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Community Forestry Impacts on Local Livelihoods: A Difference-In-Differences Analysis in Mindon Township, Magway Region, Myanmar

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Abstract: Community forests in Myanmar serve as vital resources for fulfilling local residents' fundamental needs. This study aims to evaluate the influence of community forestry on the livelihoods of these residents, employing panel data and a difference-in-differences methodology. Central to this evaluation are the important roles played by management committees, which oversee Community Forest User Groups (CFUGs). CFUG members are encouraged to engage in silvicultural activities within designated forest management areas, prioritizing them over plantation initiatives to meet set objectives. The prohibition of shifting cultivations post-establishment has led to a decline in agricultural income and its share. However, CFUGs have leveraged community forests for cattle pasturing and intensified livestock breeding, thereby positively impacting livestock-related income and its share. The establishment of community forests has also resulted in increased availability of Non-Timber Forest Products (NTFPs), although strategies related to forestry livelihood and annual income remain largely unaffected. CFUG members have been able to independently collect abundant NTFPs from community forests due to implemented conservation measures. Consequently, community forests have effectively secured critical resources such as firewood and bamboo for local subsistence needs, albeit with restrictions on commercial usage. To further enhance the effectiveness of community forestry initiatives, it is recommended that the Myanmar Forest Department invests in additional training, and extension services, and strengthens collaboration with management committees to foster greater willingness and participation among CFUGs. Moreover, exploring opportunities for commercializing community forest products holds promise for long-term improvements in the livelihoods of local residents.

Keywords: Community Rules, Difference-In-Differences Approach, Forest Management Practices, Livelihood Strategies, Local Economy, Management Committees, Sustainable Development

1. Introduction

Forests encompass approximately 30% of the Earth's land area, equivalent to 4 billion hectares [1,2], and serve as invaluable resources offering both tangible and intangible benefits to humanity [3]. Among these benefits, firewood stands out, constituting 40% of global renewable energy sources, with one-third of the world's population relying on it for essential daily energy needs such as cooking, heating, and water boiling [4,5]. However, forests face significant threats from deforestation and degradation, primarily driven by the conversion of forested lands to agricultural and livestock use—a consequence of the ongoing expansion of the global population [6,7]. Moreover, the introduction of foreign activities, including ecotourism [8–10] and farmers' intentions to lease forestland [11], has posed challenges to forest conservation efforts, necessitating careful management strategies to balance conservation goals with economic benefits. These challenges not only endanger the livelihoods of forest-dependent communities but also contribute to habitat loss for native species, perpetuating land degradation [4,12]. Integrating sustainable development principles into forest management is crucial for the long-term health of ecosystems [13,14]. Employing robust methodologies to measure sustainability [8,15,16] is vital for evaluating the effectiveness of community forestry initiatives. Urgent and effective forest management practices are imperative, with community forestry emerging as a solution to these issues. Sustainable forest management practices through community forestry are essential for preserving forest resources and promoting sustainable development for present and future generations.

Community forestry, characterized by its decentralized and community-driven approach to natural resource management, stands out as a sustainable solution capable of both preserving environments and meeting the essential needs of local populations [17]. Particularly prominent in developing nations, the devolution of authority to local communities has emerged as a flexible and effective tool for ensuring the sustainable management of forests and equitable access to forest resources [18]. This approach is widely practiced

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worldwide, with adaptations made to align with diverse social, political, historical, cultural, and administrative contexts [19]. Demonstrated as a successful forest management strategy, community forestry harnesses collective action among local residents to combat deforestation and forest degradation, promoting long-term sustainability under specific conditions [20]. This model encompasses five key categories based on tenure rights, including participatory conservation, joint forest management, community forestry with limited devolution, community forestry with full devolution, and private ownership [19].

In today's world, the pursuit of social, economic, and environmental sustainability is paramount to safeguarding our finite planet for future generations. To this end, the United Nations Sustainable Development Goals (SDGs) were established, serving as a global framework adopted by nearly all nations on September 25, 2015, and officially enforced on January 1, 2016, with a set timeline until 2030. Myanmar, as a signatory to the SDGs, is committed to achieving the specific goals and targets outlined within them. The Myanmar Forest Department, operating under the Ministry of Natural Resources and Environmental Conservation, has implemented comprehensive strategies such as the 30-year master plan (2001-2031) and the Myanmar Restoration and Rehabilitation Program (MRRP) (2017-2027) to align with the SDGs and other international agreements such as the Paris Agreement and the Convention on Biological Diversity. These initiatives aim to restore degraded forests and conserve existing natural forests. In this context, community forestry emerges as a crucial component in Myanmar's efforts to meet the SDGs, serving as a key indicator for Goal No. 1 (no poverty), Goal No. 2 (zero hunger), Goal No. 13 (climate action), and Goal No. 15 (life on land).

Myanmar boasts abundant natural resources, encompassing both renewable and non-renewable assets such as forests, jade, coal, petroleum, soil, water, and natural gas. Among these, forests stand out as vital contributors to both the livelihoods of local communities and the economy of Myanmar. The country hosts diverse forest types and is renowned for its high quality teak, recognized globally for its excellence [21]. Ranking as the second largest forest volume in the Association of Southeast Asian Nations region, Myanmar's forests cover nearly half of its total land area [1]. However, despite this richness, depletion issues have arisen due to mismanagement and excessive exploitation. Over recent decades, Myanmar's forest resources have been heavily exploited to support the country's economy [22], leading to a significant increase in deforestation and forest degradation. Alarmingly, forest coverage in Myanmar has dwindled between 1990 and 2015, with an annual forest change rate of -1.2%, resulting in the loss of 407,100 hectares of forest annually during this period [1].

In Myanmar, forest plantations and community forestry initiatives are strategically implemented in line with the 30-year master plan and the MRRP to combat the pressing challenges of deforestation and forest degradation. In 2006, the Forest Department introduced a private-owned forest plantation system as a shift from the centralized state-owned model, aiming to decentralize control and promote local community involvement in forest management [23]. However, despite efforts, forest plantations are only able to mitigate 14.79% of the country's annual deforestation rate. As a result, community forestry projects have been established across Myanmar as viable alternatives to address this issue, aiming to meet the basic needs of local communities, improve livelihoods, and contribute to sustainable forest management. The active engagement of local residents is paramount in ensuring the success of community forest management initiatives, serving as a crucial solution to simultaneously conserve de-graded forests and meet the essential needs of Myanmar's communities [24].

The rural landscape of Myanmar is home to nearly 70% of its population, with a significant portion relying on forest resources for their sustenance. According to the latest population census from 2014, approximately 81% of rural inhabitants depend on forest products, such as firewood for cooking and timber or bamboo for household necessities [25]. For these communities, forests serve as the cornerstone of their livelihoods, providing essential resources for both subsistence and income generation through the collection of timber and non-timber forest products (NTFPs) [21,25]. Consequently, there has been a notable surge in demand for timber and NTFPs among rural residents, prompting the Forest Department to recognize the socio-economic significance of rural communities in the National Forest Policy (1995), outlining their key role in achieving forestry strategic goals. To address these dynamics, the Forest Department introduced community forestry through the issuance of community forestry instructions (CFIs) in 1995, subsequently revised in 2016 and 2019. Community forestry, as defined in Myanmar, encompasses all sustainable forest management and utilization activities involving local community participation. This includes the establishment of new forest plantations, such as monoculture, mixed, and agroforestry plantations, as well as the management of existing natural forests, with the aim of creating employment, generating income, ensuring food

security, stabilizing ecosystems, and enhancing environmental conditions [25].

Based on these principles, community forests in Myanmar can be broadly categorized into two types: the establishment of new forest plantations and the management of existing natural forests. The specific objectives of Myanmar's CFIs include meeting the basic needs of local communities related to forests and trees, providing employment and income opportunities to reduce poverty, increasing forest cover sustainably, ensuring sustainable utilization, and promoting participatory forest management [25]. In light of these objectives, this study was conducted to assess the impacts of community forestry on the livelihoods of local communities in three community forests located in Mindon Township, Magway Region, Myanmar. Additionally, the study aimed to explore management practices, community regulations, and silvicultural activities employed in the management of community forests within the study area.

2. Conceptual Framework

Forests play a critical role in the livelihoods of rural communities in Myanmar, serving as a primary source of subsistence and income generation through the collection of NTFPs [21]. The demand for firewood, for instance, is substantial, with the average household in the dry zone of Myanmar consuming approximately 6.27 tons annually [26]. Moreover, the demand for other NTFPs has surged significantly, driven by the continuous population growth of the country. Notably, in the Sagaing Region of Myanmar, nearly 95% of rural households rely on NTFPs obtained from community forests to meet their basic needs [27]. As such, the Myanmar Forest Department has outlined ambitious plans to expand the total area of community forests to 919,000 hectares by 2030, as per the objectives set in the 30-year master plan. However, despite efforts, the current established area represents only 27% of this target, indicating a significant need for further establishment across the country. To bridge this gap, the Forest Department has initiated community forestry projects, underpinned by the Community Forestry Strategic Plan (2018-2020), aimed at achieving these targets. Nevertheless, several challenges impede the development of community forestry in Myanmar, including limited physical and financial resources, inadequate human resource capacity, short-term benefits from community forests, restricted access to information, technology, and markets, as well as insufficient cooperation between Community Forest User Groups (CFUGs) and authorities [28].

In mangrove areas, CFUGs primarily engage in agriculture and forestry activities, whereas non-CFUGs rely on wage labor, fisheries, and small businesses for income [24]. However, the establishment of community forests brings about significant changes, impacting household income conditions. Income generated from these forests becomes a crucial part of local residents' overall earnings, helping to alleviate income inequality among CFUGs and offering opportunities for employment and off-farm income generation [29–31].

Following the establishment of community forests, there is a noticeable shift in the consumption and dependence on NTFPs. CFUGs benefit from improved access to NTFPs within their designated areas, while non-CFUGs rely solely on natural forests, farmlands, and other open spaces for NTFP procurement. CFUG households, obtaining firewood from community forests, experience higher food consumption rates and collect larger firewood quantities compared to non-CFUG households that are dependent on natural forests. The active involvement and motivation of CFUGs in managing community forests drive their increased interest in collecting firewood from these areas post-establishment. Furthermore, the establishment of community forests reduces the time spent gathering firewood and other NTFPs, positively impacting agricultural and other livelihood activities [32,33].

Therefore, despite numerous studies exploring various aspects of community forests worldwide [34–37], including in Myanmar, there remains limited evidence regarding the impacts of community forestry on the livelihoods of both CFUGs and non-CFUGs. Specifically, there is a gap in understanding how livelihood strategies, income conditions, and NTFP consumption and dependency change over time, using robust methodologies such as the difference-in-differences approach. Previous studies have often overlooked detailing the specific management practices, community rules, and silvicultural activities implemented in community forest management [17,37–39]. Consequently, there is a lack of comparative studies examining the before and after effects of community forest establishment between these two groups. To address these research gaps in Myanmar, this study aims to achieve two objectives: firstly, to assess the impacts of community forestry on the livelihoods of local people in terms of livelihood strategies, income conditions, and NTFP consumption and dependency using panel data and the difference-in-differences approach; secondly, to investigate community forest management practices, community rules, and silvicultural activities to gain insight into how community forests are managed in the study area. Conceptual framework of the study is described in ***Figure 1***.

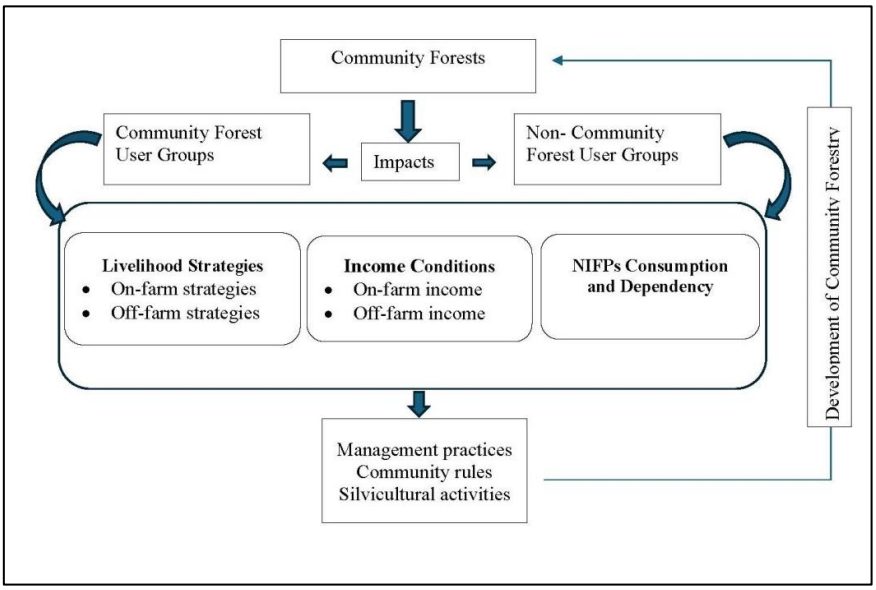

Figure 1 Conceptual Framework of the Study

3. Methodology

3.1. Study Area

Three adjacent community forests, designated as CF1, CF2, and CF3, located in Mindon Township, Magway Region, Myanmar, were chosen as the focal point of this study. These community forests were established simultaneously and represent well-functioning and well-institutionalized examples of community forestry in the region. Data pertaining to CFUGs were gathered from villages managing and utilizing the community forests, while data on non-CFUGs were collected from villages not involved in community forest management within the study area. The selection criteria for the study area included community forests established between four to seven years ago, ensuring a sufficient period for institutionalization and functionality. Additionally, non-CFUG villages were chosen based on their proximity to the studied community forests, ensuring similar socioeconomic and climatic conditions to CFUG villages. Primary data collection involved household surveys, focus group discussions, key informant interviews, and direct observation methods. Furthermore, secondary data were sourced from various sources, including the Forest Department, General Administration Department, as well as published and unpublished reports, journals, articles, papers, and books.

3.1.1. CF1

CF1, managed jointly by Shan Ywar Village and Kan Kone Village, boasted participation from 207 households within the CFUG. Established during the 2014-2015 period, CF1 encompassed both plantation and forest management components. The total area of CF1 spanned 373.12 hectares, comprising 199.11 hectares of plantations and 174.01 hectares of managed existing forests. Pay Kone Village, situated approximately 2.83 kilometers southwest of CF1, was selected as the non-CFUG counterpart. This village, with 35 households, served as the closest non-CFUG community to CF1.

3.1.2. CF2

CF2, managed jointly by Pay Taw Village and Nyaung Kyat Village, involved the participation of 116 households within the CFUG. Established during the same period as CF1, in 2014-2015, CF2 featured both plantation and forest management components. Covering a total area of 124.64 hectares, CF2 comprised 92.27 hectares of plantations and 32.37 hectares of managed existing forests. Min Ywar Kaing Village, located approximately 3.14 kilometers southwest of CF2, was designated as the non-CFUG village for CF2, with the closest proximity to the community forest.

3.1.3. CF3

CF3, managed jointly by Kan Lae Village, Moe Kaung Village, and Taung Phi Lar Village, involved 183 households within the CFUG. Established during the same period as CF1 and CF2 in 2014-2015, CF3 encompassed both plantation and forest management activities. Spanning a total area of 442.32 hectares, CF3 comprised 175.23 hectares of plantations and 267.09 hectares of managed existing forests. Kaing Nge Village, located southwest of CF3, was designated as the non-CFUG counterpart. With a distance of approximately 1.93 kilometers from CF3,

Kaing Nge Village was the closest non-CFUG community to CF3.

3.1.4. Non-CFUG Villages

All of the selected non-CFUG villages, Pay Kone Village, Min Ywar Kaing Village, and Kaing Nge Village relied primarily on agricultural systems for their livelihoods. The villagers in these non-CFUG villages engaged in the cultivation of rice, sesame, peanut, chickpeas, and pigeon peas as primary sources of income. Additionally, wage labor, migrant labor, and small businesses served as supplementary sources of income for these communities. Consequently, none of the selected non-CFUG villages were dependent on forests under non-community forest governance systems.

3.2. Data Analysis

The quantitative data collected for the study underwent analysis using SPSS Version 29 and Microsoft Excel 2021 software. Descriptive statistics, panel regression analysis, and the Hausman test were employed to achieve the study objectives. Descriptive statistics were utilized to examine the demographic characteristics of respondents, household profiles, management practices, silvicultural activities, training attendance, and loans obtained by respondents. Panel regression analysis was conducted to explore the impacts of community forest establishment on livelihood strategies, on-farm and off-farm annual household incomes, as well as the consumption and dependency on NTFPs in terms of collection quantity for various purposes, daily time spent on collection, and distances traveled for collection. The Hausman test was employed to determine whether fixed effects or random effects were appropriate for the panel regression analysis.

In this study, the difference-in-differences approach was utilized within the panel regression method, a common practice in empirical economics. This approach integrates an interaction term between time and group indicators, allowing for the examination of changes over time and differences in outcome variables between groups [40]. The difference-in-differences approach is a widely employed method, especially in evaluating policy effectiveness. It involves analyzing two distinct groups: a treatment group and a control group. The treatment group experiences the intervention solely in the second period, while the control group remains unaffected by the intervention in both periods. In our study, CFUGs were identified as the treatment group, whereas non-CFUGs were designated as the control group. To implement the difference-in-differences approach, the study employed the recall method. While this method can yield valuable information, it also heightens the risk of recall errors such as omissions, telescoping, over-reporting, and under-reporting [41,42]. Additionally, the length of the recall period directly influences the accuracy of estimations. Hence, opting for a shorter recall period is advisable to mitigate recall errors.

Concerning the difference-in-differences approach, the analysis involved two dummy variables for the CFUG variable (g = 1 for CFUGs and g = 0 for non-CFUGs) and two dummy variables for the time variable (t = 1 for after establishment and t = 0 for before establishment). Consequently, CFUGs had two conditions: before (Y_{10}) and after (Y_{11}), while non-CFUGs also had two conditions: before (Y_{00}) and after (Y_{01}). The differences for CFUGs ($\Delta CFUG$) were calculated by subtracting the before condition (Y_{10}) from the after condition (Y_{11}) of CFUGs, and similarly, the differences for non-CFUGs ($\Delta nonCFUG$) were calculated by subtracting the before condition (Y_{00}) from the after condition (Y_{01}) of non-CFUGs. The difference-in-differences approach was then computed using the following formula, developed by Ashenfelter and Card [43]:

$$DID = \Delta CFUG - \Delta nonCFUG \quad (1)$$

$$\Delta CFUG = Y_{11} - Y_{10} \quad (2)$$

$$\Delta nonCFUG = Y_{01} - Y_{00} \quad (3)$$

Where: DID represents the difference-in-differences impact of community forests, $\Delta CFUG$ denotes the changes observed in CFUGs, $\Delta nonCFUG$ signifies the changes observed in non-CFUGs, Y_{11} represents the condition of CFUGs after establishment, Y_{10} represents the condition of CFUGs before establishment, Y_{01} represents the condition of non-CFUGs after establishment, and Y_{00} represents the condition of non-CFUGs before establishment.

Furthermore, the following equation was utilized for panel regression analysis to investigate the impacts of community forestry on the livelihoods of local people:

$$Y_{it} = \beta_0 + \beta_1 x_{1it} + \beta_2 x_{2it} + \beta_3 x_{3it} + \cdots + \delta G_i + \theta T_t + \alpha DID_{it} + \varepsilon_{it} \quad (4)$$

Where: Y_{it} represents the outcome of interest, $x_{1it} \ldots x_{\infty it}$ denote the independent variables, G_i is the dummy variable for CFUG (1 for CFUG and 0 for non-CFUG), T_t is the dummy variable for time (0 for before and 1 for after the introduction of community forests to CFUGs), DID_{it} is the dummy variable for the difference-in-differences interaction term (G_i x T_t), α represents the impacts of community forests (DID coefficient), ε is the error term, and i refers to the household.

To analyze income conditions, we accounted for all sources of income, including on-farm annual income (from agriculture, livestock, and forestry) and off-farm annual income (from small businesses, government employment, wage labor, trade, and migrant labor). To calculate net annual income, the total value of inputs required for each income source was subtracted from the total value of outputs. Agricultural income comprised both the subsistence and commercial values of crops from cultivation, and we estimated the annual agricultural income accordingly. For calculating livestock income, we utilized the formula introduced by Cavendish [44].

$$Y_0 = P_0 \frac{r}{r-\left(\frac{1}{1+r}\right)^T+1} \quad (5)$$

Where: Y_0 represents annual livestock income, P_0 denotes the net price of the livestock unit, r is the discount rate, and T represents the lifespan of the livestock unit.

Net annual livestock income for each livestock was determined by multiplying the number of livestock by the annual livestock income. Household annual livestock income was then calculated by aggregating the net annual income from each livestock. For forestry income calculation, both subsistence and commercial purposes were taken into account to calculate the total forestry income. This involved estimating the quantity of collected NTFPs for each type and determining the prices for each type of NTFP. For the analysis of off-farm income, the earnings from small businesses, government employment, wage labor, trade, and migrant labor were aggregated.

Furthermore, to assess income in 2013, real income figures were utilized, adjusted for inflation using the inflation rate of Myanmar between 2013 and 2019, which stood at 44.0%. Livelihood strategies employed by both CFUGs and non-CFUGs were delineated by determining the proportions of income derived from each activity. Qualitative data from the study were analyzed by drawing upon information and insights gathered from focus group discussions, key informant interviews, and direct observations recorded during fieldwork. This qualitative data complemented the quantitative findings, contributing to the accuracy and interpretation of the results obtained from quantitative analysis.

4. Results and Discussion

4.1. Profile of Respondents and Households

The descriptive statistical analysis revealed notable differences in demographic characteristics between CFUGs and non-CFUGs. Among CFUG respondents, the majority were male, comprising 71.7% of CFUGs. Conversely, among non-CFUG respondents, a majority were female, constituting 55.9% of the non-CFUG population. However, both CFUGs and non-CFUGs were predominantly aged between 46 to 60 years, representing 44.6% and 52.9% of their respective populations. Similarly, a significant proportion of both groups had completed primary education, with 59.8% of CFUGs and 55.9% of non-CFUGs having attained this level of education.

Regarding household profiles, CFUG households typically consisted of three or six family members, representing 22.8% of CFUG households each. In contrast, non-CFUG households typically had four family members, accounting for 29.4% of non-CFUG households. CFUG households predominantly owned residential land areas between 0.11 to 0.20 hectares (47.8%), whereas non-CFUG households typically possessed smaller areas, primarily between 0.02 to 0.10 hectares (73.5%). Similarly, both CFUG and non-CFUG households predominantly owned agricultural land areas ranging from 0.01 to 1.50 hectares, with proportions of 56.5% and 54.4%, respectively. How-ever, a higher percentage of non-CFUG households were landless compared to CFUG households, with 17.6% of non-CFUG households lacking land, compared to only 8.7% of CFUG households. Furthermore, the majority of both CFUG and non-CFUG households reported total gross annual incomes below MMK 5,000,000 (approximately USD 2,300), constituting 42.4% and 63.2% of each group, respectively.

4.2. Impacts of Community Forestry on Livelihood Strategies

All households in the study area relied on a range of livelihood strategies, including agriculture, livestock rearing, forestry, small businesses, government employment, wage labor, trade, and migrant labor. These strategies were identified as the predominant means of sustaining livelihoods in the region. Analytical findings revealed that the establishment of community forests had a significant negative impact on the agricultural livelihood strategy at a 1% significance level with fixed effects. On average, the share of annual agricultural income decreased by 10.2% following the establishment of community forests, while other factors remained constant. This decline was attributed to the prohibition of shifting cultivation in community forest areas post-establishment, prompting some households to transition away from agriculture, thereby reducing the share of agricultural income.

Conversely, the establishment of community forests had a significant positive impact on the livestock

livelihood strategy at a 5% significance level with random effects. On average, the share of annual livestock income increased by 7.9% following the establishment of community forests, holding other variables constant. CFUG households engaged more in livestock breeding, utilizing community forests for cattle pasturing after securing land tenure through community forest initiatives, resulting in an increase in the share of livestock income post-establishment. However, panel regression analysis results indicated no significant impact on the forestry livelihood strategy. This was attributed to CFUG households' lack of access to electricity, leading to a significant reliance on firewood for cooking and heating, with bamboo extensively used in fencing and agricultural activities. Similarly, there was no significant impact on small business, government employment, wage labor, trade, and migrant labor livelihood strategies on average, with other variables held constant, following the establishment of community forests (**Table *1***).

While the establishment of community forests resulted in significant negative and positive impacts on agricultural and livestock livelihood strategies, respectively, there were no significant effects observed on forestry livelihood strategy and other off-farm strategies due to community forest establishment. This contrasts with a previous study in Myanmar, which noted that the livelihood strategies of CFUGs in the Mandalay Region shifted from off-farm to on-farm strategies following community forest establishment. Interestingly, these CFUGs had previously relied on income from daily wage labor and the majority were landless [28].

Table 1 Impact of community forestry on livelihood strategies

Dependent Variable	Hausman Test (X^2)	Independent Variable	DID Coefficient (p – value)	
			Random effect	Fixed effect
Agricultural income share (%)	X^2 = -2.47 (p is not available) **Fixed effect**	User status (1 if CFUG, 0 otherwise)	5.85 (0.014)	0
		Time status (1 if after establishment, 0 otherwise)	0.09 (0.977)	-0.84 (0.761)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	-10.08 (***0.004****)	-10.15 (***0.005****)
Livestock income share (%)	X^2 = 4.30 (p = 0.116) **Randon effect**	User status (1 if CFUG, 0 otherwise)	-7.80 (***0.047****)	0
		Time status (1 if after establishment, 0 otherwise)	-4.76 (0.117)	-8.25 (***0.019****)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	7.87 (***0.030****)	11.15 (***0.014****)
Forestry income share (%)	X^2 = -2.32 (p is not available) **Fixed effect**	User status (1 if CFUG, 0 otherwise)	-0.95 (0.236)	0
		Time status (1 if after establishment, 0 otherwise)	0.09 (0.811)	-0.18 (0.568)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	0.42 (0.310)	0.42 (0.308)
Small business income share (%)	X^2 = 5.79 (***p = 0.055****) **Fixed effect**	User status (1 if CFUG, 0 otherwise)	0.10 (0.948)	0
		Time status (1 if after establishment, 0 otherwise)	-0.61 (0.518)	1.65 (0.107)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	-1.16 (0.526)	-1.35 (0.588)
Government staff income share (%)	X^2 = 27.96 (***p < 0.001****) **Fixed effect**	User status (1 if CFUG, 0 otherwise)	-0.77 (0.652)	0
		Time status (1 if after establishment, 0 otherwise)	-0.03 (0.975)	2.91 (***0.083****)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	-1.29 (0.306)	-1.57 (0.406)
Wage labors income share (%)	X^2 =0.37 (p = 0.832) **Randon effect**	User status (1 if CFUG, 0 otherwise)	0.14 (0.953)	0
		Time status (1 if after establishment, 0 otherwise)	-1.67 (0.261)	-2.41 (0.253)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	1.17 (0.506)	2.01 (0.426)
Trade income share (%)	X^2 = 1.92 (p = 0.383) **Random effect**	User status (1 if CFUG, 0 otherwise)	-0.81 (0.322)	0
		Time status (1 if after establishment, 0 otherwise)	-0.01 (0.849)	0
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	-0.01 (0.323)	1.06 (0.326)
Migrant labor income share	X^2 = 16.68 (***p < 0.001****)	User status (1 if CFUG, 0	-3.04	0

Dependent Variable	Hausman Test (X^2)	Independent Variable	DID Coefficient (p – value)	
			Random effect	Fixed effect
(%)	**Fixed effect**	otherwise)	(0.101)	
		Time status (1 if after establishment, 0 otherwise)	-0.93 (0.644)	7.12 (***0.039*****)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	1.36 (0.587)	-1.56 (0.714)

Significance levels *, **, and *** are 10 %, 5%, and 1% respectively.
Source: Field Survey, 2019

4.3. Impacts of Community Forestry on Annual Household Income

4.3.1. Impacts of Community Forestry on On-farm Annual Household Income

The panel regression results highlight significant findings regarding the impact of community forest establishment on various income streams. Firstly, there was a significant negative impact on annual agricultural income at a 1% significance level with fixed effect. On average, annual agricultural income decreased by 534,333.40 MMK (USD 254.04), holding other factors constant. This decline can be attributed to a shift in livelihood strategies away from agriculture following the prohibition of shifting cultivations in community forest areas post-establishment. Conversely, there was a significant positive impact on annual livestock income at the same significance level with random effect. On average, annual livestock income increased by 534,489.10 MMK (USD 254.10), as CFUG households engaged more in livestock breeding, utilizing community forests for cattle pasturing after securing tenure. This finding aligns with a study in the dry zone of Myanmar, indicating CFUGs' preference for using community forests as a secondary grazing option [26].

However, the establishment of community forests did not yield a significant impact on forestry annual income on average. This lack of significance can be attributed to CFUG households' reliance on firewood for daily energy needs, such as cooking and heating, due to the absence of electricity access. Additionally, bamboo was widely utilized for fencing and agricultural activities. These findings echo previous literature in the Sagaing Region, Myanmar, where NTFP collection contributed minimally to the income generation of CFUGs [23] (***Table 2***).

Table 2 Impact on community forestry on on-farm annual household income

Dependent Variable	Hausman Test (X^2)	Independent Variable	DID Coefficient (p – value)	
			Random effect	Fixed effect
Annual agricultural income (MMK)	X^2 = -3.37 (p is not available) **Fixed effect**	User status (1 if CFUG, 0 otherwise)	384,323.50 (***0.022*****)	0
		Time status (1 if after establishment, 0 otherwise)	46,099.77 (0.463)	4,898.63 (0.931)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	-494,099.30 (<***0.001*****)	-534,333.40 (<***0.001*****)
Annual livestock income (MMK)	X^2 = 2.95 (p = 0.229) **Randon effect**	User status (1 if CFUG, 0 otherwise)	-152,175.30 (0.200)	0
		Time status (1 if after establishment, 0 otherwise)	165,686.50 (0.125)	-156,507.70 (0.504)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	534,489.10 (<***0.001*****)	1,139,029.00 (***0.003*****)
Forestry income share (%)	X^2 = -2.79 (p is not available) **Fixed effect**	User status (1 if CFUG, 0 otherwise)	-14,698.45 (***0.027*****)	0
		Time status (1 if after establishment, 0 otherwise)	15,519.66 (***0.001*****)	12,070.56 (***0.002*****)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	7,134.05 (0.110)	7,134.05 (0.109)

Significance levels *, **, and *** are 10 %, 5%, and 1% respectively.
Source: Field Survey, 2019

4.3.1. Impacts Of Community Forestry on Off-Farm Annual Household Income

Off-farm income analysis revealed a notable impact on annual small business income as a result of community forest establishment, significant at a 10% level with random effect. On average, annual income from small business activities increased by 567,323.60 MMK (USD 269.76), holding other variables constant. This increase can be attributed to CFUG household reallocating time and resources previously dedicated to NTFP collection towards other small business endeavors, such as operating small shops, restaurants, or engaging in sewing activities to bolster household income. However, annual government staff income, wage labor income,

trade income, and migrant labor income were insignificantly affected by community forest establishment, maintaining their average levels despite the introduction of community forests. This finding contrasts with a previous case study in Nepal, where community forests offered job opportunities to poorer households through activities like resin tapping and forest guarding, contributing to off-farm income generation [46] (***Table 3***).

Table 3 Impact on community forestry on off-farm annual household income

Dependent Variable	Hausman Test (X^2)	Independent Variable	DID Coefficient (p – value)	
			Random effect	Fixed effect
Annual small business income (MMK)	X^2 = 3.91 (p = 0.142) **Random effect**	User status (1 if CFUG, 0 otherwise)	-286,823.00 (***0.036*****)	0
		Time status (1 if after establishment, 0 otherwise)	-165,577.60 (***0.061****)	15,970.59 (0.756)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	567,323.60 (***0.083****)	553,429.40 (0.130)
Annual government staff income (MMK)	X^2 = 13.45 (***p = 0.001*****) **Fixed effect**	User status (1 if CFUG, 0 otherwise)	52,624.81 (0.483)	0
		Time status (1 if after establishment, 0 otherwise)	-1,902.48 (0.977)	170,664.70 (***0.077****)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	-12,818.45 (0.854)	-32,388.18 (0.782)
Annual wage labor income (MMK)	X^2 = 0.43 (p = 0.808) **Random effect**	User status (1 if CFUG, 0 otherwise)	71,092.47 (0.266)	0
		Time status (1 if after establishment, 0 otherwise)	-23,100.96 (0.592)	-38,266.47 (0.461)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	-7,598.70 (0.899)	5,238.21 (0.938)
Annual trade income (MMK)	X^2 = 1.63 (p = 0.443) **Random effect**	User status (1 if CFUG, 0 otherwise)	-13,221.08 (0.273)	0
		Time status (1 if after establishment, 0 otherwise)	-125.95 (0.844)	0
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	-1,029.48 (0.413)	24,304.35 (0.376)
Annual migrant labors income (MMK)	X^2 = 17.29 (***p < 0.001*****) **Fixed effect**	User status (1 if CFUG, 0 otherwise)	71,077.77 (0.583)	0
		Time status (1 if after establishment, 0 otherwise)	-203,417.30 (***0.088****)	341,911.80 (***0.051****)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	78,921.66 (0.639)	-125,511.80 (0.645)

Significance levels *, **, and *** are 10 %, 5%, and 1% respectively.
Source: Field Survey, 2019

4.4. Impacts of Community Forestry on NTFPs Collection

4.4.1. Impacts of Community Forestry on Quantity of NTFPs Collection for Subsistence Purposes

The establishment of community forests in the study area serves as a critical avenue for meeting the basic needs of local residents in terms of forest and tree-related resources. Despite the introduction of forest product commercialization in 2016, community forests continue to play a vital role in providing essential forest products, particularly NTFPs, for the subsistence needs of the local population. These NTFPs encompass various items such as firewood, poles, posts, bamboo, bamboo shoots, and mushrooms. According to panel regression analysis, the quantity of firewood collected for consumption experienced a significant positive impact from community forest establishment, evident at a 1% significance level with fixed effect. On average, the quantity of firewood collected to meet daily consumption needs increased by 0.48 tons due to the establishment of community forests. However, the quantity of poles and posts collected for consumption showed no significant impact on average, holding other variables constant.

In contrast, there was a notable positive impact on the quantity of bamboo collected for consumption, significant at a 1% significance level with fixed effect. With community forest establishment, the average quantity of bamboo collected for subsistence purposes increased by 47.07 bamboos, while bamboo shoot collection for consumption also saw a significant positive effect, with an average increase of 1.72 kilograms, both holding other factors constant. Similarly, mushroom collection for consumption purposes experienced a significant positive impact from community forest establishment, evident at a 10% significance level with fixed effect, resulting in an average increase of

0.37 kilograms, holding other variables constant (***Table 4***).

Table 4 Impact on community forestry on quantity of NTFPs for subsistence purposes

Dependent Variable	Hausman Test (X^2)	Independent Variable	*DID* Coefficient (*p*-value)	
			Random effect	Fixed effect
Quantity of firewood collection (tons) for consumption	X^2 = -0.02 (*p* is not available) Fixed effect	User status (1 if CFUG, 0 otherwise)	0.49 (0.177)	0
		Time status (1 if after establishment, 0 otherwise)	-0.31 (0.046**)	-0.30 (0.015**)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	0.48 (0.004***)	0.48 (0.004***)
Quantity of poles and posts collection (no.) for consumption	X^2 = -0.02 (*p* is not available) Fixed effect	User status (1 if CFUG, 0 otherwise)	-0.14 (0.193)	0
		Time status (1 if after establishment, 0 otherwise)	0.23 (0.167)	0.22 (0.179)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	0.46 (0.425)	0.46 (0.423)
Quantity of bamboo collection (no.) for consumption	X^2 = -5.50 (*p* is not available) Fixed effect	User status (1 if CFUG, 0 otherwise)	-74.46 (<0.001***)	0
		Time status (1 if after establishment, 0 otherwise)	-13.90 (0.119)	-24.41 (0.001***)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	47.07 (<0.001***)	47.07 (<0.001***)
Quantity of bamboo-shoot collection (kg) for consumption	X^2 = -0.46 (*p* is not available) Fixed effect	User status (1 if CFUG, 0 otherwise)	-0.81 (0.370)	0
		Time status (1 if after establishment, 0 otherwise)	0.32 (0.175)	0.12 (0.318)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	1.72 (0.007***)	1.72 (0.007***)
Quantity of mushroom collection (kg) for consumption	X^2 = -0.43 (*p* is not available) Fixed effect	User status (1 if CFUG, 0 otherwise)	-0.17 (0.404)	0
		Time status (1 if after establishment, 0 otherwise)	-0.04 (0.533)	0
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	0.37 (0.089*)	0.37 (0.088*)

Significance levels *, **, and *** are 10 %, 5%, and 1% respectively.
Source: Field Survey, 2019

The significant and positive impact of community forest establishment on NTFPs collection for consumption, including firewood, bamboo, bamboo shoots, and mushrooms, underscores its role in ensuring food security and meeting the basic needs of local communities. This aligns with similar findings in studies conducted in Nepal [46] and India [47], highlighting the integral objective of community forestry in Myanmar.

However, the establishment of community forests did not yield a significant impact on the commercial collection of firewood, bamboo, bamboo shoots, and mushrooms, on average, when holding other variables constant. Additionally, neither CFUG households nor non-CFUG households engaged in the commercial collection of poles and posts. Consequently, the impact on the quantity of poles and posts collected for commercial purposes could not be assessed. In the study area, poles and posts were primarily utilized for repairing and maintaining local household materials and constructing newlywed households' houses. Moreover, the extraction of NTFPs is strictly prohibited in the study area by the management committees to facilitate forest restoration efforts, although opportunities for subsistence collection have increased following the establishment of community forests (***Table 5***).

4.4.2. Impacts of Community Forestry on Quantity of NTFPs Collection for Commercial Purposes

Table 5 Impact on community forestry on quantity of NTFPs for commercial purposes

Dependent Variable	Hausman Test (X^2)	Independent Variable	*DID* Coefficient (*p*-value)	
			Random effect	Fixed effect
Quantity of firewood collection (tons) for sale	X^2 = -0.04 (*p* is not available) Fixed effect	User status (1 if CFUG, 0 otherwise)	-0.20 (0.123)	0
		Time status (1 if after establishment, 0 otherwise)	0.01 (0.940)	0.01 (0.318)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	-0.01 (0.321)	-0.01 (0.318)
Quantity of poles and	—	User status (1 if CFUG, 0	—	—

Dependent Variable	Hausman Test (X^2)	Independent Variable	*DID* Coefficient (*p*-value)	
			Random effect	Fixed effect
posts collection (no.) for sale†		otherwise)		
		Time status (1 if after establishment, 0 otherwise)	—	—
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	—	—
Quantity of bamboo collection (no.) for sale	X^2 = -1.56 (*p* is not available) Fixed effect	User status (1 if CFUG, 0 otherwise)	-82.99 (0.014**)	0
		Time status (1 if after establishment, 0 otherwise)	26.85 (0.091*)	15.59 (0.156)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	-15.59 (0.158)	-15.59 (0.156)
Quantity of bamboo-shoot collection (kg) for sale	X^2 = -0.00 (*p* is not available) Fixed effect	User status (1 if CFUG, 0 otherwise)	0.22 (0.332)	0
		Time status (1 if after establishment, 0 otherwise)	-0.01 (0.850)	0
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	0.18 (0.322)	0.18 (0.319)
Quantity of mushroom collection (kg) for sale	X^2 = -0.41 (*p* is not available) Fixed effect	User status (1 if CFUG, 0 otherwise)	0.12 (0.168)	0
		Time status (1 if after establishment, 0 otherwise)	0.02 (0.338)	0
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	0.02 (0.322)	0.02 (0.319)

Note: Impacts of community forests on poles and posts sale cannot be calculated because no households from CFUG and non-CFUG sell poles and posts.
Significance levels *, **, and *** are 10 %, 5%, and 1% respectively.
Source: Field Survey, 2019

4.4.3. Impacts of Community Forestry on Time Taken and Distances Needed to Travel for NTFPs Collection

Local residents previously spent a considerable amount of time each day and traveled significant distances to collect NTFPs from various sources. However, the establishment of community forests has notably reduced both the time spent per day and the distance traveled, particularly for CFUG households. Panel regression analysis revealed a significant reduction in the time spent per day for firewood collection as a result of community forests establishment, with an average decrease of 0.64 hours per day at a 1% significance level, holding other factors constant. Similarly, there was a significant decrease in the distance traveled for firewood collection, with an average reduction of 1.11 kilometers, also at a 1% significance level. However, the time spent per day and distance traveled for poles and posts collection were not significantly impacted by community forests establishment.

Regarding bamboo collection, there was a significant reduction in both the time spent per day and the distance traveled. The time spent per day decreased by an average of 0.75 hours, while the distance traveled decreased by an average of 1.20 kilometers, both at a 1% significance level. For bamboo shoot collection, although there was no significant impact on the time spent per day, there was a significant decrease in the distance traveled, with an average reduction of 0.34 kilometers at a 5% significance level. In contrast, there were no significant impacts on either the time spent per day or the distance traveled for mushroom collection on average due to community forests establishment. CFUG members were able to reduce both the time and distance for firewood, bamboo, and bamboo shoot collection after the establishment of community forests, as the forests were conveniently located near their residential areas (

Table 6). This finding aligns with a previous study conducted in Nepal [46].

Table 6 Impact on community forestry on time taken and distance needed to travel for NTFPs collection

Dependent Variable	Hausman Test (X^2)	Independent Variable	*DID* Coefficient (p-value)	
			Random effect	Fixed effect
Time taken per day (hours/day) for firewood collection	X^2 = -0.40 (*p* is not available) Fixed effect	User status (1 if CFUG, 0 otherwise)	0.86 (0.004***)	0
		Time status (1 if after establishment, 0 otherwise)	-0.35 (0.079*)	-0.40 (0.036**)
		DID dummy (1 if CFUG and after	-0.64	-0.64

Dependent Variable	Hausman Test (X^2)	Independent Variable	*DID* Coefficient (p-value)	
			Random effect	Fixed effect
		establishment, 0 otherwise)	(0.004***)	(0.004***)
Distance needed to travel for firewood collection	X^2 = -0.86 (p is not available) Fixed effect	User status (1 if CFUG, 0 otherwise)	0.89 (0.001***)	0
		Time status (1 if after establishment, 0 otherwise)	-0.17 (0.254)	-0.22 (0.103)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	-1.11 (<0.001***)	-1.11 (<0.001***)
Time taken per day (hours/day) for poles and posts collection	X^2 = -0.00 (p is not available) Fixed effect	User status (1 if CFUG, 0 otherwise)	-0.03 (0.093*)	0
		Time status (1 if after establishment, 0 otherwise)	0.09 (0.321)	0.09 (0.318)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	0.06 (0.609)	0.06 (0.607)
Distance needed to travel for poles and posts collection	X^2 = -0.02 (p is not available) Fixed effect	User status (1 if CFUG, 0 otherwise)	-0.02 (0.122)	0
		Time status (1 if after establishment, 0 otherwise)	0.07 (0.310)	0.07 (0.318)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	0.01 (0.948)	0.01 (0.948)
Time taken per day (hours/day) for bamboo collection	X^2 = -7.09 (p is not available) Fixed effect	User status (1 if CFUG, 0 otherwise)	-0.45 (0.255)	0
		Time status (1 if after establishment, 0 otherwise)	-0.20 (0.380)	-0.44 (0.042**)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	-0.75 (0.002***)	-0.75 (0.002***)
Distance needed to travel for bamboo collection	X^2 = -9.90 (p is not available) Fixed effect	User status (1 if CFUG, 0 otherwise)	-0.16 (0.642)	0
		Time status (1 if after establishment, 0 otherwise)	0.14 (0.430)	-0.09 (0.602)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	-1.20 (<0.001***)	-1.20 (<0.001***)
Time taken per day (hours/day) for bamboo shoot collection	X^2 = -0.84 (p is not available) Fixed effect	User status (1 if CFUG, 0 otherwise)	-0.74 (0.030**)	0
		Time status (1 if after establishment, 0 otherwise)	0.15 (0.156)	0.07 (0.318)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	0.15 (0.396)	0.15 (0.393)
Distance needed to travel for bamboo shoot collection	X^2 = -1.69 (p is not available) Fixed effect	User status (1 if CFUG, 0 otherwise)	-0.53 (0.066*)	0
		Time status (1 if after establishment, 0 otherwise)	0.27 (0.012**)	0.19 (0.052*)
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	-0.34 (0.025**)	-0.34 (0.025**)
Time taken per day (hours/day) for mushroom collection	X^2 = -0.09 (p is not available) Fixed effect	User status (1 if CFUG, 0 otherwise)	-0.11 (0.523)	0
		Time status (1 if after establishment, 0 otherwise)	-0.01 (0.737)	0
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	0.10 (0.268)	0.10 (0.266)
Distance needed to travel for mushroom collection	X^2 = -0.05 (p is not available) Fixed effect	User status (1 if CFUG, 0 otherwise)	-0.03 (0.809)	0
		Time status (1 if after establishment, 0 otherwise)	-0.01 (0.785)	-0.00
		DID dummy (1 if CFUG and after establishment, 0 otherwise)	-0.01 (0.831)	-0.01 (0.830)

Significance levels *, **, and *** are 10 %, 5%, and 1% respectively.
Source: Field Survey, 2019

4.5. Management Practices, Community Rules and Silvicultural Activities

The management committees overseeing community forests in Myanmar have designated three distinct types of management responsibilities for CFUG households. Firstly, there is the "managed by groups" approach, where some or all CFUG households collectively oversee the forests. Their duties encompass reporting any illegal activities or encroachments within the community forest area to the management committees, actively participating in community forest activities, and being authorized to

gather NTFPs exclusively from the managed forest area. Secondly, there is the "managed by individuals" model, where individual CFUG households assume responsibility. These households are tasked with establishing plantations to meet survival targets, managing and executing activities within their designated plantation areas, and holding the authority to sell and harvest forest products, including timber and NTFPs, exclusively from their plantation zones. Lastly, there is the "managed by combining both individuals and groups" approach, which integrates both individual and collective management styles. CFUG households in this category participate in both plantation establishment and the management of existing forests. They are permitted to gather NTFPs not only from their plantation areas but also from existing forest management zones.

The statistical analysis revealed that CFUG households in CF1 predominantly managed their community forests collectively, constituting 75.7% of CF1's CFUGs, followed by a combination of individual and group management type, accounting for 24.3%. Similarly, in CF2, half of the CFUG households (50.0%) opted for group management, while the remaining 50.0% chose the combined individual and group management approach. In CF3, the majority of CFUG households (74.2%) engaged in group management, with the remaining 25.8% adopting the combined individual and group management method. Interestingly, despite the availability of three types of community forest management practices in Myanmar, the study areas exclusively utilized two approaches: group management and combined individual and group management. Notably, no members employed the individual management practice for their community forests.

Community forests in Myanmar are classified into three types based on their management practices: (1) plantation establishment, (2) agroforestry plantation establishment, and (3) managing existing forests. Plantation establishment involves monoculture or mixed plantations aimed at restoring community forests. In the community forests studied, new plantation establishment was deemed unnecessary due to the favorable survival conditions observed in initial forest inventories conducted by the Mindon Township Forest Department. Therefore, gap plantings were implemented for plantation establishment, minimizing adverse effects on the ecosystem and environment as clear felling is prohibited. The most commonly planted tree species in these community forests included Teak (*Tectona grandis*), Pyin-ka-do (*Xylia xylocarpus*), Pa-dauk (*Pterocarpus macrocarpus*), Zaung-bale (*Lagerstroemia villosa*), Yon (*Anogeissus acuminate*), Aurisha (*Acacia auriculiformis*), Yinma (*Chukrasia tabularis*), Shaw-byu (*Sterculia versicolor*), Mezali (*Senna siamea*) and Tauk-kyan (*Terminalia alata*).

CFUG households involved in plantation establishment are authorized to sell and collect timber and NTFPs from their plantations. They are also responsible for meeting survival percentages and targets for plantations, as directed by management committees. Statistical analysis revealed that 24.3% of CFUG households from CF1, 50.0% from CF2, and 25.8% from CF3 engaged in plantation establishment to manage their community forests. However, none of the CFUG households implemented agroforestry plantation establishment in any of the studied community forests, as indicated by the statistical analysis of responses provided by CFUG respondents.

Existing forests management involves overseeing the remaining areas of community forests, excluding plantations. CFUG households are responsible for managing these areas to prevent illegal activities and encroachments, and to conserve the forest resources. Commonly explored tree species in the existing forests management areas of the studied community forests include Teak (*Tectona grandis*), Pyin-ka-do (*Xylia xylocarpus*), Mezali (*Senna siamea*), Thitmagyi (*Albizia odoratissima*), Lein (*Terminalia pyri*falia), Sha (*Acacia catechu*), Zaung-bale (*Lagerstroemia villosa*) and Tauk-kyan (*Terminalia alata*). In each community forest, all CFUG households are required to manage the existing forests area. They have permission to collect NTFPs from this area for subsistence purposes, and are also permitted to sell certain NTFPs such as bamboo shoots and mushrooms for small-scale commercial activities. As a result, all CFUG households in the studied community forests are involved in managing the existing forests area.

Before the onset of the rainy season each year, the management committees issue notices to neighboring villages as part of community rules to prevent conflicts. If CFUG members discover instances of illegal timber extraction, unauthorized NTFP collection, or encroachments in the community forests' area by neighboring villagers, they are required to report such activities to the management committees. For a first offense, offenders from neighboring villages must plant new trees as a penalty. Repeat offenders face fines as penalties for subsequent violations. Additionally, the management committees of community forests conduct regular meetings, financial discussions, and benefit sharing sessions with CFUG members. These gatherings serve to update members on the progress of community forests, discuss financial matters, and

outline benefit sharing procedures. During these meetings, all community forest users have the opportunity to engage in open discussions and share their insights and knowledge related to community forestry. The management committee functions as the regulatory body responsible for organizing activities, convening meetings, making decisions, and overseeing the equitable sharing of benefits from the community forests in the study area.

Within the community forests studied, the management of forest plantations falls under the responsibility of community forest users involved in plantation establishment, while the management of existing forest areas is a collective task shared by all CFUG members. While every community forest user has the opportunity to independently collect NTFPs from existing forest areas, only members involved in To achieve the goals of community forest management, various silvicultural tasks such as weeding, pruning, thinning, coppicing, fertilizer application, and fire protection are essential for maintaining the plantations established by CFUGs. Descriptive statistical analysis unveiled that weeding activities were conducted by 24.3% of CFUG households in CF1, 50.0% in CF2, and 25.8% in CF3 over the last twelve months of the fieldwork. Similarly, pruning activities were conducted by 8.1% of CFUG households in CF1, 16.7% in CF2, and Similarly, for the management of existing forest areas, silvicultural tasks such as weeding, climber cutting, boundary demarcation, forest guarding, and fire protection are essential. Descriptive statistical analysis showed that, during the last twelve months of the fieldwork, 13.5% of CFUG households in CF1 engaged in weeding and climber cutting activities in their existing forest management area, while households in CF2 and CF3 did not participate in these activities. Additionally, 25.0% of CFUG households in CF2 and 19.4% in CF3 engaged in boundary demarcation activities, whereas no households in CF1 did. Furthermore, although 25.0% of CFUG households in CF2 carried out forest plantation establishment are authorized to sell and collect timber and NTFPs from their designated plantations. Furthermore, the management committees oversee the sale of NTFPs, particularly bamboo, for commercial purposes from the common existing forest management areas. In terms of benefit sharing derived from commercial activities, the management committees allocate 25% of the net income to their funds, while the remaining 75% is earmarked for development activities in the CFUG villages. These development endeavors include road and bridge construction, roof installations for wells, and contributions to village schools, all in accordance with agreements reached among CFUG members. This distribution scheme mirrors findings from a similar study conducted in Nepal [45].

25.8% in CF3. Coppicing activities were reported by 24.3% of CFUG households in CF1, 4.2% in CF2, and 25.8% in CF3. Fire protection activities were carried out by 21.6% of CFUG households in CF1, 50.0% in CF2, and 25.8% in CF3. However, no CFUG households engaged in thinning or fertilizer application activities in any of the studied community forests during the past year, as the trees were either too young for thinning or too mature for fertilizer application.

guarding activities in the existing forest management area, none of the households in CF1 and CF3 did. None of the CFUG households in the three community forests conducted fire protection activities, as the trees in the existing forest management area are naturally resistant to fire hazards. However, surface fires occur annually in community forests, which can have a positive impact on trees by providing natural fertilizers and clearing weeds.

Table 7 provides detailed information on the silvicultural activities conducted by CFUG households for both their plantations and existing forest management areas.

Table 7 Silvicultural activities operated by CFUG households

Community Forests Types	Silvicultural Activities	Number of CFUG Households which Implemented (% within CF Name)			Total
		CF 1	*CF 2*	*CF 3*	
Plantations establishment	Weeding	9 (24.3%)	12 (50.0%)	8 (25.8%)	29 (31.5%)
	Pruning	3 (8.1%)	4 (16.7%)	8 (25.8%)	15 (16.3%)
	Thinning	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Coppicing	9 (24.3%)	1 (4.2%)	8 (25.8%)	18 (19.6%)
	Fertilizer applying	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Fire protecting	8 (21.6%)	12 (50.0%)	8 (25.8%)	28 (30.4%)
Managing existing forests	Weeding and climbers cutting	5 (13.5%)	0 (0.0%)	0 (0.0%)	5 (5.4%)
	Boundary demarcation	0 (0.0%)	6 (25.0%)	6 (19.4%)	12 (13.0%)
	Forest guarding	0 (0.0%)	6 (25.0%)	0 (0.0%)	6 (6.5%)
	Fire protecting	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)

Furthermore, this study examined the opportunities, such as trainings and loans, that CFUG households gained as a result of the establishment of community forests. It uncovered five fundamental trainings offered by the Forest Department at both regional and district levels, encompassing topics such as plantation and nursery establishment, forest management, leadership, livelihood enhancement, and scaling up community forest-based commercial programs.

The descriptive statistical analysis revealed that 2.7% of CFUG respondents from CF1, 8.3% from CF2, and 9.7% from CF3 had attended trainings on plantation and nursery establishment. Similarly, 5.4% of CFUG respondents from CF1, 4.2% from CF2, and 6.5% from CF3 had participated in forest management trainings. However, only 4.2% of CFUG respondents from CF2 had received livelihood improvement trainings, with no attendees from CF1 and CF3. Furthermore, none of the CFUG respondents from the three community forests had participated in leadership trainings or community forest-based commercial programs upscaling trainings. This lack of participation suggests a limited collaboration between the community forest management committees and the Mindon Township Forest Department, consistent with findings from other studies on community forests in Myanmar [28]. To address this, the Township Forest Department should ensure that information about trainings held at the regional or district level is shared with every management committee, while management committees should communicate their training needs and preferences to the Township Forest Department. Nonetheless, the establishment of community forests has contributed to the enhancement of human capital through the provision of trainings and extension services, aligning with findings from a similar study conducted in Nepal [46].

Moreover, CFUG members have the opportunity to access loans from the management committees of the studied community forests at a low interest rate. These loans are provided to CFUG households to address livelihood challenges and to bolster funds through the interest accrued on these loans, aligning with findings from a study conducted in Nepal [46]. According to the results of the statistical analysis, 13.5% of CFUG respondents from CF1, 20.8% from CF2, and 22.6% from CF3 availed themselves of loans from their community forest management committees. ***Table 8*** provides further details on the trainings attended and loans obtained by CFUG respondents.

Table 8 Trainings attended and loans taken by CFUG respondents

Types of Trainings/ Loans Taken	Number of CFUG Respondents who Attended/ Taken (% within CF Name)			
	CF 1	***CF 2***	***CF 3***	***Total***
Plantations and nursery establishment trainings	1 (2.7%)	2 (8.3%)	3 (9.7%)	6 (6.5%)
Forest management trainings	2 (5.4%)	1 (4.2%)	2 (6.5%)	5 (5.4%)
Livelihood improvement trainings	0 (0.0%)	1 (4.2%)	0 (0.0%)	1 (1.1%)
Leadership trainings	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Community forest based commercial programs upscaling trainings	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Loans taken	5 (13.5%)	5 (20.8%)	7 (22.6%)	17 18.5%)

5. Conclusions and Recommendations

Management committees are integral to the effective management of community forests in the study area. They play a crucial role by providing low interest loans to CFUG members and allocating funds for the development of public infrastructure. While the silvicultural activities conducted by participants for forest plantations appear adequate, more emphasis should be placed on silvicultural activities for the management of existing forests to fully realize the objectives of community forests. A significant proportion of CFUG members reported positive changes in their forests and livelihoods following the establishment of community forests. However, only a minority of members possessed knowledge of the management, governance, and regulations issued by the government pertaining to community forestry. This underscores the need for greater extension services to be implemented for CFUGs in the study area. Furthermore, a minority of CFUG members had received training related to community forests, with some training programs not yet being conducted. Therefore, there is a pressing need for more training opportunities to be provided, and increased cooperation between the Forest Department and CFUGs is essential in order to address these gaps in knowledge and skills within the community.

The prohibition of shifting cultivations within community forest areas post-establishment has led to a decline in agricultural income and the agricultural income share among CFUG members. However, the utilization of community forests for cattle pasturing and increased livestock breeding have contributed to the enhancement of livestock income and its share. Furthermore, the establishment of community forests has resulted in an increased availability of NTFPs, meeting the critical basic needs of local residents.

Despite this, there has been no significant impact on forestry livelihood strategy and annual income. CFUG members have been able to independently and abundantly collect NTFPs from community forests due to conservation efforts initiated post-establishment. As a result, community forests have become essential for securing basic necessities such as firewood and bamboo for subsistence purposes. However, permissions for the commercial extraction of NTFPs, including firewood, poles, posts, bamboo, bamboo shoots, and mushrooms, are currently not granted. Moving forward, management committees should consider granting permissions for sustainable commercial extraction of NTFPs to increase income and enhance the livelihood conditions of CFUG members.

After the establishment of community forests, CFUG members were able to reduce the time spent on collecting firewood and bamboo, which were the most commonly gathered NTFPs in the study area. This reduction in time indirectly contributed to an increase in small business annual income, as the saved time was redirected towards investing in small business activities such as sewing, operating small shops, and managing small restaurants to generate household income. The proximity of community forests to the residential areas of CFUG members meant that they no longer needed to travel as extensively as before, when natural forests or farmlands served as the primary collection sources. To further enhance the management of community forests, the management committees of the studied community forests should consider revising their management plans. The existing plans, prepared in 2013, need to be updated in accordance with the new amendments to the CFI enacted in 2019. These amendments introduced the commercialization of community forest products to promote the livelihoods of local people. During the revision process, emphasis should be placed on the commercialization of community forest products, and defining a management cycle to implement silvicultural activities aimed at enhancing the livelihoods of local people.

In conclusion, this paper has explored the multifaceted impacts of community forest establishment on the livelihoods of local people in Myanmar, shedding light on various aspects ranging from income generation to resource management. Through descriptive statistical analysis and panel regression results, the study revealed significant shifts in livelihood strategies, with both positive and negative impacts observed across different sectors. Moreover, the establishment of community forests played a critical role in securing basic needs such as NTFPs, positively impacting the livelihoods of local people. Overall, this study underscores the importance of community forests in Myanmar as a means of enhancing livelihoods, emphasizing the necessity for ongoing efforts to fully leverage their benefits while addressing existing challenges. This includes advocating for revised management plans that adhere to updated regulations and facilitate the sustainable commercialization of forest products.

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