Graduate Program in Sustainability Science
Global Leadership Initiative
Graduate School of Frontier Science
THE UNIVERSITY OF TOKYO

2020

Master's Thesis

Analysis of the impact of successional agroforestry on the household economy in the West Amazon, Brazil

（ブラジル・西アマゾンにおける遷移型アグロフォレストリーの世帯経済への影響分析）

Submitted on 17 August

Advisor: Professor Aya Suzuki
Co-advisor: Associate professor Toshinori Tanaka

武田真由子
Mayuko Taketa

Analysis of the impact of successional agroforestry
on the household economy in the West Amazon, Brazil

Abstract

In Manicoré, one of the emerging hot spots of deforestation in the South Amazonas, Successional Agroforestry (SAF) has been promoted since 2008 to preserve nature and improve the economic conditions of the small farmers. Although positive changes in agricultural practices among some farmers have been observed, SAF's economic impact has not proven yet due to the lack of quantitative data on their economic activities. Agroforestry is conducted mostly in developing countries. Due to the unavailability of reliable data, few studies were conducted on the economic impact. Even when economic analyses were conducted, annual income data were obtained by a single round (or a few times) of interviews. Therefore, it not only casts doubt about the accuracy of data but is unable to capture yearly cashflow, wherein SAF's contribution can be measured. This study collected detailed quantitative data by a one-year diary survey to investigate the hypothesis that SAF in Manicoré contributes to the household economy and to examine the factors influencing the adoption of SAF and income for better intervention.

The results showed that the SAF-farmers had significantly higher annual income, more stable monthly income, mitigated damage by weather-related events and price fluctuations, and less expense on food purchase than the NON-SAF farmers. The SAF farmers have more acquaintances who conduct SAF than their NON-SAF counterparts, while age, years of education, family size, tenure, and assets did not show significant differences between the two groups. However, the disparity in income between the SAF farmers was substantial, suggesting that income does not rise by merely adopting SAF. The comparison of the two groups of the SAF demonstrated that the upper income had a smaller size of SAF cultivation than the lower income, but higher domestic labor capacity and more agricultural

machines, although the adoption of SAF was found not to require these resources. Moreover, the upper income group was negotiating more with middlemen on the price of crops than the lower income group.

So far, the local government or NGOs support the small farmers by focusing on cultivation techniques through the SAF project. These results suggest that additional intervention for increasing productivity for cultivation and improving sales skills for making SAF more profitable would be effective to achieve sustainable development in the Amazon area.

Keywords: Agroforestry, Successional Agroforestry, Amazon rainforest, Amazonas, Economic analysis

Acknowledgements

This research was conducted for a two-year master course in Japan and a two-year field survey on leave. First, I would like to appreciate K. Matsushita Foundation for giving me the scholarship that allowed me to stay and conduct the research in Brazil. I also appreciate Nomura Foundation, The Sumitomo Foundation, and The Mitsui & Co. Environmental fund for their financial supports that enabled this complicated field research to be accomplished.

I would like to express my sincerest gratitude to my supervisor, Professor Aya Suzuki, for all the support during this long period in both Japan and Brazil. She provided me with not only useful technical advice but also moral support. Without her help, I could not go through lots of difficult phases. I would also like to thank my co-advisor, Associate professor Toshinori Tanaka for inspiring my interest in developing the discussion of the thesis and technical advice.

I would like to acknowledge Toru Sadamori, Director of Curumim Japão, for his support in various forms. This research was only possible because of all his dedicated work in the last decades in the study area and emotional support in the back.

I would also thank my teammates for data collection, which was the most challenging and the most exciting part of this research, Dilson Rodrigues of Director of IDEAS, Rodolfo Torres, Nilson Reateque, and Adriano Araujo of Department of Agriculture of Manicoré. Thanks to your knowledge, toughness, and friendship, we managed to complete the challenging missions.

I would like to express my great appreciation to all the farmers who participated in the research for their cooperation and kindness to let us stay at their home always. The more time I spent with them, the more I fell in love with the Amazon. It was definitely the experience of a lifetime.

Finally, I must express my very profound gratitude to my spouse, Pablo, for providing me with unfailing support and continuous encouragement throughout my years of study and technical assistance, especially in the technology area.

This accomplishment would not have been possible without all of them. Thank you.

Table of contents

List of tables

List of figures

1 INTRODUCTION

1.1 Amazon and deforestation

Climate change has become one of the most urgent issues which international society should tackle with collective efforts. IPCC 5th Assessment Report pointed out that about a quarter of anthropogenic greenhouse is emitted from Agriculture, Forestry, and Other Land Use (AFOLU), which is mainly from deforestation and agricultural emissions from livestock, soil, and nutrient management. FAO indicated that between 2010 and 2015, the average net loss of the forest in the world was approximately 3,308,000 ha/year. The biggest loss happened in Brazil, with an average of 984,000 ha/year, which is responsible for 29% of a total loss. (FAO 2015). According to Amazonas Sustainable Foundation(2015), in 2010 Brazil possessed 519,520,000 ha of forest, and 354,390,000 ha were covered in the Amazon area. This meant that Brazil held one-third of the world's rainforest and allowed the country to be proud of the wealthiest biodiversity worldwide. Preventing deforestation in the Brazilian Amazon is one of the essential keys to the world's struggling mitigation against climate change.

In general, mass deforestation in the Amazon area has resulted from road building, extractive logging, pasture development, large-scale industrial agriculture, and bush fire (Angelsen et al.2012).In addition, one of the crucial factors that escalates these aggravations is the increased outflow of the rural population who seek opportunities for more cash income to cities . In the south of Amazonas state, which is the research area of this study and one of the emerging hot spots of deforestation, small scale abandoned farmlands have been substituted by ranch (Pontes 2016). According to Sadamori (2017), traditionally, local people living in harmony with natural resources, depending on their lives heavily on rivers and

forests, have been functioning as “Forest guardians.” They are generally very cautious about possible destructive developments in their areas since they will be the first and most severely affected victims by a loss or damage to natural resources if they are to happen. Therefore, the presence of local people itself somehow can hinder developers or loggers from exploiting nature. Therefore, the loss of these ‘Forest guardians” as a result of the migration of local farmers to cities for economic necessity increases vulnerability against deforestation.

Given these situations, successional agroforestry (SAF) has been promoted in several places in the Amazon with an expectation of achieving both forest conservation and improvement of small farmers ‘economic conditions. (Sadamori 2011, Yamada 2005, Blinn et al.2013). This paper examines the case study of Manicoré in the South Amazonas, where SAF has been promoted since 2008.

1.2 Agroforestry and Successional Agroforestry

1.2.1 Agroforestry and its potential

According to the world-leading expert of agroforestry Professor Nair, agroforestry is defined by two fundamental characteristics (1993, pp13-14): “the deliberate growing of woody perennials on the same unit of land as crops and/or animals, either in some form of spatial mixture or sequence” and “having a significant interaction (positive and/or negative) between the woody and non-woody components of the system, either ecological and/or economical.” He also mentioned that agroforestry aims to bring an increase in productivity and sustainability compared to mono-cultural agriculture. Increasing attention has been paid to agroforestry recently for its possible contribution toward multi-field solutions such as rural development, forest management, mitigation or adaptation for climate change, land use, and biodiversity protection.

IPCC's special report on land (2017) states that desertification, land degradation, and food security are the main land-related problems that climate change possibly affect severely. In the report, 28 possible global response options for land management are evaluated from 5 aspects: 1) Mitigation, 2) Adaptation, 3) Desertification, 4) Land degradation, and 5) food security. Among all the options, only three options are evaluated as having significant large positive impacts in all five aspects:1)Increasing food productivity,2)Increased soil organic carbon content, and 3)Agroforestry. In terms of the cost for each option, agroforestry is evaluated to require the lowest cost. In particular, the following positive influences are listed as agroforestry's contribution.

- Increasing carbon sequence in soils and biomass
- Improve water and nutrient use efficiency
- Create a favorable micro-climate for crop production
- Curb GHGs emission of CO^2 ,NH^4,and N^2O,
- Increase biological N^2O fixation → less fertilizer necessity
- Improve soil structure & water holding capacity → lower rate of erosion
- Improve food security through increases in productivity and stability
- Provide economic, ecological, and social stability through diversification of species and productivity

1.2.2 Agroforestry in Brazil

In Brazil, the systematic agroforestry was introduced and disseminated by descendants of Japanese immigrants in the east Amazon area of Tomé-açu in Pará state, in the process of trying to diversify products after severely getting hit by the great crash of the price of peppers (Nishizawa et al. 2005). They explored alternative ways after having experienced destructive damage caused by the severe disease on the monoculture practice of black pepper. According to Yamada (1999), Japanese farmers traditionally tend to utilize their limited land to the

fullest in an effective way. Their agriculture is considered to be more resource-intensive than pastures requiring low productive vast land that many European immigrants have conducted. This farming method was developed with a combination of traditional Japanese agriculture and traditional local home garden in the Amazon and with emphasis on time-series profitability (Sadamori 2011). Now it is called “Sistema de agroflorestal de Tomé-açu(SAFTA) (Sadamori 2017) and broadly recognized as sustainable agriculture method domestically and internationally. In 2010, the agricultural “cooperative by the Japanese-Brazilian Mixed Agricultural Cooperative of Tomé-Açu (CAMTA) “received the National Award for Regional Development by Brazil's president for its contribution to the local economy and environment. This methodology has been introduced to Manicoré, as the Japanese NGO invited a trainer from Tomé-Açu, and groups of farmers in Manicoré visited Tomé-Açu several times since 2008.

1.2.3 Successional Agroforestry (SAF) and its potential

SAFTA is considered a type of Successional Agroforestry (SAF). SAF is a farming method of planting woody perennials and crops, mimicking natural plant succession (Figure1-1). Natural plant succession of secondary forests means the natural process of reforestation after a major disturbance such as wildfire of primary forest. First, pioneer species that are tolerant of high UV radiation and poor soil quality grow. As environmental conditions such as light, topsoil temperature, and moisture, and nitrogen cycles change, secondary species like annual herbaceous plants appear, followed by perennial plants. At the next stage, non-shadow-resistant trees start growing, providing shadow for shadow-resistant trees that are dominant in climax forests(Yong 2017). By applying SAF, farmers try to mimic these functional characteristics of natural succession stages to promote tree-growth and crop productivity, creating forest ecosystems intentionally.

According to Jastrow et al.(2007), native vegetation of almost all terrestrial ecosystems is dominated by perennial plants, and the belowground carbon allocation of these perennials is a key variable in determining formation rates of stable soil organic carbon. When perennial vegetation is replaced by annual crops, inputs of root-associated carbon decline substantially. For example, perennial grassland species allocate around 67% of productivity to roots, whereas annual crops allocate between 13-30% (Saugier 2001, Johnson et al.2006). Having more perennial plants in cropland, which is conventionally dominated by annual crops, is a key for reducing the loss of soil organic carbon. Yong (2017, p179) introduces the concept of SAF: "(SAF) integrates indigenous knowledge of intercropping multi-purpose subsistence species, modern agroforestry techniques, and assisted natural regeneration to emphasize biodiversity, and the use of ecological succession to establish a productive forest system." It is also insisted that SAF can be used "as a transitional phase in restoration that simultaneously helps provide for human livelihoods, reduces the initial costs of restoration, and extends the period of management of restoration."

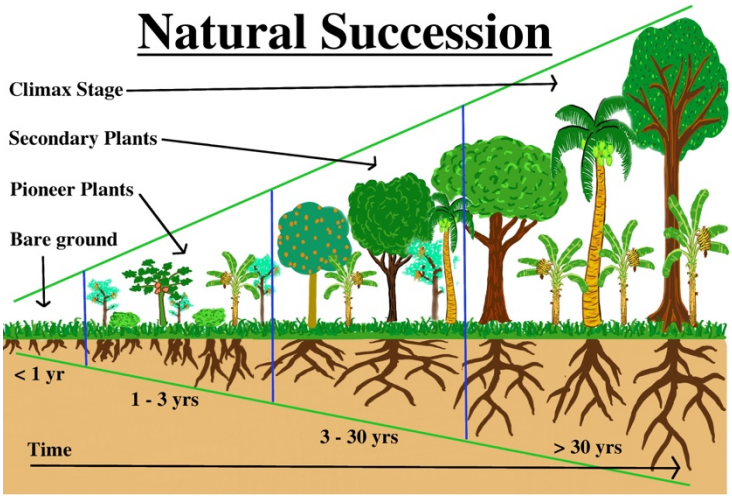


Figure 1-1:Illustration of natural succession of forest (Gietzen 2019).

1.2.4 SAF in Manicoré

The model combination that has been promoted in Manicoré is as follows. (Sadamori, 2017) (Figure 1-2)

- Short-term crops (harvested within a few months, one-time harvest only): Cassava, maize, watermelon
- Perennial mid-term crops (harvested within a half year around, available for a few years): Banana, pepper, passion fruit
- Fruit (harvested after a few years, available for long term): Cacao, acai, cupuassu
- Forest, non-timber products (harvested after a few years, available for longer-term): Brazil nuts, andiroba (extracted oil), rubber
- Trees for timber (Available after 7-decades): Teak, mahogany, cedro

Figure 1-2:Farms in Manicoré. The first year of SAF with banana, acai, cupuassu planted after opening the land (Left). A matured farm with pepper, passion fruit, acai, brazil nuts, and trees for timbers etc.(Right) (Pictures taken by the author)

While agroforestry functions well in Tomé-açu, the eastern Amazon, it is not popular in the west because of the absence of pioneers and promoters (Sadamori 2011). Besides, due to the influence of traditional indigenous culture, local people were not familiar with planting trees and having middle to long term plan to generate livelihood by agriculture. Since the promotion of SAF started in 2008, it has been newly pervading the practice of preparing seedlings for planting and the concept of having a plan for agriculture for better livelihood.

Yamada (2005) and Sadamori (2017), who are familiar with SAFT in Tome-acu and Manicoré, explained the following positive impact that SAF possibly provides.

-Environmental impacts

- Positive effects of nutrition/water on the soil, which can reduce the necessity for fertilizer (At the first stage, successional species can utilize the nutrition from previous species, and at latter stage matured nutrition cycle in an ecosystem is increased)
- Reduction of disease risk compared to monoculture practice that can reduce the amount of pesticide
- Helping reforestation (about 1,200 trees/ha planted)
- Higher biodiversity than mono-crop agriculture practice

-Socio-economic impacts

- Income is available in the short-term, middle-term, and long–term at the same plot, enabling farmers to settle at one place, instead of conventional nomad style with swidden practice
- Stabilization of income by dispersion of risk against disease, disaster, and change in market price, with a combination of various crops/products
- Contribution to food security by providing various food for self- consumption
- Higher profitability per hectare compared to swidden practices or pastures
- Higher local employment creation capacity

According to Sadamori (2017), the economy boosts by monoculture crops in the Amazon area in history such as rubber and black pepper, always ended up with farmers suffering from the damages of devastating diseases or price fluctuations in the international market. Considering the positive impacts listed above, SAF possibly contributes to a sustainable

livelihood in rural areas, environmentally and socioeconomically. As mentioned earlier, while many organizations and researchers have suggested various positive impacts of agroforestry including SAF, the dissemination is not easy, and there have been many cases that farmers have failed to continue its practices (Otsuki and Ogo 2010).

In the case of Manicoré, even though there have been changes emerging among people in the concept of agriculture; still, only a limited people are practicing SAF even after many seminars conducted by NGOs and local governments for the last ten years. Given their efforts, nowadays, many farmers have already heard about SAF and have some interests; however, they still feel barriers to implement it in real. Generally speaking, farmers are relatively conservative for introducing new agricultural methods, since the failure of production may mean losing everything to them (Sadamori 2017). Besides, agroforestry requires more time and effort to learn and implement than monoculture practice. Therefore, strong incentives, especially financially, are necessary for them to decide not only to adopt a new method but also to continue implementing it (Martinelli et al.2019)

1.3 Preliminary fieldwork and research gap

Now the question is how and how much actually SAF contributes to household economy in Manicoré. In 2016, I conducted a preliminary fieldwork to understand the local situation and tried to find quantitative income data of farmers. However, it was revealed that none of the departments of municipal and none of NGOs or organizations working there did have any quantitative data on the income of rural farmers. Neither none of farmers of all the 18 interviewed had any idea on how much they earn yearly from selling agriculture crops. Several officers explained that agriculture in this area is very responsive to climate events such as rains and dryness, and it causes frequent changes in price and yield, making it difficult to estimate actual income. In effect, the record of unit price of banana from January to July in 2016, which one of the farmers who used to work in Manaus kept, revealed the

significant fluctuations of unit price in 7 months, 190 % of change from 35 BRL to 18 BRL. Moreover, farmers in this area usually do not have direct market access due to the geological isolation and transportation limitation, forcing them to depend on middlemen who drop by their residents. There is an enormous number of middlemen from large to small scale, who offer different prices, making it difficult to get the picture of real market prices at the farm gate level.

Although most organizations working in this area also wanted to acquire quantitative data for better understanding or for the evaluation of their project, it had been impossible due to the lack of resources and capacities to collect such data. Having quantitative economic data of rural farmers has been a mutual challenge for organizations working in this area.

1.4 Literature review

As more and more attention has been paid to agroforestry in recent years for its possible contribution toward multi-field solutions, much research in various areas has been conducted. Nevertheless, predominant studies are focusing on natural science areas such as carbon absorption or biodiversity, and agriculture science such as soil analysis and farm management. Martinelli et al. (2019) also claimed that many studies of agroforestry deal with the biophysical and technical aspects of agroforestry systems. On the other hand, research on the economic impact of agroforestry is still limited.

Scherr et al. (1991） pointed out that since currently most of the agroforestry practices are conducted in developing countries, the insufficiency of trustable income data in quantity and quality makes economic analysis of agroforestry difficult. Martinelli et al.(2019) insisted that an increasing number of studies assessing the economic value provided by marketing ecosystem services such as Payment for Ecosystem Services (PES) for agroforestry are insufficient to encourage the farmers, and the detailed information of the economic performance of agroforestry is needed for promoting the adoption of the practice.

Though it is still a smaller volume, several studies discuss influencing factors on the adoption of agroforestry or the income by agroforestry farmers. Pattanayak et al.(2002) examined 32 studies on the adoption of agroforestry technology and found out that soil quality, plot size, tenure, and assets are statistically influential for decision-making. Blinn (2013) claims that land size, family size, and social participation are influential. Regarding the influencing factors on income, education (Safa 2005, Phandanouvong 1998, B.D.Zira 2020), land size (Sadeghi .2001, Safa 2005, Safa 2004, B.D.Zira 2020) and family size (Safa 200, Phandanouvong 1998, B.D.Zira 2020) are often listed. Most studies demonstrate that agroforestry farmers' annual income is higher than the control group. However, most researches dealing with the economic impact of agroforestry use only the annual income calculated by single round (or a few times) interviews (Cedra et al.2012, Blinn et al.2013, Safa 2005, Neupane 2001, Hughes 2020). Considering the diversified crops that agroforestry is supposed to provide and the informality of small farmers' economic activity in developing regions, the accuracy of data remains questionable. Furthermore, cash flow through a year, which is critical for smallholders who often have little savings, cannot be captured by the data of annual income only. We also need to examine the variation across months, especially in the area having drastic seasonal changes in a year, such as intense dry and rainy seasons.

1.5 Research question

This study aims to investigate if SAF in Manicoré contributes to the household economy regarding 1) income[1] increase and stabilization, 2) mitigation of possible damages by weather-related events or price fluctuations, and 3) food security empirically. Also, it also examines 4) the factors influencing the adoption of SAF and the income for a deeper understanding of economic activities in general for better intervention in the future.

[1] In this thesis, the term “income” refers to revenue from crop sales

For achieving the objectives, quantitative data on SAF's financial performance is essential, but an estimation of annual income by a one-shot interview is not feasible for farmers in Manicoré due to the frequent fluctuations of prices and yield, especially for farmers who conduct SAF. Therefore, I decided to collect monthly quantitative data of each farmer through a whole year in order to conduct a detailed analysis of the impact of SAF on the household economy and the influencing factors on the adoption of SAF and the income.

2 Research area

The target area of this research is the state of Amazonas, which is located in the west of Brazil and possess the biggest rainforest area, about 45% of the Brazilian “Legal Amazon” (Viana et al.2008)

2.1 Legal Amazon

"Legal Amazon" in Brazil consists of 9 states located in the north part of the country. The area covered stretches at about 5.2 million ㎢, which represents 51% of Brazil's land. (Brazilian Institute of Geography and Statistics (IBGE) 2012). According to the National Institute for Space Research (INPE), by 2018, It is estimated that 17.3% of forest cover has been lost compared to the estimated forest cover of pre-1970. Due to the lack of access to the big cities in the southern area, the primary forests in Amazonas so far has been protected compared to the surrounding states. According to the data provided by INPE updated in December 2019, accumulated deforestation in Amazonas state was 26,959 ㎢ (6.04% of total forest area), while neighboring states Pará state and Mato Grosso state, which have access to the south directory, having 152,165 ㎢(34.12%) and 146,142 ㎢ (32.77%) of deforestation area respectively. However, given the recently improved condition of roads, the rate of deforestation in Amazonas has been growing. Among the nine states, only two states showed the increase in the deforestation rate between 2004-2019, which are Roraima state and Amazonas state with an increase of 98% and 15%, respectively. Though Pará state and Mato Grosso state still have the biggest loss of forest in the county, the rate of deforestation started decreasing with -56% and -86% each. Considering the size of the forest area of Amazonas,

which is nine times of Roraima, the risk of increasing deforestation in Amazonas is becoming a risky threat to the attempt for the conservation of the Brazilian Amazon.

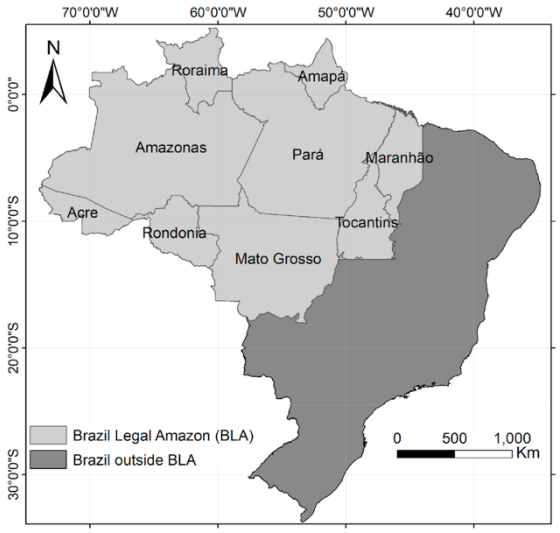


Figure 2-1 : Map of "legal amazon" in Brazil (Cabral et al.2018)

2.2 Amazonas state

Geography & gap

Amazonas state is located in the northwest part of the country. According to the IBGE database, land area is 1,559,168.117 km²(2018), being the country's biggest state that accounts for 18% of Brazilian territory. The population is 4,144,597(2019), which accounts for only 2% of the country with a population density of 2.23 /㎢ (the national average is 22.43/㎢). It is one of the most thinly populated states. The capital city, Manaus is located in the eastern part of the state, possessing 52% of the total population of 2,182,763 in less than 1% of the total state land, which indicates an overconcentration of people in the capital city. As can be predicted, Manaus has characteristics that are in sharp contrast to the other 61 municipalities as table 1.1 shows. In fact, Amazonas state is one of the poorest states in Brazil, having about 53% of the population living under half of the World Bank's poverty line (1.90USD) outside of the capital city, Manaus (Marta et al.2015).

Table 2-1:Demographic data of Manaus and other 62 municipalities in Amazonas state

	Manaus	Mean of 61 municipalities	Difference
Population [2019]	2,182,763	32,161	67 times
Population density [2018]	158.06	3.03	52 times
MHDI(Municipal human development index) [2010]	0.74	0.56	1.3times
Realized revenue - R$ (×1000) [2017]	4,743,520.97	68,142.43	69 times
GDP per capita - R$ [2017]	34,362.71	9,686.41	3.5 times

Source: IBGE (https://www.ibge.gov.br/cidades-e-estados/am.html downloaded on 10th July 2020)

Deforestation in Amazonas state

The recent rapid increase in deforestation in Amazonas is happening in the south of the state concentratedly. Pontes (2016) insists that it was caused by the expansion of ranch and soy production of neighboring states Mato Grosso, Rondônia, Acre. He explains that there are basically three patterns of the expansion:

1. Small scale abandoned farmland being substituted by ranch
2. Expansion of ranch and logging by immigrants from neighboring states along with the BR 364 and BR317 (BR: Trans Amazonian Highway)
3. Expansion of grains with advanced technology and business investment

Given this situation, in 2017, three municipalities in south Amazonas, Apuí, Manicoré, and Nova Aripuanã, are added to the list of "municipalities for actions of prevention, monitoring, and control of deforestation" by the Federal government. Manicoré, one of the frontiers for deforestation fighting, is this study's site.

2.3 Case study: Manicoré

Geography & Population

Manicoré is located in the south of Amazonas state. The direct distance from Manaus is 332 km; however, it is usually necessary to travel about 600 km by river on which most of the transportation is dependent (Figure 2-2). In fact, Trans-Amazonian highway connect Manaus

and Manicoré by about 1000 km of drive, but it has been abandoned and the condition of road makes it not available in most of a year. As the state of Amazonas having no route by land to other parts of the country, intra-state transportation is also very limited with huge dependency on rivers. Manicoré is based along Madeira River, the biggest tributary among over 1000 tributaries in the Amazon area with 3,520 km in length. Madeira river is famous as a typical "white river (Rio Branco) "that provides very nutritious water, which is very beneficial to farmers living nearby the river. Madeira River is also geopolitically important by connecting two big capital cities, Manaus of Amazonas state and Port Velho of Rondônia state. Being in the middle of these two important cities, Manicoré is one of the core cities in this area.

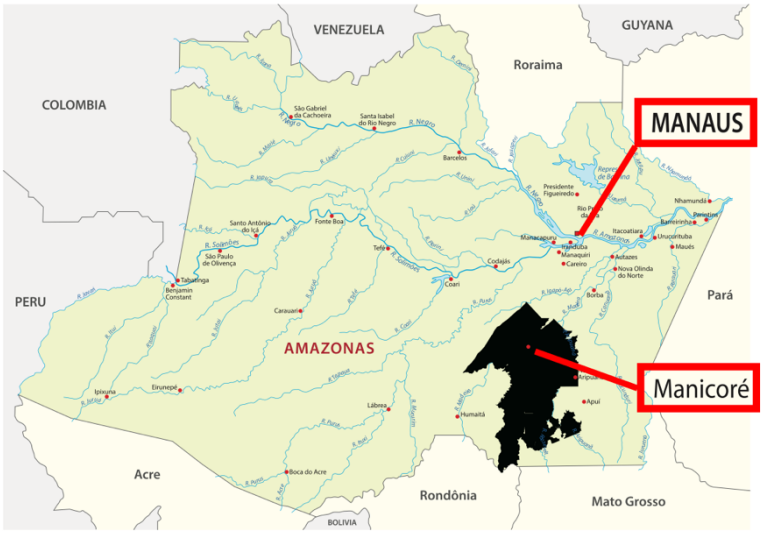


Figure 2-2: Location of Manaus and Manicoré
Source: Rainer Lesniewski / Shutterstock.com (Edited by the author)

IBGE database shows that the size of Manicoré is 48.315,021 ㎢ , which is approximately 1.2 times of the total area of Kyushu in Japan. It is quite a large municipal, being 18th in size among 5,570 municipals in the country. Such a vast land only possess 55,751 residents (2019)with 0.97/ ㎢ density. It is one of the sparsest areas in Brazil. According to the Department of Agriculture in Manicoré, about one-third of the population lives in the city of

Manicoré, and the rest live in the countryside extremely sparsely, where very little basic infrastructure is established yet. Since there is no cellphone signal in the countryside, it is almost impossible to communicate with them unless you visit them. Without any roads giving access to the countryside from the city, boats on the rivers are only transportation available for people in the countryside. The transportation cost is very high, since boats require more fuel than cars, for instance, boats with 40 km/h motor requires 7-8 times of fuel than cars with the same speed. Due to the cost and the time, the movement of residents is very limited in the countryside.

Economy

GDP per capita of Macnicoré is 9,065. Rs(Equivalent to 1,691USD)[2] (2017), which is about 37% of Manaus. It is slightly higher than the state average of 7,074.49Rs. However, there is persistent doubt if this figure correctly reflects the reality, because the majority of farmers in the remote area do not pay any tax or register the income in the official system. This figure possibly represents more of the reality of residents in Manicoré city. IBGE reported that only 3.7% of the population is with jobs that are officially registered (2017) and that 49.8% of the population receive less than half of the minimum wage monthly (2010).

2.4 Current situation in Manicoré

Loss of "forest guardians"

According to Pontes (2016), Manicoré is one of the areas that suffers from "small -scale abandoned farmland being substituted by ranch" and "expansion of grains with advanced technology and business investment." The increased outflow of rural populations seeking opportunities for more cash income in more industrial areas aggravates the deforestation

[2] It was calculated using the exchange rate of 1st July 2020 provided by OANDA.(https://www1.oanda.com/lang/ja/currency/converter/)

situation in Manicoré (HANDS 2010). In fact, Brazil has various laws against logging that might cause significant damage to the environment, having received international pressure after catastrophic deforestation in the past in the Amazon. However, regulation by law becomes valid only with an adequate monitoring system. As mentioned, the size of municipalities in the Amazon is so vast and sparse that the power of law does not function effectively for regulation purposes with limited resources. Therefore, as explained in the section 1.1, the loss of "Forest guardians "caused by economic necessity increases the vulnerability against the escalation of deforestation (Sadamori 2017). The colored area in Figure 2-3 shows the tree canopy loss since 2000 in the neighboring area of Manicoré at the year of 2005 and 2019. The expansion of canopy loss in this area can be observed.

2005 2019

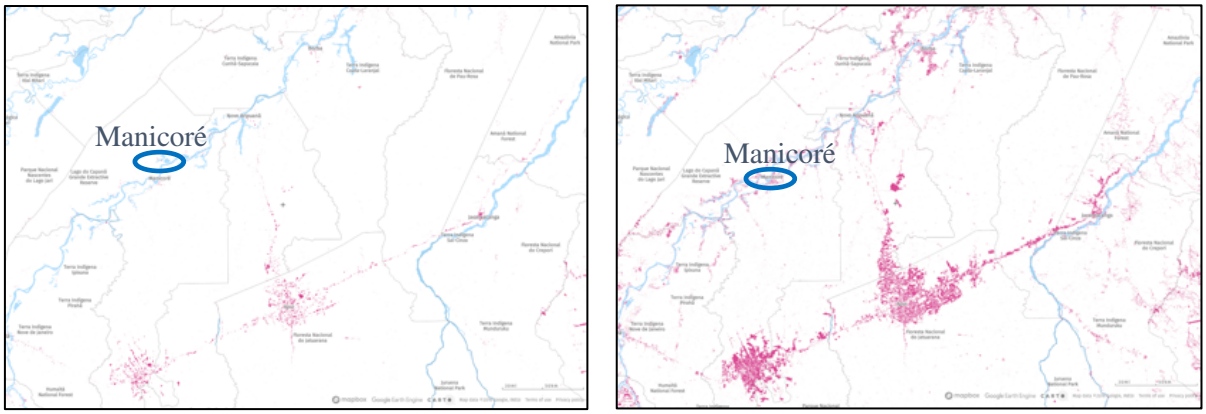


Figure 2-3: Loss of tree canopy compared to 2000, Source: https://www.globalforestwatch.org/(downloaded **on the 22nd June 2020)**

Changes in swidden practice

People in Manicoré traditionally have engaged in small-scale (1-2ha) swidden practice (Sadamori 2011). When the vast bush fire in the Amazon caught international attentions in August of 2019, some media claimed that swidden cultivation to open land for agriculture had caused the fire. However, in fact, swidden practice in small-scale has been successful in sustainable land management historically when accompanied by a sufficient fallow period

(Sadamori 2011 and Padoc et al.1985)[3]. However, people began to abandon the nomad lifestyle and started to live on settled land when the individual land possession system started. Then, the fallow period became shorter in order to utilize the limited land to its maximum potential. The insufficiently short fallow period causes the degradation of soil, which results in lower productivity in cultivation and lower income for farmers. As a result, more people are forced to go to the city for better income opportunities to survive（HANDS 2010）

New challenges

From the interviews and observation of the preliminary field research, it was discovered that farmers in Manicoré have been facing new problems. Weather-related events, possibly the impact of climate change such as floods, drought, and unusual patterns of rain, are happening more frequently and causing greater impacts. For instance, a historically huge flood occurred in 2014 and destroyed almost all the crops in riverside. It is normal in this area that the water level changes by 20-30m between the rainy season and the dry season. Local people have learned well how to adjust themselves to such a dynamic environmental change by living in high-floored houses or changing the timing for planting or harvesting. However, in 2014, the water went up much higher than standard years and remained high for about four months, which was very unusual. Normally, even if a water level rises, it goes down in one month or so. Many houses in the riverside were flooded, which forced people to live in boats or to move to the cities for a while and caused devastating damage to houses, including appliances or furniture. The farmers reported that it also damaged almost all crops in the riverside, including water -resilient crops such as acai and cacao that could survive usual small-scale floods.

[3] *Large-scaled burning for mass logging or mass industrialized agriculture causes destructive damages on the ecosystem. It is important to distinguish the types of burning.

In other years, people suffered from an increased risk of drought. In 2016, according to a local farmer, they did not have rainfall for about 60 days in a row in the dry season. The local newspaper "Rede Amazonica" reported that Madeira river recorded the lowest water level in the last 48 years. It dried up many young seedlings. In general, as the weather becomes excessively dry, the number of executions of swidden cultivation increases since it gets more challenging to grow crops. Besides, the drier the weather gets, the more likely the farmers fail in burning practice, making more area than expected burnt. According to old farmers, it was neither the temperature was as hot as now, nor the water level went so low in the past, even in dry seasons. A scientist of Center for Weather Forecasting and Climate Research explained to Mongabay, a nonprofit conservation and environmental science news platform, that eight of the ten driest rainy seasons in Brazil's northern region recorded since 1962 happened after the year 2000. Further, he reported that a significant sign of a reduction in the rain through the years was observed.

Another urgent problem in this area is the rapid increase of illegal gold mining in the river. According to local people, it started increasing in around 2010, and the number of people engaged jumped up drastically after 2014. They use mercury in the process of extracting gold, which is highly toxic to the environment and human and now is internationally regulated. Traditionally, most people in the countryside heavily depend on protein intake on fish consumption. The research conducted in Humaita, a municipality next to Manicoré, shows that 75% of 120 samples had hair-Hg levels above 10 mg/g (Oliveira et al.2010). Considering the amount of 0.05 mg/g that the World Health Organization sets for health alert, a concern of mercury pollution in the rivers is increasing. Illegal gold miners are coming from their own municipality and outside neighboring states, or even neighboring countries such as Columbia. Some groups from outside are equipped with big rafts and advanced machines, while locals tend to have smaller and simpler equipment. Usually, they

operate mining by hiring temporary workers for 2-3 weeks each time. The majority of local people who are engaged in illegal gold mining are these temporary workers.

Gold mining is basically available only in the dry season when the water level is low. These temporary workers are farmers at the same time, and they work for gold mining several months in a year to supplement their income. As more and more people devote themselves to illegal gold mining, the industry structure in Manicoré has been changing. A cooperative group was established for gold mining, and a shop for exchanging gold for money was opened at the main street of the town. Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA) and Chico Mendes Institute for Biodiversity Conservation (ICMBio) have been tackling illegal gold mining for a decade; however, the number of miners keeps increasing. In October 2017, in Humaita, a group of gold miners set the building of IBAMA and ICMBio on fire for protesting after the IBAMA and ICMBio seized rafts of illegal gold mining, burning some of the rafts. In interviews with a local TV, one of the gold miners insisted that it is the only way for him to earn enough cash for his family and that the government should provide alternative means if they want people to stop gold mining. Working in gold mining requires a few weeks or months to stay isolated in small and noisy rafts without any communication means. In preliminary fieldwork, several farmers confessed that they do not like the work of illegal gold mining since they are worried about their families remained in villages, but they had no other choices due to financial necessity.

Cut the vicious cycle

All the 18 farmers interviewed in the preliminary research expressed their unwillingness to migrate to cities or pollute the river. They are eager to keep living with the forest and river that they are so familiar with. Many people told us that they feel stress living in cities. However, the influence of the cash economy has been prevailing even in the middle of amazon. Now they also need cash to get access to necessary medication or proper education

for children, which they think are necessary for the quality of life. They are even not favorable when people outside strongly claim conservation of the Amazon forest. They insist that they also have the right to utilize their land for increasing their income.

To sum, un-sustainable swidden practice decreases soil fertility, which lowers the productivity and income of farmers. It makes people functioning as "Forest Guardians "to migrate to cities for better income to survive, aggravating vulnerability against deforestation. Consequently, the impact of climate change increases, causing more weather-related events such as floods, drought, and unusual patterns of rain, which drives more and more people to choose to migrate to cities or going for illegal gold mining. To end this vicious cycle (Figure 2-4), it is necessary to have a sustainable management system that enables small–scale farmers in rural areas to earn enough cash income through environmentally friendly agricultural practices so that they are not to be forced off their land or go for illegal gold mining due to financial necessity. Given this situation, the Department of Agriculture started the promotion of successive agroforestry since 2008 with the cooperation of a Japanese NGO, a local NGO, and government bodies such as the Executive Commission for Cocoa Cultivation Plan (CEPLAC).

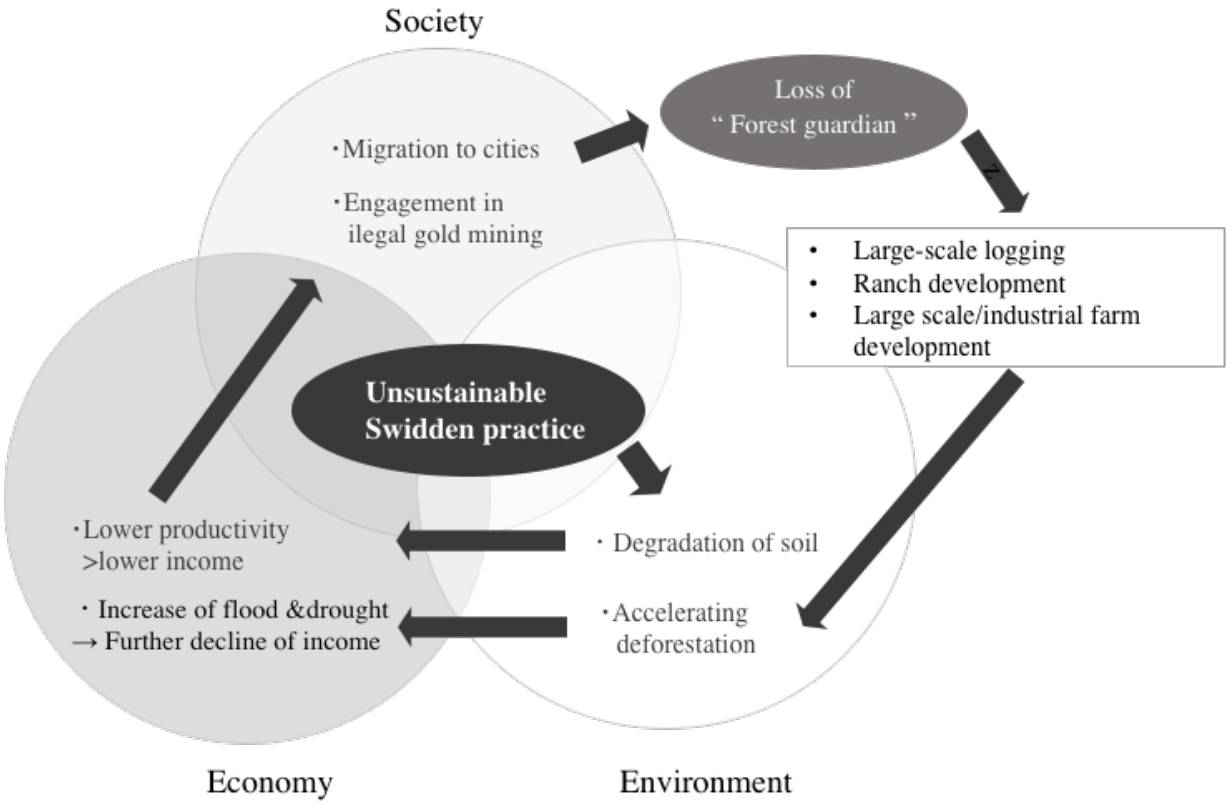


Figure 2-4: Diagram of vicious cycle happening in Manicoré (drawn by the author)

3 Methodology

3.1Research approach

For investigating the research question, this study employed principally a quantitative data analysis approach using the data obtained from the one-year diary survey. One-year diary data collection is expected not only to improve the accuracy of the data but also to reveal the income structure and monthly variations throughout the year, which could not be picked up by conventional single-shot surveys. Diary-based data collection was considered not feasible in the Amazon so far due to the high illiteracy and the remained influence of bartering culture. However, as the better education system has been established in the last few decades, literacy rate dramatically improved and selling crops as a business became common. The new methodology for bringing out the reality in the Amazon area was worth trying. The data was collected by monthly visits of a group of enumerators and I who assisted farmers for recording.

3.2 Survey design

Two types of questionnaires were used:1) One-year diary questionnaire for daily activities and 2) One-shot survey questionnaire for non-time-sensitive general information.

1) The one-year diary questionnaire was developed with the cooperation of local NGOs and the Department of Agriculture of Manicoré. After having found in preliminary fieldwork in 2016 that the frequency of sale and purchase activities of farmers is quite low in this study area, I decided to apply this method. The questionnaire was finalized after two pilot tests in May-June 2017 and January-February in 2018 (Table3-1). The questionnaire was comprised of questions on income from crop sales, income from other activities, expenses on agriculture (for materials and labor), food purchase, self-consumption, and planting. The biggest

challenge of this survey was if farmers can keep the record properly for a year, especially for older generations who have difficulties in reading and writing. Even given the regular assistance, the questionnaire should be as simple as possible so that they can keep recording without trouble. Therefore, I made the questionnaire in such a form that they only need to check the boxes or put numbers basically. The farmers were asked to keep the record on the questionnaire provided, and the content was checked at regular visits and transferred to the tablets. The contents of the questionnaire are as follows. (See APPENDIX A)

Section1: Income

1. Agriculture sale/ Date, Type of crop, Location, To who, Quantity, Price
2. Other activity/Date and period, Type of activity, Price

Section 2: Expense

1. Agriculture material /Data, Type and objective, Quantity, Price
2. Labor/Data, Type and objective, Quantity, Price
3. Food purchase/Data, Items, Location, Price

Section 3: Self -consumption

・Type of crops and quantity of self-consumption for a week

Section 4: Planting

・Date, Type of crop, Location, Quantity

*Except some numbers (date, quantity, and price), name of the crop for sale, and objectives, all are provided by single/multiple choices.

2) One-shot survey for non-time-sensitive general information was also developed separately. It was composed of 9 sections, mostly with multiple choices or numbers. The survey was

conducted in interviews, generally taking 40 minutes to 1 hour per person. The followings are the contents. (See APPENDIX B)

1. General information (Age, sex, community, education)
2. Family members (Number, age, domestic labor for agriculture, families outside, education history for children)
3. Agriculture (Knowledge and experience of SAF, training experience, SAF neighbors, type, size and status of land
4. Variety of crops in the field (not necessarily for sale)
5. Damage of the flood in 2014 and the drought in 2016
6. Marketing (Number of middlemen, information source on prices, negotiations with middlemen, agriculture loans,)
7. Expense (gas, gasoline, communication, transport, education, health, leisure)
8. Possession (Transportation means, communication tools, agriculture machines and infrastructure, home electronics, live stocks)
9. Preference of life (Countryside or city, agriculture or non-agriculture for a living)

Table 3-1:Timeline of activities

Period	Activities
August (2016)	・Preliminary research
May-June(2017) and January-February(2018)	・Pilot test for questionnaire
August, September, and November (2018)	・Explanation sessions at the training organized by NGO in Manicoré
December(2017)- March(2018)	・Individual visit
January - March (2018)	・Explanation session at three communities for asking the participation of NON-SAF farmers
April (2018)-March (2019)	・One-year diary survrey
November (2018) to March(2019)	・One-shot survey

3.3 Data collection

One-year diary data were collected from April 2018 to March 2019, and one-shot interviews were conducted from November 2018 to March 2019 (Table 3-1). Monthly visits for

checking and collecting diary data were the most critical and challenging part of this survey. For facilitating the operations, I hired four personnel for research implementation: three agriculture extension workers from the Department of Agriculture in Manicoré and one local NGO leader. As repeated, farmers live very distantly and sparsely with no communication means, making it almost impossible to make an appointment. Even municipal officers do not have much information on the specific locations of residents in remote areas. Moreover, a boat, which is the only transportation means, is highly dependent on the water level that changes by 20-30 meters throughout a year, and it hinders the boat from reaching some villages depend on the conditions. This complexity and unpredictability of natural factors make visits to farmers 'homes itself very challenging. Besides, in general, farmers usually do not have much contact with outsiders, and they are cautious to visitors from outside. It also happened several times that some researchers and politicians visited them for research purposes but never returned for sharing feedback or result, which made local farmers feel suspicious. Therefore, it was critically important for the data collection that the research team had the staffs who have abundant knowledge of local geography and good long-term relationships with local farmers.

3.4 Target and sampling

In order to examine the effect of SAF and influencing factors on income, I collected data from 1) farmers conducting SAF (SAF farmers) and 2) farmers not conducting SAF(NON-SAF farmers).

Sampling

1)SAF farmers

Farmers who understand the concept of SAF and continue implementation intentionally are basically only those who participated in training and have been followed up by NGOs and the

Department of Agriculture. Thus, SAF farmers we interviewed were referred by them. They live scattered in more than 16 communities.

2)NON-SAF farmers

At first, the attempts were made to collect NON-SAF farmers living in the same communities of SAF farmers for setting close conditions by asking SAF farmers to bring neighbor NON-SAF farmers to the training in Manicoré city or to distribute questionnaires to their neighbors. However, it was found that many neighbors, in fact, do not live in the accessible distance on foot. Due to the limitation of resources (time, budget, human resources), we decided to find NON-SAF farmers in a few communities concentratedly for enabling us to conduct follow-up visits, in addition to having some neighbor NON-SAF farmers living in the same community of SAF-farmers. Inside of these communities, NON-SAF farmers were selected randomly by the leaders of the community.

The following activities for explaining the survey purpose and requesting their participation were conducted before data collection.

- Explanation sessions at the training organized by NGOs in Manicoré (August, September, and November in 2017)
- Individual visits for who did not participate in the training above (December 2017- March 2018)
- Explanation session at three communities for asking the participation of NON-SAF farmers (January - March 2018)

During the process, it was found that many farmers stopped farming even within this short period. Nine farmers (SAF-:2, NON-SAF:7) among 52 who attended the explanation sessions in August/September 2017 were not available in April 2018, because some moved to cities

and others decided to dedicate themselves more to gold mining(Table 3-2). After many struggles to collect participants, we started the data collection in April 2019 with 72 samples(SAF:33, NON-SAF:39). However 19 farmers(SAF:4, NON-SAF:15) became unavailable due to the following reasons: the change of social conditions(moved to cities for work, for health reasons, moved to gold-digging), the change of accessibility (Some areas became impossible to reach in some seasons due to the water level or watershed) or simply giving up recording. Eventually, the one-year data collection of 53 farmers living in 18 communities were completed (Table3-3). The area covered stretched about 250 km in length, locating in the upper river, the lower river, and a tributary of Madeira river. Although the sample size of 53 is relatively small, it represents approximately 1% of the estimated number of households in the countryside of about 5500. Among them, 29 are SAF farmers, and 24 are NON-SAF farmers. Here, SAF farmers and NON-SAF are defined based on self-recognition, being divided by their response to the question, “Do you conduct SAF?”. In this thesis, all analyses are made using this definition.

Table 3-2:Change of the number of participants (Preparation period)

# Participants at explain session (August, September 2017)	52
# Participants moved to cities or engaged in gold mining by April 2018 of above	9 (SAF-2, NON SAF-7)

Table 3-3:Change of number of participants (Data collection period)

	SAF	NON SAF	Total
# Initial participants (April 2018)	33	39	72
# Final participants (March 2019)	29	24	53

3.5 Analysis method

First, the data was organized and checked for duplication of input. Then all the separated monthly data were combined for one-year data for each individual for analysis. Then Skewness / Kurtosis tests for normality was used to determine if the continuous variables of

interest were normally distributed or not. A Mann-Whitney U test was applied for the non-parametric variables with less than 0.05 Prob>chi2 and T-test for parametric variables with more than 0.05 Prob>chi2. A Chi-square test was applied for binomial variables. All tests were conducted with STATA, a statistical software program.

4 Results

This section presents the results of the analysis for evaluating whether SAF in Manicoré contributes to the household economy concerning income increase and stabilization, mitigation of possible damages by weather-related events or price fluctuations, and food security as well as for examining other factors influencing the adoption of SAF and income.

4.1 Socio-economic characteristics

Tables 4-1 and 4-2 show the results of Mann-Whitney U tests and chi-square tests of socio-economic characteristics by five pairs. (See APPENDIX C for the detailed results)

Pair1:
SAF farmers had significantly more acquaintances who conduct SAF (Mean=3.9, Median=3.00) than NON-SAF farmers (Mean=0.91, Median=0.00) (p=0.0000). Significant differences in the size of possessed land(SAF: Mean=49.88, Median=20.00, NON-SAF: Mean=40.25, Median=6.75, p=0.004) and planned land(SAF: Mean=5.685, Median=4.0, NON-SAF: Mean=2.5, Median=2.0, p=0.0002)were observed as well. The percentage of land used for planning did not have significant difference. In addition, more SAF farmers had some information source on prices of crops than NON-SAF farmers. (X2 (1), N = 53) = 3.9536, p = 0.047)

Pair2:
The comparison of upper income group and lower income group did not have significant difference in the size of possessed land, while the size of planted(Upper: Mean=5.54, Median=4.00, Lower: Mean=2.88, Median=3.00, p=0.0097) and the size of SAF (Upper: Mean=1.68, Median=1.5, Lower: Mean=0.92, Median=0.00, p=0.0752) showed significant differences. Another significant difference was observed in the number of agriculture loans used in the past (Upper: Mean=0.629, Median=0.00, Lower: Mean=0.27, Median=0.00,

p=0.0759) ,though still a limited number of farmers (13 and 7 respectively) had experience of use it. There were significant differences in possession of motor grasscutter and spray for pesticide （X2 (1), N = 53) = 4.9338 and 3.2671 , p = 0.026 and 0.071 respectively) and in the information source on price（X2 (1), N = 53) = 3.1808 , p = 0.075).

Pair 3:
Intra-SAF farmers comparison by income showed a significant difference in the number of family member who work for agriculture. (SAF-Upper: Mean=4.87, Median=4.00, SAF-Lower: Mean=3.29, Median=3.00, p=0.0441). As for the size of SAF cultivation, unexpectedly, SAF-Lower income farmers had bigger size of SAF (Mean=2.75, Median=2.00) than SAF-Upper income group (Mean=1.65 Median=1.50) (p=0.0892) . Significant differences in possession of spray for pesticide and chain-saw （X2 (1), N = 53) = 4.5487 and 4.4414 , p = 0.033 and 0.035 respectively)were confirmed. In addition, more SAF-Upper income farmers responded that they negotiate with middlemen for sales（X2 (1), N = 29) = 4.2693 , p = 0.039).

Pair 4:
Intra-NON-SAF farmers comparison by income shows a significant difference only in the size of planted land (NON-SAF Upper: Mean=3 Median=3.0, NON-SAF Lower: Mean=2.21, Median=1.75, p=0.0971).

Pair 5:
The comparison of the SAF -Upper income group and NON-SAF -Upper income group showed similar results of the Pair 1 basically. Significant differences were observed in the size of planted land(SAF Upper: Mean=5 Median=4.0, NON-SAF Lower: Mean=3, Median=3.00, p=0.0788) and in information source on price （X2 (X2 (1), N = 24) = 4.2188 , p = 0.040).

Table 4-1: Paired Mann-Whitney U test results of socio-economic characteristics

	Pair 1 p	Pair 2 p	Pair 3 p	Pair 4 p	Pair 5 p
Socio-Economics					
Age	0.437	0.575	0.760	1	0.5251
Education(Year)	0.971	0.148	0.759	0.3239	0.659
# of family member	0.250	0.362	0.0633*	0.952	0.0986*
# of family member for agriculture	0.841	0.758	0.0441**	0.6593	0.4268
# of SAF farmers :know	0.0000***	0.332	0.757	0.6144	0.0102**
Land size-Possesd	0.004***	0.146	0.369	0.862	0.0122**
Land size-Planted	0.0002***	0.0097***	0.806	0.0971*	0.0788*
Land size-SAF	N/A	0.0752*	0.0892*	N/A	N/A
% of planted land / Possed	0.7625	0.5588	0.2246	0.2476	0.3135
Sales-related					
# of middlemen : know	0.4883	0.6564	0.2193	0.8134	0.4386
# of loans for agriculture in tha past	0.1728	0.0759*	0.9609	0.6602	0.2253

***, **, and * signify statistical significance at the 1,5, and 10 % level, respectively.

Pair1: SAF (N=29) and NON-SAF(N=24)
Pair2: Income Upper (N=27) and Income Lower (N=26)
Pair3: SAF -Upper income (N=15) and SAF -Lower income (N=14)
Pair4: NON-SAF -Upper income (N=12) and NON-SAF -Lower income (N=12)
Pair5: SAF -Upper income (N=15) and NON-SAF -Upper income (N=12)

Table 4-2:Paired chi-square test results of socio-economic characteristics

	Pair 1 p	Pair 2 p	Pair 3 p	Pair 4 p	Pair 5 p
Socio-Economics					
Asset: Nursery. -	0.032**	0.498	0.55	0.653	0.137
Asset: Generator	0.356	0.697	0.362	0.653	1
Asset: Motor gras cutter	0.176	0.026**	0.054	0.206	0.183
Asset: Spray for pescide	0.269	0.071*	0.033**	0.682	0.095*
Asset: Chain saw	0.219	0.893	0.035**	0.013	0.168
Sales-related					
If negotiate with middlemen	0.679	0.589	0.039**	0.653	0.722
If have info source of price	0.047**	0.075*	0.292	0.615	0.04**

***, **, and * signify statistical significance at the 1,5, and 10 % level, respectively

Pair1: SAF (N=29) and NON-SAF(N=24)
Pair2: Income Upper (N=27) and Income Lower (N=26)
Pair3: SAF -Upper income (N=15) and SAF -Lower income (N=14)
Pair4: NON-SAF -Upper income (N=12) and NON-SAF -Lower income (N=12)
Pair5: SAF -Upper income (N=15) and NON-SAF -Upper income (N=12)

4.2 Agricultural Income (Year)

Annual income from crop sell

As shown in Table 4-3, the annual income from crop sales of SAF farmers (Mean= 10,308.22 BRL, Median= 8,329 BRL) was significantly bigger than those of NON-SAF farmers (Mean=5,090.83BRL, Median=4,382.5 BRL) (p=0.0.0036). The comparison between SAF-Upper income farmers (Mean= 15,618.42 BRL, Median=10,447.5 BRL) and NON-SAF - Upper income farmers (NON-SAF - Upper income) (Mean= 7,665.417BRL, Median= 6,118.5 BRL) also showed a significant difference (p=0.0018). Furthermore, SD of SAF farmers was found to be almost 1.9 times of NON-SAF farmers.

Table 4-3:Paired Mann- Whitney U test of annual income from crop sell

		Mean (BRL)	SD	Median(BRL)	p
Pair 1	SAF (N=29)	10,308.22	9,203.30	8,329.00	0.0036***
	NON SAF(N=24)	5,090.83	4,024.30	4,382.50	
Pari 2	SAF -Upper income (N=15)	15,618.42	10,160.22	10,447.50	0.0018***
	NONSAF -Upper income (N=12)	7,665.42	3,851.86	6,118.50	

***, **, and * signify statistical significance at the 1,5, and 10 % level, respectively

4.3 Agricultural Income (Month)

Income from crop sale by month

First, Figure 4-1 shows the means of monthly agriculture income of SAF and NON-SAF farmers throughout the year. In all months, the means income of SAF farmers were higher than those of NON-SAF farmers. A huge increase of SAF in December- February was caused by an outlier. One of the SAF farmers earned the profit of 10,500 BRL(December), 7,295 BRL(January), and 17,500 BRL(February) by working as sort of middleman for brazil nuts only in this period, visiting very remote areas and buying a huge amount to resell them to larger-scale middlemen. Considering the minimum monthly wage in Brazil of 1,045 BRL (as of 2020), which agriculture extension workers of the Department of Agriculture of Manicoré receive, the amount he earned in these three months was extraordinarily high. None of the other

farmers engaged in the type of middlemen work except him. Including his income increased the mean income for all farmers in these months a lot.

Thus, I plotted Figure 4-2 as a modified version, taking out of the outlier, and it looks more moderate than Figure 4-1. Although the modified version was used for analysis in this study, his case casts a new light on the possibility of earning a large amount even in this area, with some creativity. Even without the outlier, Figure 4-2 and Table 4-4 also showed that the mean monthly incomes of SAF were higher than NON-SAF farmers in all the months, with a similar movement of ups and downs except March. The detailed analysis of this movement will be provided in section 4-5.

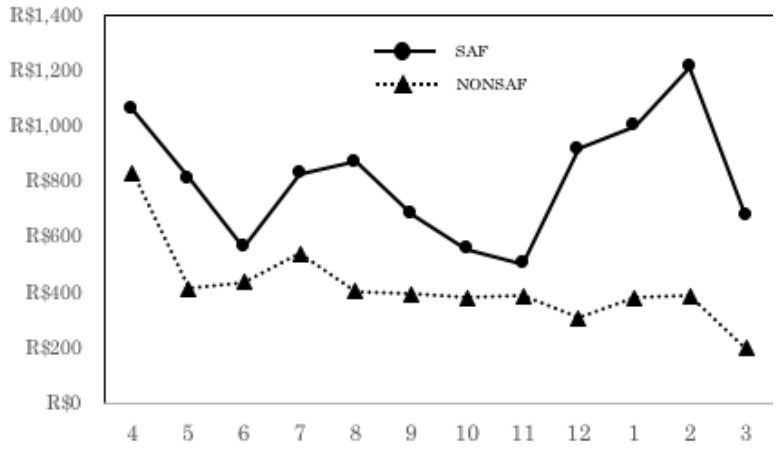


Figure 4-1:Mean of income from crop sale by month with an outlier

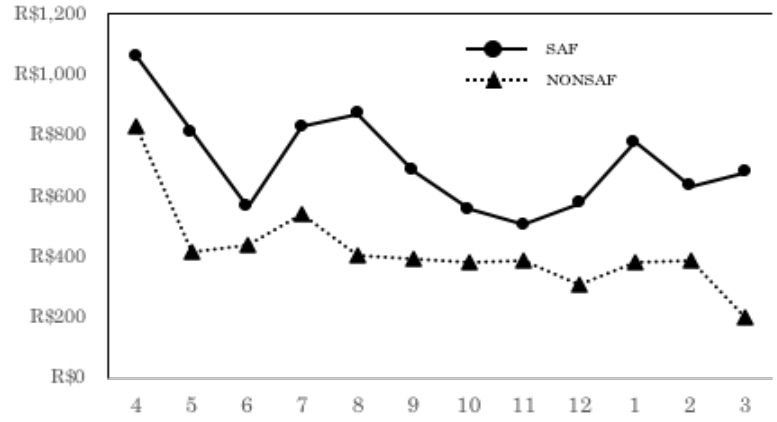


Figure 4-2: Mean of income from crop sale by month w/o an outlier

Table 4-4:Mean and SD of income from crop sale by month without outlier

		4	5	6	7	8	9
Mean income	SAF	1062.466	812.9483	563.8966	829.1207	871.6328	683.2759
	NON-SAF	793.5417	416.4375	439.2917	541.9583	404.25	394.1667
SD	SAF	937.1098	638.7133	520.1341	1184.427	997.6129	696.7801
	NON-SAF	1091.211	423.2176	535.8409	1117.039	442.5622	540.8418

		10	11	12	1	2	3
Mean income	SAF	556.931	505.25	576.25	777.6786	632.8929	677.4655
	NON-SAF	381.9583	389.3333	310.0417	381	389.4375	622.6644
SD	SAF	695.8541	591.7216	576.306	588.5194	465.9472	198.1667
	NON-SAF	536.3071	421.7573	402.3825	481.2325	551.6498	195.1712

Secondary, Figure 4-3 shows the percentages of SAF and NON-SAF farmers who did not have any agricultural income from crop sales each month. In all the months except for July, the percentage of NON-SAF farmers without agricultural income was higher, with an average of 23.61% of NON-SAF and 10.6% of SAF. There were two months in a year that 37.5% of NON-SAF farmers did not earn anything from crop sales, while the highest percentage of SAF farmers was 17.24%. Furthermore, 58%(N=17) of SAF farmers had some income in all 12 months, while only 30%(N=8) NON-SAF farmers had.

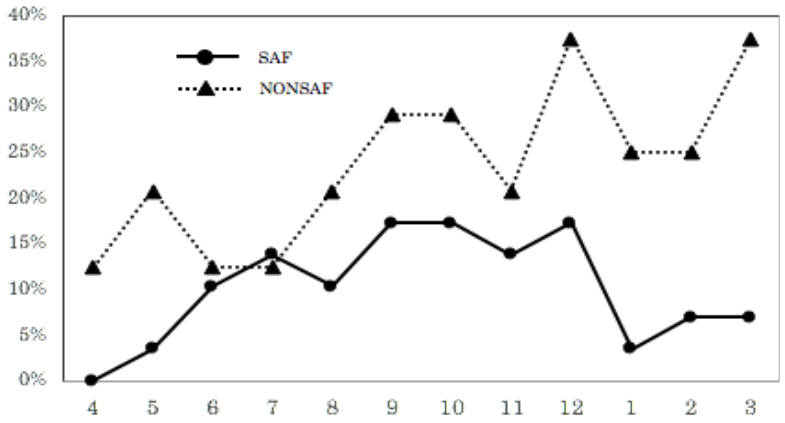


Figure 4-3: The percentages of farmers with zero income from crop sales

As the third analysis of monthly income, Table 4-5 displays the means and the medians of the coefficient of variation (CV), which represents the ratio of the standard deviation to the mean, of individual monthly income within a year. It can show the degree of variation of monthly

income throughout the year. It indicates that there were significant differences in all the comparisons expect between NON-SAF- Upper income group and NON-SAF- Lower income group, suggesting that SAF farmers, especially upper income, had more stable monthly income through a year.

Table 4-5:Paired Mann- Whitney U test of Coefficient of variation (CV) of individual monthly income within a year

		Mean	Median	p
Pair 1	SAF (N=29)	0.87	0.68	0.068*
	NON SAF(N=24)	1.17	0.84	
Pair 2	Income Upper (N=27)	0.77	0.65	0.007***
	Income Lower (N=26)	1.24	1.19	
Pair 3	SAF -Upper income（N=15)	0.65	0.59	0.040**
	SAF -Lower income（N=14)	1.09	0.98	
Pair 4	NONSAF -Upper income （N=12)	1.14	0.79	0.563
	NONSAF -Lower income （N=12)	1.21	1.09	
Pair 5	SAF -Upper income（N=15)	0.65	0.59	0.045**
	NONSAF -Upper income （N=12)	1.14	0.76	

***, **, and * signify statistical significance at the 1,5, and 10 % level, respectively

4.4 Crop variety

Number of crop variety sold

Table 4-6 shows that the number of crop variety sold of SAF farmers (Mean=5.45, SD=2.91) were significantly bigger than those of NON-SAF farmers (Mean=3.96, SD=2.07)(t(51.80)=2.1702, p=0.0.0036), and NON-SAF-Upper income farmers (Mean=4.67, SD=2.19) had more varieties of crops than NON-SAF-Lower income farmers (Mean=3.25, SD=1.76)(t(22.88)=1.7458, p=0.0943). No significant differences in the Pairs 2 and 3, and 5.

Table 4-6:Paired T-test of number of crop variety to sell

		Mean	SD	t	p	d.f
Pair 1	SAF (N=29)	5.45	2.91	2.1702	0.0346**	51.8048
	NON SAF(N=24)	3.96	2.07			
Pair 2	Income Upper (N=27)	5.33	2.97	1.599	0.1162	49.2979
	Income Lower (N=26)	4.19	2.17			
Pair 3	SAF -Upper income (N=15)	5.60	3.44	0.2896	0.7744	26.3323
	SAF -Lower income (N=14)	5.29	2.33			
Pair 4	NONSAF -Upper income (N=12)	4.67	2.19	1.7458	0.0943*	22.8828
	NONSAF -Lower income (N=12)	3.25	1.76			
Pair 5	SAF -Upper income (N=15)	5.60	3.44	0.8565	0.3997	25.593
	NONSAF -Upper income (N=12)	4.67	0.67			

***, **, and * signify statistical significance at the 1,5, and 10 % level, respectively

Top 5 varieties of crops

Although the total number of varieties of crops sold reached 53 types, 82% of all the sales amount was composed of 5 main crops: Banana(Musa sp.), Cassava powder(Manihot esculenta), Brazil nuts(Bertholletia excelsa), Cacao(Theobroma cacao) and Acai(Euterpe oleracea) (Figure 4-4). While Banana and Cassava powder were transacted by a similar percentage of both SAF and NON-SAF farmers, smaller percentages of NON-SAF farmers sold the other three crops (Table 4-7)[4]. Regarding the total sales amount of TOP 5 crops, huge

[4] Originally, brazil nuts, cacao, and acai are categorized as tree and it can be considered as agroforestry if farmers sell these products. There seem to be two cases that NON-SAF farmers transacted these crops in this study where definition of SAF was decided based on their self-recognition.: 1) Collecting wild crops 2) Conducting SAF without awareness.

gaps were observed in banana, brazil nuts, cacao, and acai while not in cassava powder, even considering a difference in the sample number（SAF=29, NON-SAF=24） (Figure 4-5).

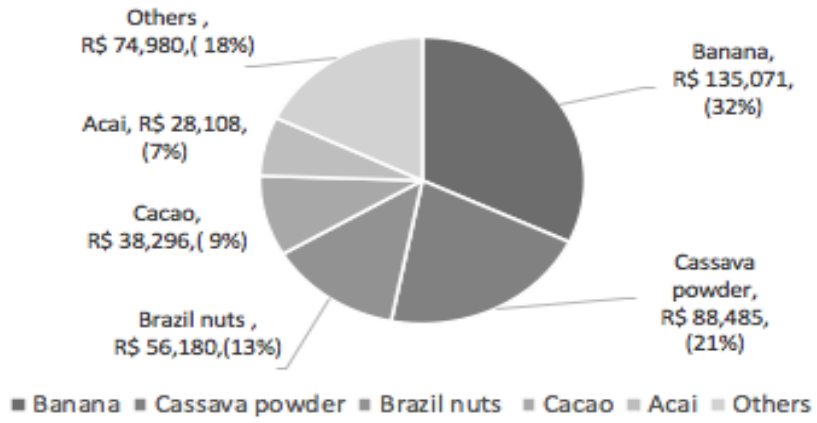


Figure 4-4:Percentages of the crops in total sales

Table 4-7:The number of producers who sold TOP 5 crops

	1.Banana	2.Cassava powder	3.Brazul Nuts	4.Cacao	5.Acai (Not processed)	5.Acai (Processed)
#	30 (56.5%)	30 (56.6%)	16 (30.19%)	19 (35.85%)	18 (33.96%)	10 (18.87%)
(N=29)	16 (55.17%)	16 (55.17%)	14 (48.27%)	13 (44.83%)	13 (44.83%)	9 (31.03%)
(N=24)	14 (48.27%)	14(48.27%)	9 (6.89%)	6 (20.68%)	5 (17.24%)	1 (3.44%)

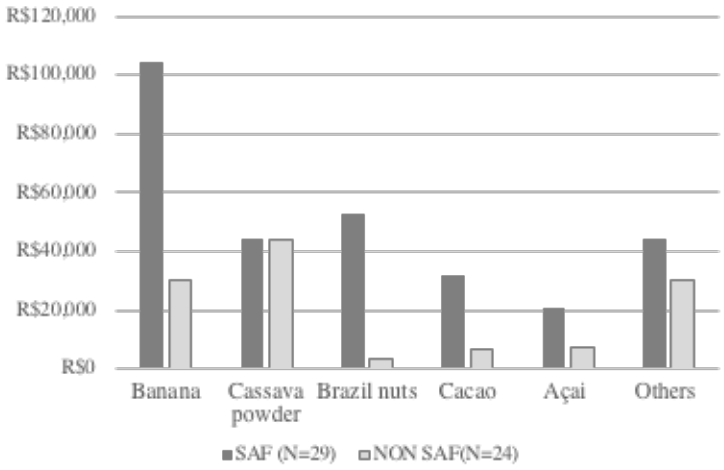


Figure 4-5:Total amount of TOP 5 crops sales

Ratios of TOP 5 crops to individual income

Table 4-8 shows the means and medians of the shares of sales from each TOP5 crop to the individual farmer's total income. Significant differences in the dependency of Brazil

nuts(SAF: Mean=13%, Median=0%, NON-SAF: Mean=2.55%, Median=0%) and acai (SAF :Mean=8.86%, Median=1.90%, NON-SAF: Mean=6.21%, Median=0.00%) were found between SAF and NON-SAF farmers (p=0.002 and 0.029 respectively). Among all comparisons concerning income, only one significant difference was observed, the percentage of acai between Upper income group (Mean=8%, Median=2%) and Lower income group (Mean=8%, Median =0%) (p=0.076).

Table 4-8:Paired Mann- Whitney U test of mean ratios of TOP 5 crops to individual income

Pair 1	SAF (N=29)		NON-SAF(N=24)		
	Mean	Median	Mean	Median	p
Banana	33.26%	30.30%	29.11%	11.11%	0.660
Cassava powder	20.82%	3.27%	26.10%	6.73%	0.641
Brazil nuts	12.88%	0.00%	2.55%	0.00%	0.002***
Cacao	8.47%	0.00%	8.39%	0.00%	0.308
Acai	8.86%	1.90%	6.21%	0.00%	0.029**

Pair 2	Income Upper (N=27)		Income Lower (N=26)		
	Mean	Median	Mean	Median	p
Banana	31.82%	25.21%	30.92%	15.04%	0.741
Cassava powder	28.07%	6.22%	18.16%	2.76%	0.436
Brazil nuts	6.53%	0.00%	9.94%	0.00%	0.554
Cacao	9.53%	0.00%	7.30%	0.00%	0.804
Acai	7.57%	1.90%	7.75%	0.00%	0.076*

Pair 3	SAF -Upper income （N=15)		SAF -Lower income （N=14)		
	Mean	Median	Mean	Median	p
Banana	33.96%	25.59%	32.51%	32.81%	0.726
Cassava powder	24.14%	0.00%	17.27%	4.01%	0.927
Brazil nuts	9.78%	0.00%	16.19%	5.00%	0.121
Cacao	13.47%	0.00%	3.12%	0.20%	0.981
Acai	5.37%	1.90%	12.60%	5.61%	0.522

Pair 4	NONSAF -Upper income （N=12)		SAF -Lower income （N=14)		
	Mean	Median	Mean	Median	p
Banana	25.18%	13.84%	33.04%	9.88%	0.977
Cassava powder	29.32%	25.52%	22.88%	3.12%	0.549
Brazil nuts	5.09%	0.00%	0.00%	0.00%	0.149
Cacao	6.34%	0.00%	10.45%	0.00%	0.404
Acai	6.25%	0.00%	6.17%	0.00%	0.684

Pair 5	SAF -Upper income （N=15)		NONSAF -Upper income （N=12)		
	Mean	Median	Mean	Median	p
Banana	33.96%	25.59%	25.18%	13.84%	0.510
Cassava powder	24.14%	0.00%	29.32%	25.52%	0.507
Brazil nuts	9.78%	0.00%	5.09%	0.00%	0.342
Cacao	13.47%	0.00%	6.34%	0.00%	0.204
Acai	5.37%	1.90%	6.25%	0.00%	0.180

***, **, and * signify statistical significance at the 1,5, and 10 % level, respectively

4.5 Income of TOP 5 crops by month

This section shows the mean monthly incomes of TOP 5 crops by SAF and NON-SAF farmers.

Banana

Banana is the main crop in this area, composing the biggest percentage (32%) of all crop sales. Though the numbers of SAF and NON-SAF who sold banana did not have a significant difference (SAF=16(55.71%), NON-SAF = 14(48.27%), a considerable gap in mean income was observed in Figure 4-6. Banana is usually harvested through a year, having the biggest production in the middle of the rainy season (February - April). However, the flood in late February -March in this year affected the harvest in floodplain[5] severely, since banana is quite weak in water. Given that more than 86% of banana transactions were made in the floodplain, the impact of that flood was considerably huge. A significant decrease in income in February - March, especially for SAF farmers, was confirmed. The comparison to the income of April, which was the result of last season, infers the significant loss of harvest in this season.

[5] There are basically two types of land exit in the Amazon basin, *Várzea* (Floodplain) and *Terra firme*" (Upland). *Várzea* can be categolized into 1) *Várzea baixa*(Low) where is inundated every year and *Várzea alta* (High) where is inundated every a few year. Banana, cacao, and acai grow well in *Várzea alta* and Brazil nuts grow in *Terra firme*. In this thesis, for the sake of simplicity, *Várzea alta* is referred to as "Floodplain" and *Terra firme* is *as* "Upland"

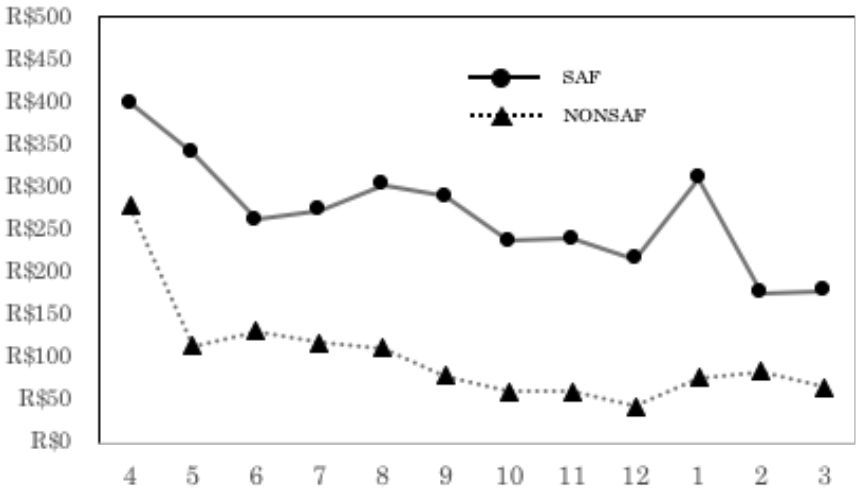


Figure 4-6:Mean income from banana by month

Cassava powder

Despite having the same number of farmers for banana sales (SAF=16(55.71%), NON-SAF = 14(48.27%), a big gap between SAF and NON-SAF farmers were not found in the mean income of cassava powder (Figure 4-7). Cassava powder was the only crop that did not have a big gap between SAF and NON-SAF farmers in income among TOP 5 crops.

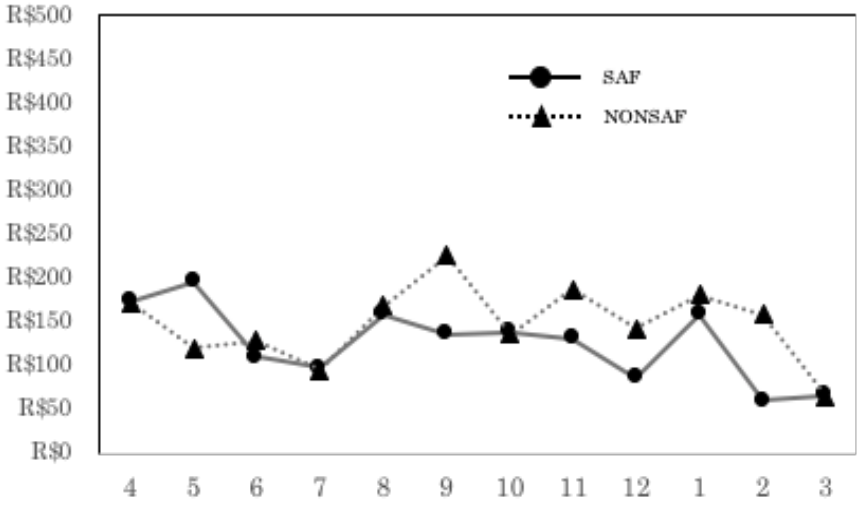


Figure 4-7:Mean Income from cassava powder by month

Brazil nuts (w/o outlier)

The percentage of SAF farmer who sold brazil nuts was about seven times of NON-SAF farmers. Figure 4-8 is the modified version of mean income from brazil nuts without the outlier mentioned above in the section 4.3. Unlike banana and cassava powder, the harvest season of brazil nuts is limited in the rainy season, as the figure illustrates. It is harvested in upland, which is free from the risk of the flood; therefore, the sales were not affected even in February and March. Furthermore, the average price of brazil nuts in this year was very high (48 BRL/bucket), compared to the price of 2020 season being 25 BRL/bucket. It can be inferred that SAF farmers enjoyed this price increase.

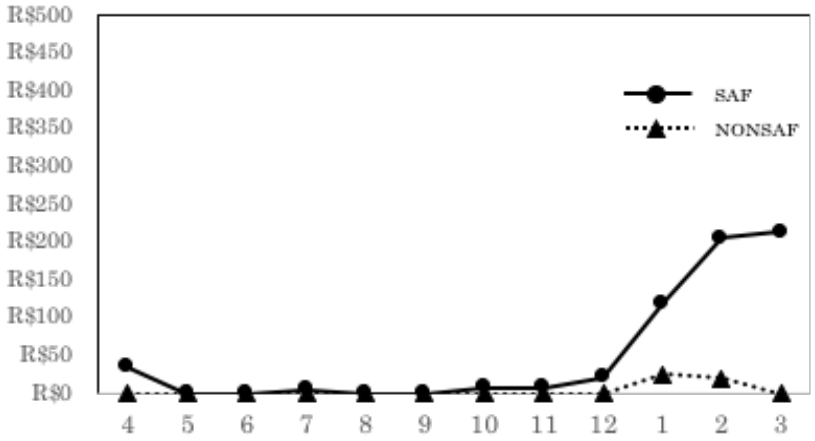


Figure 4-8:Mean Income from brazil nuts by month

Cacao

The percentage of SAF farmer who sold cacao was about two times of NON-SAF farmers. Two types of cacaos grow in this area, native cacao, and hybrid cacao. Native cacao grows in floodplain and is harvested in the rainy season, and hybrid cacao grows in upland being harvested in the dry season. The 91% of transactions observed in this study were native cacao (86 are natives, 9 are hybrid). Although native cacao is relatively resilient against water and could survive the water level of that flood, the mean income in the rainy season was very low for both SAF and NON-SAF farmers (Figure 4-9). It was caused by the record poor harvest that was possibly caused by unusual heavy rain in the dry season. Some farmers said the

harvest was even less than half of the usual harvest. Compared to the mean income of SAF in April, which was the result of last season, poor harvest in this season can be inferred. As for the price, the average price of cacao per kg in this year was 5.4BRL, while it jumped up to 8 BRL in 2020.

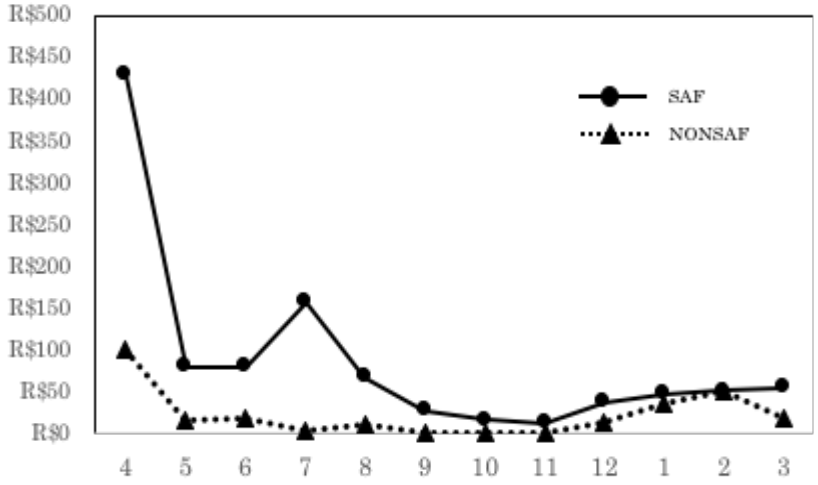


Figure 4-9:Mean Income from cacao by month

Acai

The percentage of SAF farmers who sold acai was about 2.6 times of NON-SAF farmers. Acai is also a rainy season harvested crop that grows in both upland and floodplain. In this study, about a quarter of transactions were made in the floodplain (N=26), and the rest was in upland (N=77). Furthermore, acai is more water-resilient compared to a banana, once it gets tall. As a result, they did not have much decrease in February - March even with the flood. (Figure 4-10)

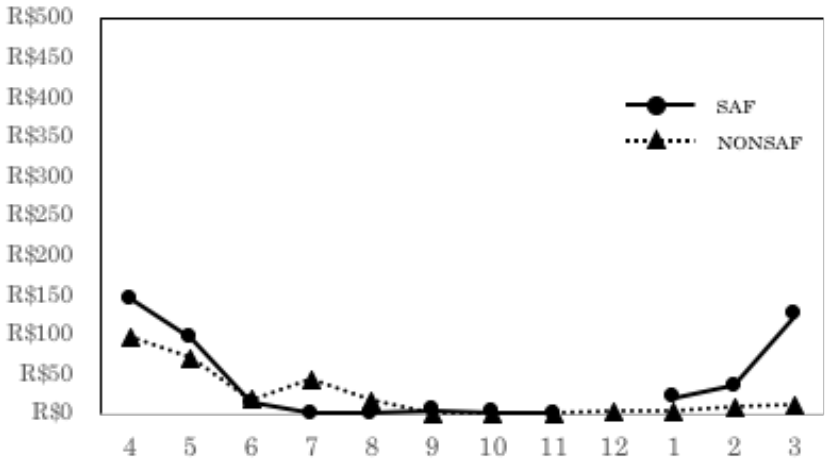


Figure 4-10:Mean Income from acai by month

4.6 Expense on food purchasing

SAF is expected to contribute to food security by providing food from its own farm. A significant difference in the annual expense on food purchasing between SAF(Mean=3,066.19BRL, SD=1,585.32) and NON-SAF(Mean=4,083.95BRL, SD=1742.85) was confirmed (t(48.89)=-2.1960, p=0.0329) while the mean number of family members of both groups are approximately same (Table 4-9). Interestingly, SAF-Lower income farmers spent significantly smaller expenses on food (Mean=2,025.16 BRL, SD=1,240.84) than SAF-Upper income farmers (Mean=4,037.82 BRL, SD=1,240.97) while NON-SAF-Lower farmers spent the almost same amount of NON-SAF-Upper income farmers. (4,007.92 BRL and 4,160.00 respectively). It suggests that SAF can be beneficial, especially for lower-income farmers, to reduce the cost of food purchases.

Table 4-9:Paired T-test of annual expense on food purchasing

		Mean	SD	Mean of # family member	t	p	d.f
Pair 1	SAF (N=29)	3,066.19	1,585.32	5.89	-2.1960	0.0329**	48.8919
	NON SAF(N=24)	4,083.95	1,752.85	5.54			
Pair 2	Income Upper (N=27)	3,565.46	1,462.29	5.88	0.1627	0.8715	47.4717
	Income Lower (N=26)	3,487.19	1,990.50	5.57			
Pair 3	SAF -Upper income (N=15)	4,037.82	1,227.97	6.80	4.2867	0.0001***	28.8164
	SAF -Lower income (N=14)	2,025.16	1,240.84	4.90			
Pair 4	NONSAF -Upper income (N=12)	4,160.00	1,418.72	5.16	0.2081	0.8372	20.8327
	NONSAF -Lower income (N=12)	4,007.92	2,097.35	5.91			

***, **, and * signify statistical significance at the 1,5, and 10 % level, respectively

4.7 Expense on agriculture (Material, Labor)

Materials

As table 4-10 shows, the majority of farmers did not purchase seeds, fertilizers, and pesticides. Interestingly, the percentage of SAF farmers who purchased fertilizers and pesticides smaller than NON-SAF (about one-thirds and a quarter, respectively). Besides, in

comparisons of the amount spent on all the agricultural products, no significances were found in any pairs (Table 4-11).

Table 4-10:Number of producers who purchased seeds, fertilizer, and pesticide

	Seeds	Fertilizer	Pescide	None of them
Total	11 (20.75%)	14(26.41%)	9 (16.98%)	35(66.04%)
SAF (N=29)	6 (20.69%)	9 (13.79%)	2 (6.89%)	23(79.31%)
NON-SAF(N=24)	5 (20.83%)	10 (41.66%)	7 (29.16%)	12(50%)

Table 4-11:Paired Mann-Whitney U test of mean amount for expense on agriculture materials

		Mean (BRL)	Median(BRL)	p
Pair 1	SAF (N=29)	1,171.92	845.00	0.4748
	NON SAF(N=24)	881.18	571.00	
Pair 2	Income Upper (N=27)	1,316.19	852.60	0.194
	Income Lower (N=26)	753.72	651.50	
Pair 3	SAF -Upper income (N=15)	1,563.81	965.50	0.2752
	SAF -Lower income (N=14)	752.04	777.25	
Pair 4	NONSAF -Upper income (N=12)	1,038.38	711.00	0.2727
	NONSAF -Lower income (N=12)	723.98	491.00	

***, **, and * signify statistical significance at the 1,5, and 10 % level, respectively

Labor

Table 4-12 shows the result of the Paired Mann-Whitney U test of the mean amount for annual payment on labor. In the study area, there is a traditional cooperation system, “mutirao.” If they work for five days to help someone in the group, the group members will work for them for five days for return. This system has fallen into desuetude in recent years, and monetary exchange for labor has become dominant, but four farmers utilized this system during the survey period. This unpaid labor was also calculated in monetary value using the mean value of the actual paid cost observed by this study and included in the figures in the table. First, paid-out cost for labor is not high for SAF farmers (Mean=740.69BRL, Median=200BRL) compared to NON-SAF farmers (Mean=746.48BRL,

Median=434.75BRL). Upper income farmers (Mean=1,180.50BRL, Median=467 BRL) , especially NON-SAF- Upper income farmers(Mean=1,214.636BRL, Median=668.5 BRL) had a significant difference on the expense on labor, compared to Lower income groups(p=0.0703 and p=0.0107 respectively) . There are no significant differences between SAF farmers and NON-SAF farmers or intra-SAF farmers by income groups. While higher income groups seem to spend more on hiring workers, we also need to examine whether these extra costs are leading to higher profits. Thus, I also compared the hiring costs between groups based on profits. As table 4-13 shows, the comparison using profit (here simply calculated by "Income - labor cost"), no significant differences were observed in any pairs.

Table 4-12:Paired Mann-Whitney U test of mean amount for labor

		Mean (BRL)	Median(BRL)	p
Pair 1	SAF (N=29)	740.69	200.00	0.1908
	NON SAF(N=24)	746.48	434.75	
Pair 2	Income Upper (N=27)	1,180.50	467.00	0.0793*
	Income Lower (N=26)	289.31	197.50	
Pair 3	SAF -Upper income (N=15)	1,155.67	200.00	0.3534
	SAF -Lower income (N=14)	296.07	152.50	
Pair 4	NONSAF -Upper income (N=12)	1,214.63	668.50	0.0107**
	NONSAF -Lower income (N=12)	278.33	137.50	
Pair 5	SAF -Upper income (N=15)	1,155.67	200.00	0.2576
	NONSAF -Upper income (N=12)	1,214.63	668.50	

***, **, and * signify statistical significance at the 1,5, and 10 % level, respectively

Table 4-13:Paired Mann-Whitney U test of mean amount for labor by profit groups

		Mean (BRL)	Median(BRL)	p
Pair 1	Profit Upper (N=27)	1,180.50	370.00	0.4582
	Profit Lower (N=26)	289.31	197.50	
Pair 2	SAF -Upper profit (N=15)	961.07	100.00	0.9639
	SAF -Lower profit (N=14)	535.00	200.00	
Pair 3	NONSAF -Upper profit (N=12)	973.79	551.00	0.0722
	NONSAF -Lower profit (N=12)	519.17	137.50	
Pair 4	SAF -Upper profit (N=15)	901.00	60.00	0.1316
	NONSAF -Upper profit (N=12)	973.79	551.00	

***, **, and * signify statistical significance at the 1,5, and 10 % level, respectively

5 Discussion

Based on the findings thus far, this chapter discusses whether SAF in Manicoré contributes to the household economy in regard to income increase and stabilization, mitigation of damages by weather-related events and price fluctuations, and food security. Besides, the factors that influence the adoption of SAF and the income are examined for better intervention in the future.

5.1 Discussion on research questions

1)Income increase and stabilization

The results confirmed that the average annual income from crop sales for SAF farmers was significantly higher than those of NON-SAF farmers by twofold (Table 4-3). Even in the comparison between SAF- Upper income group and NON-SAF -Upper income group, the SAF group had a significantly higher income. However, SD of SAF farmers was more than double of NON-SAF farmers, suggesting a considerable gap between successful SAF farmers and the others. It can be presumed that income does not rise by merely adopting SAF. In fact, the farmer called “model farmer” equipped with a well-designed SAF plot and abundant knowledge about planning techniques turned out to be a low-income farmer, selling only three crops in small quantities out of 67 varieties in his land.

In respect of the stability of income, the results indicated that SAF farmers had more stable income throughout the year than NON-SAF farmers (Figure 4-3 and Table 4-5). Again, the gap exists intra-SAF farmers in the stability as well, while NON-SAF farmers did not have significant differences by income group.

The results are basically consistent with the previous studies (Safa 2005, Phandanouvong 1998, B.D.Zira 2020, Sadeghi et al.2001) on higher income of SAF farmers than the comparison groups and with the statements of Yamada(2005) and Sadamori (2017)

on SAF‘s contribution on the stability of income: However, the significant gap withing SAF farmers, which most previous studies did not mention, deserves more attention.

2) Mitigation of damages by weather-related events/price fluctuations

In March, when a flood occurred in the study area, the mean income of NON-SAF farmers decreased while the mean income of SAF farmers increased (Figure4-2). The result of table 4-6 showed that SAF farmers sold more diversified crops than NON-SAF farmers, and the analysis of monthly income of top5 crops demonstrated the importance of diversification of crops (Figure4-6,4-8,4-9,4-10).

Banana, which is the main crop in this area, are mostly harvested in the floodplain and died quickly with water. Therefore, the harvest of banana in March was severely affected by the flood. Besides, cacao, which is also mostly harvested in floodplain, suffered from historically poor production probably due to unusual rain in the dry season. On the other hand, brazil nuts harvested in upland and free from water damage had a price rise this year and gave good profit to farmers. Besides, acai, which is water-resilient and available both in upland and floodplain, did not get damaged in March either. Consequently, brazil nuts and acai mitigated the damage from the poor harvest of banana and cacao.

Recently, the frequency and impact of weather-related events such as floods, drought, and even unexpected weather patterns have been increasing in the study area, which directly affects the income from crops. In line with such a volatile harvest, the fluctuation of prices occurs concomitantly. Given this situation, the significance of dispersion of risk is increasing. The proven contribution of SAF for mitigation of damage is noteworthy.

Although the period of this study’s analysis was limited to one-year, the result still could support the claim of Yamada (2005) and Sadamori (2017) that SAF can help the dispersion of risk against disaster and change in market price, with a combination of various crops/products

3) Food security

The contribution of SAF to households' food security by reducing the food expenditure was confirmed by the results (Table 4-9). It was an important finding that SAF could help especially lower income farmers. The difference of the mean food expenditure between SAF -Low-income group and NON-SAF -Low-income group was 1982.76 BLR, which makes a meaningful change in their household economy, considering the mean income of lower income group of 3272.614 BLR. This result is in accordance with the findings reported by Dawson et al. (2013) and the statement of Yamada (2005) and Sadamori (2017) on the contribution of SAF to household food security.

4) Other factors

(1) Expense on agriculture (Material, Labor)

First, it was found that most farmers did not purchase for agricultural inputs, such as seeds, fertilizers, and pesticides (Table 4-10). Especially for fertilizers and pesticides, the percentages of SAF farmers who purchased these materials were only 20-30% of NON-SAF farmers. This finding agrees with the standpoint of Yamada (2005) and Sadamori (2017)' on the reduced necessity of pesticide and fertilizer of SAF. Secondly, the results of the comparisons of paid cost on labor and domestic labor capacity indicated that the adoption of SAF does not necessarily require more labor than conventional practice (Table 4-1 and Table 4-12). Another finding is that although the correlation between income and labor investment was shown, there were no significant differences in the labor expense for comparisons of groups based on their profit (Table 4-13). It possibly suggests that labor increased the income but not enough to increase the profit proportionally. One of the possible reasons for this phenomenon is frequent price fluctuations of crops. In the interviews, many farmers explained that the lack of information on prices makes it difficult for them to predict the final profit when they invest on labor.

(2) Variety of crops

The results demonstrate that SAF farmers sold more varieties than NON-SAF farmers significantly (Table 4-6). However, no differences were observed between Upper- income group and Lower-income group. Considering the stabler income among months of SAF farmers than NON-SAF farmers (Figure4-3 and Table 4-5), it could suggest that increasing the variety of crops for sales is more important in respect of mitigation functions, rather than of direct increase in income. No robust patterns were found between the percentage of each TOP 5 crops composed and the income. The combination of crops of each farmer was much more diverse than expected. To find out some patterns of influencing income, a bigger sample would be required.

(3) Socio-economic characteristics

1.Factors influencing on the adoption of SAF

It was revealed that SAF farmers tend to have significantly more acquaintances who conduct SAF than NON-SAF farmers. It can justify the dissemination project strategy trying to increase the number of "model farmers "in various communities to encourage new farmers to start SAF. Age, years of education, family size, tenure, and assets, which are often considered to be influencing factors for decision-making for adopting agroforestry ((Pattanayak et al.2002, Blinn et al.2013) were not significantly different in any comparisons. The size of the possessed land of SAF farmers was larger than those of NON-SAF farmers. It could suggest a possibility of extra resources for making it easier to challenge a new farming method; however, the percentages of the utilization of possessed land were low in both groups (33.08% and 32% respectively). It means that the possessed land size is not necessarily a constraint for both groups of farmers for the adoption of SAF. Although many previous studies listed the size of land as an influential factor for the adoption of agroforestry (Pattanayak et al.2002), this result demonstrates the importance of examining the utilization

rate as well. Besides, a significant difference was found in whether they have any information source on prices of crops, which could suggest that SAF farmers tend to keep themselves open to agricultural information.

2.Factors influencing on income

The sizes of planted land were significantly different in all pairs except in the Pair 3, intra-SAF farmers. Surprisingly, it was found out that the size of SAF cultivation of the SAF-Upper income group was significantly smaller than the SAF-Lower income group. It can be presumed that the size of planted land affects the income significantly, but it is insufficient to increase the income further by applying SAF. The results show that SAF- Upper income group had more family members available for agriculture and more agriculture machines such as motor grass cutter, spray for pesticide, and chainsaw than SAF-Lower income group. Besides, they try to negotiate with middlemen on the price of crops than the other group.

As for negotiation, the unit prices of crops transacted in this area were found to have more variability than expected. The original expectation that the unit price is correlated with distance from the city or the volume of transactions did not apply in this area. Even with our relatively small sample of farmers, I have received the names of as many as 131 middlemen, some seem big-scaled businessmen, and others seem very small-scaled. It was observed that sometimes even the same middleman offered the different unit prices in the same community in the same period. Besides, the number of middlemen that the farmers know did not have any significant influence on the unit prices or income, suggesting that it is not necessarily essential to have more marketing channels to receive higher prices. The farmers who do not negotiate explained that they do not negotiate because they do not have information on prices or do not want to damage the relationship with middlemen. Our interviews with some farmers and a few middlemen suggest that trust and relationships are essential for a business in this area. Although how the unit price is decided by interactions of farmers and middlemen was

out of scope in this study, it will possibly provide essential keys for understanding unique economic activity in this area.

Furthermore, the number of agriculture loans used in the past and the possession of information sources on prices significantly differed between Upper income group and Lower income group. It possibly suggests that farmers with upper income are more conscious about "business" involved in agriculture. Actually, it was found that some farmers with higher incomes developed creativity for increasing the profit. For instance, a farmer utilized a free space at the city's market that municipal make it open for small farmers to sell directly to consumers. He can make a higher profit, even considering the cost of transportation. Others tried to make more non-perishable products and keep them till the price rises. These ideas are not much complicated to carry out; however, very few farmers go into action. The difference in consciousness about "business" in agriculture would generate the gaps in income between the farmers.

These findings imply that for the purpose of income increase by applying SAF, increasing productivity for cultivation, and improving sales skills for increasing profit could be effective, in addition to increasing the planted size.

Previous studies listed education(Safa 2005, Phandanouvong et al.1998, B.D.Zira 2020), land size (Sadeghi et al.2001, Safa 2005, Safa 2004, B.D.Zira 2020)and family size(Safa 200, Phandanouvong et al.1998, B.D.Zira 2020) as common influencing factors on income. In this study, education was not influential in all the comparisons, and land size and family size were partially influential. To sum up, while the expected impacts SAF that previous studies suggested were applied well to the result of this study, the applicability of influencing factors on the adaptation or on income was limited. These results prove the effectiveness of

SAF and also demonstrate the necessity of careful consideration of area-specific social-economic factors for application, since various socio-cultural circumstances highly determine the economic activity of smallholder farmers. The accumulation of comprehensive, detailed data at field level would be required for identifying the generalized patterns on influencing factors.

5.2 Limitation

There are there limitations that this study was not able to cover at present. First, this study was able to analyze only association, not causality. Initially, I was planning to conduct a regression analysis for fining causality but had to give up due to the reduced sample size, as explained in section 3.3. Secondly, all the analyses in this study were made based on the definition of SAF and NON-SAF using self-recognition. However, there could be some cases that self-recognition and actual practice were different; for instance, some NON-SAF farmers conduct SAF without awareness. If the different definitions were used, a different result would be provided, and a comparison of results by applying different definitions would deepen the analysis. Third, although one of the unique characteristics of SAF is a time-series profit generated, a one-year survey cannot capture it. It could be worth trying to collect panel data after several years to analyze time-series changes, using the results of this study as baseline data. Further studies will be encouraged to cover these aspects.

6 Conclusion

This study aimed at examining the impact of SAF on the household economy and the influencing factors on the adoption of SAF and on the income in Macnicorè. The results showed that the SAF-farmers had significantly higher annual income, more stable monthly income, mitigated damage by weather-related events and price fluctuations, and less expense on food purchase than the NONSAF farmers. However, the disparity in income between the SAF farmers was substantial, suggesting that income does not rise by merely adopting SAF. The comparison of the two groups of the SAF demonstrated that the upper income had a smaller size of SAF cultivation than the lower income, but higher domestic labor capacity and more agricultural machines, although the adoption of SAF was found not to require these resources. Moreover, the upper income group was negotiating more with middlemen on the price of crops than the lower income group. It was also found that Upper income group utilized significantly more agriculture loans in the past than Lower income group.

This study makes a unique contribution to the studies of the economic activity of small farmers in the Amazon by revealing the detailed quantitative economic data that did not exist and showing the differences of SAF farmers 'performance empirically. Further, the monthly income data collected by one-year diary survey showed the importance of understanding the cash flow through a year that a conventional single round interview cannot capture, especially in the area with drastic seasonal change such as intense rainy and dry seasons, although it requires multi-year research for further understanding of SAF's contribution.

SAF is considered to be a more environmentally sound agricultural method than conventional swidden cultivation, especially regarding the preservation of biodiversity and soil organic carbon and establishing a sound forest ecosystem. The contribution to stabilization of income and food security play essential roles for the livelihood of small

farmers, and the importance of mitigation function is increasing. SAF surely can be beneficial to both farmers and nature. However, to achieve an effective income increase for encouraging smallholders not to migrate to cities or not to turn into illegal mining for economic necessity, additional interventions would be necessary, together with the promotion of SAF. This study suggests the possible necessities of increasing productivity for cultivation and improving skills for sales, such as better access to information and negotiation skills with middlemen.

So far, the support of the government or NGOs for SAF project has focused on cultivation techniques. Thanks to their efforts, the new practice of preparing seedlings for planting has prevailed in the study area where gathering culture used to be dominant, which was a significant step. In this area, none of the agricultural cooperatives function for the distribution of crops, although farmers have a major disadvantage of market access. Given this situation, farmers are required to be a good businessman for securing the profit, in addition to being a good farmer with a high capacity of cultivation; However, the culture of agriculture as a business is still not developed in this area. As a next step, interventions on the business aspect of small farmers' agricultural activities, along with support for improving cultivation techniques, would make further progress toward achieving sustainable development in the Amazon area.

Cited reference

Angelo, M. J., & Du Plessis, A. (2017). IPCC_Climate change and land. Research Handbook on Climate Change and Agricultural Law, 1–472. https://doi.org/10.4337/9781784710644-IPCC

Angelsen, A., Brockhaus, M., Sunderlin, W.D.,and Verchot, L.V. 2012 Analysing REDD+: Challenges and choices. CIFOR, Bogor

Blinn, C. E., Browder, J. O., Pedlowski, M. A., & Wynne, R. H. (2013). Rebuilding the Brazilian rainforest: Agroforestry strategies for secondary forest succession. Applied Geography, 43, 171–181. https://doi.org/10.1016/j.apgeog.2013.06.013

Cabral, A. I. R., Saito, C., Pereira, H., & Laques, A. E. (2018). Deforestation pattern dynamics in protected areas of the Brazilian Legal Amazon using remote sensing data. Applied Geography, 100(October), 101–115. https://doi.org/10.1016/j.apgeog.2018.10.003

Cerda, R., Deheuvels, O., Calvache, D., Niehaus, L., Saenz, Y., Kent, J., Vilchez, S., Villota, A., Martinez, C., & Somarriba, E. (2014). Contribution of cocoa agroforestry systems to family income and domestic consumption: looking toward intensification. Agroforestry Systems, 88(6), 957–981. https://doi.org/10.1007/s10457-014-9691-8

Dawson, I. K., Place, F., Torquebiau, E., Malézieux, E., Iiyama, M., Sileshi, G. W., Kehlenbeck, K., Masters, E., Mcmullin, S., & Jamnadass, R. (2013). THE WORLD BANK Forests for Food Security and Nutrition Agroforestry, food and nutritional security Agroforestry, food and nutritional security. International Conference on Forests for Food Security and Nutrition, FAO, Rome, 13–15 May, 2013, 21. https://doi.org/10.5716/WP13054.PDF

FAO (2010). Global Forest Resources Assessment 2010, Food and Agriculture Organization of the United Nations, Rome

FAO (2015). Global Forest Resources Assessment 2010, Food and Agriculture Organization of the United Nations, Rome

FUNDAÇÃO AMAZONAS SUSTENTÁVEL (Amazonas Sustainable Foundation) .2010 Available at:<http://kkji.kp3k.kkp.go.id/index.php/dokumen/finish/18-presentasi/2-apresentacau-brasil> [Accessed 20 November 2015]

Gietzen,R.(2016) . Abundance Agroforestry - A Syntropic Farming Guidebook ,https://www.echocommunity.org/resources/ae1d762e-d561-4a7e-80b3-de9ddeaa6259 (Accessd 16 July 2020)

Hughes, K., Morgan, S., Baylis, K., Oduol, J., Smith-Dumont, E., Vågen, T. G., & Kegode, H. (2020). Assessing the downstream socioeconomic impacts of agroforestry in Kenya. World Development, 128, 104835. https://doi.org/10.1016/j.worlddev.2019.104835

IBGE Database https://www.ibge.gov.br/ (Accessed 15 July 2020)

IBGE Território -dados geográficos https://brasilemsintese.ibge.gov.br/territorio/dados-geograficos.html, (Accessed 15 July 2020)

INPE "TerraBrasillis" http://terrabrasilis.dpi.inpe.br/app/dashboard/deforestation/biomes/legal_amazon/rates,(Accessed 15 July 2020)

IPCC (2014): Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change

Jastrow, J. D., Amonette, J. E., & Bailey, V. L. (2007). Mechanisms controlling soil carbon turnover and their potential application for enhancing carbon sequestration. Climatic Change, 80(1–2), 5–23. https://doi.org/10.1007/s10584-006-9178-3

Martinelli, G. do C., Schlindwein, M. M., Padovan, M. P., & Gimenes, R. M. T. (2019). Decreasing uncertainties and reversing paradigms on the economic performance of agroforestry systems in Brazil. Land Use Policy, 80(September 2018), 274–286. https://doi.org/10.1016/j.landusepol.2018.09.019

Mongabay, Hanbury,S. (2020) Satellite data show Amazon rainforest likely drier, more fire-prone this year, https://news.mongabay.com/2020/04/satellite-data-show-amazon-rainforest-likely-drier-more-fire-prone-this-year/ (Accessed 15 July 2020)

Nair, P. K. R. 1993.An Introduction to Agroforestry. Kluwer Academic Publishers, Dordrecht, the Netherland

Neupane, R. P., & Thapa, G. B. (2001). Impact of agroforestry intervention on farm income under the subsistence farming system of the middle hills, Nepal. Agroforestry Systems, 53(1), 31–37. https://doi.org/10.1023/A:1012296803189

Nishizawa, T., Koike, Y., Hongo, Y. and Yamada, M. 2005. Amazon:Hozen to kaihatsu(in Japanese)[Amazon: conservation and development] Asakurashoten

NPO HANDS. Amazon seibu ni okeru agroforestry hukyu katsudou houkokusyo ［Report on the agroforestry promotion project in the West Amazon］. NPO HANDS,2010

Oliveira, R. C., Dórea, J. G., Bernardi, J. V. E., Bastos, W. R., Almeida, R., & Manzatto, N. G. (2010). Fish consumption by traditional subsistence villagers of the Rio Madeira (Amazon): Impact on hair mercury. Annals of Human Biology, 37(5), 629–642. https://doi.org/10.3109/03014460903525177

Otsuki, T., Ogo,T.2010. Determinants of adoption of agroforestry in Kenya. OSIPP Discussion Paper: DP-2010-J-002.

Padoch, C., Inuma, J. C., De Jong, W., & Unruh, J. (1985). Amazonian agroforestry: a market-oriented system in Peru. Agroforestry Systems, 3(1), 47–58. https://doi.org/10.1007/BF00045738

Pattanayak, S.,Mercer,D.,Sills,E.,& Yang,J.(2003) Taking stock of agroforestry adoption studies ,Research Triangle Institute, Working paper02_04 April 2002

Phandanouvong, K. (1998), Socio-economic Aspects of Traditional Agroforestry Practice in Two Villages in Vientiane Province, LAO People's Democratic Republic, unpublished MSc. Thesis, Universiti Putra Malaysia

Pontes, R. V. R., Noronha, M. C. de, & Pontes, K. R. de M. (2016.). Desflorestamento no sul do Amazonas : embate entre o desenvolvimento econômico e a conservação ambiental. 61–87.

Rede Amazonia,Henrique,M. Falta ade chuvas diminui nível médio do Rio Madeira em Porto Velho, RO, http://g1.globo.com/ro/rondonia/noticia/2016/07/falta-de-chuvas-diminui-nivel-medio-do-rio-madeira-em-porto-velho-ro.html (Accessed 16 July 2020)

Sadamori,.T. Agroforestry - Hito to moriga kyousei suru nougyou [Agroforestry - The agriculture that human and forest live together, IN: Koike,Y.,Tamura,R.(eds) , Teiko to sozo no mori amazon jizokutekina kaihatsu to minshu no undou(in Japanese) [The Amazon, the forest of resistance and creation. The sustainable development and public movement].Gendaikikakushitsu Publishers,2017, pp.102-124

Sadamori,T.2011. Amazonseibu ni okeru Agroforestry no fukyukanousei to sono seiyakujyoken:Manicole-shi niokeru hukyukatsudou wo jirei toshite（in Japanese）[The possibility and restriction of agroforestry dissemination in the west Amazon: Case study of dissemination activity in Manicole] master's thesis, Nihon Fukushi University Graduate School of International Social Development

Sadeghi, J., M., Toodehroosta, M. and Amini A., (2001), Determinants of Poverty in Rural Areas: Case of Savejbolagh Farmers in Iran, Working Paper No. 0112, presented in Economic Research Forum, Cairo

Safa, M. S. (2005). Socio-economic factors affecting the income of small-scale agroforestry farms in hill country areas in Yemen: A comparison of OLS and WLS determinants. Small-Scale Forest Economics, Management and Policy, 4(1), 117–134. https://doi.org/10.1007/s11842-005-0008-7

Scherr, S. (1994). “Not out of the woods yet: challenges for economics research on agroforestry.” American Journal of Agricultural Economics 74(3):802-808

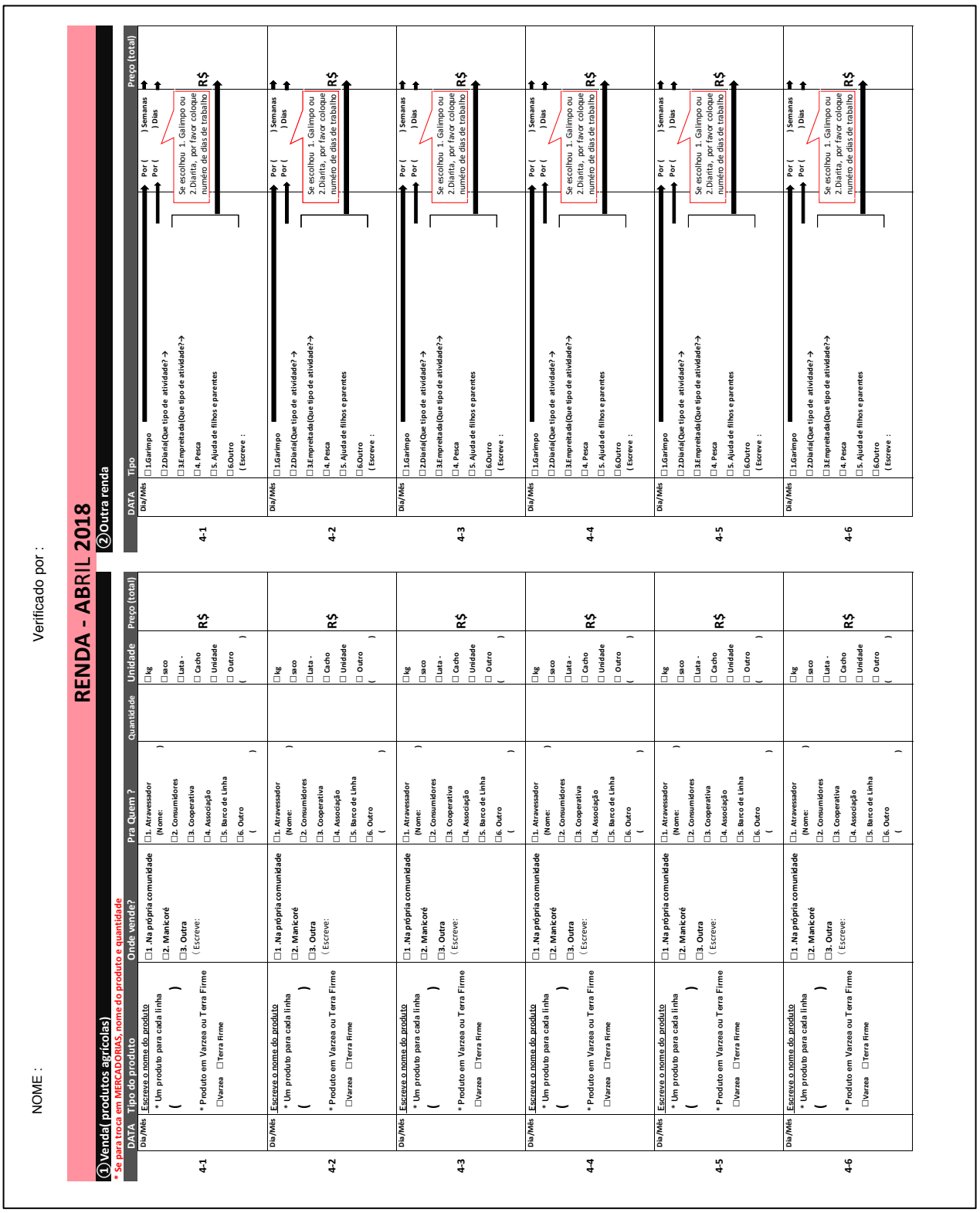
Viana, V., Cenamo, M., Ribenboim, G., Tezza, J., Pavan, M., 2008. Juma Sustainable Development Reserve:The First REDD Project In the Brazilian Amazon. Fundação Amazonas Sustentável. Manaus

Yamada, M., Gholz, H.2002, An evaluation of agroforestry systems as a rural development option for the Brazilian Amazon, Agroforestry Systems , Volume 55 (2),pp81-87.

Young, K. J. (2017). Mimicking Nature: A Review of Successional Agroforestry Systems as an Analogue to Natural Regeneration of Secondary Forest Stands. https://doi.org/10.1007/978-3-319-69371-2_8

Zira, B. D., & Gupa, M. A. (2020). Determinants of Agroforestry Practitioners Income in Semi-Arid Region of Nigeria. Asian Journal of Agricultural Extension, Economics & Sociology, 13(March), 67–72. https://doi.org/10.9734/ajaees/2020/v38i230311

Appendix A :One-year diary survey questionnaire (April)



NOME :

Verificado por :

RENDA - ABRIL 2018

①Venda(produtos agrícolas)

* Se para troca em MERCADORIAS, nome do produto e quantidade

DATA	Tipo do produto	Onde vende?	Pra Quem ?	Quantidade	Unidade	Preço (total)
4-1	Dia/Mês Escreve o nome do produto * Um produto para cada linha ( ) * Produto em Varzea ou Terra Firme □Varzea □Terra firme	□1. Na própria comunidade □2. Manicoré □3. Outra (Escreve:)	□1. Atravessador (Nome:) □2. Consumidores □3. Cooperativa □4. Associação □5. Barco de Linha □6. Outro ( )		□ kg □ saco □ Lata - □ Cacho □ Unidade □ Outro ( )	R$
4-2	Dia/Mês Escreve o nome do produto * Um produto para cada linha ( ) * Produto em Varzea ou Terra Firme □Varzea □Terra firme	□1. Na própria comunidade □2. Manicoré □3. Outra (Escreve:)	□1. Atravessador (Nome:) □2. Consumidores □3. Cooperativa □4. Associação □5. Barco de Linha □6. Outro ( )		□ kg □ saco □ Lata - □ Cacho □ Unidade □ Outro ( )	R$
4-3	Dia/Mês Escreve o nome do produto * Um produto para cada linha ( ) * Produto em Varzea ou Terra Firme □Varzea □Terra firme	□1. Na própria comunidade □2. Manicoré □3. Outra (Escreve:)	□1. Atravessador (Nome:) □2. Consumidores □3. Cooperativa □4. Associação □5. Barco de Linha □6. Outro ( )		□ kg □ saco □ Lata - □ Cacho □ Unidade □ Outro ( )	R$
4-4	Dia/Mês Escreve o nome do produto * Um produto para cada linha ( ) * Produto em Varzea ou Terra Firme □Varzea □Terra firme	□1. Na própria comunidade □2. Manicoré □3. Outra (Escreve:)	□1. Atravessador (Nome:) □2. Consumidores □3. Cooperativa □4. Associação □5. Barco de Linha □6. Outro ( )		□ kg □ saco □ Lata - □ Cacho □ Unidade □ Outro ( )	R$
4-5	Dia/Mês Escreve o nome do produto * Um produto para cada linha ( ) * Produto em Varzea ou Terra Firme □Varzea □Terra firme	□1. Na própria comunidade □2. Manicoré □3. Outra (Escreve:)	□1. Atravessador (Nome:) □2. Consumidores □3. Cooperativa □4. Associação □5. Barco de Linha □6. Outro ( )		□ kg □ saco □ Lata - □ Cacho □ Unidade □ Outro ( )	R$
4-6	Dia/Mês Escreve o nome do produto * Um produto para cada linha ( ) * Produto em Varzea ou Terra Firme □Varzea □Terra firme	□1. Na própria comunidade □2. Manicoré □3. Outra (Escreve:)	□1. Atravessador (Nome:) □2. Consumidores □3. Cooperativa □4. Associação □5. Barco de Linha □6. Outro ( )		□ kg □ saco □ Lata - □ Cacho □ Unidade □ Outro ( )	R$

②Outra renda

DATA	Tipo	Preço (total)
4-1	Dia/Mês □1.Garimpo □2.Diaria(Que tipo de atividade? → □3.Empreitada(Que tipo de atividade?→ □4. Pesca □5. Ajuda de filhos e parentes □6.Outro (Escreve :) Por ( ) Semanas Por ( ) Dias Se escolhou 1. Garimpo ou 2.Diarita, por favor coloque numéro de dias de trabalho	R$
4-2	Dia/Mês □1.Garimpo □2.Diaria(Que tipo de atividade? → □3.Empreitada(Que tipo de atividade?→ □4. Pesca □5. Ajuda de filhos e parentes □6.Outro (Escreve :) Por ( ) Semanas Por ( ) Dias Se escolhou 1. Garimpo ou 2.Diarita, por favor coloque numéro de dias de trabalho	R$
4-3	Dia/Mês □1.Garimpo □2.Diaria(Que tipo de atividade? → □3.Empreitada(Que tipo de atividade?→ □4. Pesca □5. Ajuda de filhos e parentes □6.Outro (Escreve :) Por ( ) Semanas Por ( ) Dias Se escolhou 1. Garimpo ou 2.Diarita, por favor coloque numéro de dias de trabalho	R$
4-4	Dia/Mês □1.Garimpo □2.Diaria(Que tipo de atividade? → □3.Empreitada(Que tipo de atividade?→ □4. Pesca □5. Ajuda de filhos e parentes □6.Outro (Escreve :) Por ( ) Semanas Por ( ) Dias Se escolhou 1. Garimpo ou 2.Diarita, por favor coloque numéro de dias de trabalho	R$
4-5	Dia/Mês □1.Garimpo □2.Diaria(Que tipo de atividade? → □3.Empreitada(Que tipo de atividade?→ □4. Pesca □5. Ajuda de filhos e parentes □6.Outro (Escreve :) Por ( ) Semanas Por ( ) Dias Se escolhou 1. Garimpo ou 2.Diarita, por favor coloque numéro de dias de trabalho	R$
4-6	Dia/Mês □1.Garimpo □2.Diaria(Que tipo de atividade? → □3.Empreitada(Que tipo de atividade?→ □4. Pesca □5. Ajuda de filhos e parentes □6.Outro (Escreve :) Por ( ) Semanas Por ( ) Dias Se escolhou 1. Garimpo ou 2.Diarita, por favor coloque numéro de dias de trabalho	R$

NOME:

Verificado por:

DESPESA(1)-ABRIL 2018

③DESPESA(Produtos Agrícolas)

	DATA	Tipo do produto	Onde compra	Quantidade	Unidade	Preço (total)
4-1	Dia/Mês	☐1.Sementes (Tipo → ☐2.Adubo ☐3.Agrotóxicos ☐4.Mudas (Tipo → ☐5. Gasolina (para uso de roçadeira/ moto poda/motosserra) ☐6.Outro ( )	☐Loja (Propria comunidade) ☐Loja (Manicoré) ☐Atravessador ☐Outro (		☐Gramas(g) ☐Saco ☐Litro ☐Unidade ☐Outro ( )	R$
4-2	Dia/Mês	☐1.Sementes (Tipo → ☐2.Adubo ☐3.Agrotóxicos ☐4.Mudas (Tipo → ☐5. Gasolina (para uso de roçadeira/ moto poda/motosserra) ☐6.Outro ( )	☐Loja (Propria comunidade) ☐Loja (Manicoré) ☐Atravessador ☐Outro (		☐Gramas(g) ☐Saco ☐Litro ☐Unidade ☐Outro ( )	R$
4-3	Dia/Mês	☐1.Sementes (Tipo → ☐2.Adubo ☐3.Agrotóxicos ☐4.Mudas (Tipo → ☐5. Gasolina (para uso de roçadeira/ moto poda/motosserra) ☐6.Outro ( )	☐Loja (Propria comunidade) ☐Loja (Manicoré) ☐Atravessador ☐Outro (		☐Gramas(g) ☐Saco ☐Litro ☐Unidade ☐Outro ( )	R$
4-4	Dia/Mês	☐1.Sementes (Tipo → ☐2.Adubo ☐3.Agrotóxicos ☐4.Mudas (Tipo → ☐5. Gasolina (para uso de roçadeira/ moto poda/motosserra) ☐6.Outro ( )	☐Loja (Propria comunidade) ☐Loja (Manicoré) ☐Atravessador ☐Outro (		☐Gramas(g) ☐Saco ☐Litro ☐Unidade ☐Outro ( )	R$
4-5	Dia/Mês	☐1.Sementes (Tipo → ☐2.Adubo ☐3.Agrotóxicos ☐4.Mudas (Tipo → ☐5. Gasolina (para uso de roçadeira/ moto poda/motosserra) ☐6.Outro ( )	☐Loja (Propria comunidade) ☐Loja (Manicoré) ☐Atravessador ☐Outro (		☐Gramas(g) ☐Saco ☐Litro ☐Unidade ☐Outro ( )	R$
4-6	Dia/Mês	☐1.Sementes (Tipo → ☐2.Adubo ☐3.Agrotóxicos ☐4.Mudas (Tipo → ☐5. Gasolina (para uso de roçadeira/ moto poda/motosserra) ☐6.Outro ( )	☐Loja (Propria comunidade) ☐Loja (Manicoré) ☐Atravessador ☐Outro (		☐Gramas(g) ☐Saco ☐Litro ☐Unidade ☐Outro ( )	R$

④Compra (Mão de obra)

	DATA	Tipo	Objetivo	Quantas pessoas	Quantos dias	Preço / dia	Preço (total)
4-1	Dia/Mês	☐1.Trabalho diário ☐2. Mutirão	☐Limpeza ☐Plantio ☐Colheita ☐Poda ☐Outro(Principalmente para qual produto? Escreve nome de producto ( )	Pessoas	Dias	R$ / Dia	R$
4-2	Dia/Mês	☐1.Trabalho diário ☐2. Mutirão	☐Limpeza ☐Plantio ☐Colheita ☐Poda ☐Outro(Principalmente para qual produto? Escreve nome de producto ( )	Pessoas	Dias	R$ / Dia	R$
4-3	Dia/Mês	☐1.Trabalho diário ☐2. Mutirão	☐Limpeza ☐Plantio ☐Colheita ☐Poda ☐Outro(Principalmente para qual produto? Escreve nome de producto ( )	Pessoas	Dias	R$ / Dia	R$
4-4	Dia/Mês	☐1.Trabalho diário ☐2. Mutirão	☐Limpeza ☐Plantio ☐Colheita ☐Poda ☐Outro(Principalmente para qual produto? Escreve nome de producto ( )	Pessoas	Dias	R$ / Dia	R$
4-5	Dia/Mês	☐1.Trabalho diário ☐2. Mutirão	☐Limpeza ☐Plantio ☐Colheita ☐Poda ☐Outro(Principalmente para qual produto? Escreve nome de producto ( )	Pessoas	Dias	R$ / Dia	R$
4-6	Dia/Mês	☐1.Trabalho diário ☐2. Mutirão	☐Limpeza ☐Plantio ☐Colheita ☐Poda ☐Outro(Principalmente para qual produto? Escreve nome de producto ( )	Pessoas	Dias	R$ / Dia	R$

⑤Compra (Empreita)

	DATA	Tipo	Objetivo	Quantos HÁ	Preço /HÁ
4-1	Dia/Mês	☐Empreita	☐Limpeza ☐Plantio ☐Colheita ☐Poda ☐Outro( ) Principalmente para qual produto? Escreve nome de producto ( )	HÁ	R$ / HA
4-2	Dia/Mês	☐Empreita	☐Limpeza ☐Plantio ☐Colheita ☐Poda ☐Outro( ) Principalmente para qual produto? Escreve nome de producto ( )	HÁ	R$ / HA
4-3	Dia/Mês	☐Empreita	☐Limpeza ☐Plantio ☐Colheita ☐Poda ☐Outro( ) Principalmente para qual produto? Escreve nome de producto ( )	HÁ	R$ / HA
4-4	Dia/Mês	☐Empreita	☐Limpeza ☐Plantio ☐Colheita ☐Poda ☐Outro( ) Principalmente para qual produto? Escreve nome de producto ( )	HÁ	R$ / HA
4-5	Dia/Mês	☐Empreita	☐Limpeza ☐Plantio ☐Colheita ☐Poda ☐Outro( ) Principalmente para qual produto? Escreve nome de producto ( )	HÁ	R$ / HA
4-6	Dia/Mês	☐Empreita	☐Limpeza ☐Plantio ☐Colheita ☐Poda ☐Outro( ) Principalmente para qual produto? Escreve nome de producto ( )	HÁ	R$ / HA

NOME :

Verified por

DESPESA(2) -ABRIL 2018

⑥Compra de alimentos

	DATA	Tipo	Onde compra	Quanto custa
4-1	Dia/Mês	□ Arroz □ Fejão □Farinha □Macaxeira □Macarrão □Carne □Frango □Peixes □Legumes □Verdura □ Frutas □Enlatados □Café /Açucar/Bolacha/Leite □Outro( )	□ Comércio (própria communidade) □Comércio (Manicoré) □Atravessador □ Outro ( )	R$
4-2	Dia/Mês	□ Arroz □ Fejão □Farinha □Macaxeira □Macarrão □Carne □Frango □Peixes □Legumes □Verdura □ Frutas □Enlatados □Café /Açucar/Bolacha/Leite □Outro( )	□ Comércio (própria communidade) □Comércio (Manicoré) □Atravessador □ Outro ( )	R$
4-3	Dia/Mês	□ Arroz □ Fejão □Farinha □Macaxeira □Macarrão □Carne □Frango □Peixes □Legumes □Verdura □ Frutas □Enlatados □Café /Açucar/Bolacha/Leite □Outro( )	□ Comércio (própria communidade) □Comércio (Manicoré) □Atravessador □ Outro ( )	R$
4-4	Dia/Mês	□ Arroz □ Fejão □Farinha □Macaxeira □Macarrão □Carne □Frango □Peixes □Legumes □Verdura □ Frutas □Enlatados □Café /Açucar/Bolacha/Leite □Outro( )	□ Comércio (própria communidade) □Comércio (Manicoré) □Atravessador □ Outro ( )	R$
4-5	Dia/Mês	□ Arroz □ Fejão □Farinha □Macaxeira □Macarrão □Carne □Frango □Peixes □Legumes □Verdura □ Frutas □Enlatados □Café /Açucar/Bolacha/Leite □Outro( )	□ Comércio (própria communidade) □Comércio (Manicoré) □Atravessador □ Outro ( )	R$
4-6	Dia/Mês	□ Arroz □ Fejão □Farinha □Macaxeira □Macarrão □Carne □Frango □Peixes □Legumes □Verdura □ Frutas □Enlatados □Café /Açucar/Bolacha/Leite □Outro( )	□ Comércio (própria communidade) □Comércio (Manicoré) □Atravessador □ Outro ( )	R$

Consumo próprio-ABRIL 2018

⑦Consumo proprio - pra uma semana

- Coloque a quantidade que você consome
- Somente o que é produzido no seu plantio
- Não incluir produtos que compra

- Marque a semana em que preencheu

□ **1º Semana** □ **2º Semana** □ **3º Semana** □ **4º Semana**

Tipo	Quantidade	Unidade
□ Farinha		Litro
□ Macaxeira		kg
□ Beiju		kg
□ Tapioca		Litro
□ Banana		Cacho
□ Mamão		Unidade
□ Pupunha		Unidade
□ Tucumã		Unidade
□ Açaí		Litro
□ Bacaba		Litro
□ Cacau		Unidade
□ Caju		Unidade
□ Castanha		Litro
□ Cupuaçú		Unidade
□ Goiaba		Unidade
□ Laranja		Unidade
□ Limão		Unidade
□ Manga		Unidade
□ Maracujá		Unidade
□ Melancia		Unidade
□ Palmito		kg
□ Abacate		Unidade
□ Abóbora		Unidade
□ Abobrinha		Unidade
□ Cebola		Unidade
□ Maxixe		Unidade
□ Tomate		Unidade
□ Peixe		kg
□ Frango caipira		Unidade
□ Pato		Unidade
□ Ovo		Unidade
□ Feijão		kg
□ Café		kg
□		

PLANTIO-ABRIL 2018

⑧Plantio

	DATA	TIPO	Lugar (Ecossistema)	Quantos Pés?	Quantos Area?
4-1	Dia/Mês	Nome da arvore/muda/produto ( )	□Varzea □Terra firme	Pés	HÁ
4-2	Dia/Mês	Nome da arvore/muda/produto ( )	□Varzea □Terra firme	Pés	HÁ
4-3	Dia/Mês	Nome da arvore/muda/produto ( )	□Varzea □Terra firme	Pés	HÁ
4-4	Dia/Mês	Nome da arvore/muda/produto ( )	□Varzea □Terra firme	Pés	HÁ
4-5	Dia/Mês	Nome da arvore/muda/produto ( )	□Varzea □Terra firme	Pés	HÁ
4-6	Dia/Mês	Nome da arvore/muda/produto ( )	□Varzea □Terra firme	Pés	HÁ
4-7	Dia/Mês	Nome da arvore/muda/produto ( )	□Varzea □Terra firme	Pés	HÁ
4-8	Dia/Mês	Nome da arvore/muda/produto ( )	□Varzea □Terra firme	Pés	HÁ
4-9	Dia/Mês	Nome da arvore/muda/produto ( )	□Varzea □Terra firme	Pés	HÁ
4-10	Dia/Mês	Nome da arvore/muda/produto ( )	□Varzea □Terra firme	Pés	HÁ
4-11	Dia/Mês	Nome da arvore/muda/produto ( )	□Varzea □Terra firme	Pés	HÁ
4-12	Dia/Mês	Nome da arvore/muda/produto ( )	□Varzea □Terra firme	Pés	HÁ

Appendix B : One-shot survey questionnaire

1.INFORMAÇÃO GERAL

1-1.Nome do Produtor (na lista)	SINGLE-SELECT: COMBO BOX — name 002 ○ 25.Aldenor Leal Da Silva 003 ○ 12.Antonio Gabriel 004 ○ 42.Antonio Valdenor 005 ○ 35.Araim 006 ○ 37.Assis 007 ○ 08.Augusto 008 ○ 45.Benedito Rodrigues 009 ○ 46.Danilo Barbosa Campos 010 ○ 03.Dinalva 011 ○ 21.Dona Lucia 012 ○ 26.Elias 013 ○ 47.Emissanoro Gomes 014 ○ Eneias 015 ○ 24.Eneudo 016 ○ 36.Francisco Edimar 017 ○ 16.Fredson And 56 other symbols [1]
1-2.Nome completo	TEXT — namecomplete .....
1-3.Sexo	SINGLE-SELECT — gender 01 ○ Homen 02 ○ Mulher
1-4.Idade	NUMERIC: INTEGER — age ----------

1-5.Comunidade(na lista)	SINGLE-SELECT: COMBO BOX `community` 001 ○ Esperança - Rio Manicoré 002 ○ Lago dos remedios - Rio Manicoré 003 ○ Terra preta - Rio Manicoré 004 ○ São jose de onças - Rio Madeira cima 005 ○ Urumatuba- Rio Madeira cima 006 ○ Jauari -Rio Madeira cima 007 ○ São Francisco - Rio Madeira cima 008 ○ Novo prazeres - Rio Madeira baixo 009 ○ Verdum - Rio Madeira baixo 010 ○ Adeia Caiape - Rio Madeira baixo 011 ○ Jenipapo - Rio Madeira baixo 012 ○ Cachoerinha - Rio Madeira baixo 013 ○ São pedro uruá - Rio Madeira baixo 014 ○ Repartimento - Rio Madeira baixo 015 ○ Colares - Rio Madeira baixo 016 ○ Igarapezinho - Non SAF And 4 other symbols [2]
1-6.Quantas familias moram nessa comunidade?	NUMERIC: INTEGER `population_com` ----------
1-7.Quantos anos você mora nessa comunidade?	NUMERIC: INTEGER `live_year` ----------
1-8.Qual serviço tem em sua comunidade ?	MULTI-SELECT `infra_com` 01 ☐ Luz para todos 02 ☐ Sinal de celurar 03 ☐ Internet
1-9.Em qual tipo de terra sua casa fica ?	SINGLE-SELECT `land_house` 01 ○ Várzea 02 ○ Terra firme (exceto Terra preta do Indio) 03 ○ Terra preta do Indio

1-10.Possui outra casa em Manicoré?	SINGLE-SELECT 01 ○ Sim 02 ○ Não	house_mani
1-11.Até qual ano você cursou na escola?	NUMERIC: INTEGER _____	edu_year

2.MEMBROS DA FAMILIA

2-1. Quantas pessoas moram nessa casa?	NUMERIC: INTEGER _____	family_number
2-2-1.Quantos homems moram na sua casa?	NUMERIC: INTEGER _____	number_male

2.MEMBROS DA FAMILIA
Roster: IDADE & TRABALHO AGRÍCOLA
generated by numeric question number_male — number_male_age

Quantos anos ele tem?	NUMERIC: INTEGER _____	male_age
Ele faz o trabalho agrícola?	SINGLE-SELECT 01 ○ Sim 02 ○ Não	male_agri
2-2-2.Quantos mulheres moram na sua casa?	NUMERIC: INTEGER _____	num_female

2.MEMBROS DA FAMILIA
Roster: IDADE & TRABALHO AGRÍCOLA
generated by numeric question num_female — num_female_age

Quantos anos ela tem?	NUMERIC: INTEGER _____	female_age
Ela faz o trabalho agrícola?	SINGLE-SELECT 01 ○ Sim 02 ○ Não	female_agri
2-3.Quantas pessoas da sua família moram fora da comunidade? Família é qualquer pessoa que participe das finanças da cas a: ou contribui ou gasta.	NUMERIC: INTEGER _____	num_liveout

Onde ele/ela mora?	SINGLE-SELECT fam_place 01 ○ Manicoré 02 ○ Manaus 03 ○ Porto Velho 04 ○ Outro
Onde ele/ela mora(Outro)? fam_place==4	TEXT fam_place_other .....
Porque ela/ele se mudou ?	SINGLE-SELECT fam_purpose 01 ○ Para estudar 02 ○ Para trabalhar Garimpo 03 ○ Para trabalhar exceto Garimpo 04 ○ Por causa do casamento 05 ○ Outro
Porque ela/ele se mudou (Outro)? fam_purpose==5	TEXT fam_purpose_other .....
2-4.Quantos filhos acima de 18 anos você tem ?	NUMERIC: INTEGER child18 ----------
2-4-1.Quantos deles se formaram ou estão no colégio? child18>0	NUMERIC: INTEGER child18_high ----------
2-4-2.Quantos deles se formaram ou estão no faculdade? child18>0	NUMERIC: INTEGER child18_uni ----------

3.AGRICULTURA

3-1.Em qual ano você começou a fazer mudas e plantação? *EXCETO banana, melancia, mandioca	NUMERIC: INTEGER ano_muda ----------
3-2.Você já ouviu falar da SAF?	SINGLE-SELECT SAF_heard 01 ○ Sim 02 ○ Não
3-3.Você sabe o que é SAF? E SAF_heard==1	SINGLE-SELECT SAF_know 01 ○ Sim 02 ○ Não
3-4.Como você conheceu a SAF? E SAF_know==1	SINGLE-SELECT SAF_how_start 01 ○ Ouviu dos Vizinhos / famílias 02 ○ Participou de um treinamento pela CEPLAC / HANDS/IDAN 03 ○ Técnico que visitou sua casa 04 ○ Rádio / TV 05 ○ Outro
Como você conheceu a SAF(Outro)? E SAF_how_start==5	TEXT SAF_how_start_other .....
3-5.Faz SAF?? E SAF_heard==1	SINGLE-SELECT SAF_do 01 ○ Sim 02 ○ Não
3-6.Em qual ano começou ? E SAF_do==1	NUMERIC: INTEGER SAF_year_start ----------

3-7.Quais desses você sabe como fazer?

E SAF_do==1

MULTI-SELECT: YES/NO SAF_point_know

01 ☐ / ☐ Variar o tempo da colheita (Para ter os produtos durante ano todo)
02 ☐ / ☐ Variar o prazo da colheita (curto prazo, médio prazo, longo prazo)
03 ☐ / ☐ Plantar para consumo próprio
04 ☐ / ☐ Plantar para sombreamento
05 ☐ / ☐ Plantar usando espaçamento apropriado entre as plantas
06 ☐ / ☐ Plantar de forma a reduzir danos causados por doenças/pragas
07 ☐ / ☐ Plantar de forma a reduzir o risco de inundações e secas
08 ☐ / ☐ Planta de forma a reduzir o risco de variação de preço
09 ☐ / ☐ Plantar de forma a não destruir natureza
10 ☐ / ☐ Podar regularmente
11 ☐ / ☐ Usar adubos orgânicos/ pesticidas orgânicas (tipo fezes de galinha, tucupi)

3-8.Quais desses você pratica atualmente??

E SAF_do==1

MULTI-SELECT: YES/NO SAF_point_do

01 ☐ / ☐ Variar o tempo da colheita (Para ter os produtos durante ano todo)
02 ☐ / ☐ Variar o prazo da colheita (curto prazo, médio prazo, longo prazo)
03 ☐ / ☐ Plantar para consumo próprio
04 ☐ / ☐ Plantar para sombreamento
05 ☐ / ☐ Plantar usando espaçamento apropriado entre as plantas
06 ☐ / ☐ Plantar de forma a reduzir danos causados por doenças/pragas
07 ☐ / ☐ Plantar de forma a reduzir o risco de inundações e secas
08 ☐ / ☐ Planta de forma a reduzir o risco de variação de preço
09 ☐ / ☐ Plantar de forma a não destruir natureza
10 ☐ / ☐ Podar regularmente
11 ☐ / ☐ Usar adubos orgânicos/ pesticidas orgânicas (tipo fezes de galinha, tucupi)

3-9.O que você acha melhor para aprender SAF?	SINGLE-SELECT SAF_learn 01 ○ Troca de informação entre agricultores 02 ○ Participação em 1 dia treinamento (na sala de seminário) 03 ○ Participação em 1 dia treinamento (no campo) 04 ○ Visita frequente por técnicos 05 ○ Rádio / TV 06 ○ outros
O que você acha melhor o apressado SAF (Outro)? E SAF_learn==6	TEXT SAF_learn_other .....
3-10.Quantas pessoas você conhece que conduzem a SAF?	NUMERIC: INTEGER SAF_neighbor ----------
3-10-2.Entre eles, quantos vivem na sua comunidade? E SAF_neighbor>0	NUMERIC: INTEGER SAF_neighbor_comm ----------
3-11.Antes de começar a SAF, o que plantou principalmente?	MULTI-SELECT Before_SAF_plant 01 ☐ Mandioca/Macaxeira 02 ☐ Banana 03 ☐ Melancia 04 ☐ Outros
Antes de começar a SAF, o que plantou principalmente(Outro)? E Before_SAF_plant.Contains(4)	TEXT Before_SAF_plant_other .....
3-12.Antes de começar a SAF, o que coletava pra vender principalmente?	MULTI-SELECT Before_SAF_wild 01 ☐ Açaí 02 ☐ Castanha 03 ☐ Borracha 04 ☐ Outros
Antes de começar a SAF, o que coletou pra vender principalmente(Outros)? E Before_SAF_wild.Contains(4)	TEXT Before_SAF_wild_other .....

3-13.Qual tipo de terra de campo você tem?	MULTI-SELECT 01 ☐ Várzea 02 ☐ Terra firme 03 ☐ Terra preta do índio	terra

3.AGRICULTURA

Roster: TAMANHO & STATUS DE POSSE

generated by multi-select question terra — tamanho_status

Tamanho da área no total (HA)	NUMERIC: DECIMAL _	tamanho_total
Tamanho da área de plantio no total (HA)	NUMERIC: DECIMAL _	tamanho_plant
Tamanho da área de plantio SAF(HA)	NUMERIC: DECIMAL _	tamanho_SAF
Status de posse	SINGLE-SELECT 01 ○ Terra própria (inclusive a terra da família) 02 ○ Alocado pelo governo 03 ○ Emprestada pelo governo 04 ○ Alugado 05 ○ Reserva do índio 06 ○ Outros	terra_status
Status de posse(outro) E terra_status==6	TEXT	terra_status_other
Tem o documento da sua terra?	SINGLE-SELECT 01 ○ Sim（mesmo que esteja no processo) 02 ○ Não	terra_doc
3-14.Faz queimada?	SINGLE-SELECT 01 ○ Sim 02 ○ Não	queimada
3-14.Se sim, qual tamanho da área que queima por ano ? E queimada==1	TEXT	queimada_size
Por favor tirar um foto	PICTURE	agri_pic

4.VARIEDADE

4-1.Quis desses você tem no campo (Várzea)

E `terra.Contains(1)`

MULTI-SELECT `variety_varzea`

01 ☐ Abacate
02 ☐ Abacaxi
03 ☐ Abobrinha
04 ☐ Abóbora
05 ☐ Alface
06 ☐ Arroz
07 ☐ Banana
08 ☐ Cebola
09 ☐ Cebolinha
10 ☐ Coentro
11 ☐ Couve
12 ☐ Cubiu
13 ☐ Feijao
14 ☐ Jambu
15 ☐ Jerimum
16 ☐ Macaxeira

And 67 other symbols [3]

4-2.Quis desses você tem no campo (Terra firme)

E `terra.Contains(2)`

MULTI-SELECT `variety_terrafirme`

01 ☐ Abacate
02 ☐ Abacaxi
03 ☐ Abobrinha
04 ☐ Abóbora
05 ☐ Alface
06 ☐ Arroz
07 ☐ Banana
08 ☐ Cebola
09 ☐ Cebolinha
10 ☐ Coentro
11 ☐ Couve
12 ☐ Cubiu
13 ☐ Feijao
14 ☐ Jambu
15 ☐ Jerimum
16 ☐ Macaxeira

And 67 other symbols [4]

4-3.Quis desses você tem no campo (Terra preta) E `terra.Contains(3)`	MULTI-SELECT `variety_terrapreta` 01 ☐ Abacate 02 ☐ Abacaxi 03 ☐ Abobrinha 04 ☐ Abóbora 05 ☐ Alface 06 ☐ Arroz 07 ☐ Banana 08 ☐ Cebola 09 ☐ Cebolinha 10 ☐ Coentro 11 ☐ Couve 12 ☐ Cubiu 13 ☐ Feijao 14 ☐ Jambu 15 ☐ Jerimum 16 ☐ Macaxeira And 67 other symbols [5]
4-4.Quais tipos de plantio/árvore você tem mais ? (Escolha 5)	MULTI-SELECT `variety_top5` 01 ☐ Abacate 02 ☐ Abacaxi 03 ☐ Abobrinha 04 ☐ Abóbora 05 ☐ Alface 06 ☐ Arroz 07 ☐ Banana 08 ☐ Cebola 09 ☐ Cebolinha 10 ☐ Coentro 11 ☐ Couve 12 ☐ Cubiu 13 ☐ Feijao 14 ☐ Jambu 15 ☐ Jerimum 16 ☐ Macaxeira And 67 other symbols [6]

4.VARIEDADE

Roster: VARIETY_NUM

generated by multi-select question `variety_top5` `variety_num`

Várzea ou Terra firme ou Terra preta do indio?	SINGLE-SELECT `variety_num_local` 01 ○ Várzea 02 ○ Terra firme 03 ○ Terra preta do indio

Quantas árvores/ha tem?	NUMERIC: DECIMAL ----------	variety_quantity
Unidade?	SINGLE-SELECT 01 ○ Pé 02 ○ Ha 03 ○ Outro	variety_unidade
Qual unidade? variety_unidade==3	TEXT	variety_unidade_other
Tem outros tipos de plantio/árvore úteis?	TEXT	variery_other
Por favor tirar um foto	PICTURE	variety_pic

5.DANOS DE INUNDAÇÃO/SECA

5-1. Quantidade de árvores / mudas/plantações você perdeu na inundação de 2014?	SINGLE-SELECT damage_percent 01 ○ Perdeu quase tudo (90 ~ 100%) 02 ○ Perdeu muito (60% ~ 90%) 03 ○ Perdeu cerca de metade (40-60%) 04 ○ Perdeu alguns (10-40%) 05 ○ Não perdi (0-10%)
5-2.Quais árvores/mudas você perdeu em 2014? E damage_percent!=5	MULTI-SELECT damage_tree 01 ☐ Banana 02 ☐ Cacau 03 ☐ Açaí nativo 04 ☐ Açaí do Pará 05 ☐ Tucumã 06 ☐ Goiaba 07 ☐ Caju 08 ☐ Maracujá 09 ☐ Laranja 10 ☐ Graviola 11 ☐ Cupuaçu 12 ☐ Andiroba 13 ☐ Coco 14 ☐ Outras
5-2.Quais árvores/mudas você perdeu em 2014(Outras)? E damage_tree.Contains(14)	TEXT damage_tree_other .....

5.DANOS DE INUNDAÇÃO/SECA

Roster: QUANTIDADE

generated by multi-select question damage_tree quantity_damade

Quantos tinha antes de inundação?	NUMERIC: INTEGER damage_before ----------
Quantos perdeu?	NUMERIC: INTEGER damage_after ----------
5-3.Em qual ano você plantou de novo em Várzea? E damage_percent!=5	NUMERIC: INTEGER varzea_year ----------

5-4.Você começou a plantação em terra firme apenas após a inundação?	SINGLE-SELECT 01 ○ Sim 02 ○ Não	terrafirm_after
5-4.Se sim, em qual ano você começou? E terrafirm_after==1	NUMERIC: INTEGER ----------	terrafirm_year
5-5.Quais árvores/mudas plantou após o inundação? E damage_percent!=5	MULTI-SELECT 01 ☐ Banana 02 ☐ Cacau 03 ☐ Açaí nativo 04 ☐ Açaí do Pará 05 ☐ Tucumã 06 ☐ Goiaba 07 ☐ Caju 08 ☐ Maracujá 09 ☐ Laranja 10 ☐ Graviola 11 ☐ Cupuaçu 12 ☐ Andiroba 13 ☐ Coco 14 ☐ Outras	plant_after_tree
5-5.Quais árvores/mudas plantou após o inundação(outras)? E plant_after_tree.Contains(14)	TEXT ----------	plant_after_tree_other

5.DANOS DE INUNDAÇÃO/SECA

Roster: QUANTIDADE

generated by multi-select question plant_after_tree — quantity_plant

Quantos plantou?	NUMERIC: INTEGER ----------	plant_after_num
5-6.Você sabe quantas pessoas na sua comunidade desistiram da agricultura e se concentraram mais no Garimpo depois da inundação?	NUMERIC: INTEGER ----------	garimpo

5-7.Quantas árvores / mudas você perdeu com a seca em 2015?	MULTI-SELECT `seca_tree` 01 ☐ Banana 02 ☐ Cacau 03 ☐ Açaí nativo 04 ☐ Açaí do Pará 05 ☐ Tucumã 06 ☐ Goiaba 07 ☐ Caju 08 ☐ Maracujá 09 ☐ Laranja 10 ☐ Graviola 11 ☐ Cupuaçu 12 ☐ Andiroba 13 ☐ Coco 14 ☐ Outras

5.DANOS DE INUNDAÇÃO/SECA

Roster: QUANTIDADE

generated by multi-select question `seca_tree` `quantity_seca`

Quantos perdeu?	NUMERIC: INTEGER `seca_num` ----------

6.VENDA

6-1.Quantos atravessadores compram na sua localidade?	NUMERIC: INTEGER attr_num ----------
6-2.Tem fonte de informação sobre preço de produto agrícola além de atravessador?	SINGLE-SELECT info_price 01 ○ Sim 02 ○ Não
Se sim, de quem/como? info_price==1	TEXT info_price_who ....
6-3.Você normalmente negocia o preço de venda quando vende? ou vende com o preço oferecido pelos atravessadores/consumidores?	SINGLE-SELECT attr_nego 01 ○ Sim, negocio 02 ○ Não, negocio
6-4.Quantos financiamentos teve para objetivo da agricultura nos últimos 10 anos?	NUMERIC: INTEGER financiamento ----------

6.VENDA

Roster: FINANCIAMENTO

generated by numeric question financiamento — financiamento_roaster

De qual organização? financiamento>0	SINGLE-SELECT finance_org 01 ○ Banco do Amazonas 02 ○ Banco do Brasil 03 ○ AFEAM 04 ○ CEPLAC 05 ○ Outro
De qual organização(Outro)? financiamento>0 & finance_org==5	TEXT finance_org_other ....
Em qual ano? financiamento>0	NUMERIC: INTEGER finance_year ----------
Quanto foi? financiamento>0	NUMERIC: INTEGER finance_amount ----------

7.REGISTRO

7-1.Você sabe quanto você VENDEU da agricultura no ultimo ano?	SINGLE-SELECT vende_lastyear 01 ○ Sim 02 ○ Não
7-2.Qual valor foi? E vende_lastyear==1	SINGLE-SELECT vende_lastyear_amount 01 ○ Menos de R$5,000 02 ○ R$ 5,000-10,000 03 ○ R$10,000-15,000 04 ○ R$15,000-20,000 05 ○ Mais de R$ 20,000

8.OUTRA FONTE DA RENDA

8-1.Quais fontes da renda você tem?	MULTI-SELECT otherincome 01 ☐ Bolsa Família 02 ☐ Bolsa Floresta 03 ☐ Pensão 04 ☐ Salário 05 ☐ Lucro da sua loja 06 ☐ Ajuda da família 07 ☐ Outra
Qual fonte da renda você tem (outra) otherincome.Contains(7)	TEXT otherincome_other .....

8.OUTRA FONTE DA RENDA
Roster: OTHER INCOME
generated by multi-select question otherincome otherincome_amount

Quanto ganha por mês?	NUMERIC: INTEGER otherincome_amount_month ----------

9.DESPESA

9-1.Quanto gasta com Gás por mês?	NUMERIC: INTEGER des_gas
9-2.com gasolina (para bomba da agua ou gerador) por mês	NUMERIC: INTEGER des_gasoline
9-3.com Telefone(Celular / Telefone rural)por mês	NUMERIC: INTEGER des_tel
9-4.com transporte por mês	NUMERIC: INTEGER des_transport
9-5.com educação por mês (incluindo remessa para crianças que estudam fora)	NUMERIC: INTEGER des_edu
9-6.com gasta com médico/ medicamentos por ANO	NUMERIC: INTEGER des_medical
9-7.com lazer (viagem, roupas, móveis,) por ANO	NUMERIC: INTEGER des_leasure

10.POSSE

10-1.O que você tem?	MULTI-SELECT: YES/NO `asset` 01 ☐ / ☐ Barco 02 ☐ / ☐ Lancha 03 ☐ / ☐ Rabeta 04 ☐ / ☐ Canoa 05 ☐ / ☐ Televisão 06 ☐ / ☐ Rádio 07 ☐ / ☐ Celular 08 ☐ / ☐ Telefone rural (o que tá funcionando) 09 ☐ / ☐ Geladeira 10 ☐ / ☐ Freezer 11 ☐ / ☐ Máquina de lavar 12 ☐ / ☐ Banheiro (com vaso sanitário) 13 ☐ / ☐ casa de farinha 14 ☐ / ☐ Viveiro 15 ☐ / ☐ Gerador 16 ☐ / ☐ Roçadeira And 3 other symbols [7]
10-2.Qual animais granjeiros você tem?	MULTI-SELECT: YES/NO `asset_animal` 20 ☐ / ☐ Galinha 21 ☐ / ☐ Pato 22 ☐ / ☐ Porco

10.POSSE

Roster: QUANTIDADE

generated by multi-select question `asset_animal` `asset_animal_quantity`

Quantos tem?	NUMERIC: INTEGER `asset_animal_num` ----------
Por favor tirar um foto	PICTURE `asset_pic`

11.VIDA AMAZONIA

11-1.Se você tivesse opotunidade, gostaria de morar na cidade?	SINGLE-SELECT 01 ○ Sim 02 ○ Não	life_city
11-2.Se tivesse oportunidade, gostaria de desistir do trabalho agrícola e fazer outra atividade?	SINGLE-SELECT 01 ○ Sim 02 ○ Não	life_nonagri
11-3.Se sim, o que gostaria de fazer? life_nonagri==1	TEXT	life_other
11-4.Qual é o maior desafio que você tem na agricultura?	AUDIO	agri_challenge_audio
11-4.Qual é o maior desafio que você tem na agricultura?	TEXT	agri_challenge
11-5.Qual é o maior desafio que você tem com a vida aqui? (*EXCETO Agriculture)	AUDIO	other_challenge_audio
11-5.Qual é o maior desafio que você tem com a vida aqui? (*EXCETO Agriculture)	TEXT	other_challenge
11-6.De que você gosta da vida na Amazonia? Por que você gosta..	AUDIO	like_audio
11-6.De que você gosta da vida na Amazonia? Por que você gosta..	TEXT	like
Por favor tirar um foto	PICTURE	vida_pic

Appendix C :Statistic table of socio-economic characteristics

Pair 1	SAF (N=29)		NON-SAF(N=24)		
	Mean	Median	Mean	Median	p
Socio-Economics					
Age	43.89	42.00	41.08	44.50	0.437
Education(Year)	7.10	6.00	7.04	7.00	0.971
# of family member	5.89	6.00	5.54	4.50	0.250
# of family member for agriculture		4.00		3.50	0.841
# of SAF farmers :know	3.96	3.00	0.91	0.00	0.0000***
Land size-Possesd	49.88	20.00	40.25	6.75	0.004***
Land size-Planted	5.685	4.00	2.50	2.00	0.0002***
Land size-SAF	2.222	2.00	N/A	N/A	N/A
% of planted land / Possed	33.08%	25%	32%	21.53%	0.7625
Sales-related					
# of middlemen : know	4.17	4.00	4.08	3.00	0.4883
# of loans for agriculture in tha past	0.58	0.00	0.29	0.00	0.1728

Pair 2	Income Upper (N=27)		Income Lower (N=26)		
	Mean	Median	Mean	Median	p
Socio-Economics					
Age	41.629	42.00	43.653	45.00	0.575
Education(Year)	7.74	8.00	6.38	6.00	0.148
# of family member	5.89	5.00	5.58	5.00	0.362
# of family member for agriculture	4.15	4.00	3.96	4.00	0.758
# of SAF farmers :know	3.26	2.00	1.88	1.00	0.332
Land size-Possesd	34.84	16.50	55.45	8.50	0.146
Land size-Planted	5.54	4.00	2.88	3.00	0.0097***
Land size-SAF	1.68	1.50	0.92	0.00	0.0752*
% of planted land / Possed	35.52%	0%	29%	0.25%	0.5588
Sales-related					
# of middlemen : know	4	3.00	4.27	4.00	0.6564
# of loans for agriculture in tha past	0.629	0.00	0.27	0.00	0.0759*

Pair 3	SAF -Upper income (N=15)		SAF -Lower income (N=14)		
	Mean	Median	Mean	Median	p
Socio-Economics					
Age	44.13333	46.00	43.642	41.50	0.760
Education(Year)	7.33	6.00	6.86	6.00	0.759
# of family member	6.80	6.00	4.93	5.00	0.0633*
# of family member for agriculture	4.87	4.00	3.29	3.00	0.0441**
# of SAF farmers :know	4.80	3.00	3.07	3.00	0.757
Land size-Possesd	52.37	20.00	47.57	16.25	0.369
Land size-Planted	5	4.00	6.32	4.25	0.806
Land size-SAF	1.653846	1.50	2.75	2.00	0.0892*
% of planted land / Possed	29%	20%	37%	31.00%	0.2246
Sales-related					
# of middlemen : know	4.666667	5.00	3.64	3.00	0.2193
# of loans for agriculture in tha past	0.6	0.00	0.57	0.00	0.9609

Pair 4	NONSAF -Upper income (N=12)		NONSAF -Lower income (N=12)		
	Mean	Median	Mean	Median	p
Socio-Economics					
Age	40.58333	44.50	44.5	44.50	1
Education(Year)	7.75	7.50	6.33	5.50	0.3239
# of family member	5.17	5.00	6.08	0.50	0.952
# of family member for agriculture	4.17	4.00	3.83	3.00	0.6593
# of SAF farmers :know	1.33	0.00	0.50	0.00	0.6144
Land size-Possesd	13.95	7.00	67.31	6.75	0.862
Land size-Planted	3	3.00	2.21	1.75	0.0971*
Land size-SAF	N/A	N/A	N/A	N/A	N/A
% of planted land / Possed	38%	30%	25%	21.52%	0.2476
Sales-related					
# of middlemen : know	4.25	2.50	4.25	3.50	0.8134
# of loans for agriculture in tha past	0.25	0.00	0.33	0.00	0.6602

Pair 5	SAF -Upper income (N=15)		NONSAF -Upper income (N=12)		
	Mean	Median	Mean	Median	p
Socio-Economics					
Age	44.13333	46.00	40.58333	44.50	0.5251
Education(Year)	7.33	6.00	7.75	6.00	0.659
# of family member	6.80	6.00	5.166667	5.00	0.0986*
# of family member for agriculture	4.87	4.00	4.166667	4.00	0.4268
# of SAF farmers :know	4.80	3.00	1.333333	0.00	0.0102**
Land size-Possesd	52.37	20.00	13.95	7.00	0.0122**
Land size-Planted	5	4.00	3.00	3.00	0.0788*
Land size-SAF	N/A	N/A	N/A	N/A	N/A
% of planted land / Possed	29%	20%	38%	30.00%	0.3135
Sales-related					
# of middlemen : know	4.67	5.00	4.25	2.50	0.4386
# of loans for agriculture in tha past	0.6	0.00	0.25	0.00	0.2253

*P<0.1; ** P ≤ 0.05; ***P= ≤ 0.01
***, **, and * signify statistical significance at the 1,5, and10 % level, respectively