Leaflet No.

The Republic of the Union of Myanmar
Ministry of Natural Resources and Environmental Conservation

Can 30 years community forest contribute to basic needs and environmental stability in rural areas? A case study from Pintaya Township, Southern Shan state

Ei Ei Swe Hlaing (Ph.D), Deputy Director
Phyu Phyu Thinn (Ph.D), Staff Officer
Cho Cho Naing, Staff Officer
Forest Department

March, 2026

Contents

List of Tables

List of Figure

Can 30 years community forest contribute to basic needs and environmental stability in rural areas? A case study from Pintaya Township, Southern Shan state

Ei Ei Swe Hlaing, Phyu Phyu Thin and Cho Cho Naing

Abstract

Community forestry has been promoted in Myanmar as an approach to improve rural livelihoods while conserving forest resources. This study assesses whether community forests can support the fulfillment of basic needs and contribute to environmental sustainability under the Community Forestry Instructions (CFI,1995) in Pintaya Township, Southern Shan State. We applied a combination of social and ecological methods using household interview and forest sampling plots. A total of 55 respondents from 130 community forest user group members were randomly selected to collect data on fuelwood collection, socio-economic conditions and attitudes towards extension of the duration for 30 years. Six sample plots were set up, and each plot was 50 m × 50 m (0.25 ha) to assess existing forest conditions and carbon stocks. The results revealed that 62% of fuelwood consumption was obtained from community forest while 38% came from private own land and buying from local market, especially rich people. On the other hand, forest conditions have been changed because of uncontrolled firewood collection, lack of knowledge on selective felling and silvicultural operations. Consequently, carbon storage was relatively low, averaging only 11.49 tons per ha although the age of community forest reaches 30 years. The study suggests that strengthening institutional capacity and implementing systematic forest management practices are critical during the renewal period to improve forest conditions while maintaining active forest-people interactions.

Keywords: forest conditions, carbon stock, fuelwood, institutional capacity, forest-people interaction

သက်တမ်းနှစ် (၃၀) ပြည့် ဒေသခံပြည်သူအစုအဖွဲ့ပိုင်သစ်တောများ၏ ကျေးလက်ဒေသ အခြေခံ လိုအပ်ချက်များ ဖြည့်ဆည်းခြင်း နှင့် သဘာဝပတ်ဝန်းကျင်တည်တံ့စေခြင်းအား လေ့လာဆန်းစစ်ခြင်း

စာတမ်း အကျဉ်းချုပ်

မြန်မာနိုင်ငံတွင် ဒေသခံပြည်သူအစုအဖွဲ့ပိုင်သစ်တောများကို ကျေးလက်ဒေသများ၏ အသက်မွေးဝမ်း ကျောင်းဖွံ့ဖြိုးတိုးတက်ရေးနှင့် သစ်တောသယံဇာတများ ထိန်းသိမ်းရေးကို တစ်ပြိုင်နက်တည်း မြှင့်တင်နိုင်ရန်ရည်ရွယ်၍ အကောင်အထည်ဖော်ဆောင်ရွက်လျက်ရှိပါသည်။ ယခုလေ့လာမှုတွင် ရှမ်းပြည်တောင်ပိုင်း၊ ပင်းတယမြို့နယ်ရှိ ဒေသခံပြည်သူအစုအဖွဲ့ပိုင် သစ်တောလုပ်ငန်းများဆိုင်ရာ ညွှန်ကြားချက် (၁၉၉၅) အရ တည်ထောင်ထားသောနှစ် (၃၀)ပြည့် အစုအဖွဲ့ပိုင်သစ်တောများ၏ အခြေခံလိုအပ်ချက်များ ဖြည့်ဆည်းပေးနိုင်မှုနှင့် သဘာဝပတ်ဝန်းကျင် ရေရှည်တည်တံ့ရေးအတွက် အထောက်အကူပြုနိုင်ခြင်းများကို သုံးသပ်တင်ပြထားပါသည်။ လူမှုရေးနှင့် ဂေဟဗေဒဆိုင်ရာ နည်းလမ်းများကို ပေါင်းစပ်အသုံးပြုခဲ့ပြီး အိမ်ထောင်စုအလိုက်တွေ့ဆုံ မေးမြန်းခြင်းနှင့် နမူနာကွက်များချမှတ်၍ သစ်တောအခြေအနေ လေ့လာဆန်းစစ်ခြင်းတို့ကို ဆောင်ရွက်ခဲ့ပါသည်။ အသုံးပြုသူများ အဖွဲ့ဝင် စုစုပေါင်း ၁၃၀ ဦးအနက်မှ အဖွဲ့ဝင် ၅၅ ဦးကို ကျပန်းရွေးချယ်၍ ထင်းသုံးစွဲမှု၊ လူမှုစီးပွားရေး အခြေအနေများနှင့် အစုအဖွဲ့ပိုင်သစ်တော နှစ် (၃၀) သက်တမ်းတိုးခြင်း အပေါ် သဘောထားများကို ကောက်ယူစုဆောင်းခဲ့ပါသည်။ ထို့အပြင် သစ်တောအခြေအနေများနှင့် ကာဗွန် သိုလှောင်မှုပမာဏကို လေ့လာရန် ၅၀ မီတာ × ၅၀ မီတာ (၀.၂၅ ဟက်တာ) အရွယ်အစားရှိ နမူနာကွက် ၆ ကွက်ကို တည်ဆောက်၍ အပင်စာရင်းတိုင်းတာကောက်ယူခြင်းများ ဆောင်ရွက်ခဲ့ပါသည်။ သုတေသနရလဒ်များအရ ထင်း အသုံးပြုမှု၏ ၆၂ ရာခိုင်နှုန်းမှာ အစုအဖွဲ့ပိုင်သစ်တောမှ ရရှိခဲ့ပြီး၊ ကျန် ၃၈ ရာခိုင်နှုန်းမှာ ကိုယ်ပိုင်ယာမြေများမှ ခုတ်ယူခြင်းနှင့် ဒေသတွင်းဈေးကွက်မှ ဝယ်ယူအသုံးပြုခြင်း ဖြစ်ကြောင်း တွေ့ရှိခဲ့ပါသည်။ သို့ရာတွင် ထင်းထုတ်ယူမှု မထိန်းချုပ်နိုင်ခြင်း၊ ရွေးချယ်ခုတ်လှဲခြင်းနည်းစနစ်နှင့် သစ်တောပြုစုထိန်းသိမ်းခြင်း လုပ်ငန်းစဉ်များအပေါ် နည်းပညာ ဗဟုသုတ မလုံလောက်ခြင်းတို့ကြောင့် သစ်တောအတန်းအစား အခြေအနေပြောင်းလဲလာသည်ကို တွေ့ရှိရပါသည်။ ထို့ကြောင့် အစုအဖွဲ့ပိုင် သစ်တောတည်ထောင်ခဲ့ခြင်းမှာ သက်တမ်းနှစ် ၃၀ ရှိနေသော်လည်း သဘာဝပတ်ဝန်းကျင် အကျိုးပြုမှု အနေဖြင့် ကာဗွန်သိုလှောင်နိုင်မှုမှာ (၁) ဟက်တာလျှင် ၁၁.၄၉ တန်သာ ရှိနေပါသည်။ ထို့ကြောင့် အစုအဖွဲ့ပိုင်သစ်တော သက်တမ်းတိုးသည့် ကာလတွင် သစ်တောအခြေအနေများ ပိုမိုကောင်းမွန်လာစေရန်နှင့် လူထု–သစ်တော ဆက်နွယ်မှုကို ဆက်လက်တက်ကြွစွာ ထိန်းသိမ်းနိုင်ရန် အဖွဲ့အစည်းဆိုင်ရာ စွမ်းဆောင်ရည်မြှင့်တင်ခြင်းနှင့် စနစ်တကျ သစ်တောစီမံအုပ်ချုပ်မှုလုပ်ငန်းများ ဆောင်ရွက်ခြင်းတို့ကို ထည့်သွင်း အကောင်အထည် ဖော်ရန် လိုအပ်ပါကြောင်း တင်ပြအပ်ပါသည်။

Can 30 years community forest contribute to basic needs and environmental stability in rural areas? A case study from Pintaya Township, Southern Shan state

1. Introduction

Community forestry is one of the major forest management modalities in the world (Laudari, 2024) and it has great potential to improve the welfare of the estimated 450 million impoverished people living in and around forests in Asia (RECOFTC, 2007). RECOFTC (2023) defines that "community forestry is a broad term for approach that empower people to manage, protect and benefit from a local forest, which their community may have rely upon for generations'. These approaches have different name, such as social forestry in Indonesia, village forestry in Laos, Community Based Forest Management in the Philippines and Community Forestry in Cambodia, Nepal, Thailand and Myanmar. Nepal is a global leader in CF. A growing body of literature documents (e.g. Balan et al 2010, Rai et al 2016, Laudari et al 2024) pointed out that forest users are deriving benefits from different sources including forest management activities, forest products, Community Forest User Group (CFUG) support and other activities. The types of collected forest products include timber, firewood, forage and fuelwood is the main forest products collected for cooking and heating in rural areas of Nepal (Balan et al 2010). However, Laudart et al 2024, which assesses CF performance in Nepal's mid-hills since 1990s, pointed out that forest-people interaction has changed along with changes of socio-economic including less dependence on firewood for cooking, demographic and income dynamics, growing recognition of ecosystem services and changes in land use practices and resource use patterns. They suggest " magnaging CF into three different models: urban CF, protected CF, and production CF by covering larger landscapes and putting the Payment of Ecosystem Services (PES) mechanism in place." This policy implications should consider not only for Nepal but also for other countries such as Cambodia, Indonesia, Myanmar, Lao PDR and Mexico how to adpat the CF programs to the changing context by better alligning them to the need and capacitay of local communities (RECOFTC, 2021; Laudart et al., 2024).

In Myanmar, Forest Policy 1995 and 30-years Forestry Master Plan were instrumental in institutionalizing participatory forestry discourse in the country. From 1990 to 2000, forest cover has been reduced from 57.97 % to 51. 54 %. Community Forestry Instructions were adopted in 1995 to regain environmental stability and support basic needs in rural areas by enhancing people participation. In 2019, Community Forestry Instructions were promulgated to support not only basic needs but also commercial supply through promotion of community forest-based enterprises and ecosystem-services. Additionally, Forest Law enacted in 2018 provides legal framework for CF including use rights of planted Teak *Tectona grandis* in CF area, extraction of forest products and support from FD. Myanmar had established 456,220 ha of CF by 2026 March, covering 7,875 households. Of which, total number of CF area in Shan State is about 82,055 ha consists of 1,203 households, in which, natural forest conservation includes about 40,695 ha while plantations include about 41,360 ha.

A total of about (30) studies including research papers, survey reports and Master Thesis has been assessed community forestry in Myanmar in terms of livelihood contributions, deforestation and forest degradation and performance of community forest user group. Of which, about 50 % of studies assessed CF in Dry Zone followed by Shan State and Ayeyarwady. Some studies such as Oo, 2004 and Soe, 2018 conducted comparative studies of CF performance among different regions: Shan State, Dry Zone and Ayeyarwady regions. When we looked at the age of CF in Myanmar studied by various scholars, the minimum age is about 4 years while the maximum age is about 17 years. Based on previous studies, it can be concluded that local community continued participation in CF because they are getting benefits and subsistence income. It is also a promising strategy for poverty reduction (Yamauchi,2013 and Maung, 2015). Performance varies depending on social, institutional and economic factors such as leadership, distance to forest, external support and income (Aung, 2010; Hlaing et al., 2011 and Kyaw et al., 2024). Since CF started in 1995 in Myanmar, it has been almost 30 years. However, there is limited evidence on how CF performs in meeting basic needs and retain environmental stability at the village level. This study therefore seeks to fill this gap by conducting in-depth case study in Pawsanthee village in Pintaya Township, Southern Shan State.

2. Research aim

The overall objective of the research is to assess whether community forest can support the fulfillment of basic needs and contribute to environmental stability under the Community Forestry Instructions (CFI,1995). The specific objectives of the research are:

- To assess the collection of fuelwood and non-timber forest products from community forest
- To examine the existing forest conditions of community forest and its carbon storage
- To explore the interaction of forest and people during 30 years of community forest

3. Materials and Methods

3.1 Study area

Pawsanthee village CF of Pintaya Tonwship, Taungyi District was selected as the study site which is far about 20 minutes driving hour from Pintaya city as shown int the *Figure 1*. Nowadays, the village is well known in Nan-Kone village-tract for designated area of Livestock Breeding Zone. Ministry of Cooperative and Rural Development supported upgrading rural road of Pawsanthee village to concrete roads in 2025-2026 budget year. According to the key informant interview, the villagers conserved existing CF areas as “Htin Taw” and governed by the Monk according to local customs and knowledge since the era of Sawbwa. Villagers are allowed the extraction of fuelwood needed for daily cooking and heating. Outsiders are excluded from use rights. CF was formed in 1996 with the support of UNDP. The CF area is about 109.81 acre. Agriculture is main livelihood and landholding is between 1 to 22 acres. The average landholding is 3.72 acres. The villagers are Danu ethnic and average family size is about 4 people.

3.2 Data collection and analysis

Data were collected using semi-structured interviews in November and January 2025. Number of USG members is about 130 households, of which a total of 55 households were randomly selected to make semi-structured interviews. Women represented 50 % while men represented 30 % of the total interviewees. Questionnaires were designed to collect respondents’ information on household demography, land, livestock size, agricultural production, agriculture and non-agriculture income, and willingness to participate in CF for the next 30 years. For objective No. (1), basic needs mean fuelwood and NTFP supply to CFUG members. The study investigated fuelwood use and source choice for fuelwood among households participating in Community Forest User Groups (CFUGs). A total of 55 households were surveyed for fuelwood consumption analysis, and 51 households were included in the analysis of dependence on community forest (CF) fuelwood. Purposive sampling ensured representation across different income levels, landownership, and electricity access household surveys collected information on:

Demographics:	family size, presence of elderly members.
Economic variables:	household income
Land variables:	land possession status and agricultural land area
Energy access:	availability of electricity
Fuelwood use:	quantity consumed and primary source (community forest vs. own farmland).

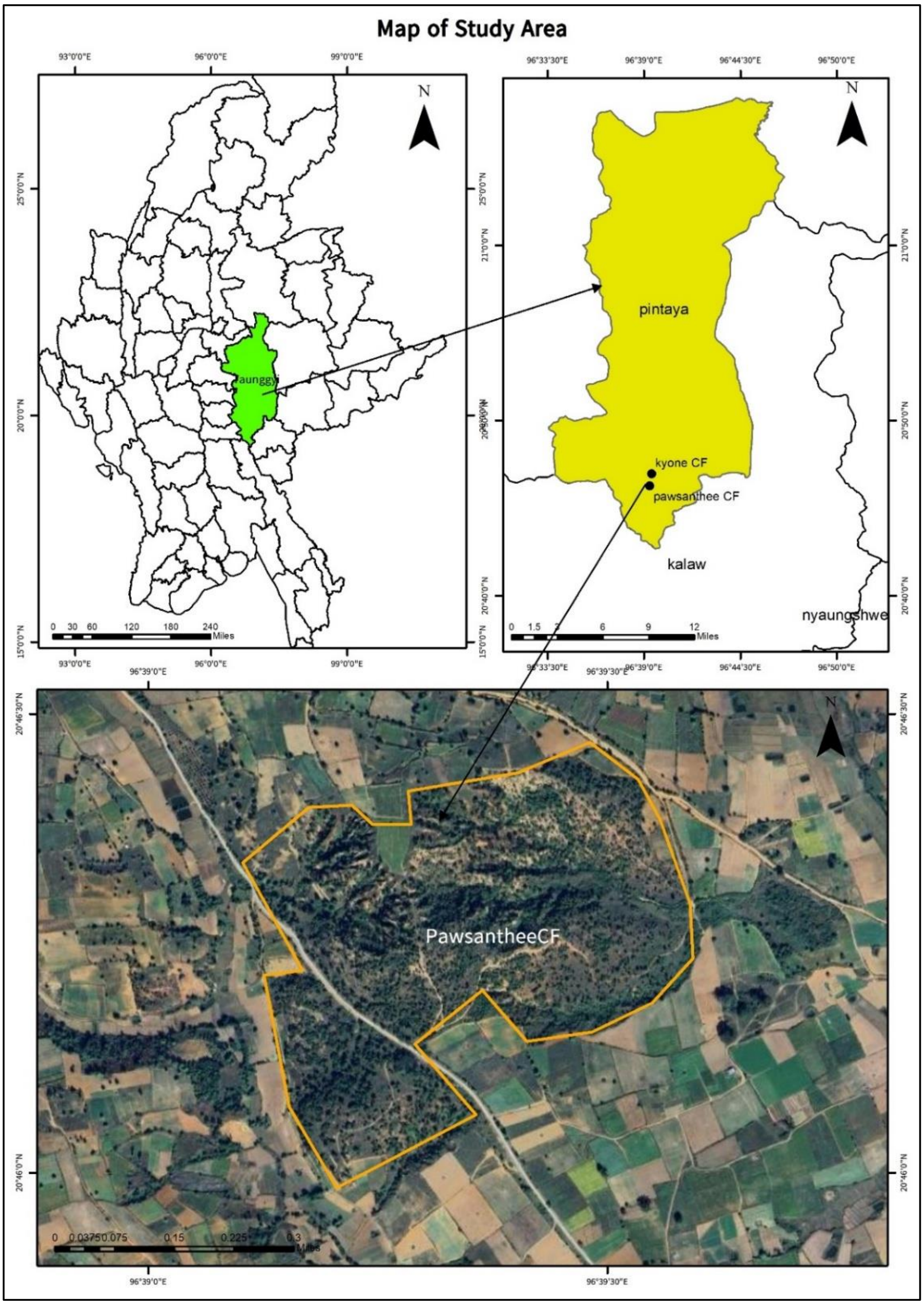

Figure 1 Map of Pawsanthee CF Area

The data collected were analyzed using two econometric models. The first model employed ordinary least squares regression to analyze the determinants of fuelwood quantity consumed, while the second model used logistic regression to identify factors influencing household dependence on community forest fuelwood relative to own farmland sources.

In order to assess current forest conditions (vegetation analysis) and carbon stocks, six sample plots were set up and each plot was 50 m × 50 m (0.25 ha). The plots were placed in different parts of the forest to get good representation. As report by (Bhattarai, 2017), 10% sampling intensity will be an appropriate sampling for the inventory of CFs in middle hills in Nepal, considering the human and financial resource. Tint et al. (2011) conducted the research on forest conditions in CFs in Myanmar in which the research used Simple Random Sampling method and sample plots are laid down at the rate of one plot per 100 acres (40.47 ha) of the natural forest in the selected CF and two SPs were laid where the area of the natural forest was less than 100 acres (40.47 ha). According to (Lamprecht, 1989) cited in (Oo T. N., 2003), the minimum representative area can be sampled as 1 ha. The forests conditions in the study area are homogeneous; thus Simple Random Sampling method will be used to lay down sample plot.

In this study, six sample plots was subdivided into two sub-sample plots with size of 100 m^2 (10m x 10m) and 25 m^2 (5m x 5m) as shown in the *Figure 2*. All trees with DBH greater than or equal to 5cm and tree height within 50 m plot, saplings 3cm < DBH < 5 cm within the 10 m sub-plot and seedlings within 5 m plots were measured.

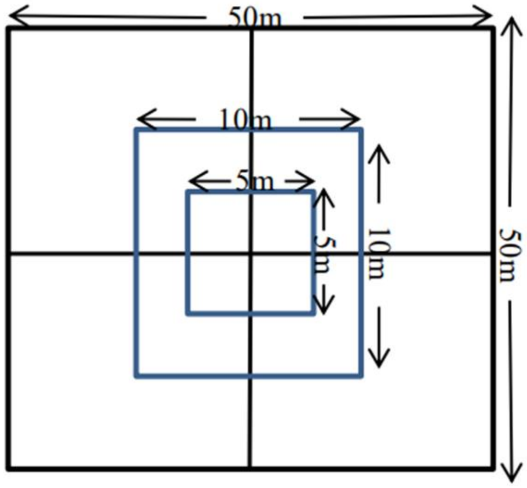

Figure 2 Sample plot design for vegetation analysis

The following values were calculated:

1. Species Richness (R): This was calculated using the Margalef index formula:
   $R = (S - 1)/\ln(N)$.
   Here, S = total number of species and N = total number of trees.
2. Shannon-Wiener Diversity Index (H'): This was calculated using the formula
   $H' = -\sum p_i \ln p_i$.
   Here, p_i is the proportion of trees belonging to species i.
3. Simpson's Diversity Index:
   Dominance (D): $D = \sum p_i^2$.

   This tells the chance that two trees picked randomly will be the same species.
4. Species Evenness (E): This was calculated using evenness index:
   $J' = H'/\ln(S)$.
   This shows how evenly the trees are distributed among the species.

In this analysis, carbon storage was assessed using the species specific allometric equation, ln AGB = -3.7268 + 1.5908 (ln DBH * H), developed for *Pinus Kesiya* (Monsang et al., 2024) where ln is the natural logarithm, AGB is the aboveground biomass (Kg/tree), DBH is diameter at breast height (cm) and H is tree height (m) and then, multiply it with 49% of conversion factor for aboveground carbon stocks (Matthews 1993; Thomas & Martin 2012). The belowground carbon storage (BGC) was calculated as 24% of the aboveground carbon stocks (AGB) (IPCC, 2006).

For objective No (3) to assess the interaction of forest and people during 30 years of community forest, our study employed Ostrom's social-ecological system (SES) framework consists of resource system, governance system, users, demography, outmigration and economic development as internal factors that shape interaction of forest and people (Ostrom, 2009). As described earlier, forest-people interaction in Nepal community forestry, particularly in the mid-hills compared to the 1990s and the early 2000s have being altered due to the changes of social context such as outmigration, demography and resource use pattern, economic context such as on and off farm activities and local market dynamics, international forestry discourses and national forest policies (Laudari et al, 2024).

4. Results and Discussions

4.1 Collection of fuelwood and non-timber forest products from CF areas

The economic value of fuelwood was estimated using the market price approach. This method calculates the value of fuelwood consumption by multiplying the quantity of fuelwood consumed annually by the prevailing local market price. Even for households collecting fuelwood from community forests without direct payment, the local market price was used as a proxy to reflect its opportunity cost. Annual household fuelwood value was computed as the product of total annual consumption (cart/year) and the average market price (MMK/cart). To capture the full economic cost of fuelwood collection, labor opportunity cost was included.

Valuation of fuelwood collection is calculated by the following equation (1)$\boldsymbol{TEV} = (\boldsymbol{Q} \times \boldsymbol{P}) + (\boldsymbol{Q} \times \boldsymbol{C_L})$ (1:

$$\boldsymbol{TEV} = (\boldsymbol{Q} \times \boldsymbol{P}) + (\boldsymbol{Q} \times \boldsymbol{C_L}) \qquad \textbf{(1)}$$

Where:

- TEV= Total economic value
- Q= Fuelwood quantity (carts/year)
- P= Market price per cart
- C_L= Labor cost per cart

Labor cost calculation for fuelwood collection is calculated by the following equation (2):

$$\boldsymbol{C_L} = \frac{\boldsymbol{W}}{\boldsymbol{D}} \times \boldsymbol{T} \qquad \textbf{(2)}$$

Where:

- W= Daily wage (15,000 MMK/day)
- D= Working hours per day (8 hours)
- T= Collection time per cart (4 hours)

According to the household interview, the surveyed households consumed a total of 270 carts of fuelwood per year. With an average market price of 80,000 MMK (~38 USD) per cart. Using the market price approach, the total annual economic value of fuelwood consumed by the surveyed households was estimated at 21,600,000 MMK (~10,286 USD). Labor cost per cart was calculated based on a daily wage rate of 15,000 MMK and average collection time of 4 hours per cart, yielding 7,500 MMK per cart. Including labor cost increased the total economic value to 23,625,000 MMK (~11,250 USD) annually.

When disaggregated by source, approximately 62% came from community forests and 38% from private owned farmlands and buying from local market, especially rich people. Notably, 62% of total fuelwood originated from the community forest, indicating that Pawsanthee Community Forest remains the primary energy source for local livelihoods. The inclusion of labor cost highlights the hidden economic burden of fuelwood collection, which represents approximately 9–10% of total fuelwood value.

Household interview revealed that 100 % of respondents collect *Matsutake mushroom* which grow under the Pine tree especially in gully area of CF, Mango ginger (Zedory) *Curcuma zedoaria*, Crab apple *Docynia indica*, Dropping figs *Ficus semicordata* for home consumption. All villgers have open access to harvest any non-timber forest products from CF area.

4.2 Determinants of Fuelwood Consumption

An ordinary least squares (OLS) regression model (equation 3) was used to examine factors affecting household fuelwood quantity. OLS was chosen for its simplicity and ability to provide unbiased estimates of the linear relationships between explanatory variables and fuelwood consumption.

$$\boldsymbol{FuelwoodAmount_i = \beta_0 + \beta_1 FamilySize_i + \beta_2 Elderly_i + \beta_3 \ln(Income_i) + \beta_4 LandPossession_i + \beta_5 AgriLandArea_i + \beta_6 Electricity_i + \epsilon_i} \quad \textbf{(3)}$$

where:

- $FuelwoodAmount_i$ is the total quantity of fuelwood consumed by household i.
- $FamilySize_i$, $Gender_i$, and $Elderly_i$ capture household demographic characteristics.
- ln $(Income_i)$ represents the logarithm of household income.
- $LandPossession_i$ and $AgriLandArea_i$ represent land ownership and agricultural land area, respectively.
- $Electricity_i$ is a binary variable indicating access to electricity.
- ϵ_i is the error term.

4.3 Determinants of Fuelwood Source Choice

A logistic regression model analyzed factors influencing household dependence on community forest fuelwood:

$$\boldsymbol{\text{logit}(P_i) = \ln\left(\frac{P_i}{1-P_i}\right) = \alpha_0 + \alpha_1 FamilySize_i + \alpha_2 Elderly_i + \alpha_3 \ln(Income_i) + \alpha_4 LandPossession_i + \alpha_5 AgriLandArea_i + \alpha_6 Electricity_i} \quad \textbf{(4)}$$

where P_i is the probability of relying primarily on community forest fuelwood. Odds ratios were used to interpret the effect of each variable, and model fit was evaluated using *pseudo* R^2.

Summarized table of results are shown in *Table 1*:

Table 1 Fuelwood Used Amount of Sample Households

Variable	OLS (Coef., p)	Logit (OR, p)
Family size	-0.173 (0.432)	0.819 (0.516)
Presence of elderly people	0.344 (0.586)	0.745 (0.771)

Variable	OLS (Coef., p)	Logit (OR, p)
Income	0.078 (0.109)	0.968 (0.555)
Agricultural land area	-0.110 (0.129)	**0.726 (0.038**)**
Electricity access	**-1.244 (0.066*)**	1.308 (0.756)
Constant	5.349 (0.000**)	-

*p < 0.10, ** p < 0.05, *** p < 0.01
Logit model reports odds ratios (OR).
Dependent variable in Model (2): 1 = fuelwood from Community Forest; 0 = own farmland.

The OLS regression results show that having access to electricity reduces fuelwood use, and this effect is statistically significant at 10% significant level. Households with electricity use much less fuelwood, which suggests that they partly switch to alternative energy sources. Household income has a small positive effect on fuelwood use at the 10% significance level. This means that higher income alone does not necessarily reduce fuelwood use in the study area. Other household factors, such as family size, gender of the household head, presence of elderly members in the household, land ownership and land holding size of agricultural land, do not have a significant impact on the amount of fuelwood used.

The Logit Regression model results show that possession of agricultural land and landholding size of agricultural land are statically significant at 5% significant level. This means that these factors have positive effect on choice of fuelwood collection by community forest user group members. The logistic regression results show the main factors that affect whether households get fuelwood from community forests instead of their own farmland. Households that own land are more likely to collect fuelwood from community forests. On the other hand, having more agricultural land reduces the reliance on community forest fuelwood. This means that households with bigger private land can get more fuelwood from their own land. Income and access to electricity do not have a significant effect on where households get their fuelwood.

4.4 Assessment of Current Forest Conditions (Vegetation Analysis)

A total of 7 tree species consists of Eucalyputs spp, *Pinus kesiya*, *Figus cunia*, *Muntingia calabura, Syzygium grande, Schima wallichii* and *Acacia auriculiformis*, and 730 individual trees were found in the studied sample plots. The total area sampled was 1.5 ha. Therefore, there are about 487 individual trees per ha. Vegetation parameters are shown in *Table 2.*

Table 2 Descriptive statistics of vegetation parameters in Pawsanthee Community Forests

S.N.	Parameters	Results
1	Number of Species	7
2	Number of Individual Trees	730
3	Shannon-Weiner Diversity Index (H′)	0.28
4	Simpson's Diversity Index (D)	0.89
5	Simpson's diversity index (1 − D)	0.11
6	Species Eveness (E)	0.14
7	Species Richness (R)	0.91

The Pawsanthee Community Forests have low species diversity ($H' = 0.28$). Shannon index values usually range from 0 to 4.5. Values below 1.5 mean low diversity. The species richness index ($R = 0.91$) also shows low species richness. This means there are not many species compared to the number of trees (730).

The Simpson's Dominance Index is very high ($D = 0.89$). This means the forest is strongly dominated by one species. The Simpson's Diversity Index ($1 - D = 0.11$) is very low. This means if you pick two trees randomly, there is only an 11% chance they will be different species. The evenness value ($E = 0.14$) is also very low. This confirms that the trees are not evenly distributed among the 7 species. The data shows that one species (*Pinus kesiya*) makes up 94% of all trees.

The diameter at breast height (DBH) of all 730 individual trees recorded in Pawsanthee Community Forests was measured and classified into five diameter classes. The diameter class distribution of trees in the Pawsanthee Community Forests is shown in *Table 3* and *Figure 3*.

Table 3 Percentage distribution of tree (DBH)

No.	Diameter Class (cm)	Community Forest	
		No. of Individuals	Percentage
1	>5-10	302	41.4
2	11-20	385	52.7
3	21-30	36	4.9
4	31-40	5	0.7
5	41-50	2	0.3
	Total	730	100

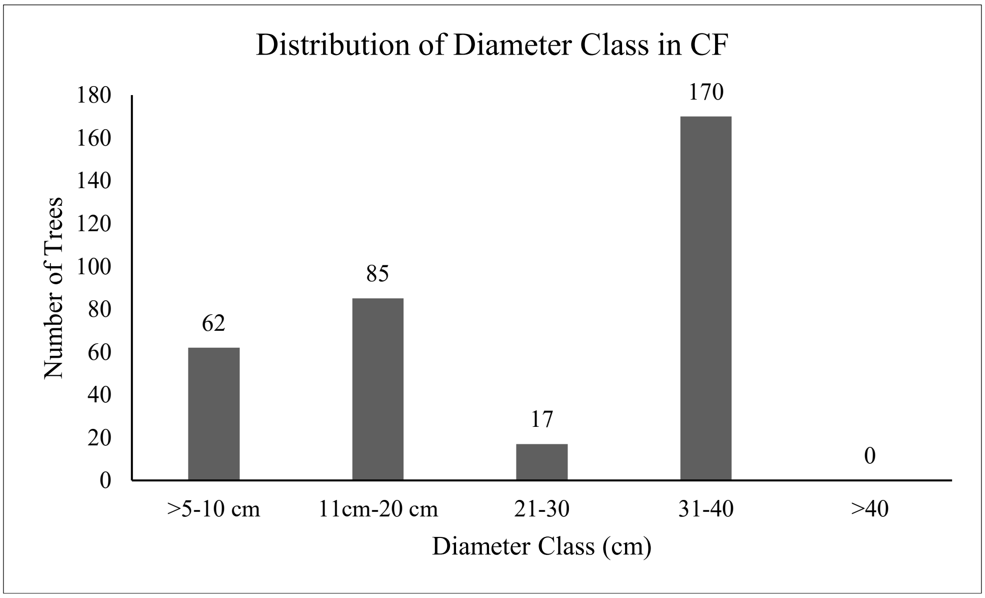

Figure 3 Distribution of Diameter Class in Pawsanthee CF

The presence of 687 trees (94.1%) in the 5-20 cm classes indicates good regeneration potential. This contrasts with many degraded forests where small diameter classes are poorly represented. Given that *Pinus kesiya* comprises 94% of all trees, it is highly probable that the vast majority of young trees (5-20 cm DBH) are also *P. khasya*. This suggests that while the forest is regenerating well, it is regenerating almost exclusively with the dominant species. The other six species, particularly those with only 1-2 individuals, are likely not producing successful regeneration. The very low number of trees above 30 cm DBH (only 7 trees, 0.96%) suggests that the forest is relatively young, established approximately 30-40 years ago and past harvesting removed most large-diameter trees. The absence of trees above 50 cm DBH is notable and large trees serve as seed sources, carbon reservoirs, and wildlife habitat; therefore, their absence signals ecological vulnerability and environmental degradation.

Table 4 Forest Cover Assessment of Pawsanthee CF

Category	FRA 2010	FRA 2015	FRA 2020	FRA 2025
Closed Forest	13.59	13.73	14.31	12.83
Open Forest	20.27	20.48	20.35	22.73
Total Forest Area	**33.86**	**34.21**	**34.66**	**35.56**
Other Wooded Land	65.7	65.48	63.07	63.23
Agriculture/ Other	10.25	10.12	12.08	11.02
Total Area	**109.81**	**109.81**	**109.81**	**109.81**

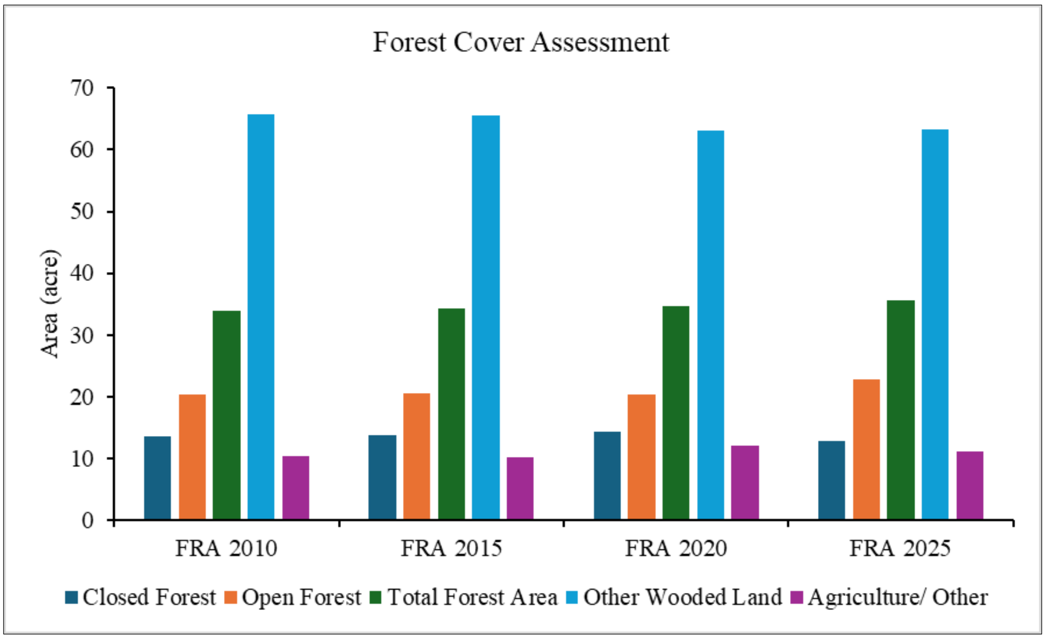

Figure 4 Forest Cover Assessment of Pawsanthee CF (FRA 2020 to FRA 2025)

Table 4 and *Figure 4* present the forest cover dynamics of Pawsanthee Community Forest (CF) from FRA 2010 to FRA 2025. The total area of the CF remained constant at 109.81 acres throughout the assessment period, indicating that changes occurred within land-use categories rather than through boundary expansion or reduction. The total forest area (closed forest + open forest) increased gradually from 33.86 acres (2010) to 35.56 acres (2025). This represents a net gain of 1.70 acres, suggesting an overall improvement in forest cover over the 15-year period. Closed forest slightly increased from 13.59 acres (2010) to 14.31 acres (2020), but declined to 12.83 acres in 2025, showing a recent reduction in dense forest stands. Open forest fluctuated moderately between 2010 and 2020 but increased notably to 22.73 acres in 2025, the highest value recorded during the study period. The increase in total forest area is primarily attributed to the expansion of open forest, which compensated for the decline in closed forest in 2025. Other wooded land declined steadily from 65.70 acres (2010) to 63.23 acres (2025), indicating a gradual conversion of these areas into forest land or other uses. Agriculture/other land fluctuated slightly, increasing from 10.25 acres (2010) to 12.08 acres (2020) before decreasing to 11.02 acres (2025). These trends suggest internal land-use transitions, likely from other wooded land to open forest, contributing to the observed increase in total forest area.

4.5 Carbon stocks

The carbon stock results for the Pawsanthee CF are presented in *Table 5* and *Figure 5*. The average carbon stock in the study area was estimated at 25.04 kg per tree and 11.49 ton per hectare. It was found that the 44.4 hectares of CF, which is dominated by *Pinus kesiya*, stores approximately 509.93 tons of carbon at 30 years of age. If such pine dominant CFs are well conserved and managed, the carbon stocks can reach the range between 0.02 to 141.43 ton per hectare at the age of 2 to 54 years (Li et., al, 2015). However, all trees in the study area cannot grow well to maturity because of repeated felling for fuelwood collection, so the carbon storage capacity of the Pawsanthee CF is relatively lower than the normal range reported for *P. kesiya* forests.

Table 5 Aboveground Biomass, Belowground Biomass and Carbon Stocks by Community Forest in Pawsanthee Village, Pintaya Township, Shan State

Plot No.	DBH_Range	No. of Trees	Average Aboveground Biomass (AGB/tree)	Average Aboveground Carbon (Kg/tree)	Belowground Biomass (kg/tree)	Belowground Carbon (kg/tree)	Total Carbon
1	6-30	40	204.63	100.27	49.11	24.06	73.17
2	7-32	46	127.15	62.3	30.52	14.95	45.47
3	4-27	80	33.23	16.28	7.97	3.91	11.88
4	2-48	224	13.27	6.5	3.19	1.56	4.75
5	2-36	173	27.53	13.49	6.61	3.24	9.85
6	3-31	125	14.29	7.00	3.43	1.68	5.11
		688					

4.6 Interaction of forest and people during 30 years of CF

Changing socio-economic, institutional and environmental context

For Pawsanthee village, fuelwood is the main energy source for daily cooking and heating, especially for the aged people in raining and winter seasons (age is about 60 years). After 2018, the dependency on forest resources for cooking fuelwood is likely to reduce as the village had access to electricity as an alternative energy source in 2018. However, only about 68 % of total respondents have access to electricity whereas remaining 32 % don't have access to electricity. It was not found that the culture of conserving trees especially Crab apple *Docynia indica* around the private owned farmlands in Pawsanthee village. Respondents answered that soil conditions do not favor the growth of Crab apple *Docynia indica*. Therefore, research findings revealed that 62% of fuelwood consumption was obtained from community forest 38% came from private owned farmlands and buying from local market, especially rich people. According to household interviews and our observation, young people are also showing interest in forest not only for fuelwood but also for the availability of food in terms of non-timber forest products and small wild animals e.g. Partridge *Francolinus pintadeanus*.

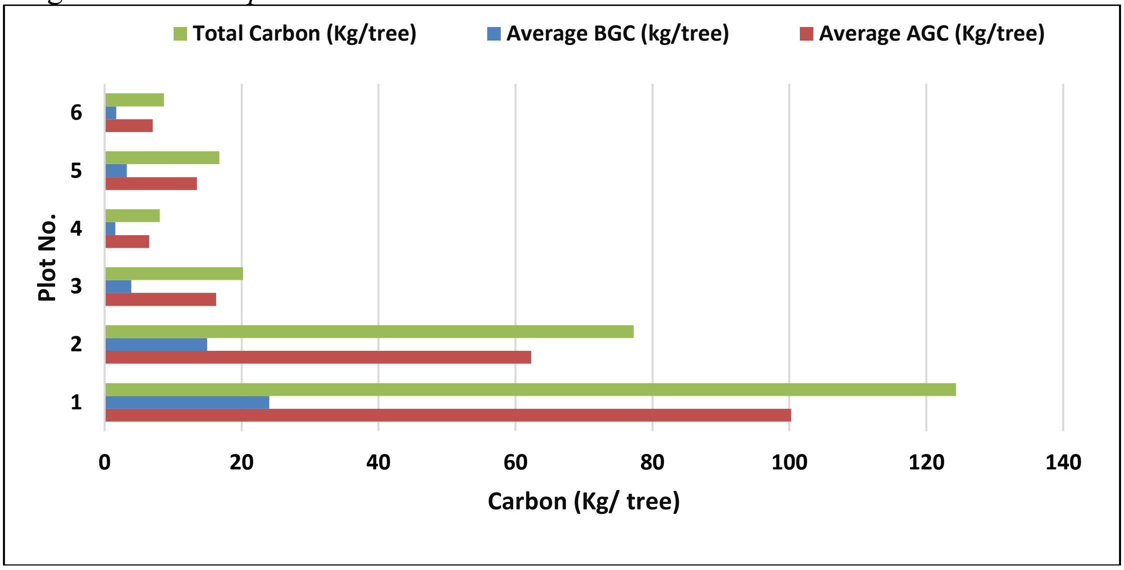

Figure 5 Aboveground Biomass, Belowground Biomass and Carbon Stocks in Pawsanthee CF

Currently, total population is over 800 for 190 households. So far, very few people migrated to cities and abroad for employment while people heavily relied on subsistence agriculture for their livelihood with limited economic opportunities. The average landholding is about 1.21 ha per household and cultivated land relies on rainfall. After 2010, cropping pattern was transformed from planting subsistence crops such as rice, ginger and taro into cash crops such as potato and cabbage according to market needs. Not only tubewell but also rainwater was harvested around their farms to enable supplement irrigation for commercial crops. According to key informant interview, about 19 households (10 % of total households) are rich and they have less access to fuelwood from CF as they buy from outside. Although socio-economic conditions have being developed villagers are still relying on fuelwood for their daily needs. As described in regression analysis, our findings also indicated that higher income alone does not necessarily reduce fuelwood use because household income has a small positive effect on fuelwood utilization.

4.7 Users and governance system of CF

When we look at the governance system, community developed management plans including planting, pruning, fire protection and harvesting with the aim of 1) to support fuelwood and non-timber forest product needs; (2) to increase awareness on environmental conservation and (3) to achieve active participation in environmental conservation. According to key informant interview, operational activities were implemented according to the management plan at the initial period, with the support of UNDP project. We also observed wild pineapple along the gully areas of CF as mentioned in the management plan. However, CFUG members can't follow up well for required silvicultural operations. They didn't conduct any village meetings for collective action of forest management activities including protection of forest fire after 2020. Additionally, they don't have by law to craft and enforce their own rules to extract fuelwood as well as to conserve the forests. Forest products from CF, especially fuelwood, are being harvested under the situation of lack of monitoring and graduated sanctions for the violation of the internal rules. For 30 years period, first Chairman of CFUG members have changed because of health conditions while second Chairman passed away in 2020. According to interviews with local FD staff and young people, there is no user group members who are respected as local leader in the village. It was found that management committee members have no social and economic incentives for acting as the leader compared to village administrative leaders.

Lower number of migration and higher dependency of forest users on resources are the strong predictor of the sustainability of social-ecological system and community forest management institutions (Ostrom, 2009 and Laudari et al, 2024). But attributes of the users especially for lack of strong leadership although users are homogenous in terms of ethnic group and livelihood, poor performance in the governance system, including lack of collective choice arrangements, monitoring makes changes in forest ecological conditions in this study context.

5. Conclusions

In this paper, we quantified fuelwood consumption of CFUG members and economic value using market price approach. We found that the surveyed households consumed a total of 270 carts of fuelwood per year, in which approximately 62% came from community forests and 38% from private owned farmlands and buying from local market, especially rich people. The total annual economic value of fuelwood was estimated at 21,600,000 MMK (~10,286 USD). Fuelwood is the main energy source for daily cooking and heating, especially for the aged people in rainy and winter seasons while 100 % of respondents collect non-timber forest products for household food consumption.

We have used vegetation analysis counter checked by assessment of forest cover changes in Pansanthee village CF during 2020 and 2025 and estimation of carbon stock to assess the existing forest conditions. Forest cover assessment shows that forest conditions have been slightly changed during 2020 to 2025 as closed forest changed to open forest about 1.47 acres. According to the existing forest conditions, 730 individual trees were recorded from six sample plots, however, there are about only 7 individual trees which is greater than DBH 30 cm (1 foot). Most of them are in the 5-20 cm diameter classes. Consequently, carbon storage capacity is relatively low because it can store only 25.04 kg per tree and 11.49 ton per ha despite the fact that carbon storage for Pine species should be between 0.02 to 141.43 ton per hectare at the age of 2 to 54 years.

Study found that higher dependency on forest resources in terms of daily cooking and heating for the aged people and non-timber forest products for food makes active interaction of forest and people for 30 years. However, lack of strong leadership and poor governance may disconnect local people from CF especially for participation in CF management activities for improvement of forest conditions, reduce collection actions, increase the risk of forest fire and erode forest.

The results suggest that Pawsanthee CF functions primarily as a production-oriented fuelwood forest rather than a biodiversity-rich natural forest system. This study can be concluded that CF can support basic needs and environmental stability according to CFI, 1995. In order to balance conservation and utilization of forest resources for renewal of 30 years, village administrative leaders should lead forest management activities including planting, pruning and cleaning of CF areas through partnership with CF management committee members for collective production.

Acknowledgements

We deeply thanks to Pintaya Township FD staff and Pawsanthee villagers who participate in our interview and field observation. We also express our sincere gratitude to the Director General of the Forest Department for providing us an opportunity to pursue this study. This work was also supported by the CF unit of the Director General office and review team members assessing 30 years of community forests to analyze forest cover and status of these CFs.

References

Aung, H. M., 2010. Levels of People Participation in Community Based Forest Management of the Dry Zone area in Myanmar: A case study of Chaung U, Nyaung U and Taungdwingyi Townships. https://doi.org/10.14456/ENNRJ.2010.15

Basnet, S., Sharma, P., Timalsina, N., Khaine, I., 2018 . Community Based Management for Forest Conservation and Livelihood Improvement: A Comparative Analysis from Forests in Myanmar.

Feurer, M., Gritten D., Than, M. M., 2018. Community Forestry for Livelihoods: Benefiting from Myanmar's Mangroves. https://doi.org/10.3390/f9030150

Hlaing, E. E. S., Inoue, M., 2011. Factors affecting participation of user group members: comparative studies on two types of community forestry in the Dry Zone, Myanmar. https://doi.org/10.1007/s10310-011-0328-8

Kyaw, K. T. W., Ota, T., Mizoue, N., Chicas, S. D., 2024. Uncovering the conservation effectiveness of community forests: A case study from Shan State in Myanmar. **https://doi.org/10.1016/j.biocon.2024.110846**

Linn. H., 2005. Community Forestry Initiatives in Myanmar: An Analysis from a Social Perspective. https://doi.org/10.1505/ifor.7.1.27.64154

Latt, M. M., 2013. Analysis of Forest Users' Benefits of Community Forest Contributing to Long-Term Forest Protection and Rehabilitation: Case Study In Inle Lake Watershed, Myanmar.

Linn, T., Htun, K. T., Gritten, D., Martin, A. R., 2019. The contribution of community forestry to climate change adaptive capacity in tropical dry forests: lessons fromMyanmar. https://www.researchgate.net/publication/335888068

Maung, T. M., Yamamoto, M., 2011**.** Accessing the framework of social forestry for the sustainable and participatory forest management-with a focus on Myanmar Bago Yoma. https://www.researchgate.net/publication/286741205

Maung, T. H. M., Ichikawa, M., 2023. Impact of community forestry program on rural livelihood strategy under socioeconomic transition: A case study in the Central Dry Zone of Myanmar. https://doi.org/10.31357/jtfe.v13i01.6305

Oo, T. N., 2004. A comparative study on community forestry development activities in three different agroecological zones: a case study of Kyaukpadaung, Nyaung Shwe and Laputta Townships in Myanmar. Master Thesis.

Soe, K. K., 2018. The interaction of Community Forestry with rural livelihoods in Myanmar: Challenges and opportunities. **https://www.researchgate.net**

San, S. M, Kumar, N., Biber-Freudenberger, N., B. Schmitt, C., 2023. Agroforestry-based community forestry as a large-scale strategy to reforest agricultural encroachment areas in Myanmar: ambition vs. local reality. **https:// www. researchgate.net**

Springate-Baginski O, MM Than, NH Wah, NN Win, KH Myint, K Tint, MKK Gyi., 2011. Community Forestry in Myanmar: Some field realities.

Soe, A. K., Sato, N., 2012. Local People's Attitudes towards the Community Forestry -The Case Studies in the Central Dry Zone of Myanmar. https://www.cabidigitallibrary.org/doi/full/10.5555/20123187407

Soe , K. H., Yeo-Chang, Y., 2019. Perceptions of forest-dependent communities toward participation in forest conservation: A case study in Bago Yoma, South-Central Myanmar. https:// doi.org/ 10.1016/j.forpol.2018.11.009

RECOFTC, 2021. Contributions of community forestry to COVID-19 response and recovery in seven Asian countries. Regional Community Forestry Training Center for Asia and the Pacific, Thailand.

Thinn, P. P., Xie, Y., T. Cirella, G., Thu, A.S., 2024. Community Forestry Impacts on Local Livelihoods: A Difference-In-Differences Analysis in Mindon Township, Magway Region, Myanmar.

Thu, P., 2014. Impacts of Community Forestry on Local Livelihood A Case Study in Dry Zone, Myanmar. https://hdl.handle.net/10371/125683

Thant, P. P., Calkins, P., 2010. Sustainable agro-forestry in Myanmar: from intentions to behavior. https://doi.org/10.1007/s10668-010-9270-8

Thin, PP., Zin, I. I. S., Latt, MM., 2020. The potential of agroforestry as a climate- smart agricultural practice for enhancing local livelihood opportunities in central dry zone, Myanmar: A case study in Pakokku District.

Than, M. M., 2018. Making Community Forestry in Myanmar a Roaring Success

Yamauchi, H., Inoue M., 2012. Contribution of community forestry in the central dry zone of Myanmar to achieving sustainable and equitable forest management. https://doi.org/10.3759/tropics.20.103