Hindawi
International Journal of Forestry Research
Volume 2023, Article ID 8657985, 13 pages
https://doi.org/10.1155/2023/8657985

Research Article

Assessment of Sustainability in Community Forests: A Study from Dolakha District, Nepal

K. C. Bishnu Bahadur,[1] Ram Asheshwar Mandal ,[2] and K. C. Sumitra[1]

[1]*Ministry of Forest and Environment, Singhdurbar, Kathmandu, Nepal*
[2]*Pokhara Univrersity, Pokhara, School of Environmental Science and Management, Kathmandu, Nepal*

Correspondence should be addressed to Ram Asheshwar Mandal; ram.mandal@gmail.com

Received 7 October 2022; Revised 8 March 2023; Accepted 29 March 2023; Published 12 April 2023

Academic Editor: Ranjeet Kumar Mishra

Sustainability in community forest (CF) is a very important issue but study regarding this is limited in Nepal. Thus, this research study was objectively conducted to assess the sustainability index including socioeconomic contribution and biodiversity status of tree species in Simpani, Bolde Setidevi, and Kalobhir community forests of Dolakha district. A total of 83 sample plots were established to collect the biophysical data. The sustainability index for overall and individual criteria was assessed on the basis of scoring provided by the community forest user groups (CFUGs). The study showed that there were 87% Braman and Chhetri in Simpani CF and their representation was 91% in the executive committee, and similar status was seen in Bolde Setidevi and Kalobhir CFs. The highest number of households were 29 receiving benefits from the timber in 2016/17. They used roughly 164.9 m^3 wood from Kalobhir CF. The highest total income was US$1495 in 2016/17 in Simpani CF, but expenditure was the highest, US$1817 in 2017/18, in Bolde Setidevi CF. There was 6308 regeneration per ha in Simpani CF but growing stock was the highest, 177.7 m^3/ha, in Bolde Setidevi CF. The Shannon Wiener index was the highest, 0.92 ± 0.087, in Bolde Setidevi CF. One-way ANOVA showed that there was no significant difference in values of the Shannon Wiener index and evenness index of the three community forests since p value is <0.05. The importance value index (IVI) value of *Schima wallichi* (63.51), *Rhododendron* species (48.61), and *Tsuga dumosa* (81.50) was found to be the highest in the Simpani, Bolde Setidevi, and the Kalobhir community forest, respectively. The overall sustainability index of Simpani, Bolde Setidevi, and Kalobhir CFs was found to be 0.61, 0.67, and 0.58, respectively. The score of extent of forest resource was found to be highest (0.82) in Bolde Setidevi CF and this score of institutional framework and governance was the lowest (0.52) in Kalobhir CF. This research study will be used to determine the sustainability in community forests.

1. Introduction

Climate action and life on land are the 13th and 14th sustainable goals of United Nations. These goals are intimately related to the sustainable management of natural resource especially the forest [1]. This linkage between the forest environment and the people is important to save the life on the earth and protect the environment. Therefore, the global policy actions such as the Convention on Biological Diversity, Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and International Union for Conservation of Nature (IUCN) have been importantly functioning as major tools aiming to protect the environment to save the life on the earth [2]. Obviously, these actions are guided by the theory of management of the resource and people. The theory of resource management, community, and sustainability are interconnected with each other thus, criteria, indicators, and verifiers came as intrinsically important.

There are two main theories behind the natural resource management. These theories are "tragedy of commons" postulated by Ells [3] and "sustainability of common property" theorized by Forsyth and Johnson [4]. Both theories are still relevant in the world. The basic principle of the first theory is that everybody is exploiting the common pools, so one relevant example of this is that, nobody care about the range land management in himalayan areas. On the other hand, there are several evidences about

sustainability of common property. The model of community-based forest management in the world is a popular regime. In addition to collective forest management, community-based resource management practices are the best examples of people's participation in forest management in Bolivia, Colombia, Mexico, Philippines, Tanzania, and Zambia. Social and joint forest management practices in India, community forest management, leasehold forest management, and collaborative forest management in Nepal are the good examples of sustainability of common property such as the forest. The main objective of these models of community managed forest is to meet the forest product demands and service of the local people and to protect the forest environment.

The sustainable forest management is a branch of forestry which deals with the continuous supply of forest products without degrading the forest health. The word sustainable is widely used to describe three key pillars specifically financially viable, environmentally sound, and socially acceptable to keep the balance between the environment and people [5–7]. Thus, the World Commission on Environment and Development emphasized to develop the idea of sustainable development in 1987, and this was adopted by the United Nations Conference on Environment and Development (UNCED) in 1992. The application of sustainability is obviously practical in forestry sector and hence the sustainable forest management is becoming more like a scientific tool in the forest management. According to the International Tropical Timber Organization (ITTO), the sustainable forest management (SFM) can be defined as "the process of management of forest in order to achieve one or more logically stated aims of forest management for the production of a perpetuity flow of preferred products and services without lessening its values and potential productivity thereby assuring no detrimental effects to both the social and physical environment" [8].

Sustainable forest management is considered as one of the most important practices in forest management which helps to achieve the sustainable development objectives of the country through forest management practices [9]. The concept of sustainable forest management often believe that, it does not directly deal with the ecological system as the community influence is more dominant in such forest management systems, but it is also true that forest, community, and environment cannot be separated from each other in an ecological function. This is an indication that the use of forest products and environmental services management eventually depends upon the social, economical, and environmental values of the forest resources [10].

In fact, sustainable forest management offers a holistic approach to apply to forest activities [11]. The main purpose of these activities is to maintain the sustainability in the socioeconomic and forest environment. Thus, sustainable forest management is considered as the supply of forest product and service demands to people without degrading the function of forest currently and in the future. In fact, there are six key benefits of sustainable forest management. These are the following: (i) continuous flow of sufficient goods and environmental services from forests to the people, (ii) management of forest soils, water, and carbon stocks and carbon storage, (iii) protecting and enhancing the biodiversity, (iv) supporting to maintain the resilience and renewal capacity of forests, (v) assuring the food-security, cultural, and livelihood needs of the forest-dependent communities particularly of the indigenous peoples, and (vi) ensuring the equitable sharing of responsibilities in forest management and of the benefits arising from forest use. Undeniably, application of these basic principles is mandatory for managing the forest by the community [12].

It is very important, when, sustainability is maintained in the forest management practices. The basic principle of community-based forest management is to manage the forest by the community, for the community, and to the community [13]. These community-based forest management practices are functioning on the basis of a certain criteria and indicator. These criteria and indicators principally emphasize to maintain sustainability in the supply of forest products and services to the people without degrading the forest condition and hence this practice is known as the sustainable forest management. Sustainable forest management (SFM) is a globally accepted goal but many countries are facing big challenges to implement it conveniently [11]. These challenges are forest degradation, fragmentation, and conversion of forest into other lands (agriculture, infrastructures, and settlement). In fact, several options have been adopted to address these challenges [14], and one of the best options is sustainable forest management because it equally considers socially acceptable, financially viable, and environmentally friendly management practice of the forest [5–7]. The community forest management in Nepal is one of the noble idea of people participation [13, 15] and it is also considered as one of the good practice of sustainability too. Nepal is a pioneer of community forest management practice but sustainable forest management is still a challenging issue [16, 17]. Forest is protected by the nearest community, and the products are utilized by them without reducing their quality, thereby developing and enhancing the forest continuously [18–20]. So, there are set of rules, regulation, guideline, directives, manuals and plans. However, there are several gaps in the study regarding the sustainability in the forest management.

Worldwide, Nepal is famous for community forest management since it has been effectively engaging the local people in forest management practices. Community forestry in Nepal started since 1970 aiming to manage the forest in perpetuity basis [21]. The community forest management practices in Nepal can be divided into three main phase. The first phase was focused on forest enhancement through plantation and regeneration promotion; second phase was emphasized on the protection of the forest while third phase is presently assumed as the sustainable management of the forest through meaningful participation of community forest users. So, this is the phase to implement sustainability in community forest effectively. In this context, the sustainability index and biodiversity assessment are important tools to evaluate sustainability in a community forest. In fact, Forestry

Sector Strategy 2016 developed by Ministry of Forests and Environment targeted to manage about 25% of forests in midhills and 50% of forests in the Terai including Siwalik under the sustainable forest management practice by 2025. Thus, this research study is important to show the sustainability status of community forest through preset criteria and indicator [22].

The community forest management practice particularly in the hilly areas of Nepal is believed to be functioning well to follow the sustainability in the forest [8, 23]. In fact, without evaluating the preset criteria, indicator, and verifier developed by the scientific community, it cannot know the status of sustainability of the community forest in Nepal and no any management actions can be taken appropriately [24, 25]. The biodiversity and ecological value (importance value index) of tree species in the forest as well as contribution of forest to the socioeconomic status of the community forest users can be the major criteria to evaluate the sustainability [11, 26, 27]. Therefore, this research study was objectively conducted to evaluate the socioeconomic contribution of community forest management, assess the growing stock, biodiversity status, and importance value index of tree species in community forests and determine the sustainability index of community forest user groups.

2. Materials and Methods

2.1. Study Area. The total area of Dolakha district lies at 27°28′ to 28°0′N and 85°50′ to 86°32′E. The elevation is 732 meter to 7134 meter from mean sea level. The temperature ranges from 2.8 (winter) to 15.1°C (summer) and mean annual precipitation is 2043 mm. *Pinus wallichiana*, *Pinus roxburghii*, *Alnus nepalensis*, *Rhododendron* species, and *Quercus* species are the common tree species of this district. There are 438 CFUGs which are managing 45487.32 ha forest area as a community forest in this district. *Nardostachys jatamansi*, *Taxus wallichiana*, *Paris polyphylla*, *Daphne* species, and *Rheum austral* etc. are common nontimber forest products (NTFPs). *Muntiacus muntjak*, *Panther parades*, *Ursus thibetanus*, *Capricornis sumatraensis*, and *Naemorhedus goral* are some common wild life species which are commonly found in this district [28].

The purposed study area was purposively selected in Kalobhir community forest user group Jiri 5, Bolde Setidevi community forest user group Bhimeshowar 8, and Simpani community forest user group Bhimeshowar 6, and all three abovementioned CFUGs are located in Dolakha district. These CFUG were selected from different location of Dolakha district. We tried to cover small to large community forest of Dolakha district while selecting study area. The forest certification project and Reducing emission from deforestation and forest degradation (redd+) pilot projects were implemented to support the community forests to manage the sustainable forests. This was the main reason of selecting these community forests in Dolakha district. The location of the study area is shown in Figure 1.

2.2. Method of Data Collection. Socioeconomic data: data was collected using focus group discussion and available report. A total of 3 small focus groups discussion were conducted to collect the data regarding the contribution of users in community forest management practice. The information regarding revenue collection, supply of timber, and firewood was reported from the audit reports and minutes records available in the CFUG. Another purpose of the focus group discussion was to collect the data to assess the sustainability in forest.

Resource inventory: data related to species diversity, regeneration status, growing stock etc. was calculated from sample plot measurement. Thus, stratified systematic sampling with random stat was adopted for sample plot measurement. A total of 83 sample plot were established to measure the tree species. The size of the sample plot was 25 m × 20 m for 10 m × 10 m for pole, 5 m × 5 m for sapling, and 2 m × 2 m for seedling measurement [29]. Diameter at breast height (DBH) and height of tree, pole, and sapling were measured as well as and the species number of seedling were counted and recorded.

To measure the sustainability, the study used indicators and verifiers developed for sustainable community-based forest management practices in Nepal [30]. They have identified 4 criteria, 26 indicators, and 60 verifiers. The criteria include (i) extent of forest resources, (ii) economic and social benefits, (iii) forest management practices, and (iv) institutional framework and governance. Forest condition, participation of people in forestry works, distribution of benefits, silvicultural operations, transparency, and office management are some of the important indicators. The number of indicators for different criteria ranges from 5 to 8. Similarly, the number of verifiers for different indicators varies from 1 to 6. Local people perceive forest management as one of the main activities in community-based forestry and considers it as a criteria for sustainable community-based forest management [30].

2.3. Data Analysis. The analysis process of collected data was categorized into 4 main types. These were (i) analysis of socioeconomic contribution of forest product, (ii) sustainability analysis, (iii) biodiversity index analysis, and (iv) statistical analysis.

2.3.1. Analysis of Socioeconomic Contribution of Forest Product. Socioeconomic data was analyzed using mean and percentage analysis.

2.3.2. Sustainability Analysis. Acquired information was categorized according to a predefined criteria and indicator. Each indicator was further assigned its ordinal value based on a suitable scale. Collected data regarding sustainability of the CFs were scaled using three points Likert's scale (1 = poor, 2 = medium or fair, and 3 = good). Later, these scores were converted to assess the sustainability index. The average score of verifier (ASV), the sustainability index for

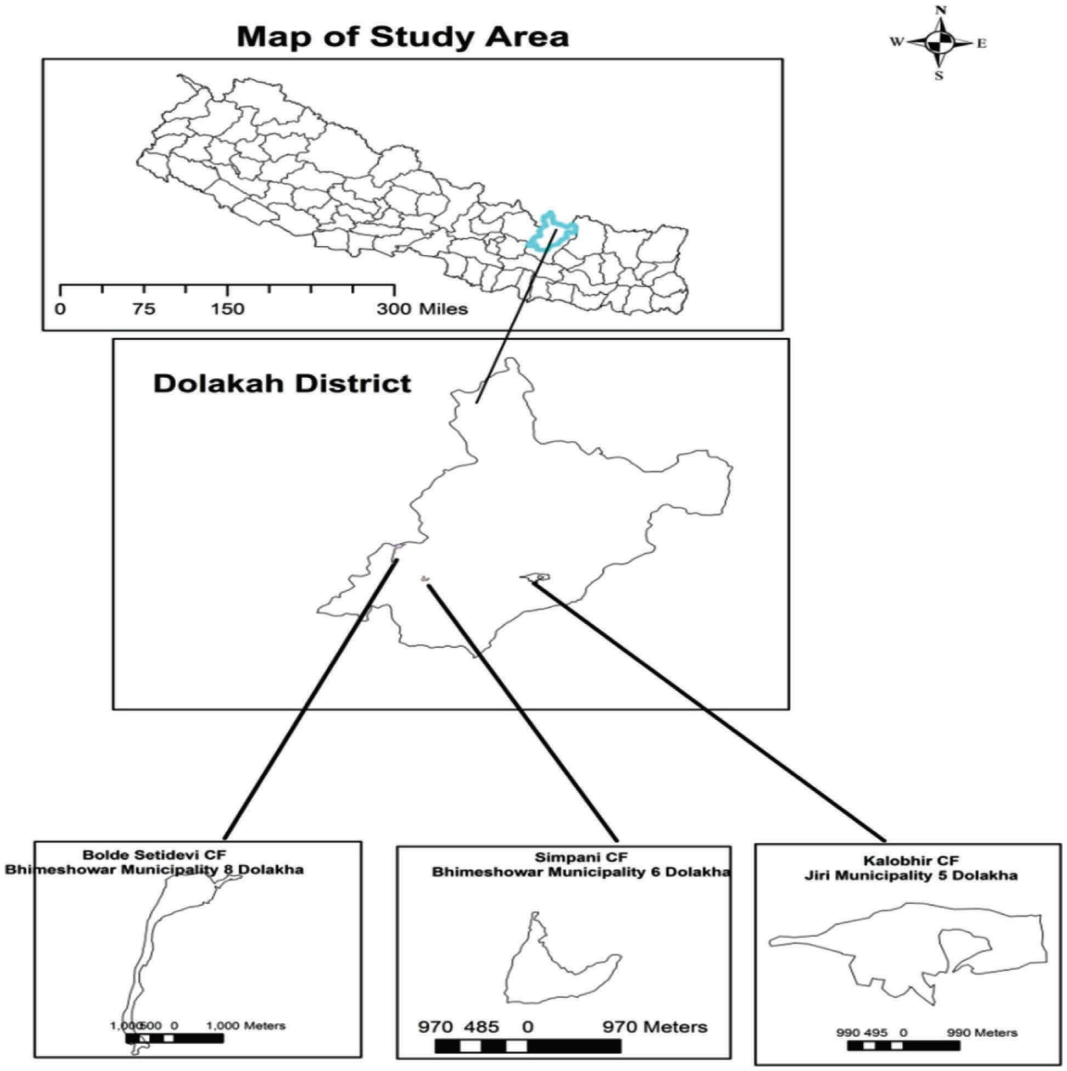


Figure 1: Map of study area.

individual criteria (SIIC), and the overall sustainability index (OSI) were calculated using the following formula:

$$\text{ASV} = \frac{\text{Sum of score of all varifiers within a criteria}}{\text{Number of verifiers in each criterion}},$$

$$\text{SIIC} = \frac{\text{Average Score of varifiers within a criteria}}{\text{Maximum Score of a Verifier can obtain}},$$

$$\text{OSI} = \frac{\text{Sum of weighted SIIC}}{\text{Maximum score of a verifier can obtain}}, \quad (1)$$

where asv stands for average score of verifiers, siic stands for sustainability index of individual criteria, and osi stands for overall sustainability index

The sustainability assessment of community-based forest management practice toward achieving the goal of sustainability was judged based on OSI as follows: good, if OSI > 0.8; fair, if 0.6 < OSI < 0.8; and poor, if OSI < 0.6. [30].

2.3.3. Biodiversity Analysis. Shannon and Wiener independently derived the function which has become to be known as the Shannon index of diversity. This indeed assumes that individuals are randomly sampled from an independently large population and all the species are represented in the sample. The Shannon index is calculated from the equation as follows:

$$\text{Shannon Wieners index}\left(H'\right) = -\sum \text{pi} \times \text{logpi}, \quad (2)$$

where pi is the relative abundance of each species, i.e., the proportion of individuals of a given species relative to the total number of individual in the community and Σ means sum of all the $(\text{pi})^2$, that is, one for each species in the community [31].

2.3.4. Statistical Analysis. The descriptive statistics such as mean, standard deviation, minimum, and maximum value was calculated to show the variation in biodiversity indexes and inferential statistics such as one-way ANOVA was applied to compare the biodiversity index in the community forest.

3. Result

3.1. Socioeconomic Status of Community Forests

3.1.1. Social Status of Users in Community Forests. The social and ethnic status of users varies according to community forests. The study showed that there were 475 people of 86 households involved to manage the Simpani community forest. The households of Braman and Chhetri were 87% and 91% (10) of them were involved in the executive committee. The male percentage was 54% and the remaining were female. Similarly, there were 677 people of 228 household in Bolde Setidevi community forest. There were 54% Braman and Chhetri and their representation was about 55% in executive committee. In case of Kalobhir CF, there were 83% Braman and Chhetri and their representation was 77% in the executive committee. So, social representation in community forests according to ethnicity was varying but somehow it was a good representation of Indigenous and Dalit people as well (Tables 1 and 2).

3.1.2. Benefited Households Using Forest Product in Community Forests. The study showed that most of the households directly benefitted from using timber, firewood, fodder, and bedding material in community forests. The results showed that maximum benefitted households was 5 using around 6 m^3 timber; this was about 47 households using 1050 Bhari firewood as well as fodder while this was 45 households receiving 4480 Bhari bedding material in 2016/17 from Simpani CF. Looking to the employment in 2016/17, it was maximum 3450 people from this community forest. Similarly, the maximum number of households was 22 using 72.1 m^3 timber in 2018/19 from Bolde Setidevi CF. Moreover, this was 29 (highest) households receiving the benefit using 164.9 m^3 timber in 2016/17 from Kalobhir CF (Table 3). The trend showed that there was fluctuation in collection of forest product especially timber in community forests.

3.1.3. Economic Contribution in CF (Income and Expenditure). The income source and expenditure items varies in community forests. The main income sources were timber/fuel wood, NTFP, bank interest. and others. Moreover, the record showed that for administrative and other sector more budgets were spent in comparison to the forest management and propoor program. The highest total income was US$1495 in 2016/17 and it was the lowest about US$572.78 in 2020/21 in Simpani CF. The highest expenditure was about US$776.18 in 2016/17 in Simpani CF. Though, there is a legal provision to spend a minimum of 25% income in forest management activities but only 10% was on this work. Similarly, in case of Bolde Setidevi CFUG, the highest annual income was US$1452 in 2020/21 and the expenditure was the highest US$1817 in 2017/18. Here, about 50% budget was spent on the forest management activities. The highest income of Kalobhir CFUG was found to be US$1715 in 2017/18 and the highest expenditure was 943 in 2019/20, and that spent on forest management activities was around 28% but there is no consistency on expenditure in different years. The trend of income and expenditure was fluctuating in the community forests (Table 4)

3.2. Status of Growing Stock and Biodiversity in Community Forests

3.2.1. Status of Growing Stock in Community Forests. The study showed that *Pinus roxburghii*, *Alnus nepalensis,* and *shima wallichi* were dominant tree species of the Simpani community forest. It was a mixed forest of pine and broad leaved species. In pole and tree stage *Pinus roxburghii* was most dominant tree species which occupied 29 and 68 percent of the forest, respectively. There was 6308 regeneration per ha, 480 pole + tree per ha, and the growing stock was 137.2 m^3/ha which showed a fair condition. In case of Bolde Setidevi community forest, it was 3754 regeneration per ha, 441 tree + poles per ha, and the growing stock (volume) was 177.7 m^3/ha which showed a good condition. Similarly, in Kalobhir CF, it was 4500 regeneration per ha, 175 tree + poles per ha, and the growing stock (volume) was 81.79 m^3/ha, and it indicated a fair condition (Table 5).

3.2.2. Status of Biodiversity Indexes in Community Forests. The Shannon–Wiener index, evenness index, species richness index, and the important value index was varying in community forests. The Shannon–Wiener index was the highest, 0.92 ± 0.087, in Bolde Setidevi CF while it was the lowest, 0.75 ± 0.05, in Simpani C.F. The value of evenness was the highest in Bolde CF, $0.46 + 0.04$, and lowest in Simpani CF, $0.45 + 0.05$, and the species richness was the highest in Bolde Setidevi with a score of 12 which was followed by Kalobhir and the lowest value with a score of 7 was found in Simpani CF. The higher the Shannon–Wiener index value, the higher the diversitys (Table 6).

One-way ANOVA showed that, there was no significant difference in value of the Shannon–Wiener index and evenness index of the three community forests since p value was >0.05. The p value was 0.34 for Shannon–Wiener index and 0.107 for evenness index. The detail statistic of one way ANOVA test is shown in Table 7.

3.2.3. Important Value Index and Preference Rank of Tree Species Available in CFs. The IVI value of different species of forest varies in the community forests. The study showed that the highest values was observed for IVI *Schima wallichi* (63.51) followed by *Pinus roxburghii* (57.44), and the lowest was observed in IVI of *Rhododendron* sp (4.35) in Simpani CF. The preference ranking by the users had given no 1 rank for *Pinus ruxburghii* followed by *Alnus nepalensis* and least preference was given to *Miliusa velutina* ranking as no 7. The study shows that there was no big difference between preferred species and ecologically abundance species. The estimated highest IVI was about (44.37) of Rhododendron species which was ranked as 7 but the lowest record of IVI

Table 1: Social status of users in community forests (household & population).

Ethnic group/caste	No. of HH	Population gender	
		Male	Female
Social composition in Simpani CFUG			
Braman/Chhetri	75 (87%)	202	215
Indigenous (Janajati)	9 (10%)	21	26
Dalit	2 (3%)	5	6
Social composition in Bolde Setidevi CFUG			
Braman/Chhetri	123 (54%)	368	366
Indigenous (Janajati)	105 (46%)	303	311
Social composition in Kalobhir CFUG			
Braman/Chhetri	83 (35%)	44	39
Indigenous (Janajati)	145 (61%)	530	527
Dalit	10 (4%)	23	18

Table 2: Social composition in executive committee.

Year	Social composition in executive committee			Gender in executive committee	
	Braman/Chhetri	Indigenous (Janajati)	Dalit	Male	Female
Social composition in Simpani CFUG					
2022	10 (91%)	1 (9%)	0	6 (54.5%)	5 (45.5%)
2019	11 (100%)	0	0	6 (54.5%)	5 (45.5%)
2017	9 (82%)	1 (9%)	1 (9%)	7 (63.6%)	4 (36.4%)
Social composition in Bolde Setidevi CFUG					
2022	5 (45%)	6 (55)	0	5 (45)	6 (55)
2019	6 (55%)	5 (45)	0	6 (55)	5 (45)
2017				7 (64)	4 (36)
Social composition in Kalobhir CFUG					
2015	3 (23%)	10 (77%)	0	10 (77%)	3 (23%)
2017	1 (9%)	10 (91%)	0	6 (54.5%)	5 (45.5%)
2019	0	7 (100%)	0	4 (57%)	3 (43%)

was (6.51) of Lyonia ovalifolia with ranked 12 in Bolde Setidevi CF. Similarly, the IVI of Tsuga dumosa was (81.5) having ranked 3 in Kalobhir CF but the IVI of Ficus nerifolia was (1.98) which ranked as 5 in this community forest. The preference ranking by the users importance value index which contributes to ecology were mismatching in the community forests (Table 7).

3.3. Sustainability in Community Forest Management Practice. The sustainability index varies according to community forests. The result showed that SIIC for the criteria, extent of forest resources, economic and social benefit, forest management and institutional framework, and governance was found to be 0.82, 0.59, 0.58, and 0.56, respectively, in Simpani CF (Figure 2).

Similarly, criteria extent of forest resource was the highest with score 0.87 in Bolde Setidevi CF. The values of the other two criteria, namely, forest management practice and economic and social benefit were 0.76 and 0.61, respectively, but the criterion of institutional framework and governance was the least, that is, 0.59. Moreover, the value of criteria extent of forest resource was found to be highest with score 0.79 in Kalobhir CF. The scores of other three criteria, namely, institutional framework and governance, forest management practice, and economic and social benefit were 0.52, 0.61, and 0.54, respectively. The overall sustainability index was found to be 0.61, 0.67, and 0.58 in Simpani, Bolde Setidevi, and Kalobhir CF (Table 8).

4. Discussion

Most of the households directly benefitted from the use of forest products such as timber, firewood, fodder, and bedding material in the community forests. They used timber for construction of their houses and firewood for cooking and heating purposes. This result is also supported by several authors who showed that community forest management practices have been supporting the local users in Nepal, and they have been using the forest products and also increasing their household income which contribute to reduce the proverty [15, 30]. Other researches also revealed that the users are getting the forest product from the community so their action in forest management is worth full [32–34]. Thus, this research study is one of the important relevant evidence.

The selling of timber, firewood, nontimber forest products (NTFP), bank interest, and others sources are the major sources of income in Simpani, Bolde Setidevi, and Kalobhir CF. Similarly, forest management activities, propoor support, social development, and administrative costs are the main expenditure in the community forest. Studies conducted in the high altitude CFs of Darchula showed that,

Table 3: Trend of forest products extraction and employment.

Fiscal year	Timber (m^3)	No. of HHs got timber	Firewood (bhari)	No. of HHs collected firewood	Fodder (bhari)	No. of HHs collected fodder	Bedding material (bhari)	No. of HHs collected bedding material	Employment generated (man days/year)
Benefits to CFUGs in Simpani CF									
2016/17	6	5	1410	47	1050	35	4480	45	3953
2017/18	5.7	5	1110	37	810	27	4460	42	3406
2018/19			1050	35	660	22	4550	45	3226
2019/20	3.1	3	1110	37	840	28	4500	46	3450
2020/21			1050	35	690	23	4410	40	3210
Benefits to CFUGs in Bolde Setidevi CF									
2016/17	43.2	16	1054	68	4630	91	6840	95	4179
2017/18	108	27	920	65	4800	89	5990	104	3913
2018/19	72.1	22	910	71	4810	96	5630	98	3790
2019/20	1.6	2	936	79	4860	91	6050	95	3950
2020/21	61.2	17	840	74	4520	94	5510	101	3629
Benefits to CFUGs in Kalobhir CF									
2016/17	164.9	29	4200	130	3610	96	8250	125	5379
2017/18	120	25	4490	130	3460	95	8340	135	5721
2018/19	4.02	3	4500	135	4625	98	7125	143	5499
2019/20	64.45	23	4430	134	4600	96	7420	129	5428
2020/21	41.08	16	4220	146	4750	102	8150	143	5452

Note: 1 bhari equals to 30 kg.

there were many sources of income in the community forest and selling NTFP was one of the important one [26]. Trade of timber and nontimber forest products ar the major income source of local users in community forest [35–37] while the major expenditure items are cost for activites like forest management, livelihood support for local people and social development [8, 38, 39].

The research showed that, the growing stock of pole and tree of 81.79 m^3/ha, 177.78 m^3/ha, and 137.2 m^3/ha and Shannon–Wiener index was 0.86 ± 0.036, 0.92 ± 0.087, and 0.75 ± 0.05 in Kalobhir, Bolde Setidevi, and Simpani community forest (CF), respectively. The growing stock of Churia forest was 114.28 m^3/ha [40]. This value differed from this research study, and the reason may because of the biotic and abiotic factors [41, 42]. A similar study was conducted in Janata, Shiva, and Ambika CF of Surkhet district which showed that the Shannon–Wiener index of the CF were 0.292 ± 0.071, 0.628 ± 0.067, and 0.742 ± 0.058, respectively [43]. The annual monitoring report of community forest of Dolakha district 2021 showed that, the average growing stock of community forest of Dolakha district was 70.75 m^3/ha. It indicates that the status of growing stock of the study area was above the average for community forest of Dolakha district. The reason behind this was more participation, better management, and priority protection of forest in the selected community forests [28]. A similar kind of study was conducted in Gaukhureshwar CF of Kavre district which showed that the Shannon–Wiener index was 0.96 [44]. The result of this study was almost similar with the result of Gaukhureshwar CF of Kavre district. This might be the reason of similar kind of physiographic and climatic condition between these study areas.

The study showed highest Importance Value Index (IVI) of Tsuga dumosa, Rhododendron species, and Shima wallichi was the highest in Kalobhir, Bolde Setidevi, and Simpani CF respectively because these are the most preferred species of users group. The Rhododendron spp, Abies

Table 4: Income and expenditure trend in community forests.

Fiscal year	Timber/ fuel wood (US$)	NTFP (US$)	Bank interest (US$)	Others (US$)	Total (US$)	Forest management (US$)	Propoor support	Social development (US$)	Administrative and others (US$)	Total (US$)
Income of Simpani CF							*Expenditure of Simpani CF*			
2016/17	40.98	0	538.92	910.34	1495	0	0		776.18	776.18
2017/18	34.43	0	491.96	142.46	673.16	153.69	0		341.56	496.51
2018/19	0	0	542.43	100.61	647.5	0	0	126.23	358.18	485.44
2019/20	22.13	0	468.56	410.32	905.03	127.05	0	499.3	104.1	735.58
2020/21	0	0	257.15	313.52	572.78	0	0	109.02	342.99	452.9
Income of Bolde Setidevi CF							*Expenditure of Bolde Setidevi CF*			
2016/17	500	115	9	197	825	180	0	66	76	321
2017/18	1246	33	8	0	1297	1147	492	0	179	1817
2018/19	834	189	16	4	1052	229	0	424	212	864
2019/20	198	201	27	4	433	444	0	164	376	984
2020/21	380	1025	35	0	1452	412	0	139	274	825
Income of Kalobhir CFUG							*Expenditure of Kalobhir CFUG*			
2020/21	318	542	589	10	1471	247	0	81	201	531
2019/20	152	845	613	5	1627	254	492	0	190	943
2018/19	221	123	551	4	906	0	0	0	385	385
2017/18	855	263	427	158	1715	282	33	0	487	804
2016/17	661	296	310	148	1426	88	123	0	164	377

Note: 1US$ = 122 NPR.

Table 5: Status of tree species density and growing stock in community forests.

Scientific name	Simpani CF			Bolde Setidevi CF			Kalobhir CF		
	Regeneration (N/ha)	Pole + tree (N/ha)	Growing stock (m^3/ha)	Regeneration (N/ha)	Pole + tree (N/ha)	Growing stock (m^3/ha)	Regeneration (N/ha)	Pole + tree (N/ha)	Growing stock (m^3/ha)
Abies spectabilis							157	7	8.64
Alnus nepalensis	2238	107	1.23				55	2	0.43
Daphniphyllum himalense							111	8	1.42
Eurya acuminata				897	50	3	103	4	1.08
Ficus neriifolia							47	2	0.44
Litsea cubeba				229	29	6.12	429	8	1.65
Lyonia ovalifolia				104	3	0.67			
Madhuca indica	1671	88	1.61						
Miliusa velutina	206	12	0.43						
Osmanthus fragrans				244	11	4.1			

Table 5: Continued.

Scientific name	Simpani CF			Bolde Setidevi CF			Kalobhir CF		
	Regeneration (N/ha)	Pole + tree (N/ha)	Growing stock (m^3/ha)	Regeneration (N/ha)	Pole + tree (N/ha)	Growing stock (m^3/ha)	Regeneration (N/ha)	Pole + tree (N/ha)	Growing stock (m^3/ha)
Pinus patula				251	42	41.73	95	5	3.77
Pinus roxburghii	696	157	61.85						
Pinus wallichiana				452	37	41.72			
Quercus lamellosa				137	14	4.67			
Quercus semecarpifolia				192	40	15.19	663	36	11.42
Rhododendron Species	0	7	29.83	749	155	34.01	847	27	4.8
Schima wallichi	1497	107	30.3						
Symplocos pyrifolia				0	16	4.51	1135	30	9.54
Symplocos racemosa				499	41	10.59			
Terminalia chebula	0	2	11.96						
Tsuga dumosa				0	3	11.39	858	46	38.6
Total	6308	480	**137.21**	3754	441	**177.7**	4500	175	81.79

Table 6: Values of biodiversity indexes in CFs.

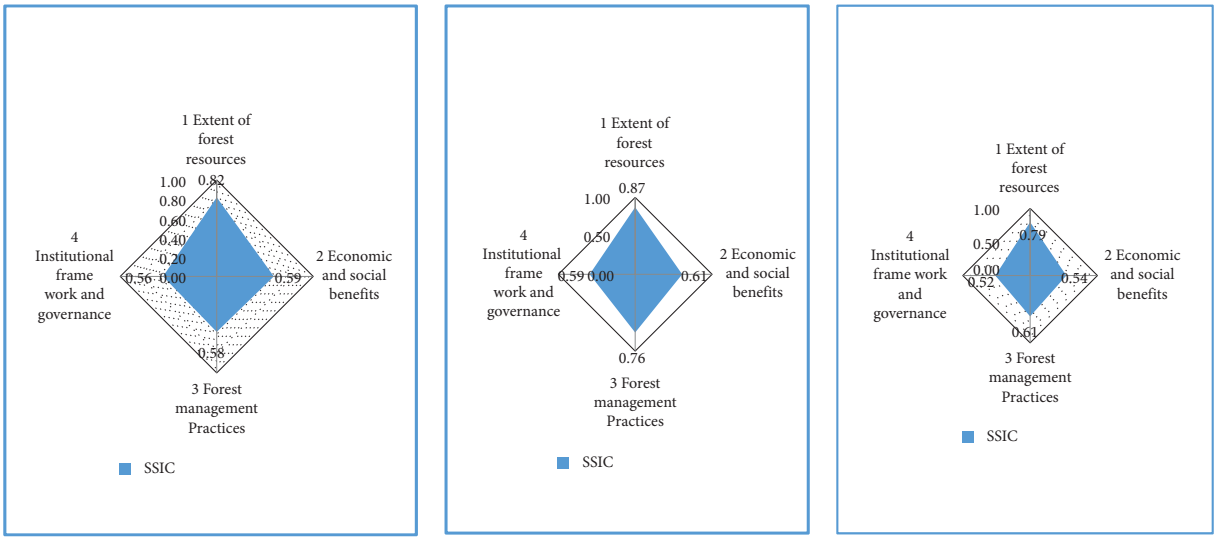
Index	Descriptive statistics	Simpani CF	Bolde Setidevi CF	Kalobhir CF
Shannon–Wiener diversity index	Mean ± SE	0.75 ± 0.05	0.92 ± 0.087	0.86 ± 0.036
	Standard deviation	0.17	0.38	0.25
	Minimum	0.56	0.35	0.35
	Maximum	1.12	1.61	1.35
Evenness diversity index	Mean ± SE	0.28 ± 0.03	0.46 ± 0.03	0.32 ± 0.01
	Sd	0.09	0.05	0.08
	Minimum	0.05	0.17	0.17
	Maximum	0.34	0.36	0.68
Species richness		7	12	11

spectabilis and Juniper spp are dominating tree species in high altitude area [45, 46] but Schima wallichi is dominant species in midhills [47, 48]. The IVI is determined the by species dominance.

The highest score of sustainability index indicates that the forest growth and condition is good enough to achieve the objective of sustainable forest management. Similarly, the second highest score was obtained by the forest management criteria which indicate that the forest management activities conducted by the CFUG is important to achieve the objective of sustainable forest management; however, it is not enough. On the other hand, the score of criteria such as institutional framework and economic and social benefit is below standard, which means that institutional set up, governance, and benefit sharing mechanism of the community forest management practice of the study area was obviously poor. A similar kind of study showed that the overall sustainability index of Sapankot Odare and KyaminHariyali CFUG were 0.50 and 0.51, respectively [30]. Similarly, another showed that overall sustainability index of the Tilaulakot collaborative forest was 0.53 [41]. These values were relatively lower than the OSI of Simpani, Bolde Setidevi, and Kalobhir which were 0.61, 0.67, and 0.58, respectively. The higher OSI of this study area of the three

Table 7: Importance value index and preference rank of tree species in CFs.

Scientific name	Simpani CF		Bolde Setidevi CF		Kalobhir CF	
	IVI	Preference rank	IVI	Preference rank	IVI	Preference rank
Abies spectabilis					23.92	2
Alnus nepalensis	41.97	2				
Alnus nepalensis					11.46	6
Daphniphyllum himalense					7.66	10
Eurya acuminata					7.03	11
Ficus neriifolia					1.98	5
Litsea cubeba			19.03	1		
Litsea cubeba					12.92	1
Lyonia ovalifolia			6.51	12		
Madhuca indica	31.34	6				
Miliusa velutina	10.63	7				
Murraya koenigii			11.7	11		
Osmanthus fragrans			11.71	9		
Pinus patula			23.06	6		
Pinus patula					15.59	8
Pinus roxburghii	57.44	1				
Pinus wallichiana			17.88	4		
Quercus lamellosa			6.12	5		
Quercus semecarpifolia			24.05	3		
Quercus semecarpifolia					48.12	4
Rhododendron species			48.61	7		
Rhododendron species	4.35	5			44.37	7
Schima wallichi	63.51	4				
Symplocos pyrifolia			7.03	10		
Symplocos racemosa			23.65	8		
Symplocos racemosa					45.47	9
Terminalia chebula	4.57	3				
Tsuga dumosa			7.65	2		
Tsuga dumosa					81.5	3



(a) (b) (c)

Figure 2: Spider web diagram of sustainability index of community forest. (a) Sustainability index of Simpani CFUG. (b) Sustainability index of Bolde Setidevi CF. (c) Sustainability index of Kalobhir CF.

Table 8: Sustainability index of Simpani, Bolde Setidevi, and Kalobhir CF.

Criteria	No. of verifier	Sum of scores of verifiers	Average scores of verifiers (c/b)	Weightage to each indicator	SIIC ($d/3$)	Weighted SIIC ($d \times e$)	OSI ($g/3$)
A	*b*	*c*	*d*	*e*	*f*	*g*	*h*
Simpani CF							
Extent of forest resources	13	32	2.46	0.15	0.82	0.369	
Economic and social benefits	18	32	1.78	0.2	0.59	0.356	
Forest management practices	11	19	1.73	0.25	0.58	0.432	0.61
Institutional frame work and governance	18	30	1.67	0.4	0.56	0.667	
Bolde Setidevi CF							
Extent of forest resources	13	32	2.61	0.15	0.82	0.37	
Economic and social benefits	18	33	1.83	0.2	0.61	0.37	
Forest management practices	11	25	2.27	0.25	0.76	0.57	0.67
Institutional frame work and governance	18	32	1.77	0.4	0.59	0.71	
Kalobhir CF							
Extent of forest resources	13	31	2.38	0.15	0.79	0.36	
Economic and social benefits	18	29	1.61	0.2	0.54	0.32	
Forest management practices	11	20	1.82	0.25	0.61	0.45	0.58
Institutional frame work and governance	18	28	1.56	0.4	0.52	0.62	

community forest might be due to more support from the Asia Network for Sustainable Agriculture and Bioresources (ANSAB), Federation of community Forestry Users Nepal (FECOFUN), and the Divisional Forest Office Dolakha for forest certification process in the previous year [42, 43].

5. Conclusion and Recommendation

There were more than fifty percent households directly depended on the CF for their daily needs. Executive committee composition was inclusive in structure but need and interests of propoor were not addressed. A large amount of budget was spent on social and other administrative sector. The growing stock and regeneration of community forest was increased before the previous years. The Shannon–Wiener index was the highest in Bolde Setidevi CF and lowest in Simpani community forest. The importance value index of *Schima wallichii*, *Rhododendron* species, and *Tsuga dumosa* was found to be the highest in Simpani, Bolde Setidevi, and Kalobhir community forest, respectively, but number and growing stock of locally preferred species such as *Litsea cubeba* was poor. The overall sustainability index was the highest in Bolde Setidevi community forest users group but it was the lowest in Kalobhir community forest users group. The sustainability index of individual criteria of extent of forest resource was good in all community forests but the index of institutional framework and governance was poor in all community forests. The index presented a clear image of the forest management practices, indicating where they are headed in terms of sustainability, as well as informing users about problems to be considered in order to improve the sustainability of their forests.

(i) Provision made in operational forest management plan for expenditure of budget should be strictly followed

(ii) To improve the overall sustainability of community forest management practice, institutional framework and governance system should be improved

(iii) To meet the demand of local users, locally preferred species should be promoted to balance the species composition of other ecologically importance species

(iv) To ensure the long-term sustainability of community forestry models, a collaborative effort between government forestry officials, concerned stakeholders, and local people is required

Data Availability

This research work is basically prepared based on the primary source of data and secondary source as well. The authors collected the biophysical and socioeconomic data directly from the field. The secondary information was gathered from community forests and division forest office, Dolakha Nepal.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

The authors acknowledge the users of group of community forest and division forest office, Dolakha for supporting this research work.

References

[1] D. Ghosh and S. K. Maiti, "Biochar-assisted eco-restoration of coal mine degraded land to meet United Nation Sustainable

Development Goals," *Land Degradation & Development*, vol. 32, no. 16, pp. 4494–4508, 2021.

[2] C. Corson and K. I. MacDonald, "Enclosing the global commons: the convention on biological diversity and green grabbing," *Journal of Peasant Studies*, vol. 39, no. 2, pp. 263–283, 2012.

[3] K. Ells, "Ecological rhetoric through vicarious narrative: the enduring significance of Garrett hardin's the tragedy of the commons," *Environmental Communication*, vol. 2, no. 3, pp. 320–339, 2008.

[4] T. Forsyth and C. Johnson, "Elinor Ostrom's legacy: governing the commons, and the rational choice controversy," *Development and Change*, vol. 45, no. 5, pp. 1093–1110, 2014.

[5] V. Gulca and R. Deal, "Sustainable Forest Management in Moldova: a guiding principle to integrate public and private forestry sectors," *Legal Aspects of European Forest Sustainable Development*, vol. 112, 2011.

[6] A. Mishra, A. N. Appadurai, D. Choudhury et al., "Adaptation to climate change in the Hindu Kush Himalaya: stronger action urgently needed," in *The Hindu Kush Himalaya Assessment*Springer, Berlin, Germany, 2019.

[7] Y. Yasmi, B. J. M. Arts, and M. A. Hoogstra-Klein, *Forest Futures: Sustainable Pathways for Forests, Landscapes and People in the Asia-Pacific Region: Asia-Pacific Forest Secor Outlook Study III*, FAO, Rome, Italy, 2019, http://www.fao.org/3/ca4627en/ca4627en.pdf.

[8] T. Murray Li, "Practices of assemblage and community forest management," *Economy and Society*, vol. 36, no. 2, pp. 263–293, 2007.

[9] E. Rametsteiner and M. Simula, "Forest certification—an instrument to promote sustainable forest management?" *Journal of Environmental Management*, vol. 67, no. 1, pp. 87–98, 2003.

[10] P. C. Kotwal, M. D. Omprakash, S. Gairola, and D. Dugaya, "Ecological indicators: imperative to sustainable forest management," *Ecological Indicators*, vol. 8, no. 1, pp. 104–107, 2008.

[11] D. S. Dahal and S. Cao, "Sustainability assessment of community forestry practices in Nepal: literature review and recommendations to improve community management," *Proceedings of the National Academy of Sciences, India - Section B: Biological Sciences*, vol. 87, no. 1, pp. 1–11, 2017.

[12] S. Linser, B. Wolfslehner, S. R. Bridge et al., "25 years of criteria and indicators for sustainable forest management: how intergovernmental C&I processes have made a difference," *Forests*, vol. 9, no. 9, 2018.

[13] S. Adhikari, T. Kingi, and S. Ganesh, "Incentives for community participation in the governance and management of common property resources: the case of community forest management in Nepal," *Forest Policy and Economics*, vol. 44, pp. 1–9, 2014.

[14] S. K. Patel, A. Sharma, and G. S. Singh, "Traditional agricultural practices in India: an approach for environmental sustainability and food security," *Energy, Ecology and Environment*, vol. 5, no. 4, pp. 253–271, 2020.

[15] M. Kumar, S. N. Phukon, and H. Singh, "The role of communities in sustainable land and forest management," in *Forest Resources Resilience and Conflicts*Elsevier, Amsterdam, Netherlands, 2021.

[16] V. Maskey, T. G. Gebremedhin, and T. J. Dalton, "Social and cultural determinants of collective management of community forest in Nepal," *Journal of Forest Economics*, vol. 11, no. 4, pp. 261–274, 2006.

[17] T. R. Gurung, *Community-based Non-Wood Forest Products Enterprise: A Sustainable Business Model*, SAARC Agriculture Centre, Dhaka, Bangladesh, 2017.

[18] B. K. Pokharel and M. Nurse, "Forests and people's livelihood: benefiting the poor from community forestry," *Journal of Forest and Livelihood*, vol. 4, no. 1, pp. 19–29, 2004.

[19] D. B. Bray, L. Merino-Pérez, and D. Barry, Eds., *The Community Forests of Mexico: Managing for Sustainable Landscapes*, University of Texas Press, Austin, TX, USA, 2005.

[20] P. Cronkleton, D. B. Bray, and G. Medina, "Community forest management and the emergence of multi-scale governance institutions: lessons for REDD+ development from Mexico, Brazil and Bolivia," *Forests*, vol. 2, no. 2, pp. 451–473, 2011.

[21] K. P. Acharya and P. Gentle, *Improving the Effectiveness of Collective Action: Sharing Experiences from Community Forestry in Nepal(No. 577-2016-39227*, International Food Policy Research Institute (IFPRI), Washington, D.C. USA, 2006.

[22] MoFE, *Forestry Sector Strategy (2016-25), Ministry of Forests and Soil Conservation*, Government of Nepal Singhdurbar, Kathmndu, Nepal, 2016.

[23] C. A. Thoms, "Community control of resources and the challenge of improving local livelihoods: a critical examination of community forestry in Nepal," *Geoforum*, vol. 39, no. 3, pp. 1452–1465, 2008.

[24] J. Xu, R. Badola, N. Chettri et al., "Sustaining biodiversity and ecosystem services in the hindu kush himalaya," in *The Hindu Kush Himalaya Assessment*Springer, Berlin, Germany, 2019.

[25] R. K. Pokharel, P. R. Neupane, K. R. Tiwari, and M. Köhl, "Assessing the sustainability in community based forestry: a case from Nepal," *Forest Policy and Economics*, vol. 58, pp. 75–84, 2015.

[26] I. Stupak, B. Lattimore, B. D. Titus, and C. Tattersall Smith, "Criteria and indicators for sustainable forest fuel production and harvesting: a review of current standards for sustainable forest management," *Biomass and Bioenergy*, vol. 35, no. 8, pp. 3287–3308, 2011.

[27] A. Jafari, H. Sadeghi Kaji, H. Azadi, K. Gebrehiwot, F. Aghamir, and S. Van Passel, "Assessing the sustainability of community forest management: a case study from Iran," *Forest Policy and Economics*, vol. 96, pp. 1–8, 2018.

[28] Dfo, *Annual Progress Report of Dolkha District*, Division Forest Office, Dolkha, Nepal, 2021.

[29] MoFSC, *Community Forestry Inventory Guideline*, Ministry of Forest and Soil Conservation, Kathmandu, Nepal, 2004.

[30] R. Pokharel and K. Tiwari, "Locally identified criteria, indicators and verifiers for evaluating sustainable community based forestry: a case from Nepal," *Banko Janakari*, vol. 28, no. 1, pp. 37–47, 2018.

[31] D. B. Zobel, P. K. Jha, U. K. Yadav, and M. J. A. Behan, *Practical Manual for the Ecology*, Ratna Book Distributors, Kathmandu, Nepal, 1987.

[32] G. Varughese and E. Ostrom, "The contested role of heterogeneity in collective action: some evidence from community forestry in Nepal," *World Development*, vol. 29, no. 5, pp. 747–765, 2001.

[33] K. R. Kanel and D. R. Niraula, "Can rural livelihood be improved in Nepal through community forestry?" *Banko Janakari*, vol. 14, no. 1, pp. 19–26, 2017.

[34] M. Dhakal and M. Masuda, "Local pricing system of forest products and its relations to equitable benefit sharing and livelihood improvement in the lowland community forestry program in Nepal," *Forest Policy and Economics*, vol. 11, no. 4, pp. 221–229, 2009.

[35] B. Belcher and K. Schreckenberg, "Commercialisation of non-timber forest products: a reality check," *Development Policy Review*, vol. 25, no. 3, pp. 355–377, 2007.

[36] K. Gauli and M. Hauser, "Pro-poor commercial management of non-timber forest products in Nepal's community forest user groups: factors for success," *Mountain Research and Development*, vol. 29, no. 4, pp. 298–307, 2009.

[37] P. Phumee and A. Pagdee, "From subsistence to market-driven: the role of non-timber forest products at community forests in Northeast Thailand," *Forests, Trees and Livelihoods*, vol. 30, no. 3, pp. 151–168, 2021.

[38] M. Dhakal and M. Masuda, "Generation and utilization of community fund in small-scale community forest management in the Terai region of Nepal," *Banko Janakari*, vol. 17, no. 2, pp. 55–61, 1970.

[39] B. K. Pokharel, P. Branney, M. Nurse, and Y. B. Malla, "Community forestry: conserving forests, sustaining livelihoods and strengthening democracy," *Journal of Forest and Livelihood*, vol. 6, no. 2, pp. 8–19, 2007.

[40] Frtc, *Churia Forests of Nepal, 2022*, Forest Research and Training Centre (FRTC), Kathmandu, Nepal, 2022.

[41] I. N. Pavlov, "Biotic and abiotic factors as causes of coniferous forests dieback in Siberia and Far East," *Contemporary problems of ecology*, vol. 8, no. 4, pp. 440–456, 2015.

[42] T. Zhou, J. Zhang, Y. Qin, M. Jiang, and X. Qiao, "The effects of biotic and abiotic factors on the community dynamics in a mountain subtropical forest," *Forests*, vol. 12, no. 4, 2021.

[43] S. Lamichane, "Sustainability livelihood security in community forest in Surkhet district, Nepal," *Annals of Forest Science*, vol. 4, 2019.

[44] S. K. Baral and K. Katzensteiner, "Diversity of vascular plant communities along a disturbance gradient in a central mid-hill community forest of Nepal," *Banko Janakari*, vol. 19, no. 1, pp. 3–10, 1970.

[45] P. K. Chhetri and D. M. Cairns, "Contemporary and historic population structure of Abies spectabilis at treeline in Barun valley, eastern Nepal Himalaya," *Journal of Mountain Science*, vol. 12, no. 3, pp. 558–570, 2015.

[46] J. Ollerton, N. P. Koju, S. R. Maharjan, and B. Bashyal, "Interactions between birds and flowers of Rhododendron spp., and their implications for mountain communities in Nepal," *Plants, People, Planet*, vol. 2, no. 4, pp. 320–325, 2020.

[47] B. Bhandari and S. K. Jha, "Comparative study of macrofungi in different patches of boshan community forest in kathmandu, Central Nepal," *Botanica Orientalis: Journal of Plant Science*, vol. 11, pp. 43–48, 2018.

[48] H. P. Pandey and S. Pokhrel, "Stocking density and DBH distribution of community forests in Nepal," *Small-scale Forestry*, vol. 20, no. 1, pp. 145–159, 2021.