1.48	0.14	0.3
incLabour[b]	-1.16	0.59	-1.97	0.05**	0.31
incRemittance[b]	-1.41	1.00	-1.40	0.16	0.24
tot.lnd	0.92	0.34	2.73	0.01***	2.51
lsu	0.14	0.14	1.05	0.29	1.15
know.afYes[c]	0.75	0.44	1.71	0.09*	2.12

For [a] - Brahmin/chhetri, [b]- agriculture, and [c]- No are the reference categories.

N = 200, *p<0.1; **p<0.05; ***p<0.01, AIC = 224.76, BIC = 267.64, PseudoR^2 (McFadden) = 0.20

We analyzed socio-economic determinants – both categorical as well as continuous – using binomial logistic regression (BNL) to see which factors contributes agroforestry adoption in farmland. We chose backward stepwise method, tested assumptions of linearity; independence of errors; and multicollinearity (Field, 2016). Our model of farmland is good fit with significant value (AIC = 224.76) at 5% level in comparison to null model (intercept only) and other model combinations. We also calculated odds ratio for each determinant.

The analysis of the BNL showed that adoption in farmland was significantly influenced by four determinants (Table 5). While every other factor was non-significant at any level, total land amount (at 0.01 level), income source as labor and madhesi ethnic groups (at 0.05 level), knowledge of agroforestry (at 0.1 level) was significant to this model. The higher level of significance suggests the higher possibility of change on independent variable if there is change on the dependent variable. The odds ratio of total land possessed by the respondent, education years, livestock units, and knowledge about agroforestry were positive to agroforestry adoption: higher these values will lead towards higher probability of agroforestry adoption (Table 5). We found one unit increase in land number of respondents would increase the odds of agroforestry adoption rate by a factor of 2.51. Agriculture is the major source of income in the region (Table 2) and increasing the land size might increase the adoption rate of agroforestry practices. Similarly, odds ratio of labour occupation category people was negative towards agroforestry adoption. People working as labour on daily wages have to rely mostly on their wages for food. Therefore, encouraging them to adopt agroforestry might not work as desired. Moreover, ethnic group as Madhesi had also significant negative odds ratio in comparison to other groups. Although being the largest population group in the region, their income sources are mostly business and remittance. Diversifying income source of these households might be tougher than encouraging other groups in the region. In addition, increasing involvement on agroforestry practices by Madhesi people might not benefit the region as expected.

4.2 Agroforestry adoption in public land

Table 6: Determinants of agroforestry adoption in public land

Variable	estimate	std. error	statistic	p.value	Odds ratio
(Intercept)	-0.49	0.74	-0.66	0.51	0.62
genFemale[a]	-1.00	0.56	-1.78	0.07**	0.37
eth.grpDalit[b]	-2.42	0.87	-2.79	0.01***	0.09
eth.grpJanajati[b]	-1.08	0.64	-1.68	0.09*	0.34
eth.grpMadhesi[b]	-1.86	0.67	-2.77	0.01***	0.16
eth.grpOthers[b]	-1.94	0.92	-2.10	0.04**	0.14
hh.hdFemale[a]	-0.38	0.82	-0.46	0.64	0.69
edu.yr	0.09	0.04	2.01	0.04**	1.09
incBusiness[c]	-1.71	1.14	-1.51	0.13	0.18
incService[c]	-0.67	0.83	-0.81	0.42	0.51

incLabour[c]	0.15	0.70	0.22	0.83	1.17
incRemittance[c]	0.23	1.13	0.21	0.84	1.26
wbrMedium[d]	0.94	0.51	1.86	0.06*	2.57
wbrPoor[d]	0.66	0.60	1.10	0.27	1.93
wbrVery poor[d]	1.86	0.73	2.55	0.01***	6.44
tot.lnd	0.12	0.18	0.66	0.51	1.13
Lsu	0.05	0.10	0.50	0.61	1.05
know.afYes[e]	0.58	0.39	1.49	0.14	1.79

For [a]:male, [b]:Brahmin/Chhetri,[c]: Agriculture, [d]: Rich, [e]: No are the reference categories. N= 200, *p<0.10; **p<0.05; ***p<0.01, AIC = 247.17, BIC = 306.54, PseudoR^2 (McFadden) = 0.15

Moreover, we analyzed socio-economic determinants – both categorical as well as continuous – of public land agroforestry adoption using binomial logistic regression (BNL) to see which factors drove adoption. We used backward stepwise method, tested assumptions of regression: linearity; independence of errors; and multicollinearity (Field, 2016). In addition, we calculated PseudoR^2 and odds ratio. Developed model was good fit with significant value (AIC = 247.17; BIC = 306.54) at 5% level in comparison to null model (intercept only) and other model combinations (Field, 2016).

Result showed gender, ethnic groups, years of education, well-being ranking have significant influence on adopting agroforestry in public land (table 6). Female category of gender, other category of ethnic groups, and years of education were significant at 0.05 level whereas Dalits and Madhesi category of ethnic groups and very poor category of well-being ranking were significant at 0.01 level. Furthermore, land amount, livestock units, income source, gender of household head, poor category of well-being ranking, and knowledge were non-significant on agroforestry adoption.

The years of education, labor and remittance category of income, well-being ranking, land amount, livestock units, and knowledge of agroforestry have positive odds to agroforestry adoption in public land whereas gender, ethnic groups, and business and service category of income sources have negative odds on the adoption of agroforestry. This means the increase in the variables of positive odds will increase the chances of agroforestry adoption and vice-versa. Moreover, Dalits has the largest negative odds (OR = 0.09) on agroforestry adoption in comparison to every other category. This implies unit increase in Dalit category will decrease the odds of agroforestry adoption rate by a factor of 0.09. This signifies minimal use of public land by the Dalits. However, we found very poor people have large positive odds ratio (OR = 6.51) that suggests the unit increase on very poor people will increase the odds of agroforestry adoption by 6.51 times.

Discussion

Agroforestry context and practices

We found very few households involved in public land agroforestry in southern Terai community while majority practice some form of traditional farmland agroforestry practices like boundary plantation, home garden, scattered tree system and small

woodlots. The Terai region of Nepal is considered as the most fertile and productive region of Nepal where agriculture dominates (Dhakal et al., 2012). Equally, Terai have ample of unused and unmanaged public lands. As per Deuja (2007), across Terai districts, about 20-23% of the land is underutilized and unmanaged and its effective management provides an important asset for southern communities not only to generate forest resources and supplement forest products but, more importantly, to reduce conflict and generate livelihood opportunities (Meena et. al. 2008). Though the agroforestry in southern Terai holds the high potentiality of enhancing local livelihood, biodiversity and north-south conflict mitigation by reducing pressure on community forests the adoption of agroforestry practices at public lands by the southern community is very low and needs multiple interventions. The study conducted by Dhakal and Rai (2020) in Dhanusa district of Terai Nepal also argues with similar results. However, in case of farmland agroforestry, the southern community is found enthusiastic and is following the predominant agroforestry practices including boundary plantation, home garden, scattered tree system and woodlots. This results resonates with the different studies conducted in different parts of Terai region of Nepal by Kiyani et al. (2017); Dhakal et al. (2015) ; Rai et al. (2017).

In terms of agroforestry system and combining crops the alley cropping and improved fallows have very low adoption rate among the households. These systems need high knowledge base for optimum benefits and frequent management activities (Amatya et al., 2018). However, Hortosilviculture and Agrisilvicultural combination dominated the larger parts of the entire agroforestry systems adopted in the southern Terai region of Nawalparasi District. Most of the tree species like *Dalbergia sissoo, Mangifera indica, Neolanarckia cadamba, Melia azedarach,* and *Tectona grandis* were grown in combination of the crops. These are low valued species economically and can have multiuse – fodder, fuelwood and timber. The less choice of high value trees might be due to strict rules on harvesting and frequent ban of Sal (*Shorea robusta*) dominated high value timber species of Terai region.

The agroforestry knowledge on crop combination and different practices, majority of households are found unfamiliar. However, majority of southern users perceived that agroforestry system can fetch multiple benefits like biodiversity conservation, livelihood improvement and help reduce north-south conflict by reducing resource pressure on available natural forests. Bhattarai et al. (2020) has suggested that the trees outside forests have provided the access to the forest resources, improved the institutional capacity and also improved the livelihood of the local communities by increasing their household income. Agroforestry has potentials for reducing soil erosion, enhancing land productivity, increasing production of fodder and fuel wood for household subsistence, and generating extra income to farmers (Neupane et al., 2002). According to Pandit et al. (2014) the practice of AF would help increase the supply of fuelwood and fodder from the farmland and as a result of that the forest condition can be improved.

On the other hand, the public and farmland agroforestry in southern Terai of Nepal not only helps on biodiversity conservation (Harvey et al., 2006; Kabir and Webb, 2008), livelihood improvement in terms of income and food security (Dhakal, 2013), but can be instrumental in reducing longstanding North-South conflict (Awazi, 2020; Sanginga et al., 2007). The agroforestry can increase the supply of forest products like timber, fuel

wood and fodder from the public and farmland. And in this fact is equally supported by a study from the Terai district by Dhakal et al., (2012) who found that the distant households in the southern Terai preferred planting the trees on their farmlands to fulfill their needs of fodder and fuelwood.

Agroforestry adoption context

The major issues of southern Terai community to adopt agroforestry was the unclear land and tree tenure followed by **l**ack of knowledge on agroforestry practices and lack of appropriate technology. Equally, the households perceived lack of technical skills amongst farmers on suitable agroforestry practices and lack of adequate capital as major challenges for agroforestry development and adoption. Moreover, households believed that they have no sufficient fund or capital to invest for new practice in terms of investing in agroforestry. The income from traditional agriculture practices with weak adoption of new technology does not generate substantial return in comparison to the use of new technologies. Equally, the challenges of qualified seeds management and lack of skilled labor are also contributing to discourage households to adopt and develop agroforestry. Since the wood products such as timber/fuelwood demand is very high and their shortage have long persisted in the region, larger portion of respondents felt accessible market as no challenge.

These issues and challenges are very common and persisting since generations. Rioux, (2015) illustrates that agroforestry development is facing several challenges prevailing land tenure systems as well as the lack of awareness and knowledge by farmers on the alternative practices. The study also agrees to the finding of (Dhakal et al., 2012) that the lack of awareness of the new technology: lack of awareness of the benefits of the trees as compared to the field crops, and lack of knowledge and skills regarding tree planting were the constraints to the adoption of AF technology in their farmlands.

Also, a major challenge to the uptake of agroforestry is land ownership. Having secure land tenure, could serve as a security for the investment to longer term improved practices such as planting agroforestry. Otherwise the farmers are likely to grow fast crops than the trees (Claude & Mulyungi, 2019). The users of public land forest have not been able to adequately reap its full-fledged benefit as per the expectation because of unclear tenure, including resource use right and inadequate legal backup for resource management and institutional development (Bhattarai et al., 2020).

The land access and tenure have been the key determinants for the agroforestry adoption (Meena et al., 2005; Bhattarai et al., 2020). However, we found that land size also determines the agroforestry adoption in private farms. This aligns with the findings from eastern Nepal (Dhakal and Rai, 2020). Moreover, we argue that small households (<5 members) also have low number of active laborers. The possession of large farm areas with low active laborers is not profitable. So, they have to either keep their lands barren or grow other species than the crops and cereals. The latter option reduces the farmer's time without any harm to the farmlands. The higher education that is linked with the agroforestry knowledge and skills and higher number of livestock's units have positive role in agroforestry adoption which seems logical. On the other hand, the majority of people engaging either in labour or livelihood income sources changing from agriculture to remittance have added challenges to agroforestry adoption in

southern communities. Moreover, ethnic group like Madhesi which is the dominating population had a less possibility of adopting agroforestry in comparison to other groups. This might be because of multiple reasons including tree ownership, skills and knowledge system, the availability of new technology and deep rooted socio-cultural believes.

Our results suggest that very poor ranked households and the education increase the adoption rate in public lands. Moreover, this also can be grouped with ethnic communities and occupation. A Dalit person with low education working as a labor will have lower chance of adopting the agroforestry in the public lands. The adoption of agroforestry in the public lands by the very poor households can be attributed to the possession of smaller private land sizes; daily fodder and grass collection for livestock; and time allocation for the agroforestry. The education can be attributed to the knowledge sharing amongst the community from committee members or the forest officials.

The agriculture dominated livelihood of Terai region of Nepal have ample of opportunities for public and farmland agroforestry. Equally, in last two decades or so, agroforestry has up surged in case of multiplying production and conserving biodiversity and livelihood improvement for southern users (Dhakal et al., 2020). In addition, the role of agroforestry in reducing the conflict and maximizing the benefits is effective around the global south (Awazi, 2020; Dhakal and Rai, 2020; Sanginga et al., 2007). In this context, we argue that the institutionalization of southern community with local institutions like community forest user groups, and local governments could be instrumental in enhancing agroforestry adoption and harnessing its sustainable benefits. Further, it will act as a strong weapon to reduce tension between southern and northern communities of this region.

Conclusion

This study identifies the adopted agroforestry systems and its determinants of the southern Terai region of Nepal. In addition, the study recognizes the issues and challenges on such adoption of such communities. We conclude that public land agroforestry has not been adopted as much as private farm agroforestry in southern Terai region of Nepal. Moreover, most of adopted practices are the form of traditional agroforestry practices like boundary plantation, home garden, scattered tree system and woodlots than the advanced agroforestry practices like alley cropping. The key factors that determined the adoption of agroforestry practices in public land were gender, land size, well-being ranking – very poor category –, and education level of a household. Majority of the issues were on the technical knowledge of the practices within and amongst a single household with land tenure and rights of the tree harvesting. We found that increasing livelihood diversification from agriculture towards remittances have added further challenges in adoption. Nonetheless, there is high dependency of people on farming and forests and wider prospects of agroforestry development in southern Terai region of Nepal. We suggest institutionalization of southern community with local institutions like community forest user groups, and local governments could be instrumental in enhancing agroforestry adoption and harnessing its sustainable benefits. Further, it will act as a strong weapon to reduce tension

between southern and northern communities of this region. We suggest critical in-depth research on the rights of agroforestry benefits from public lands in relation to conflict and land tenure for the future.

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