Climate Change Adaptation Strategies in Community Forest User Groups of Dang District, Nepal

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This study on Climate Change Adaptation (CCA) strategies in Community Forest User Groups (CFUGs) was conducted at two levels: household and user group. The study was conducted in seven Community Forests (CFs) of Dang district, Nepal, using household questionnaires administered to 570 Households (HHs) and Focus Group Discussion (FGD) checklists. Primary data on climate change adaptation strategies were collected from both the household and group levels. This study explores the understanding of CCA strategies and climate change adaptation knowledge at the local level. The understanding of climate change is primarily shaped by its adverse effects. We identified nine different adaptation strategies at the household level, while seven different strategies were observed at the user group level. Individual preferences for adaptation practices are often those that provide immediate benefits. Similarly, at the user group level, the construction of recharge ponds and ecological restoration activities were among the most widely adopted CCA strategies with strategic importance. An Eta correlation was used to assess the relationship between household income and climate change adaptation strategies, yielding a coefficient of 0.383, indicating a relationship exists. The study concludes that CFUGs have emphasized CCA strategies as an inseparable part of their community practices, as evidenced by their choices at both the household and user group levels.

***Keywords*:** Adaptation, Climate Change, Community forestry, Resource, Strategy

Climate change has been a global concern, primarily due to its direct and indirect adverse effects on humankind (Chausson et al., 2020; Dellmuth & Gustafsson., 2021; Ghimire & Chhetri, 2022; Taylor, 2023). Its most profound impacts are observed in agriculture, water resources, and the energy sector (MoFE, 2021a; Shayanmehr et al., 2022; Rej et al., 2023). The primary objective of Climate Change Adaptation (CCA) is to empower individuals and communities to address the threats and challenges in sectors directly linked to their livelihoods and institutions, such as agriculture, forestry, and water resources (Cooper & Messina, 2023; Mogess & Ayen, 2023). Therefore, CCA strategies have become an integral part of addressing these challenges.

In this study, climate change adaptation (CCA) is defined as a process that adjusts to the impacts of climate change, aiming to mitigate livelihood challenges through community-based initiatives and actions. Similarly, the discourse around CCA is becoming increasingly visible in the domain of community forestry. It has policy significance due to its sensitivity to adaptation issues (Dany et al., 2015; Bhattarai, 2020). As a result, adapting to climate change is emerging as a significant developmental challenge both globally and locally, especially for highly vulnerable countries like Nepal (Brandt et al., 2016; Roshani et al., 2022; Turner et al., 2022).

Adaptation strategies and practices have been a common concern globally (Biesbroek et al., 2010; Keessen, 2013; Wester et al., 2019; Raihan, 2023). In the context of Nepal, Community Forest User Groups (CFUGs) employ incremental, conventional, and transformative adaptation approaches to enhance community resilience, adjusting to and sustaining it (Loginova & Baterbury, 2019; Adhikari et al., 2021). Recognizing this, the Government of Nepal has also acknowledged these adaptation strategies in its policy documents (Salerno, 2017; Nepal, 2019; GoN, 2021; Rijal et al., 2022). The National Adaptation

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Plan (NAP) outlines the country's priorities for climate adaptation and is a principal document in this domain. It further identifies challenges and gaps in implementing adaptation strategies, including constraints related to financial resources, technology transfer, capacity building, and technical support, among others (GoN, 2021).

The mandatory provision requiring member countries to submit Biennial Transparency Reports (BTRs), including details on adaptation under the Enhanced Transparency Framework, has made the discussion of adaptation issues more prominent (UN, 2015; UNFCCC, 2018, 2022, 2024). Articles 9, 10, and 11 of the Paris Agreement categorically cover critical components of climate action support, including finance, technology development and transfer, and capacity-building (UN, 2015). These provisions emphasize the responsibility of developed countries to help developing nations with initiatives related to technical, financial, and capacity development.

Simply formulating adaptation plans is not enough; they require sufficient resource mobilization for effective implementation. To address this, Nepal has formulated both the Nationally Determined Contribution (NDC) Implementation Plan (2021-2030) and the National Adaptation Plan (NAP) (2021-2050) to implement its adaptation and mitigation commitments (NPC, 2014, 2017). The total climate budget of Nepal exhibits an increasing trend, and the country's engagement with international climate finance mechanisms has expanded over the years (MoFE, 2021a, 2021b; Chhetri & Rai, 2024; Laderach et al., 2024; Upreti & Chhetri, 2024).

The major challenge lies in achieving climate change adaptation while simultaneously building resilience to enhance the livelihoods of poor communities and the broader society (MoFE, 2019a, 2019b; NPC, 2021). Although the understanding of adaptation may vary in local contexts and discourses, its core remains consistent. Effective adaptation decisions require climate knowledge. This understanding, both in practice and concept, leads to a better grasp of climate change adaptation among the practitioners and CFUG users (Smit & Wandel, 2006; Wise et al., 2014; Thomas et al., 2019).

Analytical framework

Adaptation strategies and practices have become global concerns (Biesbroek et al., 2010; Keessen, 2013; Wester et al., 2019; Raihan, 2023). The concept of adaptation has been applied in various settings and themes (Keskinen et al., 2010; Wise et al., 2014; Berkhout & Dow, 2023; Cradock-Henry et al., 2023). In human systems, adaptation is understood as the process of adjusting to actual or expected climate conditions and their effects to mitigate harm or capitalize on beneficial opportunities. It plays a key role in reducing exposure and vulnerability to climate risks (IPCC, 2022). The use of adaptation practice for specific purposes links them to different adaptation approaches, including conventional, transitional, and transformative adaptation (Warner et al., 2019; Irham et al., 2022).

Conceptual framework of this study

This study is based on the understanding that climate challenges and knowledge are two principal attributes influencing the adoption of adaptation strategies. This conceptual framework conceptualizes adaptation as element of pathways of interacting changes and societal responses (IPCC, 2014; Wise et al., 2014).

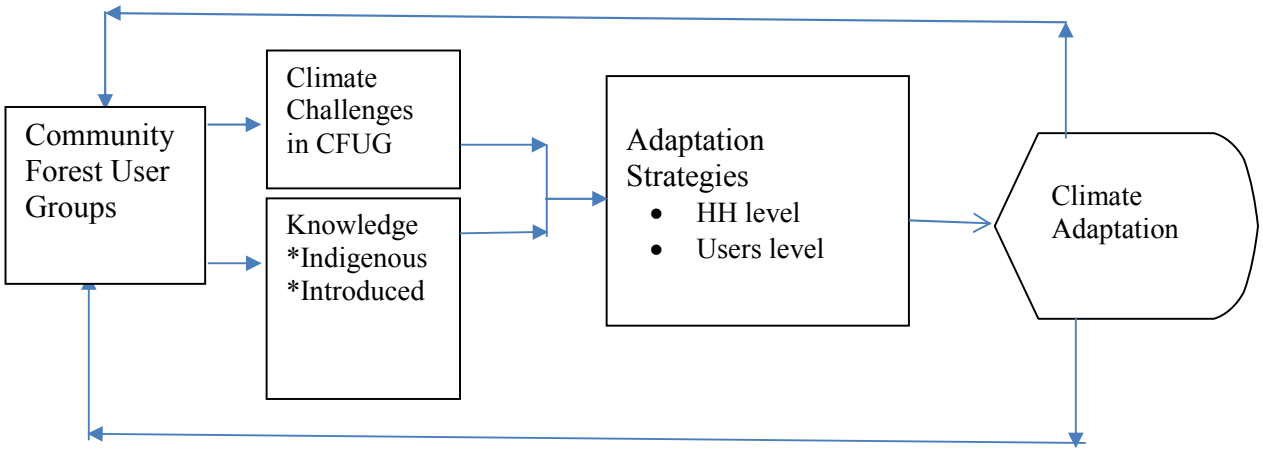

Figure 1: Conceptual Framework for the study
(**Source:** Adapted and modified based on Analytical Framework from reviewed literature)

It is an approach to suit nature according to context. This framework interprets adaptation as a decision-making process that occurs at both the individual household (HH) level and the collective community level (Figure 1).

Materials and methods

Study area

This study was conducted in seven Community Forests (CFs) located in the Dang District of Nepal (Figure 2). Historically, Dang has been known as a destination for migrants from the hilly regions, and the indigenous Tharu community constitutes a significant portion of the local population. The study aimed to explore Community Forest User Group (CFUG) strategies and to understand how these strategies are utilized at the user level. A heterogeneous mix of ethnic and socio-economic backgrounds characterizes the selected user groups. All community forests included in the study are situated within the Dang district. The name, number of participating households (HHs), and area covered by each CF are presented in Table 1.

Among the seven community forests studied, Pandaweshwor and Khadgadevi Community Forests are located in the Chure region of Dang District, while the remaining CFs are in the Mahabharat region. The Chure region is located in the southern part of the district, and the Mahabharat region is situated in the northern part. All the mentioned CFs share similar characteristics in terms of forest composition, species diversity, and patterns of human settlement. The indigenous Tharu population inhabits both regions.

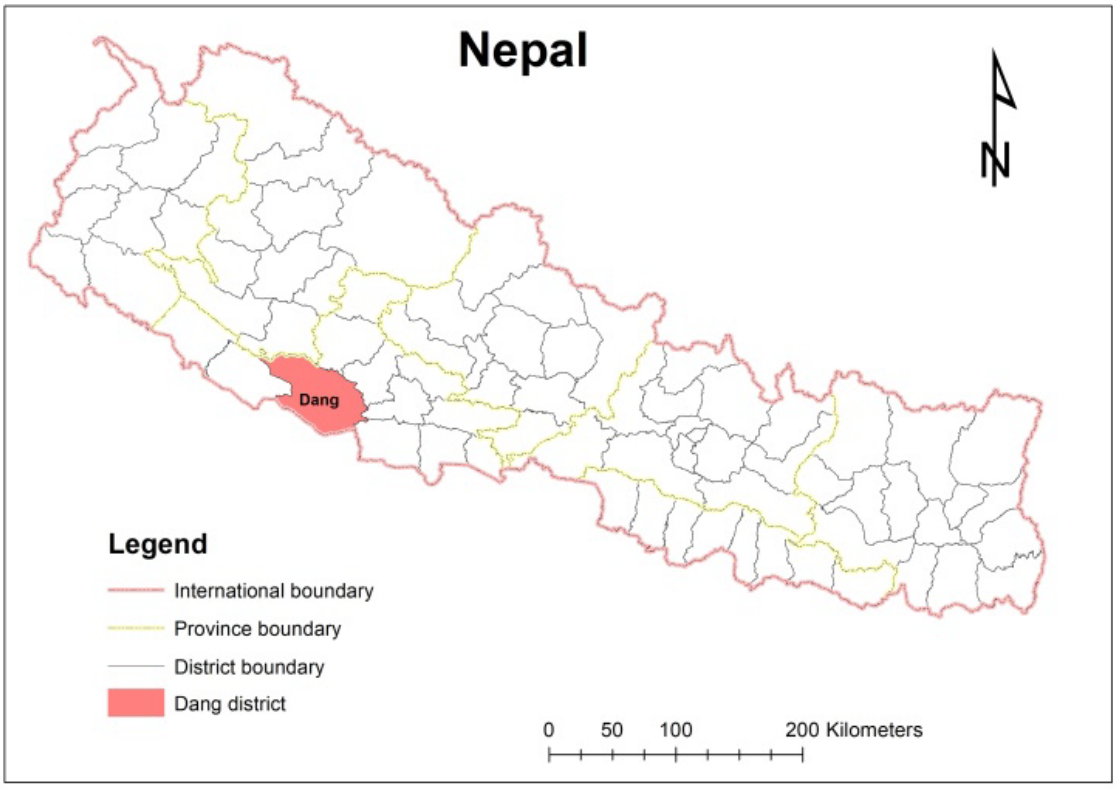

Figure 2: Map of the study district

Table 1: Name of CFUGs

SN	Name	Area (Ha)	HHs	Sample HH
1	Pandaweshwor CFUG	792	850	170
2	Khadgadevi CFUG	600	450	90
3	Kartikerani CFUG	104.6	352	72
4	Jharana CFUG	74.5	215	43
5	Bhulke CFUG	230	119	24
6	Kalika CFUG	149.2	111	23
7	Gadibara CFUG	322	735	148
	Total		**2832**	**573**

Methods

The field study aimed to explore strategies adopted for climate change adaptation at both the household and community levels. Specific strategies adopted by users were assessed as distinct strategies. Primary data were collected through Semi-Structured Interviews (SSI), Key Informant Interviews (KII), Focus Group Discussions (FGD), and direct field observations. Informal discussions during the field visit helped gather deeper information and insights, enabling the triangulation of results.

A total of 570 respondents were randomly selected for semi-structured interviews, representing 20% of the total households in the selected community forests. Similarly, 14 FGDs were conducted across the seven CFUGs. The information gathered from the FGDs provided insights that complemented the information received from SSI. The KII was conducted with a diverse group of stakeholders, including officials from district, provincial, and federal government institutions, non-government Organizations, and members of forestry networking organizations. This information helped triangulate the household-level findings, finally. After completing fieldwork, the interview texts were then organized, condensed, categorized, coded, and recorded at both the household and CFUG levels.

The level of understanding about climate change among community forest users was explored using descriptive statistical analysis. This was done to show how climate change is perceived and understood by the community.

Climate adaptation strategies were assessed at both the household and user group levels. The household questionnaire survey provided information on adaptation practices at both the individual level and community level. Focus group discussions provided more profound insights into collective strategies employed by user groups. Household vulnerability was also assessed in terms of food availability and income. The relation between household income and the choice of adaptation strategies was examined using Eta-correlation analysis. The surveyed data were analyzed using descriptive statistics and the Chi-Square test. Descriptive statistics provided information about the adaptation strategies being implemented. At the same time, the chi-square test examined the relationship between key socio-economic variables and the adaptation strategy adopted by the users.

Results

Knowledge about climate change shapes the approach communities take to tackle it. The understanding guides them in adopting strategies to mitigate its adverse effects. Communities possess skills and knowledge to adapt to climate impacts, through indigenous and other forms, such as learning. The understanding of climate change and knowledge of different contexts were found to guide the adaptation process.

In this regard, adaptation strategies in community forests were observed at two levels: the household level and the user group level. At the household level, the strategies were based on individual choices and their adaptation to climate change. While at the user group level, the strategy focused on the community as a whole.

Household-level adaptation strategies, which prioritize individual benefits, are often linked to short-term gains. Individual households or families seek tangible benefits, such as horticulture or cash crops, which provide immediate returns on investment. On the other hand, community-level strategies reflect a collective effort towards a common goal. These strategies are more strategic in nature, aiming for long-term benefits such as ecological restoration, water conservation, and the adoption of low-cost technologies, among others, with broader significance.

Understanding climate change

Climate change is a widely discussed issue in the community, with frequent use of climate-related narratives suggesting a high level of public awareness. Community members discuss it in various contexts, often focusing on its perceived adverse effects. A common understanding among people is that climate change leads to negative consequences for the community. This understanding of climate change is primarily shaped by its adverse effects, such as rising temperatures, floods, and other observable impacts (Figure 3).

Community members perceive the effects of climate change as both positive and adverse (Table 2). To explore these perceptions, Focus Group Discussions were conducted within the Community Forest User Groups, following a predefined agenda. Some adverse climate effects, such as drought, have compelled households to change their practices, like switching crops. Such adaptations have sometimes yielded a

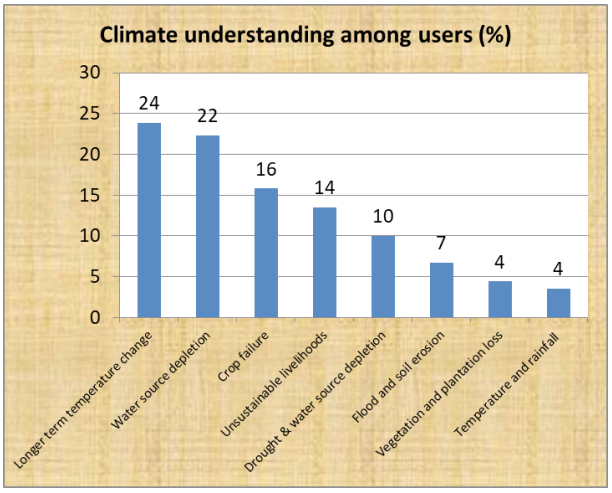

Figure 3: Climate change understanding of users (%)

higher return than conventional crops. However, FGD participants emphasized that climate change mainly affects their lives negatively. A detailed list of these adverse effects was recorded (Table 2).

Field discussions with the divisional forest office team, household interviews, and direct observation confirmed experiences of climate change impacts. Focus Group Discussions revealed multiple climate change issues and threats, such as drought and water shortages. The frequency and severity of floods have increased, and more unpredictable weather patterns and climate extremes have been observed. The high incidence of pests and diseases, along with the increased frequency and intensity of storms and weather-related disasters, was also attributed to the adverse effects of climate change. Crop failure due to frequent unfavourable weather conditions is becoming a big challenge for users. Even crops that initially showed excellent growth sometimes fail to yield at harvest time. According to CFUG members from Jharana CF, climate change education and promotion of adaptive farming practices could significantly help address these challenges. The work plan of the CF also categorically addresses climate issues and areas for future intervention, dedicating a separate section to these topics within the work plan.

Adaptation strategy at the household level

Communities have employed both indigenous knowledge and external interventions to address climate challenges, as revealed from the household (HH) data analysis. Such adaptation measures, developed by the community in the form of traditional practices or adapted practices, are mentioned as an adaptation strategy. At the household level, adaptation strategies primarily focus on providing immediate benefits to individuals. The immediate benefit is the return of the benefit in a short duration. Such a return is achieved within a year and has a direct impact on the concerned household. A total of nine different adaptation strategies were identified at the household level: water source protection, crop switching, riverbed farming, low-cost technologies, drought-resistant crops, horticulture development, and income generation activities (Figure 4). According to the field findings, the adverse impact of climate change disproportionately affects vulnerable community members due to their limited capacity to cope. Despite this, the consequences of climate change ultimately affect all households, regardless of their socioeconomic status or adaptation scale.

Switching crop

Switching crops to adapt to climate change was observed as one of the key strategies for adaptation

Table 2: Perceived effects of climate change in the study area

Adverse effect	Positive effect
• Decreased crop yields • Disappearance of some of the indigenous crop varieties • Water source shrinkage • Increased livestock pests and diseases • Declining productivity • Change in rainfall pattern • Increased flooding incidents • Soil erosion and land degradation • Unpredictable precipitation (Excessive/low) • Crop failures due to delayed monsoon and prolonged drought • River flood/Flash floods • Emerging epidemic risks (potential) • More frequent landslides • Increased hailstorm frequency	• Crop seasonal pattern changed (The crop seasonal pattern changes the crop structure, introducing new crops. For example, turmeric, wheat, new varieties of fruits such as dragon fruits, etc., plantation, harvest) • Successful adoption of climate-resilient crops

among households, serving both to address changing climatic conditions and respond to individual household circumstances. Conventional crop switching is also linked to this. Besides, crop diversification and product diversification have also been inseparable components of an adaptation strategy. The innovative farming concept among users was observed through the introduction of apiculture, integrated agricultural farms, mushroom cultivation, a cow farm, and a vegetable farm. Respondents reported that crop switching proved effective in both increasing household income and enhancing climate resilience.

Water source protection

Water source protection was claimed to be a strategy to provide a visible impact in the community through its multiple uses. Respondents reported significant water source depletion, with water shrinkage being one of the serious challenges that households face in agricultural production. Households are maintaining water source protection-related activities to address water source shrinkage.

River/Stream bed farming

River/stream bed farming practices were also observed among households with land adjacent to water systems. Essentially, this practice serves a dual purpose, generating income and conserving or stabilizing the soil. Seasonal farming was common in riverbeds, where short-rotation crops such as cucumbers and groundnuts were grown. The short rotation was preferred to avoid possible flooding.

Plantation

Plantation was linked to multiple benefits, ranging from environmental value to long-term financial returns. It served as a prominent adaptation strategy among households that provided fuelwood and fodder for livestock. Since most users were farmers, they depended on these forest products for their livelihoods.

Improved farming

Improved farming has emerged as a relatively recent concept in the community. Over time, traditional farming practices have gradually transformed as households adopt improved farming practices to address climate challenges. These traditional methods are often considered inadequate in meeting households' economic needs.

Horticulture practice and improved livestock

Horticulture practice and improved livestock management were found to be interconnected in user adoption practices. While horticulture yields long-term benefits, it simultaneously enhances both food security and household income. This approach serves as an ecological adaptation strategy and an integrated farming concept. These practices have been successfully implemented across community forests and agricultural lands.

Drought-resistant crops

Households have adopted drought-resistant crops as a means of adapting to drought. In the past, drought events have severely impacted fodder and grassland availability for livestock, resulting in the shift in cultivation practices observed in the study. Farmers now prioritize resilient crop varieties, including cash crops such as ginger and turmeric.

Low-cost technology adoption

The adoption of low-cost technologies was linked to both the household's affordability capacity and its effectiveness. People have been widely using bioengineering and other cost-effective solutions, with bamboo plantations emerging as one of the most practised examples. Recently, bioengineering techniques have been increasingly employed to protect vulnerable land from landslides and erosion.

Cash crop and income generation

Cash crop cultivation has been practiced as both an income generation measure and a climate adaptation strategy. The adverse impact of climate change affects the most vulnerable populations due to their lower coping capacity. Farmers mentioned employing nine different adaptation strategies to mitigate these challenges. Focus Group Discussions (FGDs) in Pandaweshwor Community Forest highlighted that climate impacts have the most significant effect on agriculture systems and livelihoods; at the same time, water source conservation has emerged as a critical concern.

Similarly, the respondents mentioned that earlier, people used to cultivate local species with low productivity. Farmers are now shifting towards cash crops and income-generating activities (IGAs) as an adaptation strategy, including adjusting their cropping times. Notably, severe droughts during July and August, which have previously caused lower productivity, have prompted the adoption

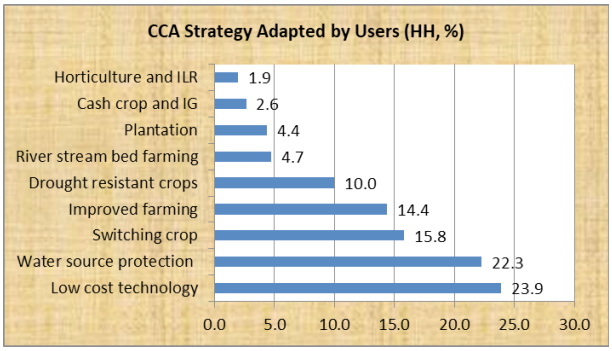

Figure 4: CCA Strategy of Users (HH%)

of drought-resistant crop varieties and modified cropping patterns.

The study revealed that the most vulnerable groups, Dalit communities (categorized as V4), demonstrated limited adaptation choices. Approximately 37% of the sampled households fell into this category. FGDs revealed that most V4 households rely on wage labor and other means of income.

Climate change adaptation strategy and its relation to variables

The Chi-square test was used to explore the relation between CCA strategies and variables such as ethnicity, gender, and occupational status (Table 3). CCA and ethnicity were found to be closely linked, with household strategies differing according to the ethnic background. Changes in a household's ethnic background were observed to influence the choice of CCA strategy ($p = 0.021$). Similarly, the chi-square values for gender ($p < 0.001$), age ($p = 0.013$), educational status ($p = 0.001$), and occupational status ($p = 0.05$) indicate that these variables significantly influence the preference for specific adaptation strategies. Across all CFUGs, Tharus (an ethnic group from Dang District) predominated numerically, except in the Gadibara CFUG, where other ethnic groups such as *Magar, Pun, and Thapa* were also present. *Brahmin, Chhetri,* and *Dalit* communities were also present in all CFUGs.

During the FGD, a discussion on adaptation strategies was conducted. The principal rationale for adopting these strategies is presented in Table 4.

Based on the discussion, adaptation emerged as a gradual process of learning and adoption. Practices such as riverbed farming, water source protection, and plantation were adopted through community learning. However, strategies such as crop switching, drought-resistant crops, and improved livestock rearing were developed as long-term measures to address adverse climate challenges.

Adaptation strategy of households and their relationship with their income

The vulnerability assessment conducted during the study also recorded household (HH) income levels. An analysis was conducted to examine the relationship between the income of all households and their adaptation strategies (Table 5). The relationship between household income and climate change adaptation strategies was assessed using an Eta correlation, with a coefficient of 0.383.

Table 3: Chi-Square Test of adaptation strategy and variables (N = 570)

Variable	Chi-Square Tests (Pearson Chi-Square)		
	Value	df	Asymptotic Significance (2-sided)
Ethnicity	29.449	16	0.021
Education	61.339	32	0.001
Gender	51.962	8	0.000
Occupational status	66.431	40	0.005

Table 4: Adaptation strategies and their rationales for use

SN	Adaptation at the household level	Rationale behind these strategies
1	Switching crop	To cope with drought and excessive rain
2	Protecting water sources	Ensuring water availability for agriculture and other purposes
3	River/Stream bed farming	Income diversification
4	Plantation	Environmental conservation and income
5	Improved farming techniques	Increased income
6	Horticulture and improved livestock rearing	Alternative crops
7	Drought-resistant crops	Safety net
8	Adopting low-cost technology	River-bed farming
9	Cash crop cultivation	Safety net and additional income

(FGD, Field visit 2022)

Table 5: Eta correlation between household adaptation strategies and income

	Eta correlation
Income of Households	0.217
Climate change adaptation strategy among households	0.383

There is a relationship between the strategy and households (HHs). Wealthy households have different adaptation strategies than poor ones. The poor rely on strategies such as riverbed farming, among others. The Eta correlation value of 0.383 indicates that household income has some relation with specific climate change adaptation strategies, but the relationship is not stronger. As a result, the livelihood strategies used by households are not only determined by income.

Adaptation practices at the user group level

At the user group level, members have their own understanding of climate adaptation, as reflected in the work plans developed by Community Forest User Groups. A review of the Community Forest Operational Plan (CFOP) provided further insight into how adaptation strategies are perceived at this level. During the CFOP formulation process, users identified the key climate challenges. Based on these existing and anticipated challenges, adaptation strategies were developed. The CFUG-level strategy is a common approach applicable to the entire CFUG as a unified entity. According to the survey, the promotion and plantation of Non-Timber Forest Products (NTFPs) are the most common strategies across all CFUGs. Adaptation efforts at this level focus on long-term benefits, considering both ecological sustainability and user needs. The long-term benefits or strategic benefits are the concerns that encompass the ecosystem with longer-term implications. Such a longer-term or strategic benefit may not provide immediate benefits, but its importance lies in ameliorating the environmental aspects linked to sustainability. Since CFUGs function as institutions, they prioritize long-term ecological resilience over short-term effects. A total of seven different adaptation strategies were observed at the user group level.

Plantation activity

Plantation activity is a prominent activity in all Community Forests (CFs). Every CF includes plantation as one of its primary activities. The CFUGs have also emphasized plantation in their work plans. The implementation of plantation activities in CFUGs follows a systematic process. First, the CFUG collects user demands based on seedlings availability, site monitoring, and verification. Seedling sources are identified in advance. If an area is found to be suitable for plantation, the CFUG provides seedling transportation, technical support for plantation activities, and monitoring and post plantation technical support to users.

NTFP promotion and plantation

The promotion of Non-Timber Forest Products through plantations is a common practice among CFUGs. This focus on NTFPs is one of the most visible activities in CF management. User groups have introduced short rotation NTFPs in the CFs.

Low-cost technology and bioengineering

CFUGs widely practice the choice of low-cost technology and bioengineering. Due to their cost-effectiveness, durability, and efficiency, low-cost technologies are being increasingly adopted by CFUGs.

Ecological restoration and income generation

Ecological restoration and income generation are strategic focuses among CF users. Income generation serves as a short-term incentive to engage the users. At the same time, ecological restoration represents the long-term strategic goal of CFUGs, aiming to address both community needs and mitigate climate change.

Ecological restoration and bioengineering

A combined approach of ecological restoration and bioengineering has been employed to achieve conservation and ecological restoration simultaneously. Construction of larger recharge ponds and fencing is one of the standard climate change adaptation strategies adopted by user groups.

Ecological restoration

Ecological restoration efforts focus solely on improving environmental services within community forests. These activities include the construction of conservation ponds and grass plantations, among others.

Bamboo, NTFP, grass, and plantation practices

Bamboo cultivation, harvesting of NTFPs, grass planting, and other plantation activities are widely practiced in the community. Since agriculture is the primary source of livelihood for users, the user groups prioritize both grass cultivation and

plantation activities. The study found that bamboo is most preferred for plantation and soil conservation purposes. Some species of bamboo shoots are used as a vegetable. Similarly, NTFPs are planted for both income generation and soil stabilization purposes. Additionally, broom grass and various bamboo species, selected for their adaptability to local microclimates, are also cultivated as a measure for soil conservation and protection of water sources.

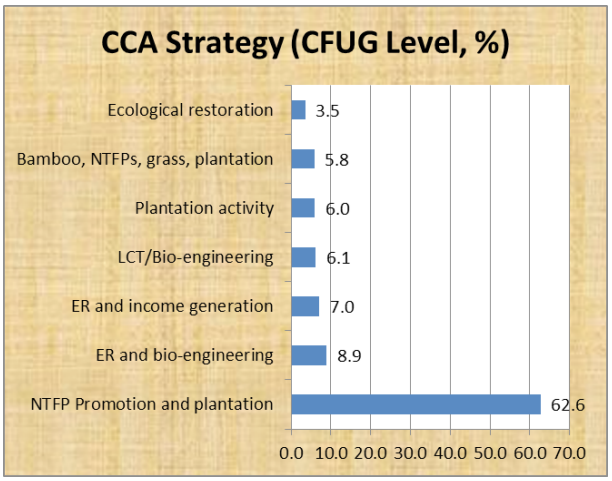

Figure 5: CCA strategy of users (%)

During the Focal Group Discussion (FGD), participants discussed the rationale behind seven different user group-level adaptation strategies (Table 6).

Discussion

Understanding climate change

Understanding climate change is a first step towards developing Local Adaptation Plans of Action (LAPA). It is critically important to explore the level of understanding in order to formulate effective plans (MoFE, 2019b). A higher level of understanding and awareness about climate change among users suggests that the CFUGs have been discussing the issue for a long time. Such understanding enables users to make informed choices about CCA strategies.

Logically, individual households prioritize immediate benefits, as they need to secure livelihoods. Household-level adaptation strategies have been widely discussed and often characterised as safety nets (Bryan et al., 2013; Pandey et al., 2018; Khadka et al., 2022; Mogess & Ayen, 2023; Fahad et al., 2023). The long-term benefits achieved by CFUGs in addressing climate change are viewed as strategic interests for minimizing the adverse effects of climate change on community forests. As institutions, it is acceptable that CFUGs must work towards long-term agendas. Adaptation offers approaches, strategies, and opportunities to mitigate the adverse effects of climate change and enhance the well-being of affected communities (MoFE, 2021a). The introduction of the climate change budget code in 2012 and the climate change financing framework reform roadmap in 2017 demonstrate the government's commitment to adaptation efforts (GoN, 2012; NPC, 2014, 2017).

Adaptation strategy at the household level

The results showed that adaptation practices are not new to the community; they have been practiced for a long time. However, there is a growing need for systematic arrangement and integration of these strategies. Various studies and assessments of adaptive strategies have demonstrated that adaptation is not a new phenomenon to local communities worldwide (Atube et al., 2021; Bednar-Friedl et al., 2022; Kumar et al., 2023). They must continually develop and implement individual and collective strategies to adapt to climate variability and environmental change (Cannon & Muller-Mahn, 2010; Bele et al., 2013; Maru, 2014; IPCC, 2014).

The National Climate Change Policy, 2019 (GoN, 2019), states that at least 80% of climate-change-related programs should be implemented at the local

Table 6: Adaptation strategies at the user group level

SN	Adaptation strategy	Rationale
1	Plantation activity	Enhance greenery and promote conservation
2	NTFP promotion and plantation	Demonstrate sustainable practices and generate income for user groups
3	Low-cost technology/Bioengineering	Conservation
4	Ecological restoration and income generation	Conservation and income
5	Ecological restoration and Bioengineering	Address drought and drinking water challenges
6	Ecological restoration	Long-term conservation at the ecosystem level
7	Bamboo, NTFPs, grass, and plantation	Align with the CFUG's adaptation plan

(FGD, 2022)

level. This is possible if households become proactive in their climate adaptation efforts. Construction of artificial ponds, pest and weed control, changes in plantation and harvesting times, and shifts in cropping patterns are some of the major adaptation strategies adopted by local communities in Nepal (Adhikari et al., 2021; Kandel et al., 2023). The nine different adaptation strategies observed at the household level are associated with the immediate adaptation benefits. The findings of this study align with those of previous studies on local adaptation strategies, such as switching crops and using low-cost technologies (Adhikari et al., 2021; Atube et al., 2021). Additionally, urban plantation has been recognized as one of the climate change adaptation measures in other parts of the globe as well (Brandt et al., 2016). Adaptation strategies have become an integral component of development discourse, and the Government of Nepal has incorporated these strategies into national policy frameworks (Salerno, 2017; GoN, 2020, 2021, 2023). Studies also support the relation between household income and adaptation strategies observed in the findings. The study shows that adaptation practices are linked to the capability to afford coping (Below et al., 2012; Shumetie & Alemayehu Yismaw, 2018; Paudel et al., 2019). The relationship between ethnicity and CCA strategy, as observed in this research, where adaptation approaches vary by household ethnicity, can be attributed to the background of the people and their choices (Delisle & Turner, 2016; Quandt, 2019).

Adaptation practices at the user group level

User group-level adaptation in the community is a long-term and visionary approach, aiming to restore forest ecosystems over time. Strategic interventions, like conserving water and restoring degraded forests, are directly linked to sustainability. Seven different strategies were observed at the user group level, and these finding aligns with other similar studies (Bartlett & Dedekorkut-Howes, 2023; Ranabhat et al., 2023). The global concerns about climate change adaptation strategies and practices (Biesbroek et al., 2010; Keessen, 2013; Wester et al., 2019; Bednar-Fried et al., 2022; Raihan, 2023) are also reflected in this finding within the community context. Ecological restoration encompasses a wide range of activities aimed at recovering physical, socio-economic, and environmental systems (MoFE, 2021c; Fu et al., 2023). The understanding of climate change adaptation in this research resembles the findings from previous studies (Pandey et al., 2018; Nor Diana et al., 2022). Climate-resilient crops are being introduced in response to drought challenges (Cooper & Messina, 2023).

Being long-term and strategic in nature, user group-level adaptation practices can be considered a transformative approach. Plantation activities, low-cost technologies, and ecological restoration measures, such as conservation ponds, discussed in the findings, support this conclusion. Such a transformative type of adaptation has the scope to fulfil National Adaptation Plan (NAP) objectives locally by identifying necessary support systems for adaptation, thereby bridging existing gaps that address climate resilience. Similarly, climate change poses social challenges at both local and global scales (de Scally & Doberstein, 2021; Yazdanpanah et al., 2023).

In the watershed communities, community adaptive practices include the use of improved seeds, changes in cropping patterns, removal of invasive species from wetlands, construction of irrigation canals, and diversification of income-generating activities, further substantiating the findings of this research (Bartlett & Dedekorkut-Howes, 2023; Ranabhat et al., 2023).

The LAPA Framework provides a roadmap to develop community-level climate action, from awareness raising to planning and implementation. Communities are encouraged to develop their own plans based on their specific local contexts. The mobilization of local resources and stakeholder engagement are also emphasized (DHM, 2017; NPC, 2021). The adaptation approach adopted by Community Forest User Groups (CFUGs) is incremental, focusing on addressing immediate challenges. At the same time, it also retains the conventional knowledge through its community and transformative adaptation approach to enhance long-term climate resilience (Loginova & Baterbury, 2019; Adhikari et al., 2021).

Opportunities for future research

The study has explored climate change adaptation strategies in Community Forests (CFs) of Dang district. Based on the researchers' understanding and review, no prior research of this kind has been conducted in the area. Therefore, these findings can serve as a stepping stone for broader research focused on community-based adaptation to climate change.

Conclusions

This study has explored that Community Forest User Groups (CFUGs) are already implementing Climate Change Adaptation (CCA) strategies. These strategies are practiced at both the household and community levels, indicating that the adverse effects of climate change are recognized as a significant issue within the CFUGs. The experiences of climate change impacts shared by users at the household level are closely linked to crop-switching patterns, one of the main adaptation strategies. Individual preferences for adaptation practices are driven mainly by the desire for immediate benefits. These CCA strategies have been introduced through a combination of traditional knowledge and development interventions, aiming to reduce risks through systematic and focused climate adaptation efforts.

Similarly, other adaptation strategies can be integrated into the future development models of CFUGs. Crop switching and low-cost adaptation activities, such as bamboo plantation, have been identified as a significant practice at the user level. Adaptation activities applied by CFs tend to be more strategic, incorporating both immediate benefits and environmental considerations, thus addressing short-term needs while promoting long-term resilience. Due to their economic feasibility and long-term effects, ecological restoration and low-cost technologies are more effective.

The community's understanding of climate change largely depends on effective communication. This understanding does not necessarily need to be uniform across all users, as factors like education level and exposure influence it. Communities perceive global climate discourse through the lens of their specific contexts and everyday experiences.

The study concludes that CFUGs perceive climate change adaptation strategies as an integral part of their livelihoods and have been actively implementing them at both community and household levels to enhance resilience. The CCA strategies have emerged through a combination of traditional community knowledge and development interventions. The adaptation activities implemented by CFs are more strategic and have incorporated both immediate livelihood benefits and long-term environmental sustainability to increase community resilience. The issue of climate change within CFUGs still needs more comprehensive and focused research.

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Author contribution

GRA: Overall research conceptualization, field work, data collection, data analysis, write-up, and manuscript submission; KRT: Supervision, review, editing, and feedback on manuscript; SA: Co-supervision, review of manuscript, and feedback.

Disclosure statement and conflict of interests

This paper presents original findings based on fieldwork conducted by the first author in Dang district, Nepal. The authors declare that they have no conflict of interest.

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