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Enhancing livelihood through participatory watershed management: a case study in Paunglaung watershed area, Myanmar



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Abstract

This study focuses on changes in rural livelihoods in terms of social, physical, human, financial, and natural capitals before and during the intervention of integrated watershed management in Leinli village by using the Livelihood Approach. Data were collected through household and key informant interviews in Leinli village during 2019 and 2024. Personnel observation and informal interviews were conducted for four successive years, from 2020 to 2024. The study found no changes in livelihood strategies before and during the project implementation. Shifting cultivation stands as primary income source followed by NTFP (Non-Timber Forest Products) collection. According to the seasonal calendar, villagers collect NTFP for about nine months a year from the surrounding natural forests. However, the farmers who participated in project activities earned significant higher annual income on average from turmeric powder than non-participated farmers at a 1 % statistically significant level. It earning higher income relates to participatory watershed management intervention, the project's contribution on knowledge, on skills in hill cultivation and on small business enterprises to promote their livelihood.

Keywords: enterprise; livelihood approach; NTFP; participatory watershed management; shifting cultivation

ဒေသခံပြည်သူများ ပူးပေါင်းပါဝင်သောဘက်စုံရေဝေရေလဲဒေသစီမံအုပ်ချုပ်ခြင်းဖြင့် အသက်မွေးဝမ်းကျောင်း ဖွံ့ဖြိုးမှုမြှင့်တင်ခြင်း

ဒေါက်တာအိအိဆွေလှိုင်၊ လက်ထောက်ညွှန်ကြားရေးမှူး၊ သစ်တောသုတေသနဌာန
ဒေါက်တာတင်နှောင်းအေး၊ ဦးစီးအရာရှိ၊ သစ်တောဦးစီးဌာန
ဒေါ်ခင်မမခိုင်သု၊ တေသနလက်ထောက်-၂၊ သစ်တောသုတေသနဌာန

စာတမ်းအကျဉ်း

ဤစာတမ်း၏ အဓိကရည်ရွယ်ချက်မှာ ဒေသခံပြည်သူများ ပူးပေါင်းပါဝင်သော ဘက်စုံရေဝေရေလဲဒေသ စီမံအုပ်ချုပ်ခြင်းစီမံကိန်းမစတင်မီနှင့် စီမံကိန်းဆောင်ရွက်နေသည့် ကာလအတွင်း စီမံကိန်းတွင် ပါဝင်လုပ်ကိုင်နေကြသော ကျေးရွာသားများ၏ လူမှုရေးအရင်း အမြစ်ကြွယ်ဝမှု၊ သဘာဝအရင်းအမြစ် ပိုင်ဆိုင်မှု၊ ငွေကြေး ပိုင်ဆိုင်မှု၊ လူ့စွမ်းအားအရင်း အမြစ်ပိုင်ဆိုင်မှု၊ ရုပ်ပိုင်းဆိုင်ရာ ပိုင်ဆိုင်မှုစသည့် တိုးတက်ပြောင်းလဲမှု အခြေအနေများအား အသက်မွေးဝမ်းကျောင်းဆိုင်ရာ ဆန်းစစ်မှုနည်းလမ်းကို အသုံးပြု၍ လေ့လာသုံးသပ်ထား ခြင်းဖြစ်ပါသည်။ လိုအပ်သော အချက်အလက်များအတွက် စီမံကိန်းတွင် ပါဝင်လုပ်ကိုင်နေ ကြသော လိန်းလီကျေးရွာအတွင်းရှိ အဓိက သက်ဆိုင်သူများနှင့် တွေ့ဆုံမေးမြန်း ဆွေးနွေး ခြင်း၊ ပါဝင်အိမ်ထောင်စု (၉၀) အား ကျဘမ်းနမူနာ ကောက်ယူမေးမြန်းခြင်းတို့ကို ၂၀၁၉ ခုနှစ် (စီမံကိန်း မစတင်မီကာလ)နှင့် ၂၀၂၄ခုနှစ် (စီမံကိန်းဆောင်ရွက်နေသည့်ကာလ) (၂) ခု အတွက် နှိုင်းယှဉ်ဆောင်ရွက်ခဲ့ပါသည်။ ထို့အပြင် လေ့လာသူကိုယ်တိုင် မေးမြန်းလေ့လာခြင်း နှင့် အလွတ်သဘော ဆွေးနွေးခြင်းတို့ကို ၂၀၂၀ ခုနှစ်မှ ၂၀၂၄ ခုနှစ်အတွင်း (၄) နှစ်ကြာ ဆောင်ရွက်ခဲ့ပါသည်။ စီမံကိန်း မစတင်မီ ၂၀၁၈ ခုနှစ်နှင့် စီမံကိန်း ဆောင်ရွက်ဆဲကာလ ဖြစ်သည့် (၂၀၂၃) ခုနှစ်အတွင်း ဝင်ငွေရရှိစေသည့် အသက်မွေးဝမ်းကျောင်း လုပ်ငန်းများ သိသာထင်ရှားစွာ ကွာခြားမှု မရှိကြောင်း တွေ့ရှိရပါသည်။ အိမ်ထောင်စု၏ **အများဆုံးဝင်ငွေ** ကို စိုက်ပျိုးရေး လုပ်ငန်းတခုဖြစ်သော (နန္တင်းစိုက်ပျိုးခြင်း)မှ ရရှိပြီး သဘာဝတောမှ သစ် မဟုတ်သော သစ်တောထွက်ပစ္စည်း ထုတ်ယူရောင်းချခြင်းမှ **ဒုတိယအများဆုံး** ဝင်ငွေကိုရရှိ ပါသည်။ ရာသီအလိုက် လုပ်ငန်းဆောင်ရွက်မှု မှတ်တမ်းများအရ သစ်မဟုတ်သော သစ်တော ထွက်ပစ္စည်းထုတ်ယူရောင်းချခြင်းလုပ်ငန်းကို တစ်နှစ်လျှင်လပေါင်း (၉)လခန့်ဆောင်ရွက်ပြီး အရွယ်ရောက်ပြီး အလုပ် လုပ်နိုင်သည့်သူတိုင်း ပါဝင်ဆောင်ရွက်ကြောင်း မေးမြန်းသိရှိရပါ

သည်။ ဤသုတေသန တွေ့ရှိချက်အရ ယခုစီမံကိန်းတွင် ပါဝင်သူများအနေဖြင့် နန္ဒင်းမှူန့်ကုန်ချော ထုတ်လုပ်ရောင်းချခြင်းလုပ်ငန်းက ယခုစီမံကိန်းတွင် ပါဝင်ဆောင်ရွက်ခြင်း မရှိသူများထက် သိသာထင်ရှားစွာ ဝင်ငွေကွာခြားမှုရှိကြောင်း တွေ့ရှိရပါသည်။ ထိုသို့ ကွာခြားရခြင်းမှာ တောင်ယာစိုက်ပျိုးရေးနှင့် အသေးစားစီးပွားရေး လုပ်ငန်းများအတွက် အသိပညာဗဟုသုတများ မျှဝေမှု၊ နည်းပညာအကူအညီ အထောက်အပံ့များပေးမှုနှင့် ဆက်စပ်လျက်ရှိကြောင်း တွေ့ရှိရပါသည်။

Enhancing livelihoods through participatory watershed management: a case study in Paunglaung watershed area, Myanmar

1. Introduction

A watershed is an ecosystem with complex interacting natural components (biotic and abiotic). Human activities directly influence the quality and quantity of surface water, groundwater, and other natural resources in the watershed. Upstream activities, such as farming, mining, and building influence river flows and water quality downstream. The main components of watershed management are resource conservation, crop production, and alternate land-use systems.

Myanmar's geographical condition states that over 80% of the country's area can be bounded as watersheds. The critical watershed areas in Myanmar are the Ayeyarwady and Chindwin River Basin, Thanlwin River Basin, Sittaung River Basin, and Mekong River Basin. Paunglaung River and its watershed area is the upper reach of the Sittaung River. To conserve Myanmar's watersheds systematically, the Forest Department has carried out watershed management programs with the aid of UNDP/FAO since the 1990s. Additionally, the Forest Department has been implementing Watershed Conservation Action Plans based on five-year intervals to conserve watershed areas of major dams and reservoirs, including Inle Lake. Conservation of existing residual forest, the establishment of the watershed plantation, soil conservation measures using civil engineering and bioengineering, and research activities are being implemented. Along with the Nay Pyi Taw Council area development into a Green City, a Clean City, and a Smart City, conservation of the forest in head watershed areas of Paunglaung River, Ngalike Creek, and Hsinthay Creek becomes crucial for ensuring better climatic conditions and sharing of water with users under the excellent management.

Watershed management must be integrated and address water and related land resources, including streams, wetlands, forests, soils, fisheries, flora, and fauna. The objective of integrated watershed management in Myanmar is to improve farmer's livelihoods and protect the environment in poor and often highly degraded watersheds in the mountainous and hilly regions by promoting a replicable model of sustainable rural development. According to Tideman, 2007, some essential principles of watershed management include utilizing the land considering its capability, conserving fertile topsoil, protecting vegetative cover throughout the year, increasing cropping intensity through inter and sequence cropping, maximizing farm income through agricultural-related activities, improving facilities for storage, transport, and agricultural marketing and improving the socio-economic status of farmers.

The project entitled “Integrated Forest Ecosystem Management Planning and Demonstration in Greater Mekong Sub-region (Myanmar)” is a cooperation program between the Forest Department of the Ministry of Natural Resources and Environmental Conservation and the Asia Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet) from 2019 to 2024 for five years. The common objective of integrated watershed management is

to improve the living standards of ordinary people in the basin by increasing their earning opportunities. The overall objectives of this watershed development are to recognize watersheds a unit for development, and to be in efficient use of land according to participating farmers' capabilities for production, and to be efficient use of natural resources for improving agriculture and allied occupation to promote the socio-economic conditions of the participants.

The participatory watershed management plan for Leinli village, the village is located in the watershed area of Paunglaung dam, was developed through empowering Leinli villagers in decision-making and implementation of agroforestry demonstration plots for 100 acres in the Paunglaung watershed area. With the support of this project, timber trees such as Padauk (*Pterocarpus macrocarpus*), Pyinkado (*Xylia xylocarpa*), Yemane (*Gmelina arborea*), fruit trees such as Jack fruit (*Artocarpus heterophyllus*), Chindayin (*Parkia speciosa*) and cash crops such as pineapple plants and elephant foot yam having been grown in mixture. According to the tree enumeration at the project site in December 2023, the average survival rate was at about 80 %. The project activities also contain the capacity building of local villagers in managing their farms through agroforestry practices, and technical and material support (for example grinder machine) for value-added product production using local raw materials. The farmers participating in this project are now running turmeric grinding business.

Researchers conducted various studies in watershed areas throughout the country, including Inlay Lake and Paunlaung watersheds in the southern Shan State of Myanmar. Most of them emphasize the causes of deforestation and forest degradation in watershed areas, explore the regeneration of old-growth forests and secondary forests in watershed areas using Assisted Natural Regeneration, NTFPs for household income, dependency on surrounding forests, causes for soil erosion, crop yields, provision of goods and services from watershed conservation by community forests (Aye et al., 2007; Mon et al., 2009; Cho et al., 2017; Kyaw et al, 2021; OO et al, 2021). There needs to be more study on detailed information of the community livelihoods (Mon et al, 2009). Based on a research report on Inlay Lake and its catchment area, Bellamy et al. (2015) also pointed out the analysis of water quality, institutional capacity needs for an integrated catchment approach, and community livelihoods as some of the leading research gaps.

Therefore, this study's primary purpose was to assess the effects of an integrated ecosystem management project on the sustainable livelihood assets (of households) participating farmers using a sustainable livelihood framework. Specifically, the study's objectives are:

1. to clarify the role of local livelihoods in Leinli village, the upstream area of the Paunglaung watershed
2. to analyze the effects of integrated ecosystem management project intervention on the household's human, natural, physical, financial, and social livelihood assets.

A comprehensive analysis of local households' livelihood aspects is essential to be aware of the livelihood condition of households undertaking the project activities; it enables the building of a strong base for households on whether the offered project activities are worthwhile.

It also contributes to project planners' decisions by visualizing the magnitude of project output and up-scaling planning on the project management strategies.

2. Materials and methods

2.1 Conceptual Framework

After formulating research objectives, the next logical step in the survey-oriented research process is explicitly developing and describing a conceptual framework. A conceptual framework defines how the reality under study is expected to behave and outlines relations between the main concepts based on prevailing theories and associated empirical works (Angelsen et al., 2011). Therefore, the conceptual framework for this research is constructed based on the theoretical background and the empirical activities during the field survey.

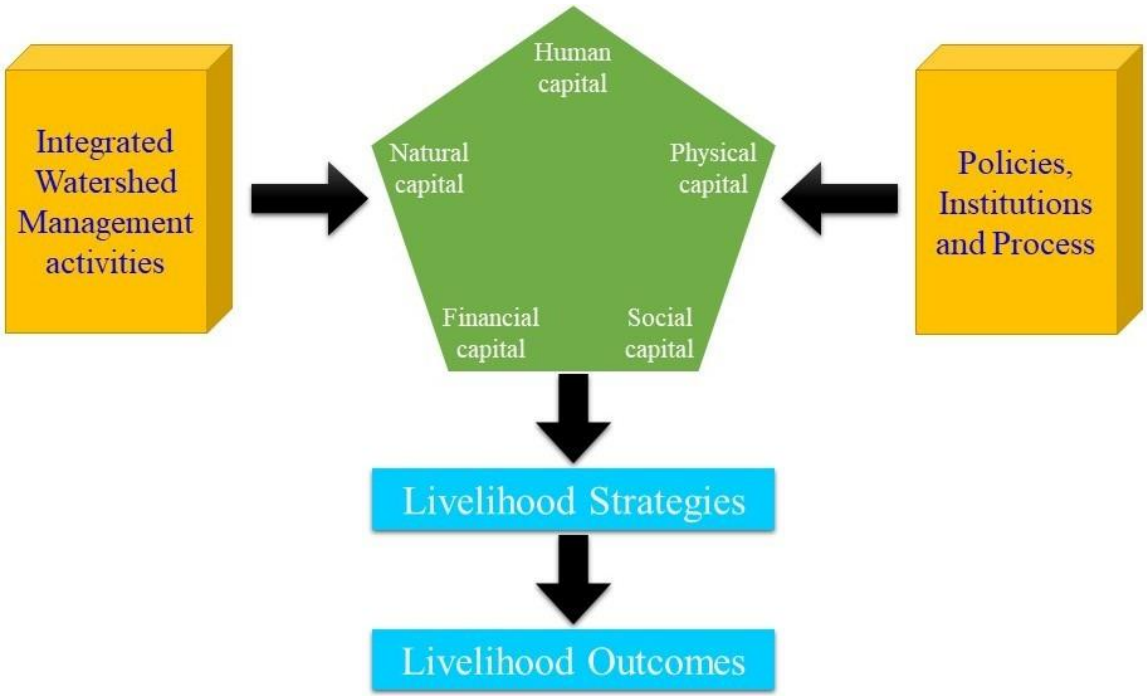

Figure 1: Sustainable livelihood framework (adapted from DFID, 2000)

The concept of a livelihood used by DFID is adapted from Chambers and Conway's (1992) work, which states that a livelihood consists of the skills, resources, and activities necessary for a means of subsistence. When a way of life is sustainable, it can withstand stresses and shocks, recover from them, and retain or improve its capacities and resources today and in the future without compromising the natural resource base (DFID, 2000). According to this idea, to maintain sustainable livelihood outcomes and strategies, one must have access to capital assets or livelihood resources (such as natural, human, physical, financial, and social capital assets). Figure (1) provides the conceptual framework for analyzing the livelihood assets or capitals of local villagers affected by the integrated management of forest ecosystem project activities in Leinli village.

2.2 Study Area

The study was conducted in Leinli village, where the demonstration for integrated management of forest ecosystem project was started in 2019. Leinli village is located near Paung Laung River and 38 kilometers away from Pin Laung town, a seat of Pin Laung Township in the Pa-O self-administered zone of Shan State in Myanmar. The farming system is small-scale subsistence farming on red and yellow turmeric, banana, avocado, jack fruit, coffee, and chili. Moreover, households raise cattle, pigs, and chickens as subsistence level livestock rearing. People in the area are highly interested in improving their income as well as improving their living environment. The income generation activities of the project hope to achieve increased interest in and understanding of projects aimed at improving the lives of local people and occupational castes. For the locals, cash income through farming is familiar and therefore, introducing small-scale processing industries is exceptionally reasonable. Currently, the project can provide income generation activities through small-scale turmeric processing business. Developing local processing industries will likely also provide local jobs opportunity in the long term.

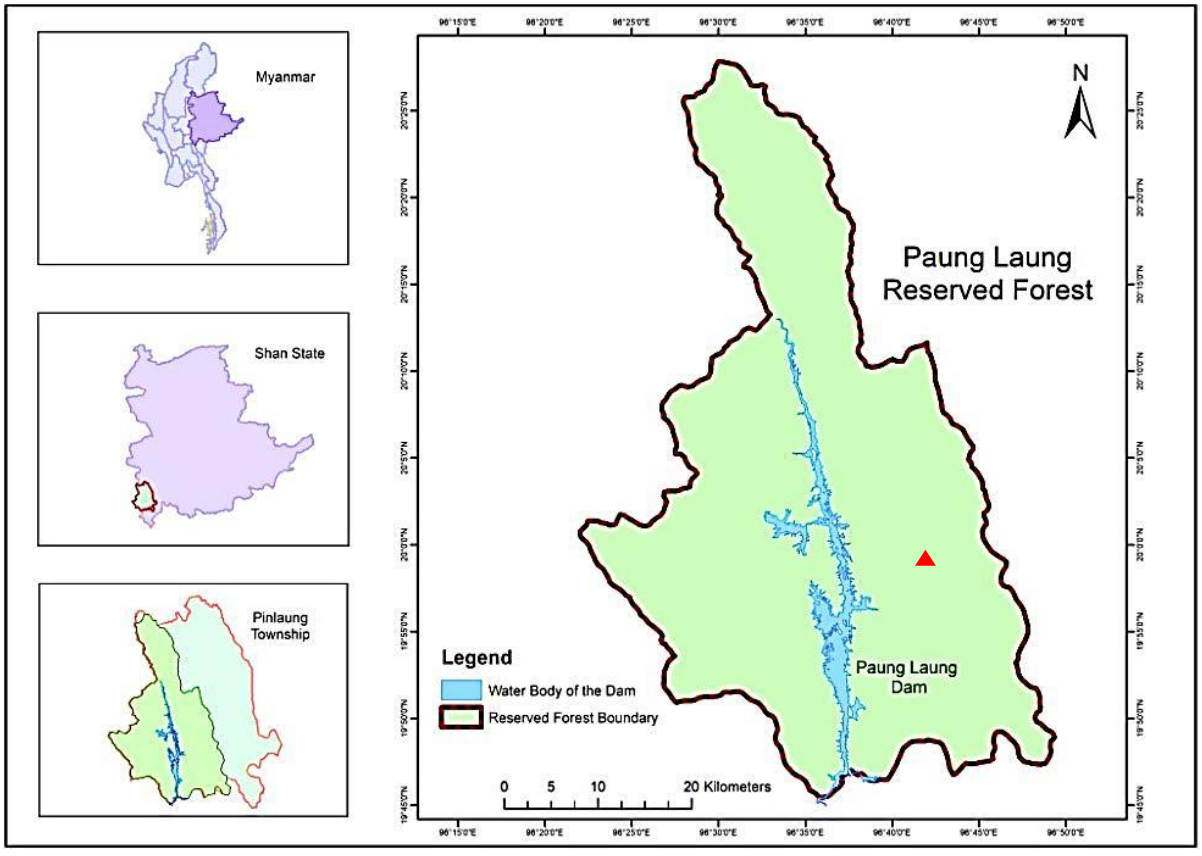

Figure 2: Study area Map of Leinli Village

2.3 Data Collection

Data was gathered for two times, one in 2019 and the other in 2024 by a group of experts from the Forest Research Institute (FRI) and the local people from the Leinli village. The total number of households in Leinli village was at 160, of which 90 households, including participant and non-participant households in the project activities, were purposefully and randomly selected to gather information on livelihood status. Thus, the total sample size was 90 households, of which 39 were direct participants in the project activities and 51 were non-participants (Table 1). For the 2024 data collection, local enumerators who are bachelor's degree holders, knowledgeable about the area, and well acquainted with the local community culture were selected and trained for one day for data collection at FRI. Local enumerators conducted a household survey in 2024 on the same sample of households conducted in 2019.

Table 1: Profile of sampled households in Leinli village

Project	Sample Households	Sampling %	Total Households
Participant	39	24	160
Non-participant	51	32	
Total	90	56	

A comprehensive draft of a structured household questionnaire was created, pre-tested, and amended before the first 2019 survey. The data were collected using personal interview techniques from sampled households based on a one-year recall period for assessing income data. The questionnaire included households' demographic, socio-economic, and livelihood characteristics. Focus group discussions were held occasionally during 2019 and 2023 to gather some contextual data to recognize the local conditions for complementing the questionnaire. The key informants included the village heads, older persons, and community mobilizers of the APFNet project. Additionally, personnel observation and informal interviews were conducted for four successive years, from 2020 to 2024. Both qualitative and descriptive approaches were employed in this research.

2.4 Data Analysis

The study defined "livelihoods" as the range of economic activities used to generate income for rural households to maintain their living. The sources of income considered are farm income (crop and livestock production), off-farm income (temporary, contract, and permanent employment), and NTFP's income (elephant foot yam, bamboo shoots, broom grass). A household's total income comes from these three sources, and it is estimated on an annual basis. Crop income was calculated by multiplying the crop yields collected and the prevailing prices during the previous twelve months. Income from livestock was calculated by multiplying the amount of consumption and sale for the past twelve months by the prices. The estimated gross

monetary value of NTFPs was calculated by multiplying all collected amounts over the previous twelve months by the prices. Earnings from wage employment were calculated by multiplying the days worked for the past twelve months by the daily wage rate. The number of days worked and daily wage rates were obtained from family members through the questionnaire survey. Income from other sources of employment, such as salaried jobs in government organizations, companies, and businesses, was calculated by multiplying the salary amount by the working days during the past twelve months. In this study, off-farm income means income from farm-based wage employment and non-farm and non-forest activities. The demand for income from various sources depends on household capital endowment (human, social, physical, financial, and for instance, poor households without agricultural land holdings have an exceptionally high demand natural). for forest products collection from the forest.

The data were encoded and analyzed using R software (version 4.3.2) and Microsoft Office Excel. Descriptive statistics summarized the profiles of the respondents. We used the mean comparison test (paired t-test) to test whether or not there is a significant difference between participants and non-participants in terms of socioeconomic characteristics of respondents between the two study periods. For a comparison of the mean divergences in sustainable livelihood assets across program participants and non-participants, a paired sample t-test was also used. Then, the livelihood asset pentagon was drawn to show the pattern of sustainable livelihood asset capacity structures between the two studied groups. This study employed the scaling method to measure the natural, physical, financial, human, and social capital. The indicators used to measure these capitals were determined by assessing the rating scale method in terms of different weights (Table 2).

Table 2: Description of measurement of sustainable livelihood asset indicators

Livelihood assets and its indicators	**Assessment Scale**				
Human asset	**1**	**2**	**3**	**4**	**5**
Age of HHH	> 60 years old	51 to 60	41 to 50	31 to 40	20 to 30
Education of HHH	Monastery education	Primary education	Middle education	High school education	Graduated
Family size	Only one	2-3 people	4-5 people	6-7 people	> 7 people
Natural asset	**1**	**2**	**3**	**4**	**5**
Agricultural land holding (Acre)	≤1	>1 to 2	>2 to 3	>3 to 4	> 4
Water	Extremely	Frequent	Inconsistent	Generally	Easy access

availability	inadequate	shortage	availability	adequate	
Physical asset	**1**	**2**	**3**	**4**	**5**
Housing quality (house type, construction,etc.)	Poorly constructed	Remain poor quality	Neutral	Enhanced housing quality	Modern housing
Household items	Lack of ownership	Insufficient	Neutral	Specific items	Wide range of household items
Financial asset	**1**	**2**	**3**	**4**	**5**
Total annual income of HH	< 600,000 MMK	600,000 - 1,000,000 MMK	1,000,000 - 2,500,000 MMK	2,500,000 - 4,000,000 MMK	> 4,000,000 MMK
Social Asset	**1**	**2**	**3**	**4**	**5**
Status of participation in any institutional program	Not interested	Limited participation	Moderate participation	Strong participation	Widespread engagement and support
Status of participation in various trainings	No participation	Limited participation	Completed 1 training	Completed 2 trainings	Completed ≥3 trainings

3. Results and Discussions

3.1 Demographic and livelihood characteristics of households

The descriptive statistics results of sample households' demographic and livelihood characteristics, such as land holding, primary crop production, and NTFP extraction, were presented in Table 3. A mean comparison test (paired sample t-test) was used to test whether there is a significant difference between participant and non-participant households in two periods. The average taungya (Acre) of households was 2.52 and 2.07 in 2018 and 2023, respectively, and the average taungya (Acre) of participating households was significantly higher than non-participating households in 2023 at a 1% significance level. Also, in 2023, project participating households' land holding area (Acre) was significantly higher than non-participating households at a 5% significance level (Figure 3; Table 3).

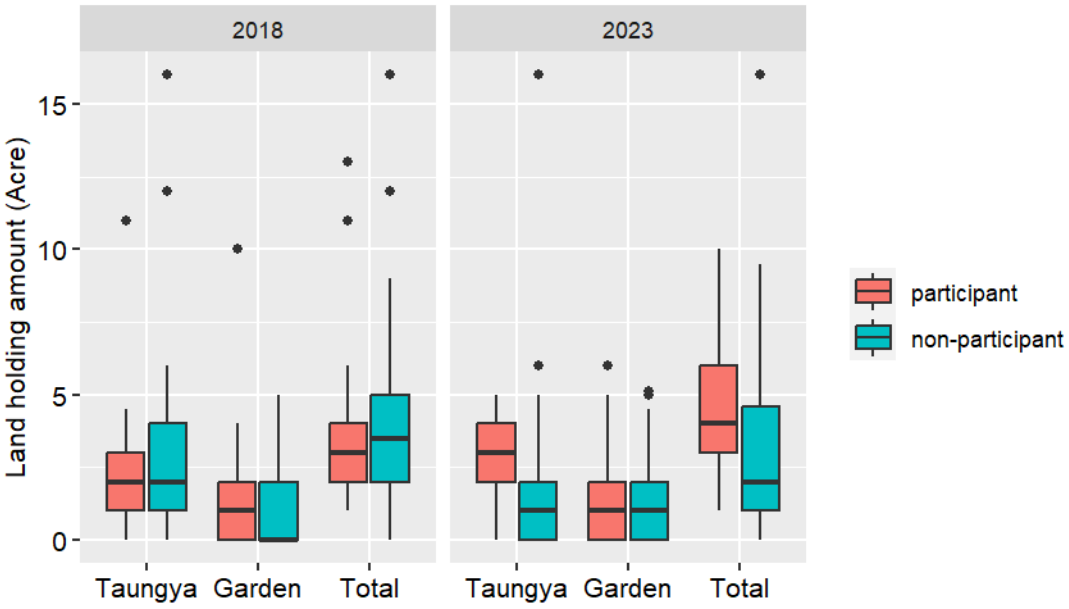

Figure 3: Land holding amount between participant and non-participant households (farmers)

Various income sources were categorized into three primary sources: (1) farming, (2) off-farm employment, and (3) NTFP collection. Farm income was the most significant income source for both participant and non-participant households, contributing the average annual farm income of MMK 960,000 in 2018 and MMK 1,030,000 in 2023 (Figure 4; Table 4). The highest crop production per household in the cropping seasons of 2018 and 2023 was yellow turmeric (488 ± 596 viss and 364 ± 429 viss), followed by red turmeric (259 ± 455 viss and 73.3 ± 260 viss), respectively. During 2023, the project participant households had better average annual crop production, such as red turmeric (113 ± 369 viss), yellow turmeric (449 ± 490 viss), and NTFPs such as elephant foot yam (30.3 ± 69.9 viss), and broom grass (15 ± 17.1 bundle) than non-participants who had average crop yield of red turmeric (43.1 ± 122 viss), yellow turmeric (300 ± 367 viss) and NTFP extraction such as elephant foot yam (20 ± 35.9 viss) and broom grass (13.7 ± 11.9 bundle), but no statistically significant difference between the two groups (Table 3). The average annual off-farm income per household generated approximately MMK 676,00 in 2018 and MMK 725,000 in 2023, respectively (Table 4). Non-participant households had a higher average annual off-farm income (MMK 797,000) than participant households (MMK 630,000), but no statistically significant difference between them (Table 4).

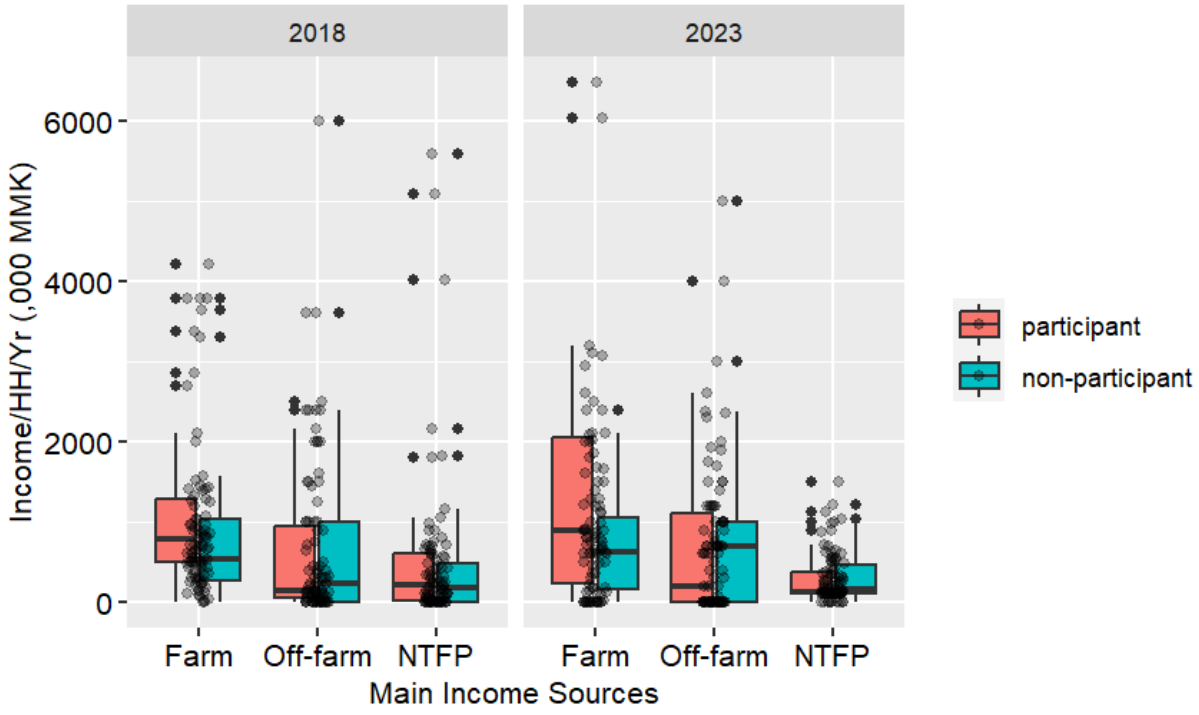

Figure 4: Contribution of three main income sources

Table 3: Demographic and livelihood characteristics of households

Characteristics	2018				2023			
	Participant (n=39)	Non-participant (n=51)	Overall (n=90)	t-test	Participant (n=39)	Non-participant (n=51)	Overall (n=90)	t-test
	(Mean±SD)	(Mean±SD)	(Mean±SD)	p value	(Mean±SD)	(Mean±SD)	(Mean±SD)	p value
Demographic characteristics								
Age	42.5 ± 13.1	46.6 ± 16.4	45 ± 13.4	0.312	45 ± 13	49 ± 14	48 ± 13.7	0.428
Educational years	2.23 ± 1.77	2.39 ± 2.59	2.32 ± 2.26	0.727	3.90 ± 2.96	3.88 ± 3.22	3.89 ± 3.10	0.982
Family size	4 ± 1.45	4 ± 1.61	4 ± 1.53	0.838	4 ± 1.33	4 ± 1.68	4 ±1.56	0.616
Livelihood characteristics								
Total land holding (Acre)	3.42 ± 2.47	4.05 ± 3.02	3.78 ± 2.80	0.282	4.38 ± 2.03	2.93 ± 2.91	3.56 ± 2.65	*
Taungya (Acre)	2.17 ± 1.84	2.79 ± 2.82	2.52 ± 2.45	0.207	2.77 ± 1.21	1.53 ± 2.49	2.07 ± 2.12	**
Garden (Acre)	1.23 ± 1.80	1.11 ± 1.39	1.16 ± 1.57	0.725	1.51 ± 1.45	1.38 ± 1.52	1.43 ± 1.48	0.684
Red turmeric production(viss/HH/Yr)	382 ± 621	165 ± 233	259 ± 455	*	113 ± 369	43.1 ± 122	73.3 ± 260	0.263
Yellow turmeric production(viss/HH/Yr)	593 ± 762	409 ± 419	488 ± 596	0.18	449 ± 490	300 ± 367	364 ± 429	0.117
Wa U extraction (viss/HH/Yr)	66.9 ± 103	115 ± 172	94.2 ± 147	0.103	30.3 ± 69.9	20 ± 35.9	24.4 ± 53.3	0.407
Broom grass extraction (bundle/HH/Yr)	33.6 ± 113	26.8 ± 53.5	83.9 ± 8.85	0.731	15 ± 17.1	13.7 ± 11.3	14.0 ± 1.48	0.687
Bamboo shoots extraction (viss/HH/Yr)	957 ± 3295	703 ± 2831	813 ± 3025	0.701	274 ± 507	293 ± 447	285 ± 472	0.855

Note: p<0.05* and p<0.01** represent statistical significance at 5% and 1% significance level.

NTFP income was the most minor contribution among the sample households in Leinli village. However, most respondents stated in the focus group discussion and household survey that almost all young people under 60 years old are involved in NTFP collection during the off-farm season, and this NTFP income served as a safety net during the hard times. The average annual revenue per household from NTFP collection slightly decreased from MMK 473,000 to MMK 301,000 between 2018 and 2023 (Table 4). In 2023, the project participant households received a higher average annual NTFP income, representing MMK 306,000, than non-participant households, which received MMK 296,000, but there was no statistically significant difference between them (Table 4).

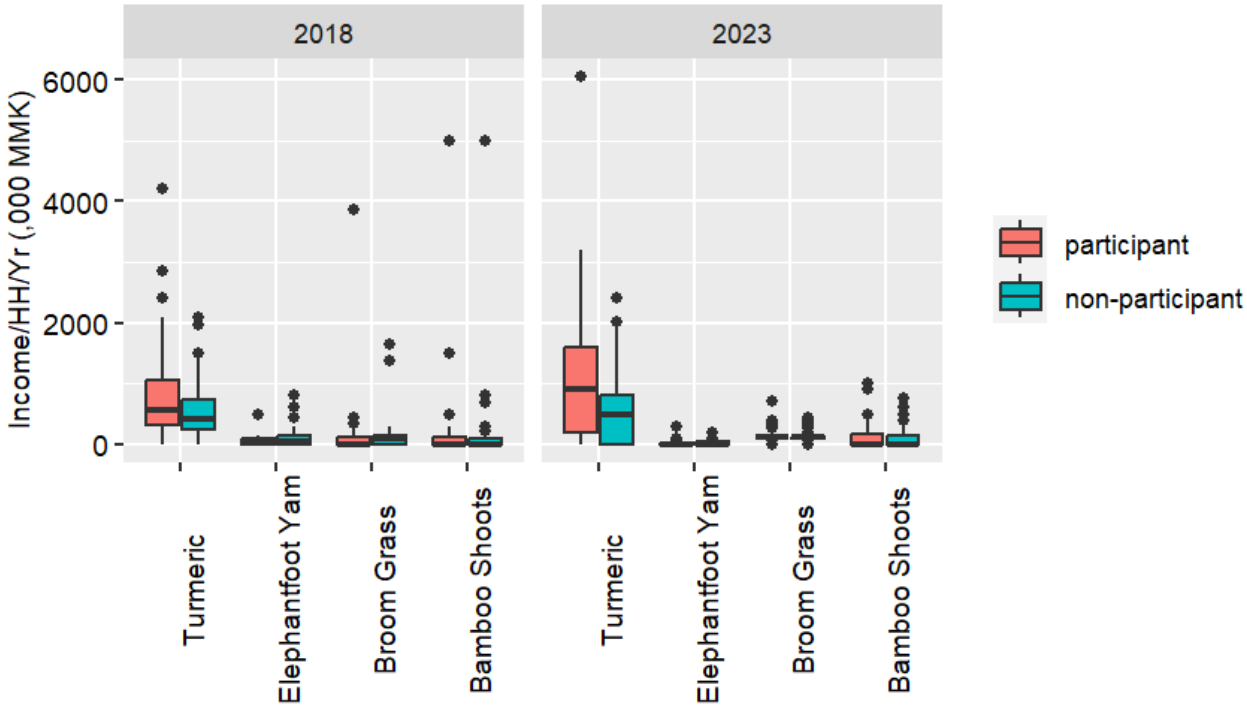

Figure 5: Income contribution of main agricultural crops and NTFPs

Paired sample t test results showed that farm income including agricultural income and turmeric income were significantly different between the two groups in 2023 cropping season (farm income: $p<0.05$; agricultural income: $p<0.05$; turmeric income: $p<0.01$) (Table 4). The project participant households had the significantly higher average annual household income from (farming: MMK 1,410,000; agriculture: MMK 1,171,000; turmeric: MMK 1,151,000) than non-participant households (farming: MMK 731,000; agriculture: MMK 645,000; turmeric: MMK 575,000) during 2023 (Table 4). Turmeric is the major crop produced by the households in Leinli village. In 2023, the project supported a turmeric grinder machine to the project participants with the aim of income generation by the development of small-scale processing. The participant households get benefit from raw turmeric as well

as turmeric powder grinded by this machine. As a result, the participant households had significantly higher average annual revenue from turmeric in 2023 than non-participant households at 1% statistically significant level (Figure 5; Figure 6; Table 4).

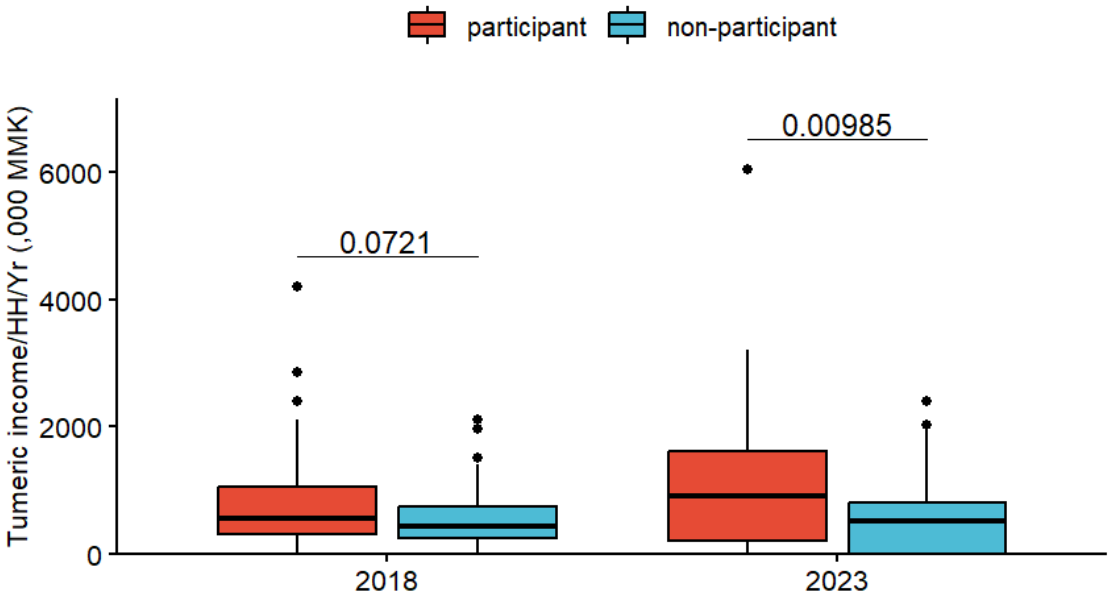

Figure 6: Turmeric income between participant and non-participant households in 2018 and 2023 (the values above the sticks represent p-value by paired sample t test)

Table 4: Comparisons of income contribution between participant and non-participant households in 2018 and 2023

Income sources (,000 MMK/HH/Yr)	**2018**				**2023**			
	Participant (n=39)	Non-participant (n=51)	Overall (n=90)	t-test	Participant (n=39)	Non-participant (n=51)	Overall (n=90)	t-test
	(Mean±SD)	(Mean±SD)	(Mean±SD)	p value	(Mean±SD)	(Mean±SD)	(Mean±SD)	p value
Farm income	1,109± 1014	845± 926	960 ± 969	0.208	1,410± 1518	731± 659	1,030 ±1160	*
Agriculture	955± 949	782± 921	858 ± 932	0.383	1,171± 1224	645 ±644	873 ± 971	*
Turmeric	859 ±868	573 ±506	697 ± 698	0.072	1,152 ±1230	575 ±620	826 ± 972	**
Livestock	153 ±388	62 ±128	102 ± 275	0.167	239 ±705	86 ±156	153 ± 482	0.191
Off-farm income	635 ±826	707 ±1165	676 ± 1030	0.731	630 ±885	797 ±959	725 ± 927	0.394
NTFP income	525 ±1027	433 ±864	473 ± 934	0.655	306 ±340	296 ±288	301 ± 311	0.881
Elephant foot yam	68 ±113	113 ±171	94 ±150	0.141	23 ±54	20 ±35	21 ± 44.6	0.729
Broom grass	178 ±618	145 ±295	160 ± 461	0.757	150 ±132	132 ±104	141 ± 117	0.487
Bamboo	47 ±144	2 ±8	22 ± 98	0.058	11 ±43	6± 27	8 ± 35	0.589
Bamboo shoots	229 ±824	171 ±708	197 ± 757	0.728	121 ±241	136 ±194	130 ± 215	0.742
Total annual income	2,269 ±1761	1,986 ±1889	2,110 ±1830	0.466	2,347 ±1636	1,825 ±1064	2,050 ±1360	0.088

Note: $p<0.05$*, $p<0.01$** represent statistical significance at 5% and 1% significance level.

3.2 Livelihood asset dimensions of households

Five livelihood assets, (1) natural, (2) physical, (3) financial, (4) human, and (5) social, were described at the spatial scale (across program participants and non-participant households in two periods). Both groups' overall sustainable livelihood asset values were described in Table 5. A paired sample t-test was used to compare the livelihood asset values between project participant and non-participant households in 2018 and 2023. The radar diagrams also depicted the livelihood asset capacity structure of the study households (Figures 8 and 9).

(a)Human asset

The indicators used to analyze human assets were age, educational years of household head, and family size. As revealed from the result of 2023, the overall human asset value of the project participant households was slightly higher (2.95) than the non-participating group (2.71) (Table 5). However, there was no significant difference between them (Table 5).

The family size is learned at between 3-5 members per family. This is well within the average family size of Myanmar, which is 4.4. The discussion with key informants revealed that the migration of youth (working age) to abroad and urban areas to look for a job was widespread in the study area after the COVID-19 pandemic.

(b) Natural asset

The area of farmland (taungya) belonging to the household, areas of gardens, and water availability were used as indicators to measure natural assets. The overall natural asset value of project participant households was higher (3.68) than the non-participants (3.13), and this difference was statistically significant at a 1% level in 2023 (Table 5). According to resource mapping and informal interviews, there are also open access areas around the village and along the Paunglaung River and its watershed for collecting bamboo shoots, elephant foot yam, and broom grass (Figure 7).

(c)Physical asset

We assessed the status of a physical asset in the components of the quality of housing structure and types of items owned by households. The results showed that the overall physical asset value of the project participant households (3.41) was greater than that of the non-participants (3.14), with a statistically significant difference at a 1% level in 2023. However, there was no significant difference in physical assets between the groups in 2018 (Table 5). All households own communication devices, and there is no rental accommodation in Leinli village.

(d) Financial asset

According to the focus group discussions mentioned in the participatory watershed co-management plan developed by the project, more than 50 % of villagers have faced food shortages and have addressed the problem or hardship by borrowing money from others with a 4-5 % interest rate per month. During the study period, there is no available credit/loan from any other sources. Thus, this study's only financial capital indicator was the household's total annual income. There are three sources of income: farm income, off-farm income, and income from collecting NTFP. As revealed from the

result, participant households' overall financial asset value was higher than non-participant households in 2018 and 2023. However, there was no significant difference between them in both periods (Table 5).

(e) Social asset

The indicators used to analyze social assets were participation in community forests, participation in integrated ecosystem management project activities, and access to training from various institutions and programs. The study result indicated that the overall social asset values of the participants (3.46 and 3.55) were better than those of non-participants (3.01 and 3.18), with a significant difference of 1% level between them in 2018 and 2023, respectively (Table 5). A few households took part in the village administrative organization.

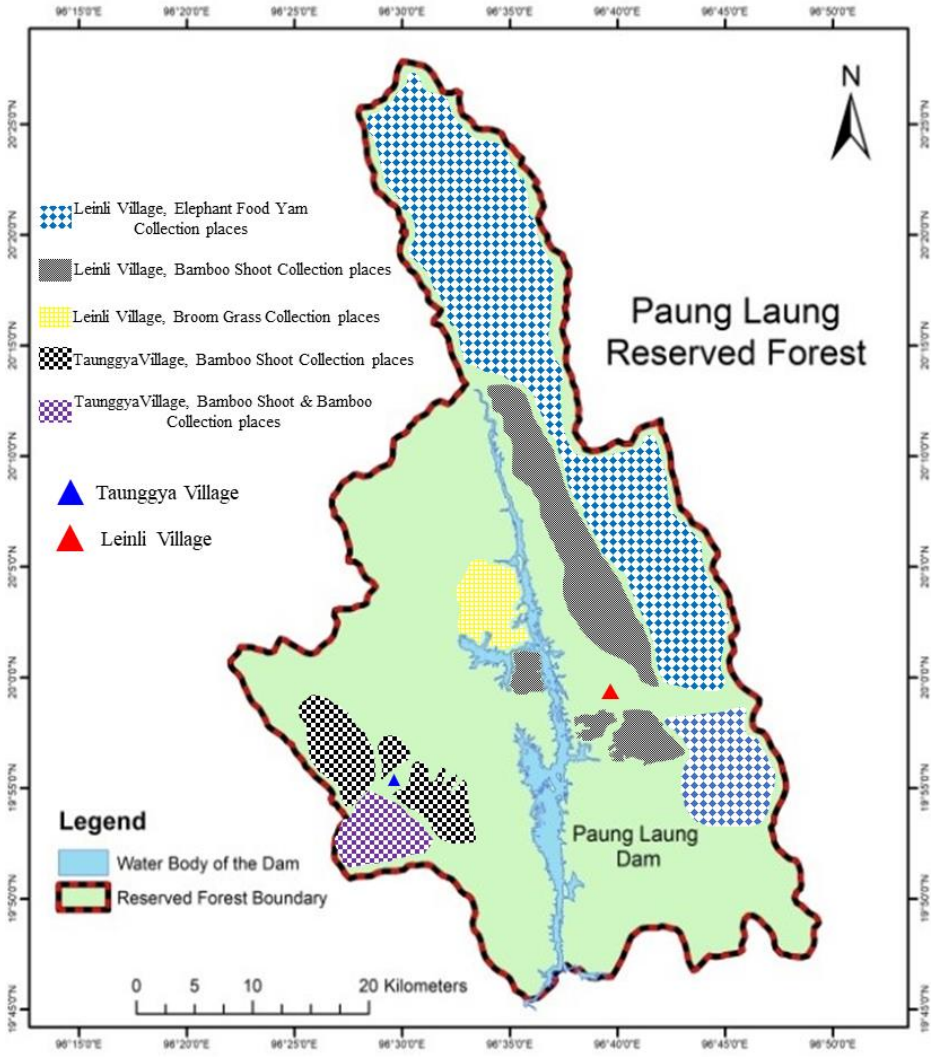

Figure 7: Natural Resources collection along the Paunglaung River

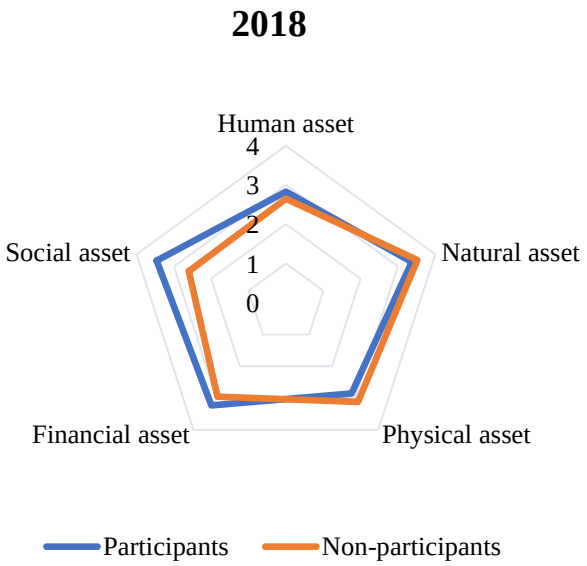

Figure 8: Comparison of overall livelihood asset values between participant and non-participant households in 2018

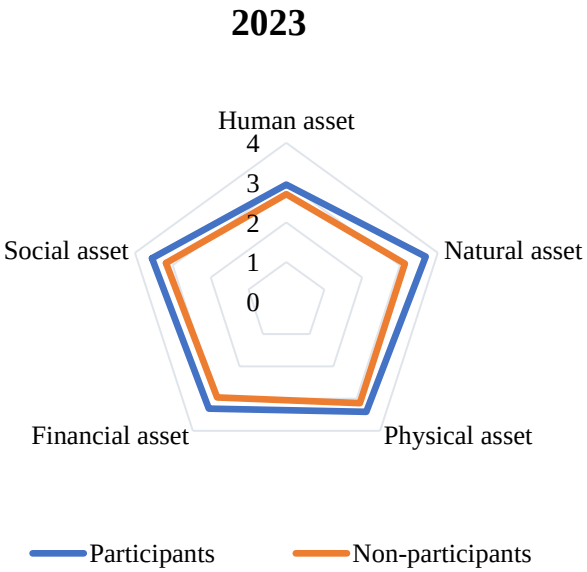

Figure 9: Comparison of overall livelihood asset values between participant and non-participant households in 2023

Comparisons of the livelihood asset pentagon of the integrated ecosystem management project's participant households versus non-participant households in 2018 and 2023 were made using radar diagrams plotted by inserting the overall value of the five livelihood assets (Figures 8 and 9 and Table 5). The Pentagon visually presents household asset information, bringing relationships among five assets. The asset with the highest capacity is the natural asset (3.68), followed by social asset (3.55), physical asset (3.41), financial asset (3.31), and human asset (2.95) for project participant households in 2023

(Figure 9; Table 5). For the project non-participant households in 2023, the asset with the highest capacity is a social asset (3.18), followed by a physical asset (3.14), natural asset (3.13), financial asset (2.96), and human asset (2.71) (Figure 9; Table 5). The human asset has the lowest asset value for participant and non-participant households compared to others because of the low educational background, old age of household heads, and small family sizes among the local households.

Table 5: Comparison of sustainable livelihood asset between participant and non-participant households in 2018 and 2023

Livelihood asset	2018				2023			
	Participant (n=39)	Non-participant (n=51)	Overall (n=90)	t-test	Participant (n=39)	Non-participant (n=51)	Overall (n=90)	t-test
	(Mean±SD)	(Mean±SD)	(Mean±SD)	p value	(Mean±SD)	(Mean±SD)	(Mean±SD)	p value
Human asset								
Age	3.33 ±1.34	2.88± 1.28	3.08 ±1.32	0.111	3 ±1.32	2.69 ±1.27	2.82 ±1.30	0.259
Education	2.44 ±0.754	2.39 ±0.896	2.41 ±0.833	0.802	2.87 ±0.864	2.82 ±0.874	2.84 ±0.974	0.804
Family size	2.72 ±0.759	2.69 ±0.836	2.7 ±0.8	0.852	2.97 ±0.707	2.68 ±0.894	2.78± 0.832	*
Overall asset value	2.83 ±0.60	2.65 ±0.66	2.73 ±0.63	0.193	2.95± 0.62	2.71 ±0.66	2.82 ±0.65	0.086
Natural asset								
Land holding (Acre)	3 ±1.36	3.37 ±1.44	3.21 ±1.41	0.213	3.74± 1.16	2.71 ±1.62	3.16± 1.52	***
Water availability	3.74 ±0.498	3.67 ±0.554	3.7 ±0.529	0.491	3.62 ±0.493	3.55 ±0.541	3.58 ±0.519	0.546
Overall asset value	3.37 ±0.825	3.52 ±0.889	3.46 ±0.86	0.418	3.68 ±0.683	3.13 ±0.989	3.37 ±0.908	**
Physical asset								
Housing quality	3.06 ±1.12	2.82 ±1.1	2.96 ±1.11	0.315	2.51 ±1.25	3.44 ±0.88	2.91 ±1.2	**
Household items	2.87 ±1.17	3.18 ±1.29	3.04 ±1.24	0.246	3.51± 0.97	3.05 ±1.39	2.96 ±1.32	*
Overall asset value	2.85 ±1.12	3.12 ±1.18	3.00 ±1.15	0.268	3.41 ±0.91	3.14 ±1.29	2.93 ±1.23	**
Financial asset								
Total annual income	3.23 ±1.13	2.95± 1.23	3.08 ±1.19	0.284	3.31± 1.06	2.96± 0.77	3.11 ±0.917	0.088
Social asset								
Participation in any institutional program	4.15 ±0.366	2.97± 0.348	3.41 ±1.67	***	4.13 ±0.399	3.14 ±0.160	2.98 ±1.32	**
Participation in various trainings	2.77 ±0.931	3.06 ±0.988	2.93 ±0.969	0.158	2.97± 1.16	3.27 ±1.40	3.14 ±1.30	0.269
Overall asset value	3.46 ±0.51	3.01 ±0.568	2.99 ±0.69	**	3.55 ±0.594	3.18 ±0.82	3.04 ±0.798	**

Note: $p<0.05$*, $p<0.01$** and $p<0.001$*** represent statistical significance at 5%, 1% and 0.1% significance level

4.Conclusions

Watershed area development become essential to rural livelihood development. This study assessed the impacts of participatory watershed management on the livelihoods of the watershed communities in Leinli village, located in the Paunglaung watershed area, using with and without approach. The study showed that most villagers are small-scale farmers because the respondents' average Taungya (acre) is 2 acres. Turmeric growing is a significant livelihood followed by off-farm income and NTFP collection. According to the results of key informant interviews, young people under 60 are involved in NTFP collection during the off-farm season, and income from NTFP served as a safety net during the hard times. 80 % of respondents have gardens with small-scale mango, jack fruit, banana, coffee, and Chin danyin growing.

Among the livelihood assets studied, natural assets are the highest, followed by social, physical, financial, and human assets in project participant households. For non-participant households, social assets are the highest, followed by physical, natural, financial, and human assets. The study area has an absolute advantage in natural assets regarding landscape, the environment, and natural-resource-led renewables, as the villagers can collect bamboo shoots, elephant foot yams, and bamboo grass from the surrounding forests. The farmers who participated in project activities earned significant higher average annual income from selling turmeric powder than non-participated farmers at a 1 % statistically significant level. It, earning higher income, relates to participatory watershed management intervention, the project contribution on knowledge skills in hill cultivation and on small business enterprises to promote their livelihood.

Financial assets play an important role in enabling other types of assets to be owned and traded while enhancing human assets can be achieved through education and training. It is required to fulfill the needs of quality strains of crops, fertilizers, and natural fertilizers for the farmers to enhance agricultural productivity from Taungya farming and gardening. Landscape restoration incorporated with the production of value-added products of local raw materials will be ensured to help the household increase human assets, financial assets, physical assets, natural assets, and social assets in the Paunglaung watershed area. Policymakers should provide more livelihood-oriented policies in watershed areas to improve their households' livelihood assets to raise agricultural productivity, income, and employment generation through income diversification, including livestock rearing.

5.References

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