Cost-Benefit Analysis of Fruit Tree Based Agro-Forestry Systems: The Case of The Htee Pu Climate-Smart Village, Nyaung-U Township, Central Dry Zone, Myanmar

Alessandro Manilay
Phyu Sin Thant
Chan Myae
Wilson John Barbon
Julian Gonsalves

IIRR
INTERNATIONAL INSTITUTE OF RURAL RECONSTRUCTION

CGIAR
RESEARCH PROGRAM ON
Climate Change, Agriculture and Food Security
CCAFS

IDRC · CRDI
Canada

Correct citation
Manilay A, Thant PS, Myae C, Barbon WJ, Gonsalves, J. 2022. Cost-Benefit Analysis of Fruit Tree Based Agro-Forestry Systems: The Case of The Htee Pu Climate-Smart Village, Nyaung-U Township, Central Dry Zone, Myanmar. Wageningen, the Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

About CCAFS
The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) is led by the International Center for Tropical Agriculture (CIAT), part of the Alliance of Biodiversity International and CIAT, and carried out with support from the CGIAR Trust Fund and through bilateral funding agreements. For more information, please visit https://ccafs.cgiar.org/donors.

Contact us
CCAFS Program Management Unit, Wageningen University & Research, Lumen building, Droevendaalsesteeg 3a, 6708 PB Wageningen, the Netherlands. Email: ccafs@cgiar.org

Photos: International Institute of Rural Reconstruction

Abstract

Htee Pu is a farming village located in the Central Dry Zone of Myanmar, where drought, high atmospheric temperature, and infertile and degraded soils are constraints to sustaining and increasing agricultural productivity and farm income. Dryland fruit-tree-based agroforestry and the raising of goats were the prominent CSA options introduced to supplement the risk-prone prevalent annual cropping systems. This study was conducted to measure the financial benefits of introducing dryland-appropriate fruit trees (with one group having an additional complementary goat component) to Htee Pu households. The Cost and Return Analysis, Payback Period for Investment Analysis, and Household Liquidity Analysis were the analytical methods that were used in the study. Estimating the Net Value generated from potential fruit harvests showed that planting fruit trees on farms or homesteads can be highly profitable. Adding the financial benefits from fruit trees to the households' farm and off-farm income resulted in improvements in the liquidity condition of a number of households. While the Cost-Benefit Analysis results were less impressive than the fruit tree project, the longer-term outcomes would improve once all the female goat breeders had reached their reproductive age. Goats would be significant additional sources of income and food for home consumption, thus a relevant CSA option as well.

Keywords

Climate smart agriculture, climate smart villages, cost-benefit analysis, agro-forestry systems

About the authors

Alessandro Manilay is a Technical Consultant/Economist for the Cost and Benefit Analysis (CBA) at the International Institute of Rural Reconstruction. Email: amanilay07@gmail.com.

Phyu Sin Thant is the Country Researcher at the International Institute of Rural Reconstruction-Myanmar. Email: phyu.thant@iirr.org

Chan Myae is a Project Coordinator at the International Institute of Rural Reconstruction-Myanmar. Email: chan.myae@iirr.org

Wilson John Barbon is the Country Director for Myanmar at the International Institute of Rural Reconstruction. Email: wilsonjohn.barbon@iirr.org.

Julian Gonsalves is the Senior Program Advisor for Asia at the International Institute of Rural Reconstruction. Email: juliangonsalves@yahoo.com.

Table of Contents

List of Tables

Acronyms

CCAFS	Climate Change, Agriculture and Food Security
CDA	Canada and the Community Development Association
CSA	Climate Smart Agriculture
CSV	Climate Smart Village
IDRC	International Development Research Centre
IIRR	International Institute for Rural Reconstruction

Introduction

The Dry Zone in Central Myanmar is an arid region where annual precipitation seldom exceeds 40 inches (1,000 mm), and the temperature reaches a maximum of 43 degrees Celsius during the summer period (MOAI, 2015 & NCEA, 2010). This is in contrast to the other parts of the country, such as the Coastal Region, which experiences rainfall that reaches a maximum of 179 inches per year and where the maximum temperature seldom exceeds 31 degrees Celsius (Thein, 2005). As a result of this uneven distribution of rainfall and extreme temperature, drought, water scarcity, and infertile soil with low water retention capacity become a significant setback in increasing agricultural productivity in the Central Dry Zone (Yee & Nawata, 2014). This condition is a consequence of past human activities that led to the denudation of lush natural forests that used to exist in the area (Sein & Htun, 2013 & Tun, 2000). The current state of natural resources and the existing ecosystem in the Central Dry Zone pose a significant challenge to farming communities in the area.

Nyaung-U Township of the Mandalay region, which houses the Htee Pu Village, has the lowest rainfall intensity among townships within the Central Dry Zone. Rainfall data of the area from 2007 to 2017 shows that precipitation was lowest in 2009 at only 13.5 inches, while the maximum was recorded in 2011 at 40.3 inches. The maximum temperature ranges from 33 to 35 degrees Celsius (International Institute of Rural Reconstruction, 2018). Subsistence farming is an everyday economic activity among the households in Htee Pu Village, where farmers grow sesame, pigeon pea, horse gram, tomato, and groundnut, as well as small livestock. They are greatly dependent on the rain to grow their crops.

To complement the existing annual-crop-based livelihood of the households in Htee Pu, fruit tree agroforestry and backyard goat-raising were introduced in 2018 by the International Institute of Rural Reconstruction (IIRR) with the support of the Climate Change, Agriculture and Food Security (CCAFS) Southeast Asia, International Development Research Center (IDRC) of Canada and the Community Development Association (CDA), a local Myanmar NGO. These Climate-Smart Agriculture (CSA) technologies were aimed at helping farmers adapt to the harsh climatic conditions of the Central Dry Zone through diversification of cropping systems and the introduction of a biodiverse range of fruit tree species and small livestock. The project was completed in 2020.

Objectives of the study

The study was conducted to estimate the current and future financial benefits to the farm households in Htee Pu Village by adopting fruit tree-based agroforestry and goat-raising.

Specifically, the study was conducted to:

1. Estimate the net financial benefits that households could generate from planting fruit trees on their farms or homesteads;
2. Estimate the net financial benefits that could be generated from goats' components that complement fruit trees; and
3. Determine the effect of planting fruit trees and raising goats on household liquidity.

Methodology

Mode and year of data collection and location of the study

Primary data for this study were generated through personal interviews of households in the village of Htee Pu in the Nyaung-U Township of the Central Dry Zone using a structured questionnaire. Data gathering was done in 2021.

Sample size determination

The households were classified into two groups based on the adapted type of CSA. The first group is composed of 51 households that planted fruit trees around their farmland. On the other hand, the second group is composed of 21 households that planted fruit trees while raising goats within their homesteads.

The sample sizes for each of the two groups were determined following the minimum requirements for a representative statistical sample. For the first group, the sample size was initially determined using the Krejcie and Morgan equation based on a 95% confidence level (Krejcie & Morgan, 1970) which yielded a sample size of 45. However, this was further reduced to 30 households, considering the mobility issues brought by the Covid-19 pandemic and political issues in the country.

On the other hand, since there were only 21 households under the second group, the number was retained as the sample size for the case study. The resulting sample sizes are presented in Table 1.

Group	Total Household	Sample Size (Krejcie and Morgan eqn.)	Sample Size Used in the Study
Fruit trees in farms	51	45	30
Fruit trees and goats in homesteads	21		21
Total	72		51

Table 1. Total number of households

Analytical methods used in the study

Cost and Return Analysis

The Cost and Return Analysis measured the financial benefit to the Htee Pu households that adopted agroforestry as a climate-smart technology. Estimates of the households' Gross Value (GV) were compared with the estimates of the operating costs incurred in employing the technology. The GV represents the potential market value of fruits that can be harvested from the fruit trees planted by the households on their farms, regardless of whether they are sold or consumed at home. The Net Value (NV) was obtained by taking the difference between the GV and the operating cost.

Since fruit trees are perennial crops, it would take three to five years before they become productive. Thus, the study estimated the Gross Value by valuing the potential annual fruit harvests once the trees reach their fruit-bearing stage. The prevailing farmgate prices of the fruits in 2021 in Htee Pu were used in the valuation. On the other hand, costs were estimated by determining the costs of materials and hired labor incurred in applying fertilizer, watering, weeding, and harvesting the fruits.

Financial benefits from goat raising were similarly determined using the Cost and Return Analysis method. Gross Value was estimated based on the income from the sale of goats, the market value of goats consumed at home, and the market value of offspring produced by the start-up (breeder) female goats. Costs related to raising the goats (e.g., cost of commercial feeds, vaccines, hired labor) were subtracted from the Gross Value to arrive at the Net Value.

Profitability Analysis

The Profitability Analysis is an important component of the Cost and Return Analysis. After the Cost and Return Analysis has determined the profit (termed as "Net Value" in this study), the profitability analysis measures how "profitable" the Net Value is in relation to the GV. This study used the Operating Profit Margin Ratio (OPMR) to gauge the profitability of growing fruit trees and raising goats. The OPMR reflects the percentage of Net Value (profit) the farmer retains out of the GV. A high percent value is preferred over a lower one. For instance, an OPMR of 65% means that a farmer keeps 65% of the GV as his profit while the remaining 35% pays for his operating expenses. On the other hand, an OPMR of 10% means that the farmer only retains 10% of his GV as profit while 90% goes to expenses. A low OPMR of 10% indicates that the farmer is operating in a disadvantaged position and will continue to do so unless his operating costs are minimized. On the other hand, the farmer with a 65% OPMR is better off because he is getting more than half of the GV as earnings, while 35% goes to his expenses in the farm operation.

Investment Analysis

The Payback Period (PP) is a simple method used to evaluate climate-smart interventions in terms of the time (in years) it would take to recover the cost of establishing the fruit farm or starting a goat herd through the accumulated yearly gross earnings. A short recovery period makes an investment more attractive than another with a longer recovery period.

Household Liquidity Analysis

The Household Liquidity Analysis was another analytical method used to determine a household's cash position by summing up all of the family's annual income. The change in household liquidity following the financial benefits from climate-smart technology(ies) was estimated by comparing the average income of households with the technology (ies) against their average income without the technology(ies). The Average Net Value, which considers both the produce sold and those consumed at home, represents the amount of household income with the technology(ies).

Results & Discussion

Fruit-tree agroforestry is a practical and low-cost means of diversifying agricultural production, especially for small-scale producers in Htee Pu. It is another avenue for income generation and reducing food insecurity among village households (Thangata, 2002). Fruit trees can also provide the villagers with dietary requirements for vitamins and other nutrients needed by the body (Marais et al., 2019). Upon consultation with the local community in Htee Pu, mango was chosen as a primary tree crop because it is known to tolerate rainfall variability while fetching assured incomes. Aside from mango, a range of tree species that tolerated poor soil conditions and erratic weather was also selected, including guava, lime, lemon, custard apple, and dragon fruit. All fruit tree planting materials were secured from local nurseries, thus providing some assurance that these were locally adapted cultivars.

Goats are the preferred livestock species that can complement an agroforestry project (Preston and Gomez, 2018). Goats are browsers of foliage and do not pose a threat to the fruit trees and crops as long as the backyard raisers manage their feeding behavior well, i.e., by harvesting forage and feeding the animals themselves instead of allowing them to graze freely. Furthermore, goat raising is considered to be a gender-positive livelihood activity because goats are "traditionally managed by women" (Leeger & Gold, 2013). Finally, the Central Dry Zone is known for the Bagan breeds of goats which the project endorsed and promoted as a way of conserving valuable livestock agrobiodiversity

Group 1: Households that Planted Fruit Trees in Their Farms

Characteristics of the households

Number of household members

The majority (84%) of the 30 households in Htee Pu had three to five members. Five percent of the households had only two family members, while 11% had six. In total, there were 113 persons living in the households under Group 1.

Age of family members

The age of the family members ranged between 5 to 87 years old. The majority (54%) were young adults (20 to 29 and 30 to 39 years old) and middle-aged persons (40 to 49 years old). The proportion of the younger family members (1 to 19 years old) to the total household age distribution was only 15%, while the older members (50 to 80 years old) was 31%.

Area of farm land and land ownership

The area of the respondents' farms ranged between 0.80 to 6.1 hectares. The average size was 2.25 hectares. All households own the land that they farm.

Fruit trees grown by the households

Planting fruit trees was done in three years, from 2018 to 2020, with all 30 households planting mango trees on their farms (Table 2). A total of 2,110 live mango trees were accounted for during the interview. In addition to mangoes, the households also planted pomegranate, custard apple, lime, and guava trees, although in varying combinations of the kind of trees. Table 2 also presents the population of these other trees. Altogether, 2,657 live fruit trees were reported by the households.

Type of Fruit Tree	2018		2019		2020		Total Fruit Trees	Percent
	No. of fruit trees	No. of HH receplents	No. of fruit trees	No. of HH receplents	No. of fruit trees	No. of HH receplents		
Mango	565	16	765	27	780	30	2,110	79%
Guava	10	1	28	5	21	4	59	2%
Lime			10	2	139	26	149	6%
Custard apple	40	1	45	9	79	16	164	6%
Pomegranate	8	2	120	10	47	8	175	7%
Total	623	20	968	53	1,066	84	2,657	100%

HH = household

Table 2. Number and type of fruit trees planted per year by households (Group 1)

Types of fruit trees planted by number of households

The project emphasized biodiverse agroforestry systems relying on intra- and inter-species diversification (as a hedge against crop failure). A diverse range of climate-hardy fruit tree species with different maturity periods (short, medium, and long) was introduced. The number of households classified by the type and the number of fruit trees planted on their farms is summarized in Table 3. Seven (7) households planted mango, lime, and pomegranate with 479 trees. Six (6) households planted 587 mango, lime, custard apple, and pomegranate trees. Another six (6) households chose to grow mango, lime, and custard apple, totaling 574 trees. Four (4) households planted a combination of mango, lime, custard apple, pomegranate, and guava, totaling 526 trees. Three (3) households planted mango, lime, guava, and pomegranate, totaling 301 trees. Lastly, there were solo households that planted other combinations of fruit trees.

Fruit Trees Planted in Farm	No. of Fruit Trees	No. of HH	Total Net Value Growing Stage (USD/HH)	Ave Net Value Growing Stage (USD/HH)	Total Net Value Mature Stage (USD/HH)	Ave Net Value Mature Stage (USD/HH)
Mango, Lime, Custard Apple, Pomegranate Guava	526	4	1,494	374	3,770	943
Mango, Lime, Custard Apple, Pomegranate	587	6	3,376	563	6,939	1,157
Mango, Lime Pomegranate	479	7	2,840	406	5,860	837
Mango, Custard Apple	35	1	152	152	334	334
Mango, Lime Custard Apple	574	6	3,339	557	6,753	1,126
Mango, Lime Guava, Pomegranate	301	3	1,738	579	3,541	1,180
Mango, Lime Guava	60	1	355	355	753	753
Mango, Custard Apple Guava	65	1	328	328	656	656
Mango, Lime	30	1	250	250	505	505
Total	2,657	30	13,872	3,563	29,111	7,490

Table 3. Gross value of fruits per household by type of fruit trees per farm at growing and mature fruiting age of trees (Group 1)

Value Estimation of Fruits to be Harvested

Assumptions used in estimating the value of fruits

The assumptions that were used to estimate the value of the fruits to be harvested are presented in Table 4. Included in the assumptions were the fruit-bearing age of the trees, yield per tree, and farmgate prices. The fruit-bearing age of most of the trees varied in terms of the earliest and latest year that the trees would start producing fruits. Taking a conservative stance, this analysis used the maximum number of years for the trees to reach the productive stage to determine which year each type of tree will start bearing fruits. The earliest fruit-bearers are custard apples and pomegranate. These perennials will reach their fruit-bearing age three years after planting. The mango trees would take the longest time (5 years) before they could be productive. A lesser yield was expected during the first five years of fruiting (growing stage). Thereafter, the harvest volume would increase when the perennials reach their mature age, where the maximum yield can be attained. This is assumed to be after five years of fruiting.

Fruit Tree	Years to bear fruits	Ave. yield within 1st 5 years of fruiting (Kg/tree)	Ave. yield after 5 years of fruiting (Kg/tree)	Ave. farm gate price (MMK/Kg)	Ave. farm gate price (USD/Kg)*
Mango	5	10	20	843.33	0.51
Guava	3 to 5	10	20	500.00	0.30
Lime	3 to 4	50	100	639.30	0.39
Custard apple	2 to 3	10	10	954.55	0.58
Pomegranate	2 to 3	10	15	952.40	0.58

* USD 1.00 = MMK 1,655.00

Table 4. Assumptions used in estimating the gross value of fruits from trees planted in farms (Group 1)

Gross and net value of fruits to be harvested by the households

Produce harvested from the fruit trees is sold to buyers or consumed at home. Since not all fruits are expected to be sold, the term Gross Value, instead of Gross Revenue, was applied to refer to the value of the potential annual harvest from the perennials. Annual fruit production was valued by applying the average farmgate prices presented in Table 4. In computing Gross Value, possible changes in farmgate prices due to market movements and inflation were not factored in. The value increases only reflected the increases in yield per tree and the number of trees reaching their fruit-bearing age over time. In addition, the Net Value (as a substitute term for Net Income or Profit) was also derived by subtracting the Operating Costs incurred by the households for raising the trees from the Gross Value.

The Gross and Net Value was estimated for each of the 30 households depending on the type of fruit trees planted on their farm. The computation was based on the maximum potential quantity of harvest during the growing and mature stages of the trees.

Table 5 summarizes the Gross and Net Value of potential fruit harvest grouped into the type of trees planted by households. The total Operating Costs incurred by the households under each subgroup are also shown in the table. Each of the households that planted mango, lime,

custard apple, guava, and pomegranate would be able to harvest fruits with an average maximum Gross Value equivalent to USD 754.00 per year during the growing stage of the trees. Subtracting the operating cost (fertilizer, hired labor for fertilizer application, field clearing, and harvesting), these households would generate a "profit" (average Net Value) of USD 550.00. When the trees reach their mature fruiting age, the households would be able to harvest fruits with a maximum average annual Gross Value of USD 1,507.00 and a Net Value of USD 1,303.00.

Households that planted mango, lime, custard apple, and pomegranate would be able to harvest fruits with an average Gross Value of USD 594.00 and USD 1,188.00 during the growing stage and when the trees reach their maximum productivity, respectively. The Net Value to be generated would be USD 563.00 and USD 1,157.00 during the growing and mature stages of the trees.

The average Gross Value of fruits that would be harvested by households that planted mango, lime, and pomegranate was estimated to be USD 431.00 and USD 863.00 during the growing and maturity stages of the trees. Profit (Net Value) would be USD 406.00 and USD 837.00 for the two stages of tree growth.

The households with mango, lime, and custard apple trees would be able to harvest fruits with an average Gross Value of USD 569.00 and USD 1,138.00 during the two stages of fruit-bearing. The corresponding Net Value would be USD 557.00 and USD 1,126.00, respectively.

Three households planted mango, lime, guava, and pomegranate. Fruit harvest from these trees would have an average Gross Value of USD 590.00 at the growing stage and USD 1,180.00 upon maturity of the trees. "Profit" was estimated at an average of USD 579.00 during the growth stage and USD 1,180.00 upon maturity. The Gross and Net Value of fruits harvested by the remaining households are also shown in Table 5.

All 30 households, regardless of the type of fruit trees they planted, would generate a total Annual Gross Value of USD 15,944.00 from the 2,657 trees during the growing stage a corresponding total Net Value of USD 14,573.00. When the trees mature, the total Gross Value will increase to USD 31,884.00, while the total Net Value will be USD 30,549.00.

Fruit Trees Planted in Farm	No. of Fruit Trees	No. of HH	Growing Stage					Mature Stage			
			Total Gross Value (USD)	Average Gross Value (USD/HH)	Total Operating Cost (USD)	Total Net Value (USD)	Average Net Value (USD/HH)	Total Gross Value (USD)	Average Gross Value (USD/HH)	Total Net Value (USD)	Average Net Value (USD/HH)
Mango, Lime, Custard Apple, Pomengranate Guava	526	4	3,014	754	815	2,199	550	6,028	1,507	5,212	1,303
Mango, Lime, Custard Apple, Pomengranate	587	6	3,563	594	187	3,376	563	7,125	1,188	6,939	1,157
Mango, Lime Pomengranate	479	7	3,020	431	179	2,840	406	6,039	863	5,860	837
Mango, Custard Apple	35	1	182	182	30	152	152	364	364	334	334
Mango, Lime Custard Apple	574	6	3,413	569	74	3,339	557	6,826	1,138	6,753	1,126
Mango, Lime Guava, Pomengranate	301	3	1,771	590	33	1,738	579	3,541	1,180	3,541	1,180
Mango, Lime Guava	60	1	398	398	43	355	355	795	795	753	753
Mango, Custard Apple Guava	65	1	328	328	4	324	324	656	656	652	652
Mango, Lime	30	1	255	255	5	250	250	510	510	505	505
Total	2,657	30	15,944	4,101	1,370	14,573	3,735	31,884	8,200	30,549	7,846

Table 5. Gross value, operating cost, and net value of fruits by combination of fruit trees at growing and mature fruiting age of trees (Group 1)

Profitability of growing fruit trees

The total cost of maintaining the fruit trees was reported to be USD 1,370.00 for all 30 households. The cost includes expenses for fertilizer and wages for hired labor for fertilizer application, harvesting and other farm maintenance costs. This amount represents only 8.6% of the total Gross Value of fruits at the growing stage and 4.3% of the total Gross Value when the trees reach their mature stage. With a minimal Operating Cost, growing the types of fruit trees selected by the households can be considered to be highly profitable. A profitability analysis using the Operating Profit Margin Ratio (OPMR) showed that, in each combination of fruit trees, the Net Value or "profit" showed very high values of OPMR (Table 6). Considering profit at the growing stage, the OPMR ranged between 73% to 99%. This indicates that the households would be able to retain 73% to 99% of their Gross Value after deducting their operating costs. Upon reaching the trees' mature stage, the expected increase in the volume of harvest would also increase "gross sales" (Gross Value), thereby resulting in higher values of OPMR. This analysis assumes that the households are the ones that will be directly involved in caring for the trees as well as harvesting and selling the fruits.

Fruit Trees Planted in Farm	No. of Fruit Trees	No. of HH	Growing Stage			Mature Stage		
			Ave Gross Value (USD/HH)	Ave Net Value (USD/HH)	OPMR	Ave Gross Value (USD/HH)	Ave Net Value (USD/HH)	OPMR
Mango, Lime, Custard Apple, Pomengranate Guava	526	4	754	550	73%	1,507	1,303	86%
Mango, Lime, Custard Apple, Pomengranate	587	6	594	563	95%	1,188	1,157	97%
Mango, Lime Pomengranate	479	7	431	406	94%	863	837	97%
Mango, Custard Apple	35	1	182	152	84%	364	334	92%
Mango, Lime Custard Apple	574	6	569	557	98%	1,138	1,126	99%
Mango, Lime Guava, Pomengranate	301	3	590	579	98%	1,180	1,180	100%
Mango, Lime Guava	60	1	398	355	89%	795	753	95%
Mango, Custard Apple Guava	65	1	328	324	99%	656	652	99%
Mango, Lime	30	1	255	250	98%	510	505	99%
Total	2,657	30	4,101	3,735		8,200	7,846	

Table 6. Operating profit margin ratio (OPMR) by type of fruit trees planted per household (Group 1)

Investment cost and Payback period

The 30 households would be spending USD 2,349.00 as an investment cost in raising fruit trees (Table 7). This would include the cost of seedlings, basal fertilizer, and hired labor for planting. By comparing the total cost to the expected Gross Value of fruits that can be harvested as early as the growing stage, we can conclude that the investment cost could be recovered in less than five years (Payback Period) after the trees start bearing fruits. The gross earnings after that period would all go to "profit" and cover any maintenance cost.

Fruit Trees Planted in Farm	Investment Cost (USD)	Total Gross Value Growing Stage (USD)	Total Gross Value Mature Stage (USD)	Payback Period (Years)
Mango, Lime, Custard Apple, Pomengranate Guava	467	3,014	6,028	LESS THAN
Mango, Lime, Custard Apple, Pomengranate	535	3,563	7,125	5 YEARS
Mango, Lime Pomengranate	521	3,020	6,039	AFTER
Mango, Custard Apple	64	182	364	
Mango, Lime Custard Apple	402	3,413	6,826	FRUIT-
Mango, Lime Guava, Pomengranate	126	1,771	3,541	BEARING
Mango, Lime Guava	139	398	795	
Mango, Custard Apple Guava	45	328	656	
Mango, Lime	50	255	510	
Total	2,349	15,944	31,884	

Table 7. Payback period for investing in fruit trees (Group 1)

Household Liquidity Analysis

Sources of income of the 30 households

The 30 households generate income from a combination of income-generating activities: growing and selling dry zone crops, operating a microenterprise, and holding off-farm skilled or unskilled jobs. The liquidity of each household in 2021 based on their reported source(s) of income is reported below.

Income from agricultural crops

Pigeon pea was grown by 80% of the 30 households in 2021 (Table 8). The other crops grown (in descending number of households) were tomato, groundnut, sorghum, and sesame.

Type of Crops	No. of HH*	Percent**
Pigeon pea	24	80%
Ground nut	12	40%
Sesame	1	3%
Tomato	15	50%
Sorghum	8	27%
Total	60	NA
* Multiple responses	** Percent of 30 HH	HH=household

Table 8. Dry zone crops planted by 30 households (Group 1)

A cost and return analysis of the production and marketing of the crops revealed that only 16 of the 30 households could generate a positive net income in 2021 from raising the crops (Table 9). On average, these households earned USD 1,345.00 from their farming activity. On the other hand, 14 households could not profit from the crops they raised. Each household lost an average of USD 415.00. Some households ended with a negative net income due to the high labor costs during the 2020 production season to do planting and harvesting for field crops.

Item	No. of HH	Average Net Income	
		MMK	USD
HH with positive Net Income	16	2,225,847	1,345
HH with negative Net Income	14	(687,100)	(415)

HH=household USD 1.00 = MMK 1,655.00

Table 9. Income of 30 households from crops planted in their farms (Group 1)

Income from own microenterprise

Twelve (40%) of the 30 households own a micro business that provides additional family income. Income ranged from MMK 200,000.00 (USD 120.85) to MMK 3.06 million (USD 1,849.00) for one year, or an average of MMK 1.12 million (USD 678.00) from operating a micro business.

Income from off-farm employment

Off-farm employment includes casual labor (odd jobs from time to time), unskilled employment (e.g., house help), and skilled formal employment (e.g., hospital worker, driver). Fifty (50%) of the 30 households have family members that found odd jobs to earn extra income. Earnings ranged from MMK 30,000.00 (USD 18.13) to MMK 1.26 million (USD 761.33) per year. On average, each of the 15 households earned MMK 397,000.00 (USD 240.00) from odd jobs.

Six households had family members that generated additional income from skilled formal employment such as working in factories. They earned an average of MMK 2.42 million (USD 2,671.00) per year and ranged between MMK 1.44 million (USD 870.10) and MMK 4.2 million (USD 2,537.80). Lastly, three households earned extra income by working as unskilled employees. The average revenue from this source of income was MMK 1.4 million (USD 845.90). The income was between MMK 1.2 million (USD 725.10) and MMK 1.8 million (USD 1,087.60).

Household Liquidity based on Farm and Off-farm Sources of Incomeless Household Expenses

While almost half of the 30 households had a negative net income when revenue from agricultural crops was solely considered, their total income improved when salary/wage from off-farm employment and sales from microenterprises were included. However, after deducting household expenses from income, the liquidity analysis showed that only 16 or 53% of the number of households exhibited a positive cash position (Table 10). They generated an average annual income of MMK 3.97 Million (USD 2,401.00) while average annual household expense was reported to be MMK 1.53 Million (USD 927.00). Thus, these households were left with a positive balance of MMK 2.44 Million (USD 1,474.00). On the other hand, 14 or 47% of the households were not liquid. The estimated average annual income was only MMK 1,264.00 considering that several of these households reported a negative income from farming, thereby reducing the positive gains obtained from off-farm jobs. In contrast, their average household expense was MMK 1.84 Million (USD 1,114.00), resulting in a negative balance.

Liquidity Condition	No. of HH	Average Income		Average HH Expense		Remaining Income	
		(MMK)	(USD)	(MMK)	(USD)	(MMK)	(USD)
Liquid	16	3,972,909	2,401	1,533,813	927	2,439,096	1473.774
Not liquid	14	1,264	0.76	1,842,929	1,114	(1,841,665)	(1,113)
Total	30	-	-	-	-	-	-

HH=household USD 1.00 = MMK 1,655.00

Table 10. Household liquidity based on income from farming and off-farm sources (Group 1)

Financial impact of planting fruit trees on household liquidity

Measuring the potential benefit of planting fruit trees on household liquidity was accomplished by adding the average Gross Value of potential harvest at the growth and mature stages of the fruit trees to the total household income generated from farming and off-farm employment. The liquidity analysis determined the number of households that would be able to improve their liquidity from the benefits that would be gained from planting fruit trees.

By adding the Gross Value of fruits to be harvested during the growing stage to the household income, three of the 14 households with a negative cash position would be able to improve their liquidity and move up to a positive cash position (Table 11). The average income of these households would increase from a negative MMK 1,841,665.00 (USD 1,113.00) to a positive value amounting to MMK 665,310.00 (USD 402.00). Eleven of the 14 households would remain to have a negative cash position. However, the negative income would also improve, ie., from negative MMK 1,841,665.00 (USD 1,113.00) to negative MMK 1,658,310.00 (USD 1,002.00). Meanwhile, the average income of the 16 households that were initially in a liquid position before adding the Gross Value of fruits would increase from MMK 2,439,096.00 (USD 1,474.00) to MMK 3,267,104.00 (USD 1,974.00) after adding "revenue" from fruit harvests. This represents a 34% increase in gross income. The outlook improves further when the Gross Value of fruits during the mature stage is considered. The average gross income would increase by 59%, ie., from MMK 2,439,096.00 (USD 1,474.00) to MMK 3,889,250.00 (USD 2,350.00).

Item	Households		Ave. HH Net Income		Change*
	No.	%	MMK	USD	
Without the gross value from fruits					
HH with positive cash position	16	53%	2,439,096	1,474	
HH with negative cash position	14	47%	(1,841,665)	(1,113)	
Sub-Total	30	100%			
With the gross value from fruits (Trees at growing stage)					
HH with positive cash position	16	53%	3,267,104	1,974	34%
HH from negative to positive cash position	3	10%	665,310	402	+
HH with negative cash position	11	37%	(1,658,310)	(1,002)	+
Sub-Total	30	100%			
With the gross value from fruits (Trees at mature stage)					
HH with positive cash position	16	53%	3,889,250	2,350	59%
HH from negative to positive cash position	7	23%	1,299,175	785	+
HH with negative cash position	7	4%	(1,229,665)	(743)	+
Sub-Total	30	100%			

HH= household USD 1.00 = MMK 1,655.00

Table 11. Improvement in liquidity status of 30 households after adding the gross value of harvested fruits (Group 1)

Group 2: Households that Planted Fruit Trees in conjunction with Goats

Characteristics of the households

Number of household members

Twenty-one households in the village of Htee Pu planted fruit trees and raised goats in their homesteads. A total of 64 persons lives in these households. The number of family members occupying the households ranged from one to six. The majority (58%) of the households had two to three family members, while 29% had four to six. There were three households (14%) with single occupants.

Age of family members

The age of the family members ranged from 13 to 90 years old. Thirty-nine percent were young adults (20 to 29 and 30 to 39 years old), while 25% were in the middle age group (40 to 49 and 50 to 59 years old). The proportion of the younger family members (13 to 19 years old) was only 11%, while the older members (60 to 90 years old) was 25%.

Area of farm land and land ownership

Fourteen of the 21 households own the land that they farm. The remaining households do not engage in farming. The area of the farmlands ranged between 0.40 to 2.80 hectares, with an average size of 1.96 hectares.

Fruit trees grown by the households

There are 456 live fruit trees in the homesteads of the 21 households (Table 12). These include custard apple, lime, guava, pomegranate, dragon fruit, and jackfruit. The majority of these trees were planted in 2019 and 2020, where 193 (42%) of the trees are custard apples. Jackfruits (7%) were the least preferred.

It is worth noting that each household planted more than one type of fruit tree on their homestead. The number of households and the types of fruit trees planted in their homesteads are shown in Table 13.

Type of Fruit Tree	2018		2019		2020		Total Fruit Trees	Percent
	No. of fruit trees	No. of HH recepients	No. of fruit trees	No. of HH recepients	No. of fruit trees	No. of HH recepients		
Custard apple	5	1	78	14	110	17	193	42%
Lime	0	0	54	12	32	7	86	19%
Guava	2	1	0	0	40	12	42	9%
Pomegranate	2	1	10	2	42	11	54	12%
Dragon fruit	10	2	37	8	2	1	49	11%
Jackfruit	0	0	23	10	9	3	32	7%
Total	19	5	202	46	235	51	456	100%

HH = household

Table 12. Number and type of live fruit trees planted per year and number household recipients (Group 2)

Types of fruit trees planted by household	No. of household	Percent
Custard apple, Guava, Lime Dragonfruit, Pomegranate, Jackfruit	4	19%
Custard apple, Guava, Lime Pomegranate	2	10%
Custard apple, Guava, Lime Dragonfruit, Pomegranate	1	5%
Custard apple, Lime, Jackfruit	2	10%
Custard apple, Guava, Dragonfruit Pomegranate, Jackfruit	1	5%
Custard apple, Lime, Dragonfruit	1	5%
Custard apple, Lime Dragonfruit, Jackfruit	3	14%
Custard apple, Lime	1	5%
Lime	1	5%
Custard apple, Guava, Lime Pomegranate, Jackfruit	1	5%
Custard apple, Lime, Pomegranate	1	5%
Custard apple, Guava, Pomegranate	3	14%
Total	21	100%

Table 13. Types of fruit trees planted in homesteads by households (Group 2)

Number of goats raised by the households

In addition to planting fruit trees, the 21 households also participated in raising goats under the IIRR-Myanmar's CSV goat project. Initially, four (4) of the households joined the project in 2018 to raise eight heads of female goats (doe) (e.g., two goats per household) (Table 14). The following year, six more households were added, and altogether started with 14 female goats. No male goats (billies) were procured since billy goats are available within the community. In 2020, 11 households joined the project, with 27 female and five (5) male goats. The total number of goats that were procured as startup (breeder) herd summed up to 52 heads.

In this study, it was assumed that female goats are mated when they are 12 months old. While goats attain puberty in seven to 12 months, as a rule, the female "should not be mated until it is one year old". Twelve-month-old female goats are old enough to give birth without suffering from any complications (TNAU, 2019). It is also better to breed the doe once a year. The study also assumed that the households purchased female goats when they are two months old at the start of a calendar year and are ready for mating at the end of the year. Each doe produces two offspring per gestation given a pregnancy period of five months (150 days) (Stewart, 2021). Thus, for this study, each startup female goat bought in 2018 would be able to produce two kids in 2019 and another set of two kids in 2020. In addition, each two-month-old female goats bought in 2019 would produce two kids in 2020. Thus, female goats bought in 2019 and 2020 would have collectively produced a total of 48 kids by end of 2020. Adding the number of startup goats, the households have in their possession 76 heads of goats by the end of 2020.

Item	Year Household Started Raising Goats						Total
	2018		2019		2020		
	Female	Male	Female	Male	Female	Male*	
Number of goats at starting year	8	0	12	0	27	5	52
Number of kids added to the herd by end of year	0		12		36		48
Goats sold or consumed	2		7		15		24
Cummulative number of goats less sold or consumed by end of 2020 **	6		17		53		76
Number of households participating	4		6		11		21

*Raised by 2 of the 11 households

**Less 2 of the 8 startup goats bought in 2018 which were consumed by the household

Table 14. Number of goats raised and number of households participating in IIRR goat project by year (Group 2)

Value Estimation of Fruits to be Harvested

Assumptions used in estimating the value of fruits

Table 15 presents the assumptions in estimating the Gross Value of fruits expected to be harvested by the households from their homesteads. Included in the assumptions were the number of years it would take for the trees to bear fruits, yield per tree, and farmgate price. The assumptions adopted for custard apple, guava, lime, and pomegranate are the same as the ones used earlier in estimating the Gross Value of fruits to be harvested from trees planted by households under Group 1. Dragon fruit and jackfruit were added in Table 15 since these perennials were planted by a number of households belonging to Group 2.

Fruit Tree	Years to bear fruits	Ave. yield within 1st 5 years of fruiting (Kg/tree)	Ave. yield after 5 years of fruiting (Kg/tree)	Ave. farm gate price (MMK/Kg)	Ave. farm gate price (USD/Kg)
Custard apple	2 to 3	10	10	955	0.58
Guava	3 to 5	10	20	500	0.30
Lime	3 to 4	50	100	639	0.39
Dragonfruit	1 to 3	5	7	500	0.30
Jackfruit	5	750	900	600	0.36
Pomegranate	2 to 3	10	15	952	0.58

USD 1.00 = MMK 1,655.00

Table 15. Assumptions used in estimating the gross value of fruits from trees planted in homesteads (Group 2)

Gross and Net Value of fruits to be harvested in homesteads

The 21 households differed in the kind and number of fruit trees they planted in their homesteads. The various combinations of fruit trees and the number of households under each combination were identified in Table 13. The Gross Value of fruits that can be potentially harvested from the combination of trees present in each homestead was estimated. Furthermore, the Net Value or "profit" was determined by deducting the Operating Cost from the Gross Value. Note that the Operating Costs incurred by the households in maintaining the fruit trees were minimal.

Similar to Group 1, the computations were based on the year where the maximum quantity of harvest could be obtained during the growing and mature stages of the trees. On the other hand, the value of the Operating Cost was derived from the data obtained from the household interviews when they were asked to recall their 2020 expenses. Table 16 presents a summary of the maximum Gross and Net Value of fruits to be harvested by the households for one year. These were classified into the various combination of fruit trees present in the homesteads. The Operating Costs that were reported by the households are also shown. During the growing stage, the Total Gross and Net Value by type of tree combination for one year would range from USD 98.00 to USD 3,780.00 and from USD 98.00 to USD 3,771.00, respectively. The Gross Value per year that all 21 households could generate is USD 9,337.00, or an average of USD 4,456.00/household. The Total Net Value for all households was estimated at USD 9,301.00 or USD 4,433.00 per household.

During the mature fruit-bearing stage, the maximum Gross and Net Values across combinations would range from USD 158.00 to USD 4,820.00 and from USD 158.00 to USD 4,811.00, respectively. The same set of values for the Operating Cost used during the growing stage was also applied during the mature stage. All 21 households could collectively generate a maximum Gross Value of USD 12,479.00 per year or USD 5,636.00 per household. On the other hand, the total Net Value for all households would be USD 12,443.00 per year or USD 6,115.00 per household.

Combination of Fruit Trees Planted in Homestead	No. of Fruit Trees	No. of HH	Growing Stage					Mature Stage				
			Total Gross Value (USD)	Ave Gross Value (USD/HH)	Oper. Cost (USD)	Total Net Value (USD)	Ave Net Value (USD/HH)	Total Gross Value (USD)	Ave Gross Value (USD/HH)	Oper. Cost (USD)	Total Net Value (USD)	Ave Net Value (USD/HH)
Custard apple, Guava Lime, Pomegranate Jackfruit	138	4	3,780	945	9	3,771	943	4,820	1,205	9	4,811	1,203
Custard apple, Guava Lime, Pomegranate	43	2	342	171	4	338	169	548	274	4	544	272
Custard apple, Guava, Lime Dragonfruit, Pomegranate	26	1	189	189	2	187	187	308	308	2	306	306
Custard apple, Lime Jackfruit	33	2	803	402	0	803	402	1,086	543	0	1,086	543
Custard apple, Dragonfruit Guava, Pomegranate Jackfruit	20	1	624	624	4	620	620	750	750	4	746	746
Custard apple, Lime Dragonfruit	25	1	192	192	1	191	191	293	293	1	292	292
Custard apple, Lime Dragonfruit, Jackfruit	61	3	2,080	693	8	2,072	691	2,707	902	8	2,699	900
Custard apple, Lime	10	1	134	134	2	132	132	235	235	2	233	233
Lime	5	1	98	98	4	94	94	195	195	4	191	191
Custard apple, Guava, Lime Pomegranate, Jackfruit	27	1	711	711	2	709	709	931	931	2	929	929
Custard apple, Lime Pomegranate	30	1	253	253	0.6	252	252	448	448	0.6	447	447
Custard apple, Guava Pomegranate	38	3	131	44	0	131	44	158	53	0	158	53
Total	456	21	9,337	4,456	36	9,301	4,433	12,479	5,636	36	12,443	6,115

Table 16. Gross value, operating cost, and net value of fruits by combination of fruit trees by growing and mature fruiting age of trees (Group 2)

Profitability of growing fruit trees

With minimal expenses required to care for the fruit trees, almost 100% of the Net Value of the fruits that the households will harvest could be retained as "profit." Table 17 shows that the "profit" that could be generated after deducting operating costs would range from 95.9% to 100% during the growing stage and 97.9% to 100% during the mature phase. A 100% OPMR indicates that households did not incur any operating expenses until the interview for this study was conducted.

Combination of Fruit Trees Planted in Homestead	No. of Fruit Trees	No. of HH	Growing Stage			Mature Stage		
			Ave Gross Value (USD/HH)	Ave Net Value (USD/HH)	OPMR	Ave Gross Value (USD/HH)	Ave Net Value (USD/HH)	OPMR
Custard apple, Guava Lime, Pomegranate Jackfruit	138	4	945	943	99.8%	1,205	1,203	99.8%
Custard apple, Guava Lime, Pomegranate	43	2	171	169	98.8%	274	272	99.3%
Custard apple, Guava Lime, Pomegranate Dragonfruit	26	1	189	187	98.9%	308	306	99.4%
Custard apple, Lime Jackfruit	33	2	402	402	100.0%	543	543	100.0%
Custard apple, Jackfruit Guava, Pomegranate Dragonfruit	20	1	624	620	99.4%	750	746	99.5%
Custard apple, Lime Dragonfruit	25	1	192	191	99.5%	293	292	99.7%
Custard apple, Lime Dragonfruit, Jackfruit	61	3	693	691	99.7%	902	900	99.8%
Custard apple, Lime	10	1	134	132	98.5%	235	233	99.1%
Lime	5	1	98	94	95.9%	195	191	97.9%
Custard apple, Guava Lime, Pomegranate Jackfruit	27	1	711	709	99.7%	931	929	99.8%
Custard apple, Lime Pomegranate	30	1	253	252	99.6%	448	447	99.8%
Custard apple, Guava Pomegranate	38	3	44	44	100.0%	53	53	100.0%
Total	**456**	**21**	**4,456**	**4,434**		**6,137**	**6,115**	

Table 17. Operating profit margin by combination of fruit trees planted in homestead per household (Group 2)

Investment cost and Payback period from planting fruit trees

The 21 households under Group 2 collectively spent USD 527.00 as an investment cost to start raising the fruit trees (Table 18). This amount covered the cost of seedlings, land preparation, hired labor for planting, and the cost of basal fertilizer application. Considering the total Gross Value that could be generated, the investment cost could be recovered in less than five years after fruit-bearing. The maximum Gross Value for one year during the growing stage was estimated at USD 9,337.00, which significantly exceeds the investment cost. Table 18 also shows that households under each sub-group, based on the combination of trees planted, would have a payback period of less than five years after the trees start bearing fruits.

Combination of Fruit Trees Planted in Homestead	Investment Cost (USD)	Total Gross Value Growing Stage (USD)	Total Gross Value Mature Stage (USD)	Payback Period (Years)
Custard apple, Guava Lime, Pomegranate Jackfruit	27	3,780	4,820	
Custard apple, Guava Lime, Pomegranate	311	342	548	LESS THAN
Custard apple, Guava Lime, Pomegranate Dragonfruit	16	189	308	
Custard apple, Lime Jackfruit	23	803	1,086	5 YEARS
Custard apple, Jackfruit Guava, Pomegranate Dragonfruit	6	624	750	
Custard apple, Lime Dragonfruit	45	192	293	AFTER
Custard apple, Lime Dragonfruit, Jackfruit	41	2,080	2,707	
Custard apple, Lime	6	134	235	
Lime	6	98	195	FRUIT-
Custard apple, Guava Lime, Pomegranate Jackfruit	14	711	931	
Custard apple, Lime Pomegranate	14	253	448	BEARING
Custard apple, Guava Pomegranate	20	131	158	
Total	527	9,337	12,479	

Table 18. Payback period for investing in fruit trees (Group 2)

Cost and return analysis of raising goats

The profitability of raising goats was analyzed for the year 2020. The cost and return data used in the analysis were obtained from nine households that joined the goat project in 2018 and 2019 (except for one of the households that consumed the goats in 2018, the same year that the goats were purchased). The Gross Value was estimated by considering the market value of the goats sold or consumed at home. In addition, the Gross Value estimation included the value of kids produced but not yet sold by 2020. The analysis considered the unsold kids as a "savings-in-kind" that the household can sell when needed. The total Gross Value of the nine households was estimated to be MMK 2. 68 million (USD 1,619.00).

Based on costs incurred in 2020, the Operating Cost amounted to MMK 1.83 Million (USD 1,108.00). It included expenses for commercial feeds, veterinary supplies, and hired labor. The latter represents 92% of the total cost. The interviews with the households revealed that they hire labor to care for the goats instead of using family labor. The cost of hired labor also covers using the hired labor's homestead to house the goats.

The resulting Net Value was estimated to be MMK 846,400.00 (USD 511.00). This "profit" represents 32% of the Gross Value. In other words, after deducting the expenses incurred to raise the goat herd, the households retain 32% of the benefits they generated from sales, including the market value of heads consumed and unsold offspring.

Item	MMK	USD
Total Gross Value	2,680,000	1,619
Operating Cost	1,833,600	1,108
Net Value	846,400	511
Ave. Gross Value	297,778	180
Ave Operating Cost	203,733	123
Ave. Net Value	94,045	57
Range Gross Value	300,000 to 320,000	181 to 193
Range Operating Cost	10,000 to 378,000	6 to 228
Range Net Value	68,000 to 253,333	41 to 153
Operating Profit Margin (OPMR)	32%	

Table 19. Cost and return analysis of raising goats by 9 households that sold or consumed goats in 2020 (Group 2)

Payback Period

The average investment cost incurred by each household for raising goats was computed to be USD 257.00 (Table 20). This was based on the price of goats purchased by the households at an average of two goats per household. Families that started to raise goats in 2018 could generate an average gross return of USD111.00 in 2019 and USD 269.00 by 2020, combining the GV of two years more than covers the investment cost. Thus, the payback period for these households is two years. On the other hand, households that started to raise goats in 2019 could still not recover their investment based on the average income they generated in 2020. Another year (2021) was required to recover their investment. Lastly, households that started goat-raising in 2020 would also need two years to recover their start-up cost, i.e., by 2022.

Year Goat-Raising Started	Ave. Gross Value in 2019 (USD/HH)	Ave. Gross Value in 2020* (USD/HH)	Average Investment Cost (USD/HH)	Year Cost Will Be Recovered
2018	126	269	257	2020
2019	0	185	257	2021
2020	N.A.	185**	257	2022

* Based on actual reported sales and consumed at home. Number of kids produced were assumed.
** Estimate

Table 20. Estimated year that invested cost can be recovered by homestead goat-raisers (Group 2)

Household Liquidity Analysis

The 21 households under Group 2 earn a living by planting crops suited to the climate of the Central Dry Zone, operating a microbusiness, and/or seeking employment off-farm. More than half (57%) of the Group 2 households grow dry zone crops (Table 21).

Nine households (43%) did not grow crops. Four of these do not own land that they can farm. The remaining five opted not to grow any crop on their land at the time of the study.

Item	No. of HH	Percent
HH that planted dry zone crops	12	57%
HH that did not plant dry zone crops	9	43%
Total	21	100%

Table 21. Number of households that planted dry zone crops (Group 2)

The combined gross earnings from crops sold or consumed at home in 2020 amounted to MMK 17.63 million (USD 10,654.00), while the operating cost was MMK 5.82 million (USD 3,515.00) (Table 22). The resulting Net Value from farming was MMK 11.82 million (USD 7,139.00). Household earnings (Net Value) ranged from MMK 11,500.00 to MMK 2.27 million (USD 6.95 to USD 1,369.50). On average, each household that grew crops earned MMK 984,583.00 (USD 595.00).

Item	Total		Average		Range of Average	
	(MMK)	(USD)	(MMK)	(USD)	(MMK)	(USD)
Gross value of crops planted	17,632,500	10,654	1,469,375	888	90,000 - 2,952,500	54.40 - 1,784
Operating cost	5,817,500	3,515	484,792	293	78,000 - 1,565,500	47.13 - 946
Net value	11,815,000	7,139	984,583	595	11,500 - 2,266,500	6.95 - 1,369.50

Table 22. Total and average net value generated by 12 households from raising dry zone crops (Group 2)

Other sources of income

In addition to farming, a number of households under Group 2 draw income off-farm from working as part-time laborers (piece work/short-term jobs), skilled (office or blue-collar jobs), and unskilled (e.g., domestic helper, janitor) employees or as owners of a micro-business (e.g., vending or tending small stores). Almost half (48%) of the 21 households have members that work as laborers (e.g., in construction) where annual income ranged from MMK 90,000.00 to MMK 2.70 million (USD 54.40 to USD 1,631.42) with an average of MMK 638,000.00 (USD 385.00) (Table 23). However, operating a microbusiness was found to provide the highest average income, i.e., MMK 1,216,667.00 (USD 735.00). Only a small number of the households (10%) have family members that earn a living from unskilled employment, where the average annual income was MMK 325,000.00 (USD 196.00).

Recall that four of the 21 households under Group 2 had no land to farm and, therefore, had no farm income. Of these households, two generated income from off-farm sources by having family members that worked as part-time laborers. The third household had a member employed as a skilled worker, while the fourth operated a microbusiness.

Similarly, of the five households that owned a farm but did not grow crops (possibly to give their land a rest), four had family members that earned some income by working off-farm as part-time laborers or as unskilled or skilled employees. The fifth household, however, did not report any additional income from any off-farm job.

Source of income	No. of HH*	Percent**	Total Income		Average		Range	
			(MMK)	(USD)	(MMK)	(USD)	(MMK)	(USD)
Operating a microbusiness	6	29%	7,300,000	4,411	1,216,667	735	300,000 to 2.50M	181.30 to 1,510.60
Casual labor	10	48%	6,380,000	3,855	638,000	385	90,000 to 2.70M	54.40 to 1,631.42
Unskilled employment	2	10%	650,000	393	325,000	196	200,000 to 450,000	120.84 to 272.00
Skilled employment	5	24%	1,378,000	833	275,600	167	180,000 to 558,000	108.80 to 337.16

HH = household * Multiple responses ** Percent of 21 households

Table 23. Off-farm sources of income by number of households generating the income and amount of income earned (Group 2)

Household liquidity status based on income from farming and off-farm employment

Out of the 21 households, five were found to be liquid based on family income from farming (value of products sold and consumed at home) and off-farm employment fewer household expenses (Table 24). Each of these households earned an average annual income of MMK 1,906,400.00 (USD 1,152.00), while the average annual household expense amounted to MMK 892,000.00 (USD 539.00). On the other hand, 16 households were not liquid. Their average annual income was estimated to be MMK 1,124,438.00 (USD 679.00). However, the average expense for household needs, i.e., MMK 1,736,188.00 (USD 1,049.00), exceeded their income by MMK 611,750.00 (USD 370.00).

Liquidity Condition	No. of HH	Average Income		Average HH Expense		Remaining Income	
		(MMK)	(USD)	(MMK)	(USD)	(MMK)	(USD)
Liquid	5	1,906,400	1,152	892,000	539	1,014,400	613
Not liquid	16	1,124,438	679	1,736,188	1,049	(611,750)	(370)
Total	21	-	-	-	-	-	-

Table 24. Household liquidity based on income from farming and off-farm sources (Group 2)

Impact of adding financial benefits from raising fruit trees and goats on household liquidity

Combining the Net Value obtained from planting fruit trees and raising goats with income from farming and off-farm employment resulted in a significant increase in the number of households considered liquid. From five households, the number increased to 12 after adding the Net Value of harvested fruits from trees at their growing stage (Table 25). This represents a 140% increase in the number of liquid households.

When the trees reach their mature fruiting age, the increase in the estimated Net Value generated from harvested fruits further improves the number of liquid households, i.e., from five to 14 households. This represents a 180% growth in the number of liquid households.

Adding the income from goats to the Net Value from trees did not increase the number of liquid households. However, the Net Value for both liquid and non-liquid households showed an improvement in values. The goat project's limited contribution to improving liquidity conditions stems from the fact that more than 50% of the households started to raise goats only in 2020. Thus, the start-up goats of these households were not yet mature to bear offspring that could be sold, consumed, or valued as savings-in-kind.

In summary, from the initial count of five households, the liquidity analysis showed that seven additional households would migrate from being not liquid to a liquid condition when the Net Value from fruit trees at their growing stage plus goat raising were added to income from farming and off-farm employment. In the longer term, when the mature stage of the fruit trees is considered, the additional number of households would be nine instead of seven when the Net Value from harvested fruits and "income" from goat raising are added.

Liquidity Condition	Ave. Net Value (NV) from Farming and Off-farm Employment			Ave. NV from Farming Off-farm Employment Fruit Trees (Growing Stage)			Ave. NV from Farming Off-farm Employment, Fruit Trees (Growing Stage) + Goats			Ave. NV from Farming Off-farm Employment Fruit Trees (Mature Stage)			Ave. NV from Farming Off-farm Employment, Fruit Trees (Mature Stage) + Goats		
	(MMK)	(USD)	No. HH	(MMK)	(USD)	No. HH	(MMK)	(USD)	No. HH	(MMK)	(USD)	No. HH	(MMK)	(USD)	No. HH
Liquid	1,014,400	613	5	1,287,590	778	12	1,300,830	786	12	1,398,475	845	14	1,405,095	849	14
% increase					27%	140%		28%	140%		37.8%	180%		38.5%	180%
Not liquid	-611,750	(370.00)	16	-531,255	-321	9	-511,395	-309	9	-529,600	-320	7	-494,845	-299	7
% decrease					-13%	-44%		-16%	-44%		-14%	-56%		-19%	-56%
Total HH			21			21			21			21			21

HH=household

Table 25. Household liquidity after adding the benefits from planting fruit trees and raising goats (Group 2)

Summary and Conclusions

Two types of households were tested in this study. The first group was 30 families that planted fruit trees on their farms. The second group was composed of 21 households that grew fruit trees and raised goats in their homesteads. Households belonging to the first group planted varying combinations of mango, guava, lime, custard apple, and pomegranate from 2018 to 2020. The households planted a total of 2,657 fruit trees. On the other hand, households under the second group planted 456 fruit trees within the same period, which included custard apple, lime, guava, pomegranate, jackfruit, and dragon fruit. In addition, the latter invested in goat-raising, starting with 52 heads between 2018 and 2020.

The Cost and Return Analysis showed that all 30 households under Group 1 would generate a maximum annual Gross Value of USD 15,944.00 from the 2,657 trees during the growing stage (first five years of fruit-bearing) of the perennials with a corresponding Net Value of USD 14,573.00. Upon reaching their mature fruit-bearing age, the total Gross Value would increase to USD 31,884.00, while the Total Net Value would be USD 30,549.00 after subtracting maintenance costs. The profitability analysis revealed high operating profit margins ranging from 73% to 99%. These values indicate that the households could retain 73% to 93% of the value of the fruits they could potentially harvest during the trees' growing stage as their "profit." Likewise, the expected increase in harvest volume when the trees reach their mature stage of growth would result in a corresponding increase in Gross Value, thereby triggering higher values of the operating profit margin.

For the 21 households under Group 2, the estimated total Gross Value and Net Value during the growing stage would be USD 9,337.00 and USD 9,301.00 per year, respectively. Reaching the mature fruit-bearing age, the Gross Value for all households combined would be USD 12,479.00, while the total Net Value would be USD 12,443.00 per year. With minimal costs to care for the trees, the households could retain 96% to 100% of the Net Value as their "profit."

Goat-raising would enable households to generate a combined annual Gross Value of USD 1,619.00. After subtracting the operating cost, estimated to be USD 1,108.00, the resulting Net Value was USD 511.00. The Net Value to Gross Value ratio represents a 32% operating profit margin. The financial benefits from raising goats will further improve when all female goats bought as start-up breeding stock reach their proper reproductive age. It is also worth mentioning that the households opted to hire labor to take care of their goats. This practice has significantly increased their operating cost leading to a lower profit margin.

The Household Liquidity Analysis showed that the estimated Net Values that could be generated from growing fruit trees and raising goats would improve the liquidity condition of households. A number of households were able to migrate from a non-liquid to a liquid financial state. For households that remained non-liquid, the Net Values obtained from the climate-smart interventions could minimize their negative cash balances. While goat-raising showed a minimal positive impact on liquidity at the time of the study, this would change once all female goats can breed and produce offsprings to increase sales revenue and generate benefits from goats consumed at home and increases in goat herds which are considered as "savings-in-kind."

For both groups of Htee Pu households, planting fruit trees is a financially viable means of mitigating the negative effect of climate change on their agriculture-based livelihood. In addition to earning revenue from the sale of fruits, perennials' presence contributes to minimizing household food insecurity by providing additional sources of nutritious food for the homes. Most importantly, these are assets households can rely on in case of intermittent failure of rains.

Goat-raising is likewise a financially beneficial complementary CSA intervention to fruit tree-based agroforestry. While the results of the initial Cost-Benefit Analysis of goats were less impressive than that of the fruit tree project, the longer-term effect would improve once all the female goat breeders had reached their reproductive age. Goats serve as additional sources of income and food for home consumption. With climate change, these breeds of animals would be important assets for farmers, including in times of annual crop failure.

References

International Institute of Rural Reconstruction. 2018. Climate Smart Village Profile: Htee Pu Village Nyaung-U Township, Mandalay Region. Retrieved from https://idl-bnc-idrc.dspacedirect.org/bitstream/handle/10625/57254/57315.pdf

Leeger, B. and M. Gold, 2013. Using Goats in Agroforestry Systems to Enhance Food Security for Subsistence Farmers, Proceedings of the 13th North American Agroforestry Conference, June 19-21, 2013, Prince Edward Island, Canada

Marais ZE, Baker TP, O'Grady AP, England JR, Tinch D, Hunt, MA. 2019. A natural Capital Approach to Agroforestry Decision-Making at the Farm Scale. Forests 10(1)

MOAI. 2015. Climate Smart Agriculture Strategy. Myanmar: Ministry of Agriculture and Irrigation, Government of Myanmar

NCEA. 2010. Myanmar's Initial National Communication Report. Nay Pyi Taw, Myanmar: Environmental Conservation Department, Ministry of natural Resources and Environmental Conservation

Preston, T. R. and M. E. Gomez, Goat Production Integrated with Agroforestry System: A Strategy to Reduce the Impact of Livestock on Global Warming, Center for Research in Sustainable Systems for Agricultural Production, Cali, Colombia

Sein CC, Htun K. 2013. Investigation of Tree species Composition and Above Ground Biomass, Tree Growth and Productivity After Seven Years of Rehabilitation Through Natural Means in the Ngalaingan Degraded Forests. Forest Research Institute.

Stewart, J.L., 2021. Pregnancy in Goats, MSD Veterinary Manual
Thein M. 2005. Economic Development of Myanmar, Singapore Institute of Southeast Asian Studies.

TNAU Agritech Portal. 2019. Animal Husbandry: Goat Production. Retrieved from http://www.agritech.tnau.ac.in/animal_husbandry/ani_goat_reproduction.html
Tun T. 2000. Greening the Dry Zone of Myanmar. Myanmar Forestry Journal.
Yee MS, Nawata E, 2015. Land Use and Farming Systems in Dry Zone, Myanmar: A Case Study in Kani, Sagauing Region. Tropical Agriculture and Development 58(4).