Ph.D. Thesis

Rubber Smallholders' Economic Condition Under The Rubber Price Fall and Possible Solution in South Sumatra, Indonesia

（ゴム価格暴落下の南スマトラ州のゴム農家の経済状況と改善の可能性）

Graduate School of Bioresources

Mie University

Dwi Wulan Sari

March 2020

INTRODUCTION

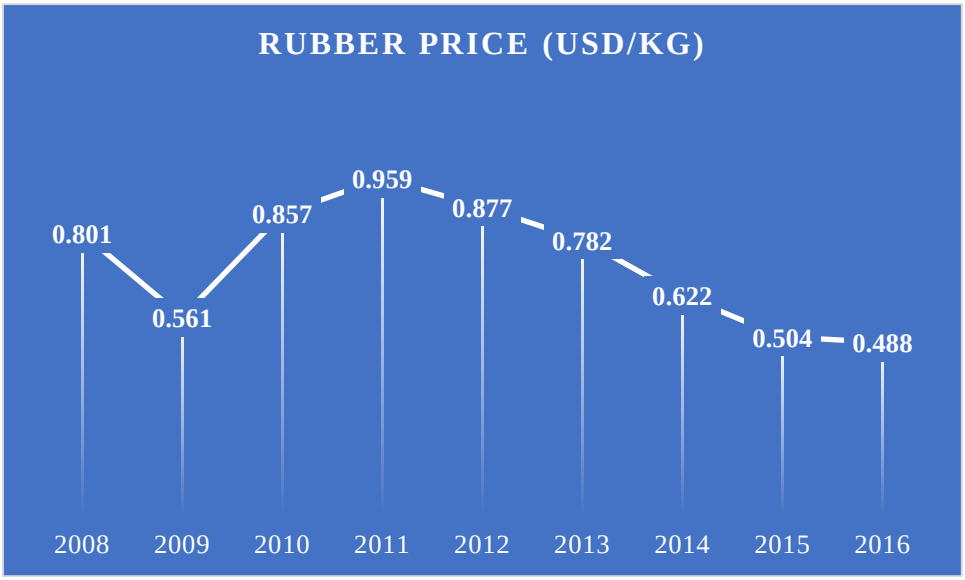
1. General Introduction

The Indonesian economy has been growing rapidly. In particular, the agro-industry sector has experienced economic growth. Rubber and oil palm are the main crops for agro-industry. Production of both these crops has increased significantly, and many farmers are dependent on these crops. From 2000 to 2017, rubber production has increased from 1,501 thousand tons to 3,603 thousand tons, and oil palm production has increased from 36,380 thousand tons to 158,343 thousand tons.

The products from these crops, natural rubber and palm oil, are international commodities, and a large proportion of production is exported. Therefore, production of both crops has been influenced by international market conditions, and increased demand for these products has encouraged crop production, not only in Indonesia, but also in other countries, particularly southeast Asian countries. As many countries have expanded production, international competition in the market has become severe and international prices have fallen. Between 2000 and 2011, the price of rubber increased from 0.67 US$/kg to 4.82 US$/kg. However, the price has fallen since then, reaching 1.57 US$/kg in 2017 (World Bank, Commodity Markets, 2018). The price of palm oil showed a similar change; it increased until 2011 and has fallen after that. The price was 46% lower in 2017 than in 2011.

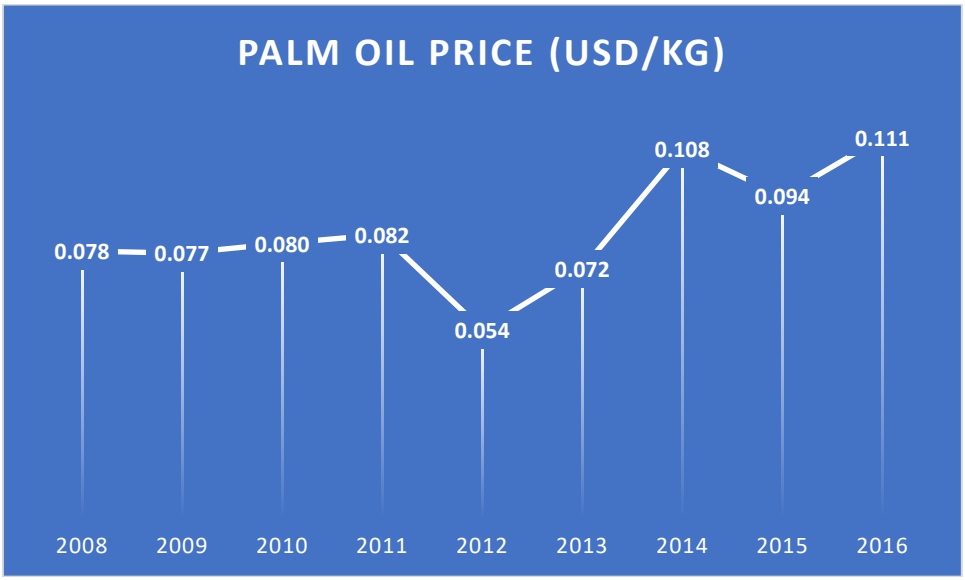
These price falls have influenced farm gate prices, particularly that of rubber. As shown in Figure 1 and Figure 2, the price of rubber was 67% lower in 2016 than in 2011, while the price of palm oil in 2016 was higher than that in 2011. The fact that the price of palm oil did not fall may be due to the government's commitment to maintaining the price, while the price of rubber is determined by market mechanisms.[1]

1. Oil palm has been developed since the 1970s with the strong support of the Indonesian government for its economic growth, while rubber has long been cultivated as a traditional commodity crop (Rai, 2014). The price policy for oil palm is one of the supports polices. A large percentage of oil palm is produced by large-scale estates, some of which are state-owned companies, while most of the rubber producers are smallholders (Yanita et al, 2016). Moreover, the main oil palm distribution route is an exclusive market system controlled by palm oil companies, while the main rubber distribution route is the traditional open market. These characteristics of rubber are considered to make it difficult to introduce price policy compared to oil palm.



Source: Directorate General of Estate Crops Indonesia, 2009–2017.

Figure 1. Rubber Price in Indonesia 2008–2016



Source: Directorate General of Estate Crops Indonesia, 2009–2017.

Figure 2. Palm Oil Price in Indonesia 2008–2016

The economic conditions of rubber farmers worsened due to the price fall. As most rubber farmers are poor smallholders, the impact of a price fall is significant. Al Muksit (2017) showed that as many as 90.53% of rubber farmers in Jambi, which is next to South Sumatra, had low incomes due to rubber price fall. Syarifa et al. (2016) pointed out that

low rubber prices had caused decrease in farmers'' income and their investment, decline in their purchasing power, and change in land use from rubber farming in South Sumatra. But it is not easy to convert to other crops, because rubber is a perennial crop.

The annual demand for natural rubber reached 8.1 million tons globally in 2014. Indonesia contributes 2.6 million tons, or approximately 25% of the total, to the global market (Indonesia Central Bureau of Statistics, 2015). Based on statistics from the Directorate General of Estate Crops of Indonesia (2015), the total area of rubber plantations in Indonesia in 2015 reached 3,610,325 hectares, consisting of 3,070,508 ha of smallholder estates, 230,900 ha of state government estates, and 308,917 ha of private estates.

Besides the price issue, another issue in rubber farming is low productivity and low in quality. The average land productivity in Indonesia is 1,058 kg/ha, which is approximately two-thirds of that of other dominant rubber-producing countries, such as Thailand and Malaysia. In particular, the productivity of smallholders is low. The land productivity of the private estates is 1,495 kg/ha, which is not significantly different from that of the other dominant countries, while that of smallholders is 966 kg/ha.

In addition, quality is an unsolved problem in the rubber industry in Indonesia. Quality improvement efforts have been undertaken through various activities, such as training, socialization, coagulant subsidies, and the implementation of an organized rubber-marketing system. According to Gapkindo (2012), the quality of rubber in the organized marketing system is better than that in traditional markets. Farmers who are involved in an organized marketing system can produce 100% clean rubber, while un-involved farmers produce only 63% clean rubber. Another quality indicator is rubber thickness. Farmers who are engaged in organized marketing produce 62% thin rubber (good quality), while uninvolved farmers produce 100% thick rubber (low quality).

The government is attempting to encourage farmers to adopt appropriate farming practices from the pre-planting stage to the post-harvest stage. It provides subsidies and knowledgeable assistance in adopting farming practices, but this program is not functioning appropriately, as 85% of rubber farmers in Indonesia are smallholders who are categorized as poor. Most farmers are unable to purchase certified seeds, fertilizers, and other production materials that can support their needs. In addition, they cannot wait for a long production time, which is more than five years after planting. Therefore, they

harvest before the suggested time. Some farmers also mix other materials or contaminants to add to the rubber weight. This certainly does not increase farmers'' income, but it causes a decrease in the quality of the rubber (Hanggokusumo, 2016).

2. Problem Statements

The number of rubber smallholders has increased over the past couple of decades. Before 2008, the price of rubber was relatively high, so rubber was the main source of their income, which could bring them to prosperity. By 2008, the price of rubber had dropped dramatically; it became unstable in the following year. As time has gone by, competitors in the international market have been increasingly numerous and offered very promising prices. As a result, price instability occurs in the domestic market, and smallholder farmers have experienced a significant decline in income (Indonesia Investment, 2018).

Since then, the economic condition of farmers has begun to decline. Low income caused farmers to prioritize food needs, so the cost of rubber plantation was a second priority. As a result, farmers have been unable to provide fertilizer in accordance with government recommendations because of limited capital. Based on this condition, this study will address the following research questions.

a) How was the economic situation of rubber smallholders under the price fall as compared to oil palm smallholders?
b) How did the farmers do their farming activities and apply the concept of good agricultural practices in their farming under their current economic conditions?
c) What factors were affected rubber production and rubber quality?

3. Objectives of the Study

Before the decline in rubber prices, rubber farming became a source of income for farmers and guaranteed the welfare of farmer families. Farmer income has tended to decrease every year till the end of 2018, while the price of food needs experiences inflation every year. This caused farmers to get worse, and it is feared that the percentage of poor farmers will continue to increase. This condition must be analysed to determine the truth of the issue and possible solutions that can be taken to cope with this problem. This study has several objectives that divided into chapters.

a. The first chapter explains the outline of the rubber industry in South Sumatra, including rubber plantation history, rubber in the international market, and characteristics of rubber in Indonesia.
b. The second chapter analyses the present economic situation of rubber smallholders under the price fall compared to oil palm smallholders. It considers a solution for the case through empirical analysis.
c. As farmers' economic situation shows a severe problem, the third chapter describes farming activities based on the Good Agricultural Practices concept. The chapter analyses farming activities carried out by farmers, whether they have applied the concepts of Good Agricultural Practices or not. Furthermore, agricultural practices are divided into several activities that determine several factors. These factors are analysed for their impact on rubber production and quality.

4. Previous Studies

Several studies related to the social and economic conditions of farmers have been performed. Productivity is a major problem for the Indonesian rubber industry, which is largely due to the age of the trees, among other factors. The total area of rubber plantations whose productivity has declined and need to be replanted is estimated at 400,000 hectares. Rejuvenation programs for old rubber trees are very difficult to implement, because the majority (85%) of Indonesian rubber plantations, like most of the country's major agricultural commodities, belong to smallholder farmers. The remaining 15% is owned by state plantation companies (7%) and private companies (8%) (Global Business Indonesia Guide, 2018).

Rubber farmers in the village of Simpang Mesuji, Simpang Pematang Sub-District, Bandar Lampung, have an average land area of 1.3 ha with revenues of $1,082.72/year. Compared to the minimum standard of living, based on the Indonesian Government Standard, 62.5% of farmers live in poor conditions (Susanto, 2017). According to data from the Indonesian Central Bureau of Statistics (2017), a family living in a village with four family members (father, mother, and two children) requires a minimum living cost of $163.60/month, with 55.83% of that value used for food fulfilment.

Husin et al. (2017), in their study of the effect of different rubber market systems on farmers' income in South Sumatra Province, stated that there was significantly different

income between farmer participants in processing and marketing units (PMUR) and non-participants. The farmers' income through the auction system was higher (about 57%), and the farmers' income through the partnership system was higher (about 64%) than that of the traditional marketing system.

Based on certain research, for the quantity, the variables of the technical factors were first tapping age, mixed fertilizers, rubber area, tree diameter, tapping frequency, tapping direction, seed source, and pest and disease management. Meanwhile, the socio-demographic factors were farmer age, farmer experience, number of family members, education, ethnicity, and farmer status (full-time or part-time) (Wiyanto and Kusnadi, 2013).

According to Syarifa and Fatayati (2013), rubber quality is influenced more by sociodemographic factors than by technical factors. The technical factors that affect the rubber quality are rubber plantation, land area, number of trees, and seed source, while the sociodemographic factors are farmer age, farmer experience, number of family members, education, ethnicity, farmer status (full-time or part-time), and involvement in a farmers'' group.

Several studies show that rubber farmers in Indonesia are dominated by smallholders who have low incomes and are categorized as poor. In addition to the economic issue, previous research has shown the conditions of quantity and quality of rubber from smallholders. These studies reveal the problems, but some issues are still being discussed and have not found a solution yet. Thus, this study offers possible solutions for the remaining problems. The first step is to clarify whether the rubber farmers categorized as poor are indeed in a vulnerable condition. Through the analysis of existing problems, it is expected that the second step will find a solution. The solution is obtained by analysing the factors that affect rubber production and quality.

5. Significance of the Study

This study tries to clarify the remaining problems mentioned above. According to Kuswanto (2019), farmers' welfare was largely determined by rubber productivity and price levels. The analysis shows that on average, Jambi Province was not as prosperous. Rubber farmers allocate more income to consumption needs compared to farming needs. As a result, it is expected that farmers make priority scale for needs fulfillment and do not neglect the financing of rubber farming and add other businesses, such as livestock and

fisheries. This study highlights that income, welfare and needs are important issues in rubber farming. Our research provides empirical information about farmers' income, minimum household expenditure, and simulated increases in price and production as alternative solutions in order to reduce the percentage of poor farmers. Some original contributions of this research are as follows:

First, the calculation of farmers' income is done from various sources of income: income from rubber farming, income from other farming, and other income from non-farming. Furthermore, farmers are grouped based on their source of income to predict better combinations of sources of income for farmers in the future.

Second, the respondents chosen also included oil palm farmers. This is because the replacement of rubber plants into oil palm plants is becoming an issue in Indonesia. By calculating income from oil palm farming, this study can show the differences between these two commodities.

Third, this study simulates changes in prices and production, then looks at their impact on income. The basis of price simulations uses fluctuations in world prices between 2008 and 2016.

Fourth, the total income obtained by farmers is then compared with the minimum standard of living needs of a family. The calculation of the standard minimum requirement is based on the government provisions for people living in rural areas. The provisions of a standard were a standard requirement per person, in this study, the calculation is done for each family.

Fifth, this study uses several mathematical models in the analysis of factors that influence income. The mathematical model created a separation between sociodemographic factors and technical factors that affect the quantity and quality of rubber.

6. Limitations of the Study

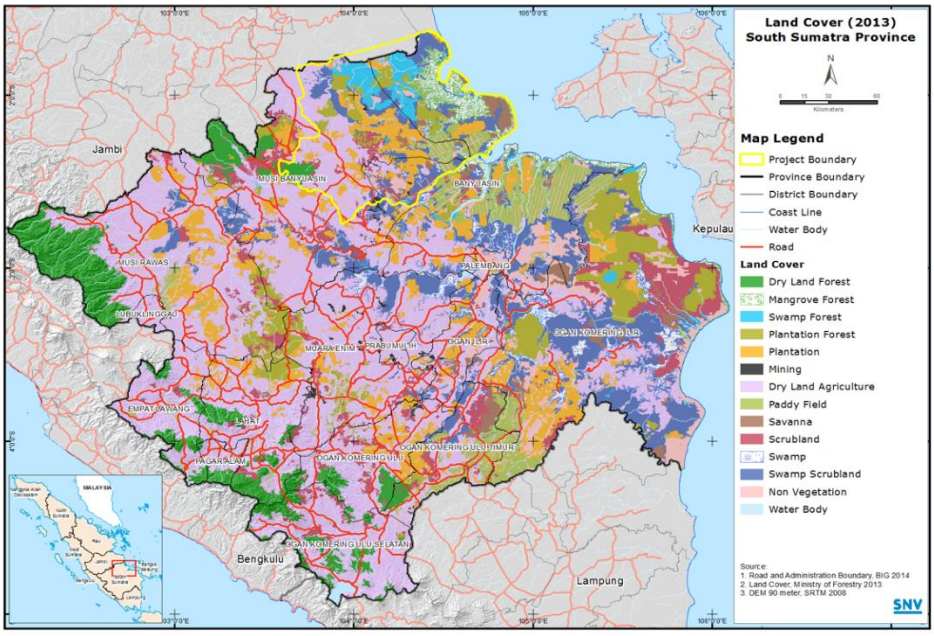
The limitations of the study consist of the following points.

1. The economic condition of farmers was analysed from the calculation of income and compared with expenditure data in 2016.
2. Expenditure data was calculated from the minimum standard needs per person in rural areas.

3. Estimates data were carried out using data from 2011 and 2016. The estimation is as follows:
    - Calculate the estimated income of farmers if there is an increase in commodity prices. Commodity prices use the highest prices between 2008 and 2016, namely prices in 2011.
    - Calculate the estimated expenditure of farmer families by using data in 2011, then compare it with the income in that year to find the percentage of farmers who have not been able to meet the minimum expenditure requirements.
    - Calculate estimated income if production increases with the use of fertilizers and chemicals in accordance with government standards to determine the percentage reduction in the number of poor farmers.
4. The determinants of quantity and quality were analysed separately.

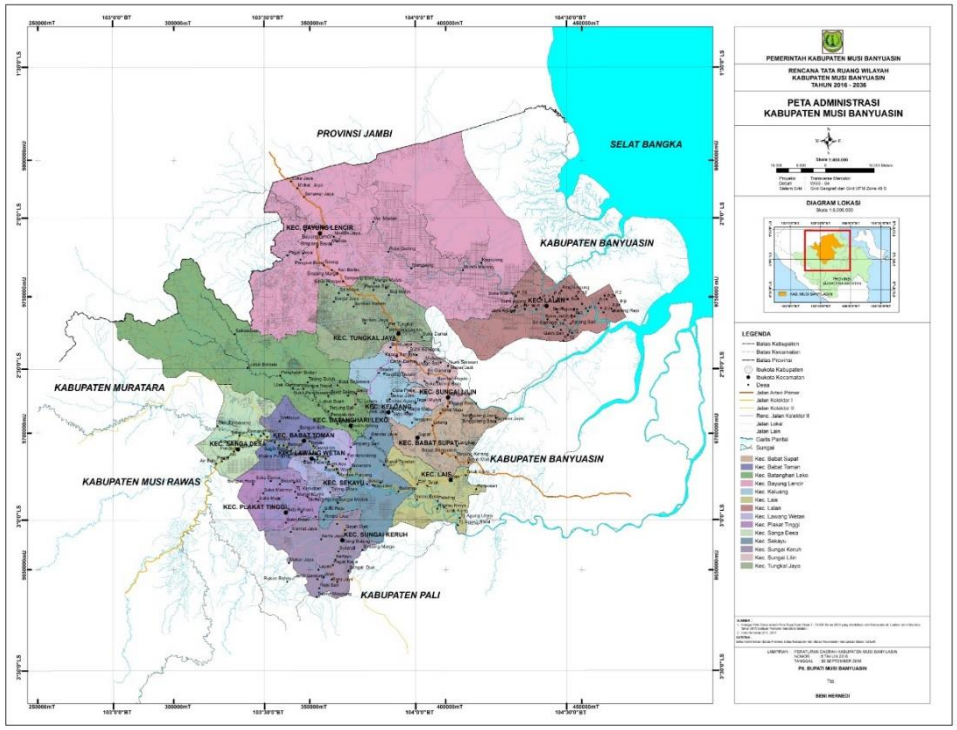
7. Data and Methodology

The outline of the objective areas includes two surveys. These two surveys have been done in Musi Banyuasin District, South Sumatra Province. Figures 3 and 4 show maps of the research locations.



Source: SNV, 2016.

Figure 3. Land Cover of South Sumatra Province



Source: Official Government of Musi Banyuasin District, 2019.

Figure 4. Musi Banyuasin District Map

This research used both qualitative and quantitative methods. The methodology was divided into three parts, as explained below:

a. Chapter I

The first chapter describes the history of rubber in Indonesia and introduces rubber plants in general. The explanation in this chapter is based on the literature review and uses pictures as illustrations.

b. Chapter II

The second chapter in this study uses primary and secondary data. Primary data were gathered through the smallholders'' survey and secondary data were collected from government documents, previous studies and so on.

South Sumatra province was selected for the objective site of the survey because the area is dominated by rubber and oil palm plantations. This study is primarily based on a survey of smallholders in South Sumatra province, which is one of the main rubber and oil palm producing areas in Indonesia. In 2016, production of rubber and oil palm was 400,790.09 tons and 1,251,709.74 tons, respectively (Indonesian Central Bureau of

Statistics, 2017). The survey was conducted in Simpang Tungkal and Mangsang villages, which are typical villages in South Sumatra province where rubber and oil palm are cultivated. Simpang Tungkal and Mangsang village were established in 1981. The Simpang Tungkal village area is 360 km^2, while Mangsang village is 120 km^2. Simpang Tungkal and Mangsang village have a distance of 124 km and 77 km, respectively. from the city of Palembang, which can be accessed by using road and river. The population density in Simpang Tungkal is 23.94 per km^2, of which 60% consists of migrants. Unlike Simpang Tungkal village, Mangsang village has a population density of 98.77 km^2. Simpang Tungkal village has a low population density because the area of the village is still dominated by forests. The dominant commodities are rubber and palm oil, which is the main source of livelihood.

A total of 147 smallholders were selected from 615 smallholders using a simple random sampling method. The survey was conducted via face-to-face interviews, and data were gathered on their socioeconomic characteristics, such as age, education, family members, and jobs other than farming, as well as farming conditions such as cultivating crops and area, production quantity, sales revenue, production cost, and so on.

The survey was conducted in November 2017. The income of respondents was calculated and evaluated in comparison with standard living expenditures. Income before the price drop was estimated by calculation with the price in 2011 and compared with the income in 2017.

c. Chapter III

Chapter III focuses on South Sumatra, as it has the largest area of rubber plantations. In 2015, 23% of Indonesia's rubber plantations were located there (Indonesia Central Bureau of Statistics, 2017). The survey was conducted in Simpang Tungkal and Mangsang villages, where rubber is a dominant commodity cultivated. Simpang Tungkal and Mangsang village were established in 1981. Simpang Tungkal and Mangsang village were established in 1981. Simpang Tungkal village area was 360 km^2 while Mangsang village was 120 km^2. Rubber is a dominant commodity in those two villages. Rice and other food crops were previously their main source of livelihood, but by the time rubber and palm oil were dominated in this area. Land in each village is also dedicated to other uses besides agriculture (non-agriculture area) as needed by the community, such as residential, offices, public facilities, and so on.

Two sets of data were collected in this study: primary and secondary data. Primary data were gathered through a simple random-sampling method to select **80 of 508 farmers** for a face-to-face interview, including age, education experience, family members, and jobs except farming, and farming conditions such as cultivating crops and area, production quantity, sales revenue, production cost, and so on. Moreover, secondary data were collected from government documents, previous research, and so on.

The survey was conducted in June 2016. This study analyses the sociodemographic and technical factors in rubber farming. Quantity is the average amount of production based on survey results, while quality is measured using several indicators to obtain a score. To see the determinants of quantity and quality, this study adapts a mathematical model, a simple multi-regression model for quantity and a logit model for quality. Mathematical model will analyse using statistical tools, SPSS ver. 16.

CHAPTER I

OUTLINE OF THE RUBBER INDUSTRY IN SOUTH SUMATRA, INDONESIA

1. Rubber Plantation History

Rubber plants began to be known in Indonesia during the Dutch colonial era. The oldest rubber plant was found in Subang, West Java, which was planted in 1862. In 1864, the rubber plant was planted in the Bogor Botanical Gardens as a new plant for collection. Furthermore, rubber was developed into plantation crops and spread in several areas. Rubber plantations were opened by Hofland in 1864 in the Pamanukan and Ciasem areas, West Java. The first type to be planted was *Ficus elastica*. Rubber plants were planted in the East Sumatra area in 1902, then brought by foreign plantation companies to be planted in South Sumatra. At that time, farmers cleared the forest to plant rice for two years, and then the field was abandoned. Before leaving the field, they usually planted perennials such as rubber and fruits. Then they would come back 10–12 years later to tap their rubber.

The Harrison and Crossfield Company was the first foreign company to start planting rubber in South Sumatra, followed the Société Financière des Caoutchoucs Company from Belgium in 1909 and an American company called Hollands-Amerikaanse Plantage Maatschappij (HAPM) in the year 1910–1991. The expansion of rubber plantations in Sumatra went smoothly due to the availability of adequate transportation facilities. This transportation is a legacy from the tobacco plantation business that has been overhauled. Soaring rubber prices in 1910 and 1911 added to the enthusiasm of plantation entrepreneurs to develop their businesses. Nevertheless, in 1920–1921 there was a depression in the world economy, which made rubber prices drop. But in 1922 and 1926 there was another price explosion due to a lack of world rubber production, while the car industry in America increased the demand for rubber.

Smallholder rubber plantations in Indonesia also developed as world rubber demand rose and prices exploded. Other things that promoted the opening of smallholder rubber plantations in some areas were the relative ease of maintenance of rubber plants and people's confidence in the bright future of rubber plantations.

In 1922, the explosion of high rubber prices made people compete to open their own rubber plantations. The Dutch Indies government at that time did not make regulations regarding the opening and exploitation of rubber plantations by the people. As a result, rubber plantations in Indonesia expanded uncontrollably, so that the rubber production capacity became excessive. The price of rubber has become difficult to maintain at a reasonable rate.

In order to maintain rubber prices, the Dutch Indies government planned to impose restrictions on producing rubber and its exports (export tax regulation). In fact, those policies were unable to implement. While export tax caused production to fall, it also reduced prices at the farmers' level.

From 1937 to 1942, the Dutch Indies government applied a coupon policy. The coupon functioned as a rubber export permit given to rubber farmers, not to exporters. Farmers who had coupons could sell their rubber directly abroad. If the rubber farmer did not wish to sell his rubber directly abroad, he could sell that coupon to other farmers or to traders or exporters. This coupon system provided social security for rubber owners because even though their rubber trees could not be tapped, rubber owners still received coupons that could be sold or cashed. This coupon system also functioned to limit rubber production.

By 1944, the Japanese government-controlled Indonesia. They made a new policy prohibiting the expansion of smallholder rubber plantations and increased export taxes up to 50% on smallholder rubber production. The impact of this policy was economic pressure on smallholder rubber farmers.

After World War II ended, demand for rubber increased again. Following Indonesia's independence in 1945, rubber plantations controlled by the Japanese were repossessed by the Indonesian government. They managed state rubber plantations (including smallholders'' plantations) and private rubber plantations so that Indonesia controlled the international natural rubber market. On the other hand, the government was less concerned with expanding land and rejuvenating old rubber plantations, leading to a significant decline in rubber production in the following years.

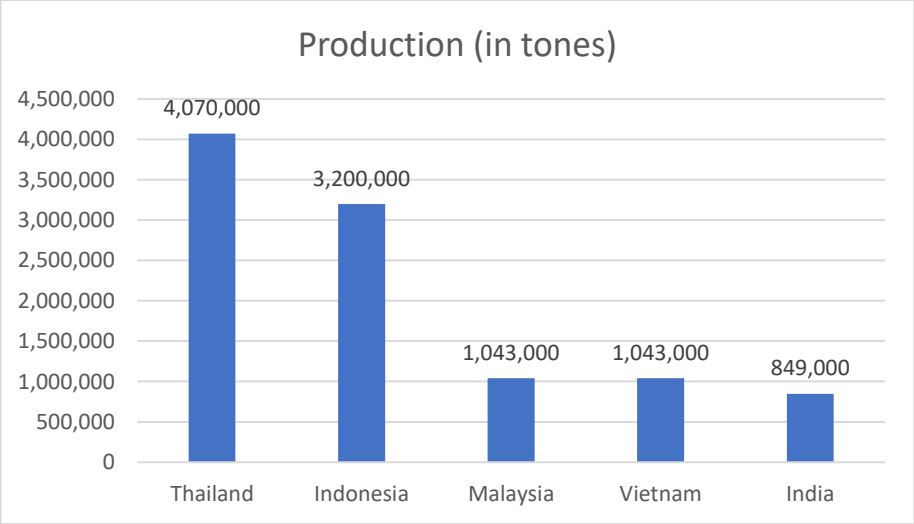
The development of rubber plantation in Indonesia from 1969 to 1994 was directed to encourage the improvement of the rural economy in order to increase farmers' welfare. In 1968, smallholder rubber plantation was around 1.7 million ha; it increased to 2.6

million ha in 1993. By that time, the area of old rubber plantations had reached 401 thousand ha, because farmers preferred to plant new rubber plantation by opening new land (from the forest) rather than rejuvenate their old rubber (Forum Pengkajian Perkaretan, 1994).

2. Rubber in Indonesia and the International Market

Rubber, known for its elastic quality, is a commodity that is used in many industrial and household products and applications around the globe. There are two types of rubber: natural and synthetic. Natural rubber is made from the juice (latex) of the rubber tree, whereas synthetic rubber is made from petroleum. Both types are interchangeable and as such influence each other's demand; when the price of petroleum rises, demand for natural rubber will increase. But when supply disruptions of natural rubber cause its price to rise, then the market tends to turn to synthetic rubber.

This section discusses Indonesia's natural rubber sector. Indonesia is one of the largest producers and exporters of natural rubber. It takes seven years for a rubber tree to reach a productive age, after which it can produce for up to 25 years. Due to the long cycle of the tree, short-term supply adjustments cannot be made.



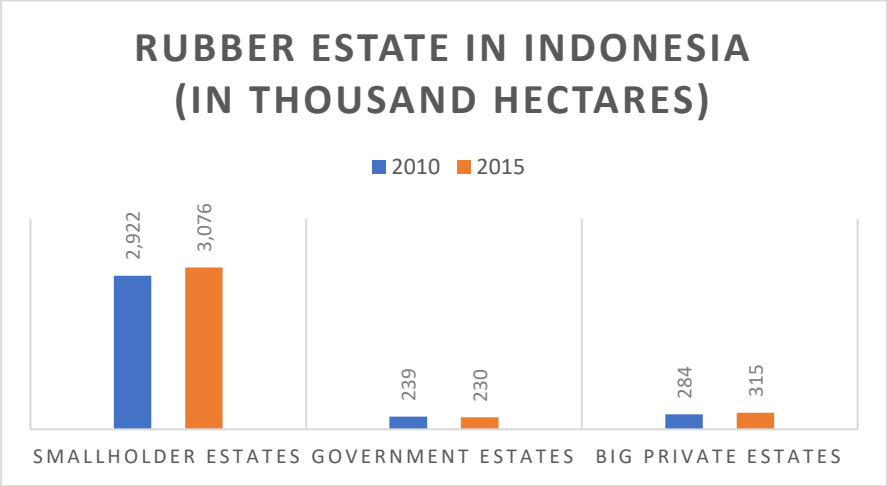
Source: Indonesian Rubber Association, 2014

Figure 5. Five Natural Rubber Producers, 2014

As the second-largest rubber producer, Indonesia has supplied a substantial amount of rubber to the global market. Since the 1980s, the Indonesian rubber industry has been experiencing steady production growth. Most of the country's rubber output—

approximately 80% is produced by smallholder farmers. Government and private estates thus play a minor role in the domestic rubber industry.

The total size of Indonesia's rubber plantation area has risen steadily over the last decade. In 2016, the country's rubber plantations covered a total of 3.64 million ha. As prospects of the rubber industry are positive, there has been a shift away from commodities such as cocoa, coffee and tea, in favour of the establishment of palm oil and rubber plantations. Smallholder rubber estates have increased over the past couple of years, while government rubber estates have shown a slight decrease, probably due to their shift in focus to large palm oil estates. Meanwhile, the size of big private rubber estates initially showed a decline between 2010 and 2012 but has started to expand at a fast rate since 2013.



Source: Indonesian Rubber Association, 2015

Figure 6. Land Size of Rubber Estates in Indonesia

Around 85% of Indonesia's rubber production is exported. Almost half of export is shipped to other Asian countries, followed by North America and Europe. The top five Indonesian-rubber-importing countries are the USA (which accounts for almost 22% of Indonesia's total rubber exports), China, Japan, Singapore, and Brazil.

Domestic rubber consumption in Indonesia is mostly absorbed by Indonesia's manufacturing industries (the automotive sector). Considering that the country's manufacturing industry has difficulty expanding significantly, domestic rubber consumption is rising only at a slow pace.

Compared to its rubber-producing competitors, Indonesia is at a low level of productivity per hectare. This is in large part due to the overall older age of its rubber trees, in combination with the low investment capability of smallholder farmers, hence reducing yields. Whereas Thailand produces 1,800 kilograms (kg) of rubber per hectare per year, Indonesia only manages to produce 1,080 kg/ha. Vietnam (1,720 kg/ha) and Malaysia (1,510 kg/ha) have higher rubber productivity as well.

Indonesia's downstream rubber industry is still underdeveloped. Today, the country depends on imports of processed rubber products due to the lack of domestic processing facilities and the lack of a well-developed manufacturing industry. The lack of domestic consumption of rubber explains why Indonesia exports about 85% of its rubber production. However, in recent years there is a change visible (although a slow one) as exports have slightly declined on the back of increased domestic consumption. About half of the natural rubber that is absorbed domestically in Indonesia goes to the tire manufacturing industry, followed by rubber gloves, rubber thread, footwear, retreat tires, medical gloves, carpets, and other tools.

As the world's largest rubber importer, policies in China can have far-reaching effects on the global rubber industry. In late 2014, the Chinese government decided to approve a new standard for compound rubber imports. The crude rubber content permitted in imported compound rubber was cut from 95–99.5% to 88%. As a result, compound rubber imports into China became subject to a 20% import duty (the same tariff as natural rubber import duties). China's new policy is a blow to its rubber suppliers in Indonesia, as it results in declining usage of compound rubber in the world's second-largest economy.

Another problem was that the USA removed Indonesian-made tires from its generalized system of preference. This US program was designed to support developing countries by cutting import duties and taxes for about 5,000 products from 123 countries. Indonesian-made tires were removed from the list, as the USA believes that Indonesia's tire industry is already sufficiently competitive. This means that tire exports to the USA are now subject to a 5% import tax.

A key driver for the global rubber market is the Asia-Pacific region, where demand is growing robustly, led by China, the world's leading rubber consumer, which is expected to account for nearly 40% of total worldwide rubber consumption by 2021

(mostly in its tire manufacturing industry). Meanwhile, strong growth in rubber consumption is also expected to occur in Indonesia, India, Vietnam, and Thailand on the back of developing automotive industries in these countries.

Like most other key commodities, international rubber prices have been under pressure after 2011 amid weak global economic activity (which had a negative impact on the automotive industry) as well as a natural rubber supply glut. Moreover, low crude oil prices made synthetic rubber very competitive; thus the price of natural rubber sunk significantly between early 2011 and late 2017. Meanwhile, advances in the development of bio-based tires also pose a threat to the rubber industry.

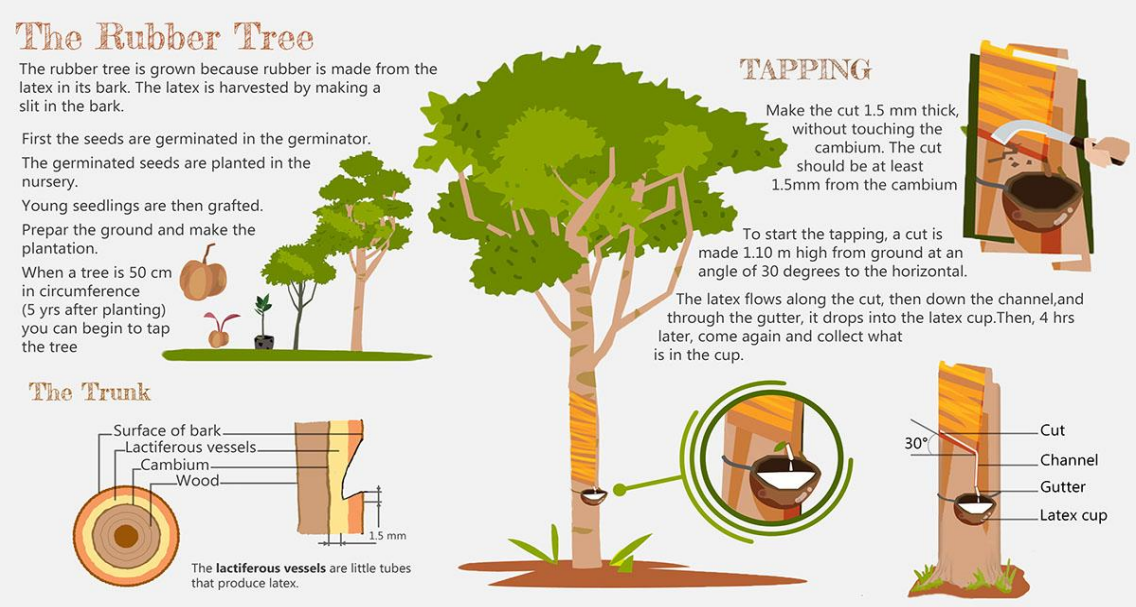
1. Characteristics of Rubber in Indonesia

Rubber is an annual estate crop in the form of a straight trunk tree. The first rubber trees grew only in Brazil, but after repeated trials by Henry Wickham, this tree was successfully developed in Southeast Asia. Nowadays rubber plantation is widely developed as a source of natural rubber. In Indonesia, Malaysia, and Singapore, rubber plants were first cultivated in 1876. The first rubber plants in Indonesia were planted in the Bogor Botanical Gardens. Indonesia once controlled the world's rubber production, but currently Indonesia's position is being challenged by two neighboring countries, Malaysia and Thailand. More than half the rubber used today is synthetic, but several million tons of natural rubber are still produced each year, and it is still an important material for several industries, including automotive and military.

The botanical classification of rubber plants is as follows:

Division:	Spermatophyta
Subdivision:	Angiosperms
Class:	Dicotyledonae
Family:	Euphorbiaceae
Genus:	Hevea
Species:	Hevea brasiliensis

Figure 7 introduces the rubber tree and illustrates how rubber trees are developed from seeds. Tapping is the important part in harvesting; farmers should be aware of the layers of tree trunk and how to tap correctly.

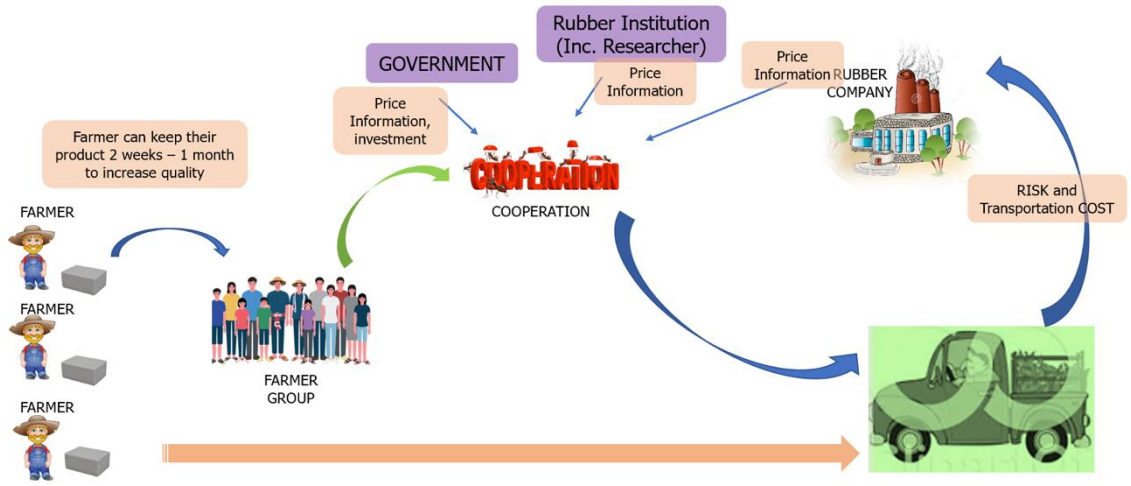


Source: behance.net, 2018.

Figure 7. Rubber Tree, the Trunk and Tapping

Rubber plantations grow in various regions in Indonesia. Normal rubber trees are tapped in their fifth year. The product from the latex clump is processed to produce rubber sheets, chunks, or crumb rubber, which are the raw materials for the rubber industry. Rubber is exported from Indonesia in various forms, such as industrial raw materials (sheet, crumb rubber, SIR) and their derivative products, such as tires, components, and so on.

Commonly used rubber products or processed into several products include RSS I, RSS II, RSS III, crumb rubber, lump rubber, and latex. The main product of rubber trees is latex, which can be sold or traded in the form of fresh latex, slab/coagulation, or smoke/wind sit. Furthermore, these products will be used as raw material for crumb rubber factories that produce various raw materials for various downstream industries, such as tires, balls, shoes, rubber, gloves, swimsuits, rubber bands, and rubber toys. The flow of rubber product from smallholder farmers to the factory is shown in Figure 8.



Source: Author illustration, 2018.

Figure 8. Rubber Marketing Process

CHAPTER II

RUBBER SMALLHOLDERS' ECONOMIC CONDITIONS UNDER THE RUBBER PRICE FALL

1. Objective

This chapter presents the economic situation of rubber smallholders under the price fall compared to that of oil palm smallholders and considers a solution for the situation through empirical analysis.

2. Result and Discussion

2.1. The Farming Characteristics of Rubber and Oil Palm

Both rubber and oil palm are perennial crops. Rubber can be harvested after five years and oil palm after three years; both are productive for 25 years. Table 1 presents the economic characteristics of both crops. Initial investment per hectare is larger for oil palm than rubber. The cost per oil palm is greater than that of rubber trees. Moreover, oil palm needs more input materials, such as fertilizer, during the growing period. The annual material cost per hectare of oil palm is also greater than that of rubber. On the other hand, the revenue of rubber is higher than that of oil palm due to high labour costs. The value added per hectare of rubber is also larger than that of oil palm. Rubber has higher profitability per hectare than oil palm, but requires five times more working days. Due to large labour input, the value added per labour is much smaller for rubber than that of oil palm. But the working hour of oil palm is concentrates at harvest time. Therefore, most oil palm smallholders hire workers for harvest, while most rubber smallholders only employ family workers.

Table 1. Economic Characteristics of Rubber and Oil Palm

		Rubber	Oil Palm
Initial Investment	US$/ha	1,574.2	1,807.1
Material Cost	US$/ha	224.2	250.9
Production		5,893.7	18,448.0
Price	US$/kg	0.5	0.1
Revenue	US$/ha	2,876.1	2,407.7
Added Value	US$/ha	2,651.9	1,786.9
Working Days	Days/ha	296.8	52.3
Added Value per Labour	US$/Day	8.9	34.4

Source: Directorate of General Estate Crop, 2016.

Rubber is expected to bring larger profits per hectare, while oil palm brings greater profit per labour. Therefore, compared to oil palm, rubber can be said to be more suitable for poor smallholders as they have more labour and less land.

Moreover, there is another factor that makes it easier for smallholders to introduce rubber than oil palm. Harvested oil palm plants must be processed within 24 hours, so farmers must secure processing factories near their farm. Therefore, most oil palm farms are either large estates that have their own factories or smallholders contracted by the factories. On the other hand, farmers can store rubber for long periods without any specific storage facilities. In addition, they can sell rubber through middlemen or other marketing channels without a contract at any time. Therefore, farmers can decide to introduce rubber with less consideration for marketing.

2.2.The Economic Conditions of Rubber and Oil Palm Smallholders

2.2.1. The Characteristics of Respondents

As shown in Table 2, the respondents can be classified into six groups according to cultivated crops and side jobs. Groups A and B are oil palm smallholders, groups C and D are rubber smallholders, while groups E and F are smallholders cultivating both crops. Groups B, D, and F were engaged in side jobs.

The smallholders who cultivate only oil palm or rubber are 70 respectively. Only seven respondents indicated that they cultivate both crops. Most smallholders cultivated a single crop and the proportion of oil palm and rubber smallholders is equal. A total of 90 respondents have side jobs, while 57 respondents do not.[2)] There is no significant difference in the proportion of oil palm and rubber smallholders with side jobs. The main side jobs held by respondents were small shops, traders, farm workers, company employees, and government officials, most of which were traditional jobs in the villages. The income from side jobs accounted for only 13% of respondents' total income. Even for the respondents with side jobs, it made up 20.3% of the total income. Although more than half of the respondents had side jobs, the income from these jobs only comprised a small part of their total income and did not significantly influence their economic condition.

(2) Sugino and Kobayashi (2015) point out that job diversification has progressed in rural areas of Indonesia.

Table 2. Groups of Respondents

Groups	Type	Number of Respondents	Percentage
Group A	Oil Palm Smallholders without Side Job	28	19.1
Group B	Oil Palm Smallholders with Side Job	42	28.6
Group C	Rubber Smallholders without Side Job	25	17.0
Group D	Rubber Smallholders with Side Job	45	30.6
Group E	Oil Palm and Rubber Smallholders without Side Job	4	2.7
Group F	Oil Palm and Rubber Smallholders with Side Job	3	2.0
Total Respondents		147	100.0

Source: The survey conducted in 2018

Table 3. Socioeconomic Characteristics of Respondents

Farmers Group	Age (year)	Family Member (person)	Family Labour (person)	Cultivating Area(ha)	
				Rubber	Oil Palm
Group A	40.8	3.9	1.6		3.5
Group B	41.6	4.2	2.1		2.8
Group C	35.4	4.1	1.8	2.4	
Group D	38.9	4.1	1.9	2.3	
Group E	51.0	5.3	1.0	1.8	2.8
Group F	33.0	3.7	2.0	2.0	4.3

Source: The survey conducted in 2018

Table 3 presents the socioeconomic characteristics of the respondents by group. The average age of the oil palm smallholders was 41.3, while that of the rubber smallholders was 37.7. The farming history in the area is thought to cause this difference in age. The government ran an oil palm planting program and most of the oil palm smallholders surveyed were children of these farmers. On the other hand, most rubber smallholders have cultivated rubber for a few generations.

The average cultivated area of oil palm smallholders was 3.07 ha, while that of rubber smallholders was 2.38 ha. A large proportion of farmland in the area had been converted from forest, and it was not difficult to obtain forest and convert to farmland before. Areas used for rubber cultivation may be smaller than those for oil palm as rubber cultivation is more labour intensive. Therefore, rubber smallholders cultivated smaller

areas than oil palm smallholders, even though there was room to expand their farmland. Smallholders cultivating both crops cultivate much larger areas than single crop smallholders.

There was no significant difference in the number of family members among the groups. However, there was a difference in the number of family workers between the groups with and without side jobs. The groups with side jobs had a larger number of family workers; the number of family workers seems to be an important factor regarding having side jobs.

2.2.2. Characteristics of Rubber Farming Practices Compared with Oil Palm Farming Practices in Indonesia

Rubber and oil palm are the most important commercial crops in Indonesia. Figures 9 and 10 show the growing phase and cost of both crops based on the governmental cultivation standard. In general, rubber plants retain their economic value for up to 25 years. Rubber plant growth starts from year 0; at this point, the land is prepared before the rubber plants are planted. In the study, most of the land used for the growth of rubber was from land that had not been utilized or was full of bushes; some, however, were planted in forest areas. Farmers carry out manual and chemical land clearing. Farmers also need to fertilize the land and buy equipment to use over the next four years.

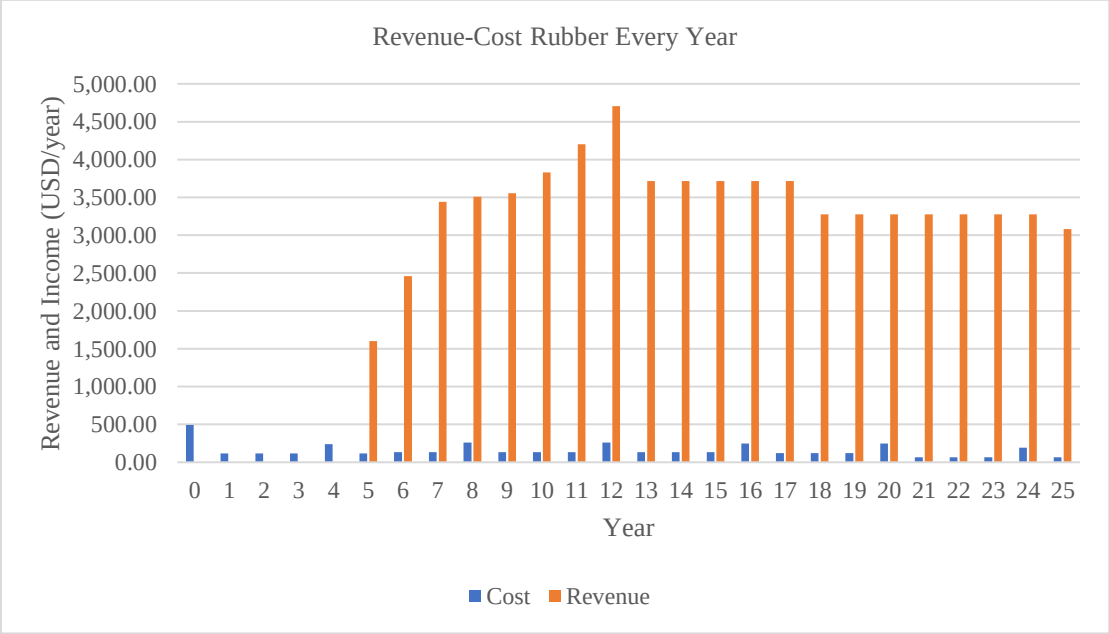
The second phase is the initial growth phase, from the first year to the fifth year. In this phase, the rubber grows but is not yet produced; farmers only carry out less intensive maintenance. Fertilization is carried out twice a year; the application of chemicals depends on the attacking insects and weeds but is usually carried out twice a year as well.

In the third phase, the rubber trees start producing. The production graph illustrates that yields tend to increase from the sixth year to the fifteenth year. Farmers must increase the fertilizer dosage so that production can be maximized.

Cost (USD/ha/year)	Year 0	Year 1–5	Year 6–15	Year 16–20	Year 21–25
Rubber tree	271.08				
Tools for every 4 years	125.49				
Fertilizer	76.66	98.04	115.50	111.04	55.46
Chemical	17.74	17.74	17.74	11.83	11.83
Labour Used	Year 0	Year 1	Year 2–4	Year 5–25	
Working days (day/ha/year)					
Family labour	60	6	18	188	
Hired labour	0	0	0	0	
Potential income for family labour (USD/ha)	315.44	31.54	31.54	988.37	
Wages hired labour (USD/ha)	0	0	0	0	

Source: Recalculated Data from Directorate General of Estate Crops, 2016.

Figure 9. Rubber Growing Phase



Source: Recalculated Data from Directorate General of Estate Crops, 2016.

Figure 10. Rubber Revenue and Cost, Year 0–25

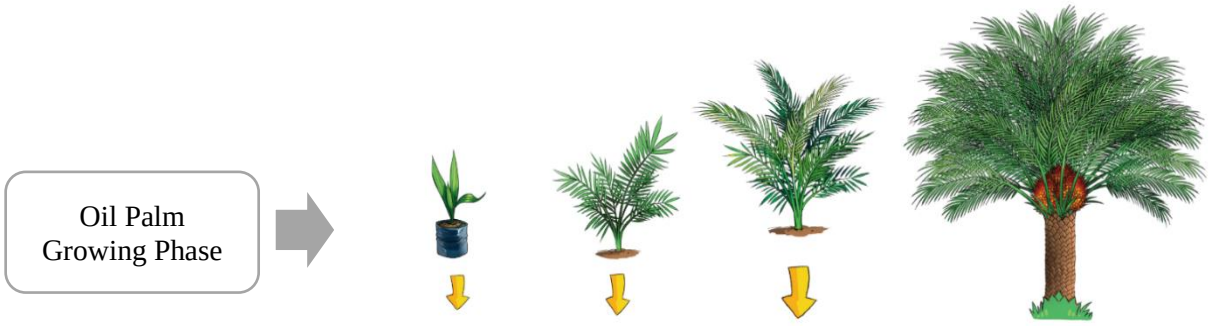
The fourth phase is the optimum rubber production phase in the sixteenth to twentieth years. In this phase, the amount of fertilizer will be slightly reduced (by 3.8%) from the previous phase. The use of chemicals for eradicating weeds will also be reduced, because trees are hardy enough to survive weed attacks.

The last phase is the phase where rubber production shows a significant decrease due to age. Production of rubber plants between the ages of 21 and 25 years is no longer responsive to the amount of fertilizer. Consequently, the dosage of fertilizer will be reduced by 52%. In this phase, farmers are expected to have prepared funds for the next planting.

The use of labour in rubber plantations tends not to fluctuate. Year 0 is the year of preparation for planting. The working time needed is 60 days per hectare if it is done by only one worker. In the first year, farmers only plant, while intensive care is carried out in the second to fourth years. The use of labour increases because rubber has entered the harvest period. Harvesting is done once every two days. Calculation of working time is based on family labour only; wages are not calculated as a cost.

Like rubber, oil palm retains its economic value for up to 25 years. Cost calculation, including equipment, fertilization, chemicals and labour, is divided into four phases according to its annual requirements. The oil palm growth phase is seen in Figure 11.

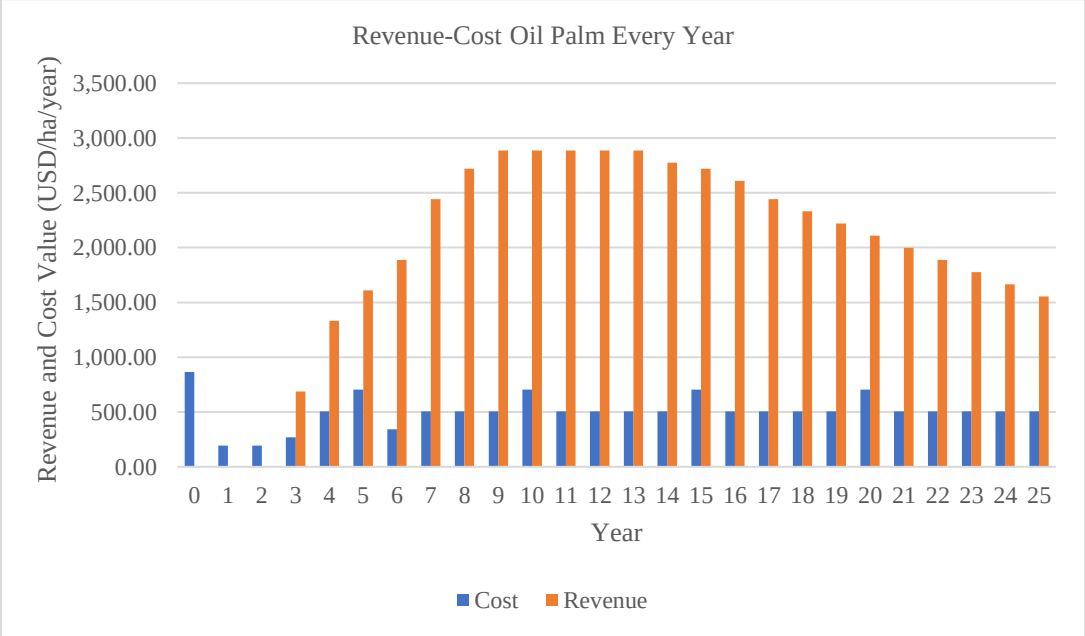
The growth phase of oil palm starts from year 0, the stage of land preparation. Most oil palm plantations use machines to prepare the land. These machines are usually rented, or people are hired to clear the land. The second phase, from the first year to the second year, is the initial growth phase. In this phase, the oil palm grows and has not yet produced. Unlike rubber, farmers are more concerned about growing oil palm. Oil palm is susceptible to pest attacks; consequently, in this phase farmers should pay more attention to fertilizer dosages. The third phase is in the third year, in which oil palm needs more fertilizer due to production preparation for the following year. In the fourth phase, oil palm starts producing. The production graph illustrates that growth tends to increase from the fourth year to the thirteenth year and slightly decreases from year 14 to year 25.



Cost in Average (USD/ha)	Year 0	Year 1–2	Year 3	Year 4–25
Oil palm tree	440.24			
Tools for every four years	198.55			
Fertilizer	9.65	158.68	235.04	164.35
Chemical	35.33	35.33	35.33	36.86
Labour				
Working days (day/ha/year)				
Family labour	60	8	8	32
Hired labour	0	0	0	24
Potential income for family labour (USD/ha/year)	315.44	42.06	42.06	168.23
Wages (USD/ha/year)	0	0	0	136.13

Source: Recalculated Data from Directorate General of Estate Crops, 2016.

Figure 11. Oil Palm Growing Phase



Source: Recalculated Data from Directorate General of Estate Crops, 2016.

Figure 12. Oil Palm Revenue and Cost, Year 0–25

Table 4 shows the farming characteristics of both crops as shown by the previous studies. Oil palm requires a larger initial investment per area than rubber. This difference is mainly caused by the difference in cost of planting trees. Palm oil companies require the farmers to grow trees from certified seeds, which they must purchase at a cost of $3–4 per tree. On the other hand, it isn't necessary to use certified seeds to grow rubber. There are some farmers who use non-certified seeds or get seeds by themselves.

Table 4. Farming Characteristics of Oil Palm and Rubber Based on Previous Studies

No	Indicators	Oil Palm		Rubber	
		Price 2011	Price 2016	Price 2011	Price 2016
1	Capital for 1 ha land area (USD)	1,328.15	1,328.15	1,079.60	1,079.60
2	Cost (USD/ha/year)	523.22	523.22	144.60	144.60
3	Revenue (USD/ha/year)	916.50	1,883.91	5,652.04	2,876.12
4	Potential income from family labour (USD/ha/year)	164.03	164.03	808.36	808.36
5	Income (USD/ha/year)	393.28	1,360.69	5,507.44	2,731.52
6	Total income (4 + 5) (USD/ha/year)	557.31	1.524,72	6,315.80	3,539.88
6	Total income / Capital (%)	42%	115%	585%	327%
7	Total income / Working Day	10.65	29.14	41.72	18.05
8	Working Day (working days/year)	52.32	52.32	151.36	151.36

Source: Recalculated Data from Directorate General of Estate Crops, 2009.

The annual cost of oil palm is higher than that of rubber because oil palm needs more intensive maintenance than rubber. Oil palm farmers tend to depend on hired labour, while a large part of the work of rubber farming is done by family workers. On the other hand, as farm work is concentrated on harvesting, most oil palm farmers must hire workers for harvesting. Comparing the costs other than that of family labour, oil palm is more costly than rubber per area.

The number of annual working days needed for rubber farming is three times greater than that needed for oil palm farming. This difference is because of the harvesting method. Usually, rubber is harvested every two days, while oil palm is harvested only twice a month.

We can therefore establish that rubber is labour intensive farming, while oil palm is capital intensive. Therefore, rubber is more suitable than oil palm for poor smallholders, who have more labour and less capital.

Moreover, there is another factor which makes rubber easier to introduce than oil palm. Harvested oil palm plants must be brought to processing factories within 24 hours. The farmers, therefore, must secure processing factories near the farm. Therefore, most of oil palm farms are large estates which have their own factories or smallholders contracted with the factories. On the other hand, farmers can keep rubber for rather long periods without any specific storage facilities. Also, they can sell rubber through middlemen or other marketing channels without a contract at any time. Therefore, farmers can decide to introduce rubber with less worry about marketing.

Table 1 shows the profitability of both crops calculated based on the sales prices of 2011 and 2016. According to the calculation based on the 2011 price, rubber can bring higher income per land unit than oil palm, while oil palm can bring higher income per labour and capital than rubber. It shows that rubber was suitable for smallholders who have more labour but less land and capital, and oil palm is suitable for farmers who have much land and capital, but less labour in 2011. But according to the calculation based on the 2016 price, oil palm can bring higher income than rubber, not only per labour and capital but per land unit. It means oil palm is a better crop than rubber for every farmer, including smallholders with less land and capital.

2.2.3. Respondents' Income and Economic Conditions

Table 5 presents the respondents' income and their economic conditions by group. Oil palm smallholders earned much larger incomes than rubber smallholders. The average income of oil palm smallholders (groups A, B) was 5,060 US$/year, while that of rubber smallholders was 2,819 US$/year, a difference of 79%. The respondents with side jobs earned larger incomes than those without side jobs, but the difference between them was small in comparison with the difference between crops. The respondents cultivating both crops earned the largest income among the groups because of their large farms.

As shown in Table 2, according to government estimates, rubber smallholders can earn more profit per hectare than oil palm smallholders. Among the respondents, cultivated areas for rubber smallholders were 22.5% smaller than those of oil palm smallholders, and rubber smallholders' farming income was less than half that of oil palm

smallholders. The reason for this situation is that rubber production per hectare was less than the standard production indicated by the government, while oil palm production per hectare was almost the same as the standard production (Table 6). The average productivity of rubber is only 46.3% of the standard productivity, while that of oil palm is 97.8%.

Table 5. Total Farmer Income per Group (Calculated by crop price in 2016)

Group	A	B	C	D	E	F
Family Member (persons)	3.93	4.17	4.12	4.13	4.25	3.67
Rubber Income (US$/year)			2,304.20	2,250.20	1,513.80	1,772.50
Oil Palm Income (US$/year)	4,909.10	4,279.80			3,610.00	6,796.20
Income from other sources (US$/year)		881.10		855.60		852.90
Total Income (US$/year)	4,909.10	5,160.90	2,304.20	3,105.70	5,123.70	9,421.60
Estimated Expenditure (US$/year)[3)]	2,584.30	2,741.00	2,710.30	2,719.10	3,453.70	2,412.10
Total Farmer Income - Estimated Expenditure (US$/year)	2,324.80	2,419.80	-406.10	386.70	1,670.00	7,009.50
Percentage of Farmers with income less than expenditure (%)	14.3	4.8	64.0	51.1	25.0	0.0

Source: The survey conducted in 2018

Table 6. Respondents' Productivity Compared with the Government Standard

(kg/ha,%)

	Average Production of the Respondents ①	Standard Production ②	①/②
Rubber	2,712	5,894	46.0
Oil Palm	18,025	18,448	97.7

Note: Standard is the expected production of recommended farming practice by the government.

Source: The survey conducted in 2018

[3)] According to the Indonesian Central Bureau of Statistics (2017), a family living in a village with four family members (father, mother, and two children) requires a minimum living cost of $ 163.60/month, with 55.83% of that value used for food fulfilment.

Table 5 also shows the proportion of respondents whose incomes were lower than their minimum living expenditure. The proportion is less than 25 %, except groups C and D; the proportion of these was more than 50 %. Around two-thirds of group C were unable to earn more income than their minimum expenditure. A total of 64 % of rubber smallholders had incomes lower than their minimum living expenditure. As previously mentioned, the economic conditions of rubber smallholders could be said to be very severe.

The rubber price fall is thought to have worsened the rubber smallholders' economic conditions. Table 7 shows the estimation of respondents' economic conditions calculated by the estimated price and minimum living expenditure in 2011, the most recent peak of the price of rubber. Farming income was obtained by multiplying the price in the survey by the change rate between 2011 and 2016, shown in Table 1. Rubber smallholders' estimated income in 2011 was more than twice that in 2016 in nominal value, and largely exceeded their minimum living expenditure.

Table 7. Estimation of Total Farmer Income per Group (Calculated by crop price in 2011)

Group	A	B	C	D	E	F
Family Member (person)	3.93	4.17	4.12	4.13	4.25	3.67
Rubber Income (USD/la/year)			4,777.80	4,670.50	3,065.70	3,673.70
Oil Palm Income (USD/la/year)	3,475.00	3,039.90			2,582.30	4,732.50
Income from Other Sources (USD/year)		881.10		855.60		852.90
Total Farmer Income (USD/year)	3,475.00	3,921.00	4,777.80	5,526.10	5,648.00	9,259.10
Estimated Expenditure (USD/family/year)	1,565.90	1,660.80	1,642.20	1,647.60	2,092.70	1,461.50
Total Farmer Income - Estimated Expenditure (USD/year)	1,909.10	2,260.10	3,135.60	3,878.50	3,555.40	7,797.60
Percentage of Farmers with Income less than Expenditure	25.0	16.7	8.0	2.2	25.0	0.0

Source: The survey conducted in 2018

The proportion of respondents whose income was lower than their minimum living expenditure decreased to 8%, while it was around two thirds in 2016. Moreover, in the

case of calculation by the 2011 price, rubber smallholders' income surpassed that of oil palm smallholders. Before the price fall, rubber smallholders were able to earn similar incomes to oil palm smallholders, and their economic conditions were not as bad as they are at present. The severe situation for rubber small holders was caused by the fall in the price of rubber.

2.3. Improvement of Rubber Smallholders' Economic Conditions

The situation in which more than half of rubber smallholders cannot earn incomes larger than their minimum living expenditure must urgently be solved. Conversion to oil palm is a possible solution, but it is not easy to do so. Conversion means replacing rubber trees with oil palm trees. In this case, they cannot earn income for several years until oil palms can be harvested. Moreover, they must prepare a large amount of capital and secure processing factories before planting. Oil palm farming requires more land than rubber farming because its land productivity is not so high. However, it is not easy to expand farmland, as the government prohibits the conversion of forest to farmland due to environmental concerns. Therefore, conversion to palm oil is not a realistic solution.

The solution for improvement of smallholders' income should be considered within the area of rubber farming. There are two measures to increase rubber farming income: price increases and productivity.

The farm price of rubber in Indonesia is lower than that in other dominant rubber producing countries, such as Thailand (Antoni et al., 2018). The main reason for this situation is that smallholders have weak bargaining power under the traditional market system, which is controlled by middlemen. The Indonesian government has introduced a policy that encourages rubber smallholders to organize joint marketing bodies called processing and marketing units. The sales by these units have raised the price of rubber compared to the traditional market (Antoni et al., 2018)[3].

If the rubber price increased by 24%, which is the price difference between sales through processing and marketing units and the traditional market shown in Antoni et al. (2018), the proportion of rubber smallholders whose income is lower than their minimum living expenditure would decrease to 50 %.

3) Processing and marketing units are also expected to contribute to improve the quality of rubber (Agustina, D. S. et al., 2017).

There also seems to be room for an increase in productivity. As previously mentioned, rubber production per hectare was less than half the standard production indicated by the government, while oil palm production per hectare was almost the same.

The standard production shows the expected production of the government recommended farming practice. Most of the oil palm smallholders started their cultivation under the governmental program and have been supported by palm oil companies. Therefore, most were able to obtain required input materials and practiced the standard technical method. On the other hand, most of the rubber smallholders have continued their family-run farms over several generations and their farming practices appear to be traditional.

The productivity of rubber smallholders is expected to increase through the improvement of their farming practices. If rubber smallholders can increase their production per hectare by 50 %, which is almost half of the gap between their actual production and the standard production, the proportion of rubber smallholders whose income is lower than their minimum living expenditure would decrease to 33%. If the price rise and improvement in productivity were achieved, the proportion would decrease to 27%.

3. Conclusion

In South Sumatra province, rubber smallholders were able to achieve income equivalent to that of oil palm smallholders before the fall in the price of rubber. The price fall has seriously deteriorated the economic condition of rubber smallholders. Nearly two thirds of rubber smallholders were found to be unable to earn sufficient income to meet their minimum living expenditure. Therefore, improvement of rubber smallholders' economic conditions is a problem that urgently needs to be solved. Although conversion to oil palm is one of the solutions, there are many difficulties preventing smallholders from converting from rubber to oil palm farming, and a solution involving rubber farming should be considered first.

The price of rubber is lower in Indonesia than in other rubber producing countries, and respondents' productivity is lower than the government standard. As rubber is a relatively old crop in the area, most rubber smallholders have continued to use traditional marketing methods and farming practices, which are not suitable for profitable farming

management. Improvements in marketing methods and farming practices are the most important issues for the improvement of rubber smallholders' economic conditions.

Though international palm oil prices have declined as well, the economic situation of oil palm smallholders has not worsened compared to that of rubber smallholders. Oil palm farming has been developed by government policy, and oil palm smallholders have close relationship with palm oil companies. Therefore, the government and palm oil companies give various supports to oil palm smallholders, and they seem to contribute to maintaining oil palm smallholders' economy. But rubber smallholders have not had sufficient support from the government, as it is a traditional crop. To enforcement rubber smallholders' capacity, it is important to improve the support of government for rubber smallholders, including price policy.

CHAPTER III
THE PRESENT SITUATION OF RUBBER-FARMING PRACTICES

1. Objective

This chapter aims to describe rubber-farming practices among smallholder farmers and identify the determinant factors causing small quantity and low quality in their products.

2. Data and Methodology

A research framework has been established to answer these objectives, as shown in Figure 13. This figure leads to the construction of a mathematical model which relates several elements.

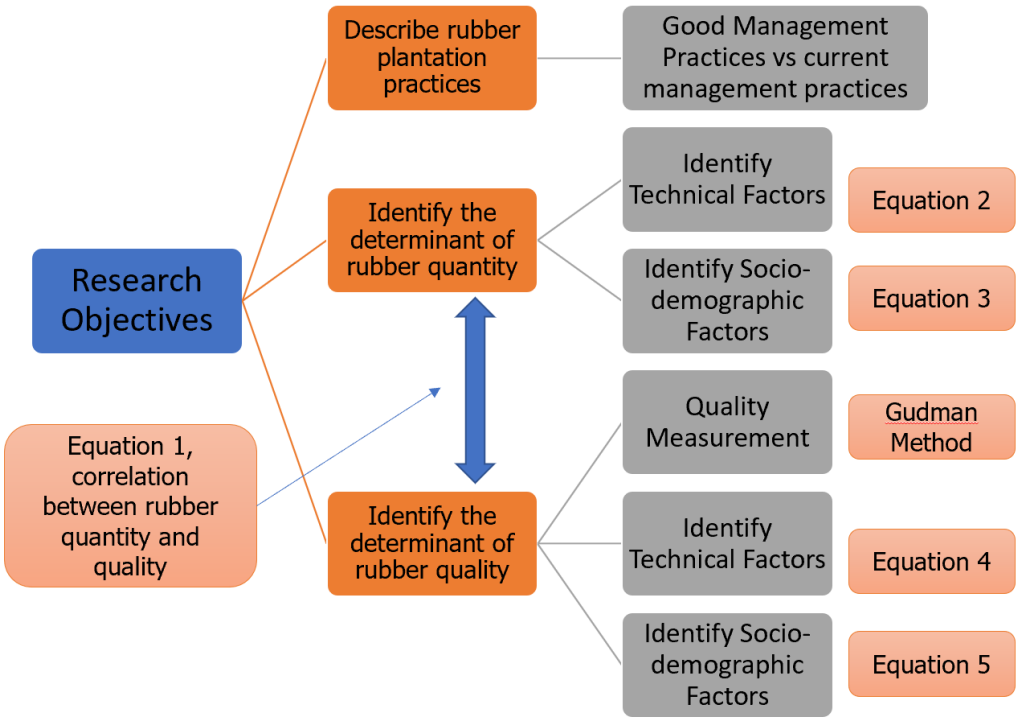


Figure 13. Framework to Identify Rubber Quality and Quantity

The research framework shown in Figure 13 shows a step toward building a statistical model based on several previous studies. The quantity of rubber is represented by production per hectare, while the quality is calculated based on the score using the Gudmann method. The quality of rubber was measured using seven indicators that have

been established by the Indonesian Agriculture Ministry (2008). The quality indicators include type of contaminant, percentage of contaminant, color and smell, application of the immersion process, coagulant, storage duration, and thickness. Regarding the data analysis, a descriptive analysis including mean values and percentages was conducted. As there is no significant correlation between quantity and the quality for each respondent, the determinants of quantity and quality were analysed separately. Sociodemographic and technical variables of rubber quality and quantity are shown in Figure 14.

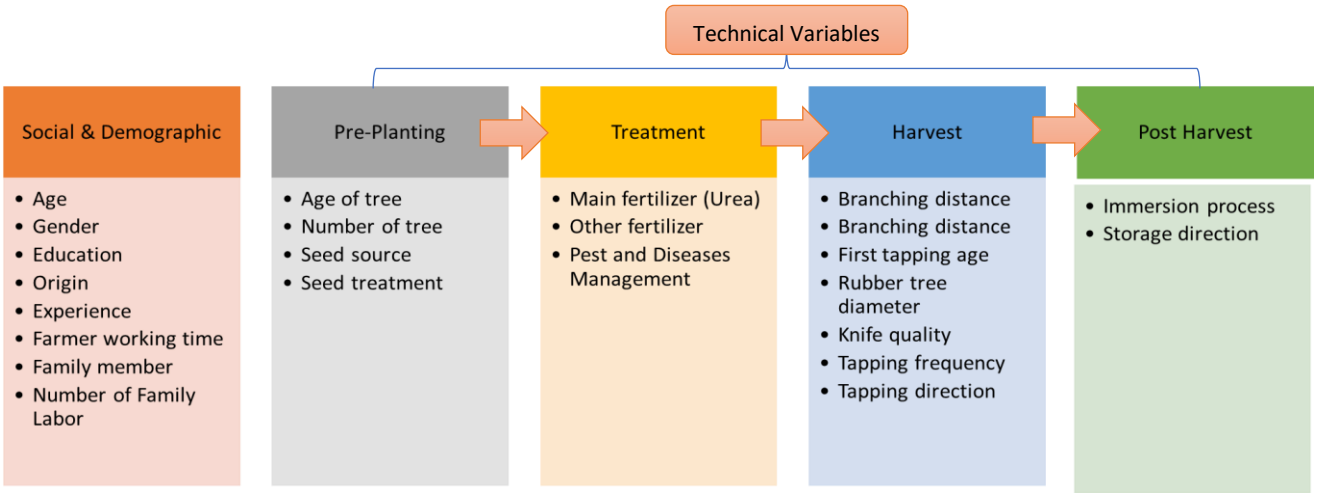


Figure 14. Sociodemographic and Technical Variables of Rubber Quality and Quantity

According to Figures 13 and 14, five statistical models have been created as follows:

Correlation between Quantity and Quality

Y = a + b X ; Y = Quantity; X = Quality … eq. 1

Determinant (technical factors) of Rubber Quantity (Linear Multiple Regression Model)

$$QN = \alpha + \beta_1 U + \beta_2 TA + \beta_3 MF + \beta_4 LA + \beta_5 NT + \beta_6 D_1 + \beta_7 D_2 + \beta_8 D_3 + \beta_9 D_4 + \beta_{10} D_5 + e \quad \text{… eq. 2}$$

QN : production (kg/ha/year)

U : urea (kg/ha/year)

TA : first tapping age (years)

MF : mixed fertilizer (kg/ha/year)

LA : rubber area (ha)

NT : number of trees

D1 : dummy tree diameter (1 = ≥ 45cm; 0 = < 45 cm)

D2 : dummy tapping frequency (1 = every other day; 0 = every day)

D3 : dummy tapping direction (1 = from left-top to right-bottom; 0 = other)

D4 : dummy seed (1 = certificate; 0 = no)

D5 : dummy pest and diseases management (1 = apply; 0 = not apply)

E : standard error

Determinant (socio-demographic factors) of Rubber Quantity (Linear Multiple Regression Model)

$$QN = \alpha + \beta_1 \mathrm{AG} + \beta_2 \mathrm{EXP} + \beta_3 \mathrm{FM} + \beta_4 D_1 + \beta_5 D_2 + \beta_6 D_3 + \beta_7 D_4 + \beta_8 D_5 + \beta_9 D_6 + e \quad \text{… eq. 3}$$

QN : production (kg/ha/year)

AG : farmer age (year)

EXP : farmer experience (years)

FM : number of family member (person)

D1 : dummy education (1 = > junior high school; 0 = junior high school/below)

D2 : dummy ethnic (1 = java; 0 = sumatra)

D3 : dummy farmer status (1 = full-time farmer; 0 = part-time farmer)

For quality measurement, the Gudman method was used. This method uses seven questions from quality indicators. The question has two types of answers (yes/no) scored 0 and 1. There are seven indicators for measuring quality, as follows:

- Contaminant (Based on regulation of Indonesian Ministry, factory role, research institution)
- Percentage of contaminant (Based on regulation of Indonesian Ministry, factory role, research institution)
- Color and smell (Based on research institution)
- Application of immersion process (Based on research institution)
- Coagulant (Based on regulation of Indonesian Ministry)

- Storage duration (Based on research institution)
- Thickness (Based on regulation of Indonesian Ministry)

According to these seven indicators, seven questions have been formulated to get a total score from each respondent. All questions have two types of responses: "a," as the first response, has a score of 1, while "b" has a score of 0.

Table 8. Seven Questions Related to Quality Measurement

Quality Indicators	Respondent	Percentage
1. Contaminant		
a. contain contaminant	38	47.5
b. does not contain contaminant	42	52.5
2. Percentage of light contaminant		
a. up to 5%	38	47.5
b. below 5%	42	52.5
3. Latex smell and color		
a. Bad	31	38.75
b. Good	49	61.25
4. Immersion process		
a. Applied	68	85
b. Not applied	12	15
5. Coagulant		
a. using improper coagulant	18	22.5
b. using proper coagulant	62	77.5
6. Storage duration		
a. less than 1 week	68	85
b. 1 week or more	12	15
7. Thickness		
a. > 150 mm	75	93.75
b. ≥ 150 mm	5	6.25

Source: Author's calculation, 2017.

The total score for each respondent was around 0 for minimum score and 7 for maximum score. After determining the total score for each respondent, the scores were categorized as follows:

a. Good in quality if answer score is greater than or equal to 4
b. Bad in quality if answer score is less than 4 (1–3)

Determinant (technical factors) of Rubber Quality

$$Q = Ln\left\{\frac{p_i}{1-p_i}\right\} = \alpha + \beta_1 \mathrm{RA} + \beta_2 \mathrm{LA} + \beta_3 \mathrm{NT} + \beta_4 + \beta_5 D_1 + \mathrm{e} \quad \text{… eq. 4}$$

Determinant (socio-demographic factors) of Rubber Quality

$$Q = Ln\left\{\frac{p_i}{1-p_i}\right\} = \alpha + \beta_1 AG + \beta_2 EXP + \beta_3 FM + \beta_4 D_1 + \beta_5 D_2 + \beta_6 D_3 + \beta_7 D_4 + e \quad \text{… eq. 5}$$

Q : quality (1 = good quality; 0 = bad quality)

RA : rubber age (years)

LA : rubber area (ha)

NT : number of trees

D4 : dummy seed source (1 = certificate; 0 = no)

3. Result and Discussions

3.1. The Present Situation of Farming Practices

Figure 15 shows the standard rubber-farming practices based on the Directorate General of Estate Crops (2014). However, most of the farmers surveyed did not apply certain steps. The survey showed that farmers adopted an efficient method at the pre-planting stage and planting stages. However, at the time of harvesting, most farmers did not follow the recommended methods. They were not able to survive long waiting periods for the harvest; thus, they did not pay attention to the harvesting criteria or the recommended approach to the harvest.

The technical practice characteristics observed from the survey were compared with the best management practice (BMP) criteria compiled by the government and research institutions. The farmers in this study had an average land area of 2.3 ha. The average use of urea fertilizer was 101 kg/ha/year. This value was significantly lower than the recommended BMP of 700 kg/ha/year. The proportion of farmers who applied urea fertilizer was less than 50%. During fertilizer application, farmers used other fertilizers in addition to urea. On the other hand, farmers who did not use urea fertilizer generally used other fertilizers as alternatives, such as manure. The amount of other fertilizers used

was only 15% of the recommended amount of 520 kg/ha/year. The low fertilizer application would be due to the farmers' inability to buy fertilizers. The farmers in this area were very poor. They had to spend their own funds to fulfil their household consumption needs rather than investing in their rubber plantation.

The number of trees owned by farmers in one hectare was 548, whereas the BMP recommendation is in the range of 460–500 trees per hectare. The use of certified seeds at all times was recommended by the government to maximize rubber production. Certified seed subsidy programmes were implemented on a sustainable basis for farmers, who would plant and replant rubber. The proportion of farmers who have used certified seeds was 76.3 %. The implementation of pest and disease management was also important, and as many as 63.8% of farmers have undertaken this through technical, mechanical, or chemical treatments.

In the harvest and post-harvest management activities, farmers should pay attention to several points, such as tapping age, tree diameter, tapping frequency, and tapping direction. Rubber trees can be tapped from the age of four to five years, depending on their condition. In this study, an average rubber farmer tapped trees at the age of five years. The diameter of the tree is one of the criteria to be considered in tapping, and it should exceed 45 cm. However, only 33.8 farmers could apply this. The diameter of the trees that did not meet the tapping criteria was caused by the lack of nutrient intake.

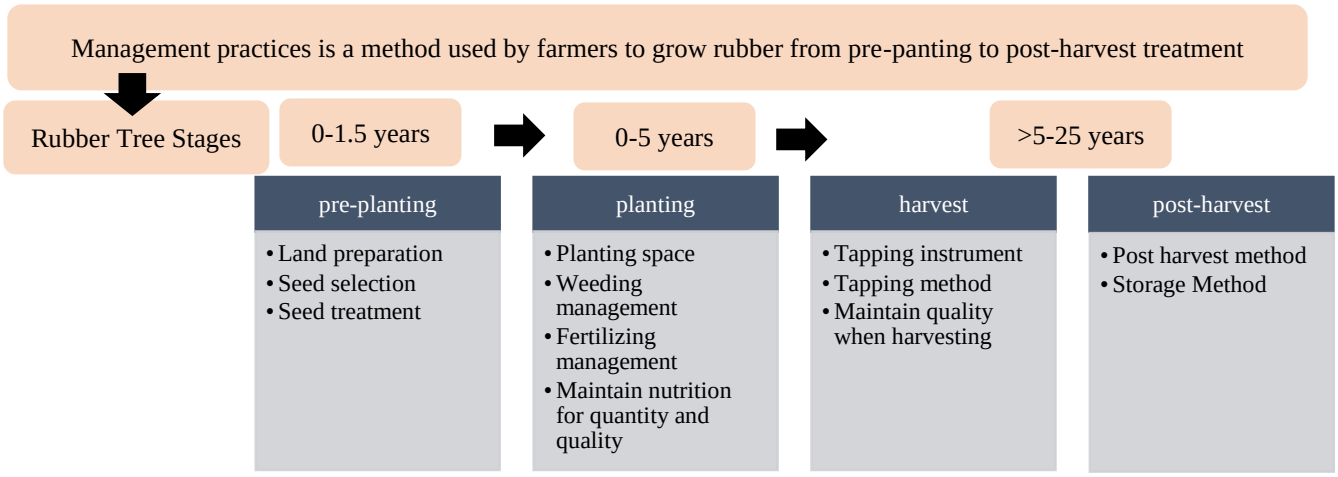


Figure 15. Rubber Farming Practices with Rubber Age

3.2. Determinants of Quantity and Quality

As shown in Table 9, only three technical factors significantly affected the quantity of rubber: number of trees, tapping direction, and seed source. Many of the recommended methods did not influence the farmers' productivity. As most farmers applied much less fertilizer than the recommended quantity, fertilization was not thought to make a large difference in productivity among the farmers. Then, a small amount of fertilizer would result in insufficient tree growth. Many of the farmers tapped the trees before they reached the recommended diameter. Some of the recommended methods may be effective for fully grown trees but may not necessarily be effective in trees that are growing insufficiently. The recommended planting density can achieve the maximum yield with adequately grown trees, but it may not be achieved with insufficiently grown trees. Though most farmers planted more than the recommended number of trees, the coefficient was positive.

Table 9. Determinants (Technical Factors) of Rubber Quantity

Variables	B	t	Sig.
(Constant)	1861.067	2.971	0.004
Urea (kg/ha/year)	0.295	0.460	0.647
Tapping age (year)	-54.988	-0.580	0.564
Mix fertilizer (kg/ha/year)	-0.374	-0.693	0.49
Land area (ha)	-29.790	-0.508	0.613
Number of trees (trees)	1.053	1.795	0.077**
D1 (tree diameter, 0 = d <= 45 cm; 1 = d > 45 cm)	118.232	0.639	0.525
D2 (tapping frequency, 0 = every day; 1 = once in two days)	131.814	0.471	0.639
D3 (tapping direction, 0 = other method; 1 = from top left to bottom right)	210.451	1.237	0.22***
D4 (seed source, 0 = not certified; 1 = certified)	442.084	2.091	0.04*
D5 (pest and disease management, 0 = not applied; 1 = applied)	-69.975	-0.387	0.7

R^2 = 16.50%; df = 79; Fsig = 21.50; DW = 1.983
Note: ***, **, and * denote significance at 5%, 10%, and 25%, respectively.
Source: Author's calculation based on the 2016 survey.

In addition, socio-demographic factors play an important role in rubber production. The regression results (Table 10) show that ethnicity and extension services had a significant influence on the rubber quantity. Sumatran ethnics produced 233.549 kg/ha/year less than Javan ethnics. Furthermore, farmers who gained extension services produced 347.805 kg/ha/year more than farmer who did not use these services.

Javan residents are a migrant population. Considering the government programme, migrant residents are facilitated with residential adjustments, including counsellors in agriculture. Thus, migrant farmers have advantages in terms of appropriate farming practices on rubber plantations. Further, the information shown in Table 10 is the matrix between the technical factors that were significant for productivity and the socio-demographic factors.

Table 10. Determinants (Sociodemographic Factors) of Rubber Quantity

Variables	B	t	sig
(Constant)	2493.260	6.876	0.000
Farmer age (year)	0.314	0.037	0.971
Farmer experience (year)	17.396	0.976	0.332
Number of family members (person)	-0.023	0.000	1.000
D1 (education)	-168.465	-0.661	0.511
D2 (ethnicity, 0 = Javan; 1 = Sumatran)	-233.549	-1.269	0.209***
D3 (farmer status, 0 = part-time farmer; 1 = full-time farmer)	95.753	0.578	0.565
D4 (farmer group, 0 = no; 1 = yes)	-164.997	-0.900	0.371
D5 (extension services, 0 = no; 1 = yes)	347.805	1.721	0.090**

R^2 = 10.80%; df = 79; Fsig = 0.388; DW = 2.156
Note: ***, **, and * denote significance at 5%, 10%, and 25%, respectively.
Source: Author's calculation based on the 2016 survey.

Javan ethnics and farmers involved in extension services gained advantages from adopting the recommended methods. The extension services seem to have had a certain effect on the improvement of the farming practices.

Table 11. Matrix of Quantity Determinants

Socio-demographic factors / Technical factors		Ethnicity		Extension services	
		Sumatran	Javan	Involved	Not involved
1	Average number of trees	542	538	528	576
2	Tapping direction				
	a. Proper technique	25.81	51.02	60.00	28.57
	b. Improper technique	74.19	48.98	40.00	71.43
3	Seed source				
	a. Certified seed (%)	55.1	67.74	100.00	46.34
	b. Non-certified seed (%)	44.9	32.26	0.00	53.66

Source: Author's calculation based on the 2016 survey.

As shown in Table 12, a significant technical factor affecting the rubber quality was the number of trees in one hectare. The rubber quality was thought to be influenced more

by the post-harvest treatment method, such as the application of coagulant and the storage method, than by the cultivation method.

Table 12. Determinants (Technical Factors) of Rubber Quality

Variable	B	Wald	Sig.	Odds ratio
Constant	7.389	10.319	0.001	1619
Rubber age (year)	-0.07	0.697	0.404	0.933
Land area (ha)	-0.065	0.13	0.718	0.937
Number of trees (tree)	-0.011	8.221	0.004*	0.989
D4 (seed source, 0 = not certified; 1 = certified)	0.121	0.036	0.849	1.129

R^2 = 25.6%; df = 79
Note: ***, **, and * denote significance at 5%, 10%, and 25%, respectively.
Source: Author's calculation based on the 2016 survey.

Table 13. Determinants (Socio-Demographic Factors) of Rubber Quality

Variables	B	Wald	Sig.	Odds ratio
Constant	-1.688	1.988	0.159	0.185
Farmer age (year)	0.006	0.061	0.805	1.006
Farmer experience (year)	0.149	3.627	0.057*	1.161
Family member (year)	0.149	0.686	0.408	1.161
D1 (education level, 1 = up to junior high school; 0 = junior high school or below)	0.343	0.170	0.680	1.409
D2 (ethnicity, 1 = Sumatran/local, 2 = Javan)	-0.212	0.140	0.708	0.809
D3 (farmer status, 1 = full-time farmer; 0 = part-time farmer)	-0.613	1.424	0.233***	0.542
D4 (farmer group, 1 = member; 0 = non-member)	0.951	3.040	0.081**	2.589

R^2 = 18.2%; df = 79
Note: ***, **, and * denote significance at 5%, 10%, and 25%, respectively.
Source: Author's calculation based on the 2016 survey.

Table 13 indicates that the socio-demographic factors that had significant effects were farming experience, farmer status, and farmer group. The farmers who had long farming experience, participated in a farmers' group, and had another job could produce higher-quality rubber. The farmers' groups would provide joint facilities for post-harvest treatment, including storage. Farmers who had other skills were more likely to be part-time farmers, in order to earn extra income, than full-time farmers. In simple terms, part-time farmers earned a better income than full-time farmers (Singh, 1981). Therefore, they

could supply the necessary facilities, such as storage, and store rubber for an appropriate period. Rubber storage between two weeks and one month would reduce the water content and improve the quality of the rubber (Gapkindo, 2012).

4. Conclusion

For the analysis of the factors of low productivity of Indonesian rubber farmers, a survey of farmers regarding their cultivation practice was conducted in South Sumatra, which is one of the dominant rubber production areas in Indonesia. Most of the farmers surveyed did not practice many of the recommended cultivation methods. In particular, most farmers applied much less fertilizer than recommended. Under a small amount of fertilizer, many of the recommended methods did not affect the production. Though the recommended methods are appropriate for fully grown trees, they may not necessarily be effective in trees that are growing insufficiently.

On the other hand, Javan ethnics who were easily instructed by extension services and farmers who were involved with extension services had higher productivity than others. The extension services seemed to have a certain effect on improving farming practices. To improve rubber-farming productivity, it seems to be important to support the farmers in improving their fertilizer application and guide them to adopt suitable methods for their actual situation. Regarding the quality of the rubber, several socio-economic factors were significant. These factors seemed to influence the post-harvest treatment, such as storage. To improve the quality, proper facilities and a certain amount of funds are essential. Facilities and financial support are also considered to be important.

CHAPTER IV
GENERAL CONCLUSION AND RECOMMENDATIONS

1. General Conclusion

1.1. Rubber and Oil Palm Characteristics

Rubber is labour intensive farming, while oil palm is capital intensive. Therefore, rubber is more suitable for poor smallholders, who have much labour and less capital, than oil palm. Harvested oil palm plants must be processed within 24 hours. On the other hand, farmers can keep rubber for rather long periods without any specific storage facilities. Also, they can sell rubber through middlemen or other marketing channel without a contract at any time.

Rubber can bring more income per land unit than oil palm, while oil palm can bring higher income per labour and capital than rubber. This shows that in 2011, rubber was suitable for smallholders with more labour, but less land and capital, and oil palm was suitable for farmers with much land and capital, but less labour. But according to the calculation using the 2013 price, oil palm can bring higher income than rubber not only per labour and capital but per land. This means that oil palm is a better crop than rubber for every farmer, including smallholders who have less land and capital.

1.2. Farmers' Characteristics

Most oil palm smallholders in the area were initially involved in government cooperation at the time of the oil palm planting program. Farmers of a similar age were involved in the program. Most oil palm smallholders are children of these farmers, whereas rubber smallholders have cultivated rubber passed down over several generations. Rubber smallholders cultivate smaller areas than oil palm smallholders even though there was room for expanding their farmland. The smallholders cultivating both crops cultivate much larger areas than single crop smallholders.

There is a difference in the number of family workers between the groups with and without side jobs. The groups with side jobs have a rather large number of family workers. Number of family workers seems to be an important factor in smallholders having side jobs.

1.3. Farmers' Income and Economic Condition

The oil palm smallholders received 79% more income than the rubber smallholders did. The respondents with side jobs received more income than the respondents without side jobs. The proportion of rubber smallholders in the respondents whose income was lower than their minimum living expenditure was 64%.

Before the price drop of rubber, rubber smallholders could get income similar to that of oil palm smallholders, and their economic condition wasn't as bad as it is at present. The rubber smallholders' severe situation was caused by the price drop of rubber.

1.4. Possible Solution

There are two measures to increase rubber farming income: a rise in the price and an increase in productivity. The sales through Processing and Marketing Units raised rubber price in comparison to the traditional market. Thus, to improve the proportion of respondents whose income is lower than their minimum living expenditure of rubber smallholders to no more than 8%, it is necessary to raise the rubber price 96.5% from the price in 2016.

The average productivity of rubber is only 46.3% of the standard productivity, while that of oil palm is 97.8%. Most of the rubber smallholders applied farming practices which are very different from the practices recommended by the government. To improve the proportion of respondents whose income is lower than their minimum living expenditure of rubber smallholders to 12.6%, it is necessary to raise their productivity 132.6% from their average productivities as shown in the survey.

1.5. Determinant Rubber Quantity and Quality

Technical factors significantly affected the quantity of rubber: number of trees, tapping direction, and seed source. In addition, sociodemographic factors play an important role in rubber production. Ethnicity and extension services had a significant influence on rubber quantity.

A significant technical factor affecting the rubber quality was the number of trees per hectare. The rubber quality was thought to be influenced more by the post-harvest treatment method, such as application of coagulant and storage method, than by the

cultivation method. Sociodemographic factors that had significant effects included farming experience, farmer status, and farmer group.

Rubber farming could draw the equivalent income to oil palm farming in South Sumatra before the price fall of rubber. But the price fall of rubber has deteriorated the rubber smallholders' economic conditions. Nearly two-thirds of rubber smallholders couldn't earn income equal to their minimum living expenditure. Therefore, improvement of rubber smallholders' economic conditions is a problem which should be solved immediately.

The rubber price in Indonesia is lower than that in other rubber producing countries, and the rubber productivities of respondents are lower than the standard set by the government. As rubber is a rather old crop in the area, most rubber smallholders have continued traditional marketing methods and farming practices, which aren't suitable for profitable farming management. It can be said that improvements in marketing methods and farming practice are the most important issues for the improvement of rubber smallholders' economic conditions.

The price fall of rubber is because of deterioration in international rubber market conditions. Future international rubber market conditions are unclear. There is a possibility that the international rubber price may recover. But because the international market is unstable, it is very important to reinforce rubber smallholders' management capacity for coping even with bad international market conditions.

Most of the farmers surveyed did not practice many of the recommended cultivation methods. In particular, most farmers applied much less fertilizer than recommended. Under a small amount of fertilization, many of the recommended methods did not affect the production. Though the recommended methods are appropriate for fully grown trees, they may not necessarily be effective in trees that are growing insufficiently.

Javan ethnics who were easily instructed by extension services and farmers who were involved with extension services had higher productivity than others. The extension services seemed to have a certain effect on improving the farming practice. For the improvement of rubber-farming productivity, it seems to be important to support farmers in improving their fertilizer application and guide them to adopt suitable methods for their actual situation. Regarding the quality of the rubber, several socioeconomic factors were significant. These factors seemed to influence the post-harvest treatment, such as storage.

To improve the quality, the proper facilities and a certain amount of funds are essential. Facilities and financial support are important.

2. Recommendation

As stated in the general conclusion, the rubber problem in Indonesia were as follow:

First, 80 percent of farmers in Indonesia are small farmers. They only have about 1-2 ha of land. Rubber is the main source of income for farmers to meet their daily needs. Second, farmers in this study still apply traditional patterns in running their farming. This traditional pattern was applied from the pre-planting process to the marketing process. Middleman still dominates in most rural areas. Third, rubber price was unstable and low. This study performs simulation calculations using price data in 2011 and 2016. The results of this study indicate that if rubber prices are good, farmers can meet their daily needs. Fourth, Rubber production and quality were low than standard. Most farmers cannot adopt good management practices recommended by the government. This is due to various factors, first, farmers are unable to buy production inputs due to high fertilizer and chemical prices. Second, more than 50 percent of farmers haven't involve in farmers' groups, so they have difficulty in obtaining government subsidies and information. Third, the number of extension staff that helps farmers in technical and marketing were limited.

This research offers several solutions to solve these problems. This advice for the farmer and government side.

1. From the farmer's side.

Based on several analyzes, oil palm can be used as an alternative besides rubber plants. But in the short term, this is not possible due to several factors. First, oil palm is a type of capital-intensive crop so farmers will find it difficult to develop plantations in the first year. Second, oil palm is an annual crop that requires harvest time for at least 3 years. This means that farmers must have another land to plant oil palm or can use the same land but they must find other sources of income. Third, if farmers want to plant oil palm, connectivity with companies is needed, because it is very important to sell the crops directly. It is because oil palm fruits should be processed not more than 24 hours after harvesting. The solutions offered are as follows: the weakness of farmers is that they do not provide enough inputs for their rubber plants because farmers cannot afford to buy fertilizer. A possible solution is to train farmers to make their fertilizer for their rubber

plants. The average backyard they have is wide and makes it possible to raise livestock. They can use manure to make organic fertilizer and the meat can also be used to fulfill their needs. If fertilizers are available, another factor is that farmers need is an education to apply the correct post-harvest pattern. For this reason, competent extension workers will be needed.

2. From the government side, what the government can do is:

a. Provision of competent agricultural extension workers to provide farmers with technical training, educate farmers on the benefits of farmer groups, develop the farmer groups, and encourage the formation of cooperatives.
b. Provision of good storage facilities for farmers' products collectively.
c. Assist farmers in marketing by forming a processing and marketing unit.
d. In the long run, make plans and provide the facilities and infrastructure for processing rubber latex into simple semi-finished materials to add product value.
e. Protect farmers with export policies and can buy farmers' products to control the amount of demand in the market.

References

Agustina, D. S., Alamsyah, A., Nugraha, I. S. 2017. The Improvement of the Quality of Raw Rubber Material and Farmers' Share through the Organized Marketing System; Case Study in South Sumatra Province, *Indonesia International Proceedings of IRC* 2017: 583-591.

Al Muksit. 2017. Analysis of Farmers` Income and Welfare in Batanghari District, Jambi Province. *Academic Thesis of Jambi University*, Indonesia.

Antoni, M., Sari, D.W., Tokuda, H. 2018. Income Difference Between Members and Non-Members of the Processing and Marketing Unit Organized by Rubber Smallholder in Indonesia. Agricultural Marketing Journal of Japan Vol. 27 No. 2. The Agricultural Marketing Society of Japan, Laboratory of Agriculture Marketing, Faculty of Agriculture. Kagoshima University.

Behance.net. 2018. Rubber Drat. https://behance.net/download.pdf (Accessed July 17, 2019).

Directorate General of Estate Crops. 2009-2017. Tree Crop Estate Statistic of Indonesia: Rubber. Publish by Secretariat of Directorate General of Estate Crops, Directorate General of Estate Crops, Ministry of Agriculture. Indonesia.

Directorate General of Estate Crops. 2009-2017. Tree Crop Estate Statistic of Indonesia: Oil Palm. Publish by Secretariat of Directorate General of Estate Crops, Directorate. General of Estate Crops, Ministry of Agriculture. Indonesia.

Directorate General of Estate Crops. 2014. *Rubber Cultivation Guidelines*. South Sumatra, Indonesia.

Directorate General of Estate Crops. 2015. *Oil Palm Cultivation Guideline*. South Sumatra, Indonesia.

Euler, M., M. P. Hoffmann, Z. Fathoni and S. Schwarze. (2016). Exploring yield gaps in smallholder oil palm production systems in eastern Sumatra, Indonesia. *Journal of Agricultural System, 146,* 111-119.The Central Bureau of Statistic. 2017. *South Sumatra in Figure Year 2017, South Sumatra, Indonesia* https://sumsel.bps.go.id/publication/download.pdf (Accessed October 17, 2018).

Gapkindo. (2012) : Annual Report, Indonesian Rubber Association, Indonesia, pp. 7–8.

Global Business Indonesia Guide. 2018. Indonesia`s Rubber Industry: Increased Competition and Falling Prices. https://www.gbgindonesia.com (Accessed June 2, 2019).

Hanggokusumo. (2016) : *Daya Saing Karet di Indonesia* [Crumb Rubber Competitiveness in Indonesia], Oral presentation in the Department of Industry and Trade of West Sumatera Province. West Sumatra, Indonesia.

Husin, L., Yulius., Dessy, A., Mirza, A,. 2017. Effect of Different Rubber Market System on Farmer`s Income in South Sumatra Province., Indonesia. https://doi.org/10.18551/rjoas. 2017, 11-33.

Indonesian Agriculture Ministry. (2008) : Regulation of the Minister of Agriculture No.38/Permentan/OT.140/8/2008: *Pengolahan dan Pemasaran Bahan Olah Karet* [Processing and Marketing Guidelines of Slab], Indonesia, pp. 3–9.

Indonesian Central Bureau of Statistic. 2015. Statistic of Rubber in Indonesia. Jakarta. Indonesia.

Indonesia Investment. (2018). Rubber and Oil Palm. https://www.indonesia-investments.com/business (Accessed August 16, 2018).

Kuswanto. 2019. Analysis of Rubber Farmer Welfare in Jambi Province, Indonesia. Russian Journal of Agricultural and Socio-economic Science., 2(86) 86-93.

Rai, S. 2014. From the Analysis of the Agriculture Business Reform: Palm Oil Value Chain in Indonesia. *Agricultural Marketing Journal of Japan* 23(3):16-25

Rivai, A., Levang. P. (2014). *Palms of Controversies: Oil Palm and Development Challenges*. Center for International Forestry Research, Bogor, Indonesia.

Sari, D.W., Tokuda, H. 2018. Present Situation of Rubber-Farming Practices -Case Study of Smallholder in South Sumatra, Indonesia. Japanese Journal of Farm Management. Vol. 56 No. 2. The Farm Management Society of Japan.

Singh, Surendra P. (1981) : Part-Time Farming: Productivity and Some Implications of Off-Farm Work by Farmers, Southern Journal of Agricultural Economics, Indonesia, pp. 61–67.

SNV Team. 2016. Preliminary Socio Economic Report: Situational Analysis of Local Communities and Their Agricultural Practices and Needs in South Sumatra. Unpublish Report. Palembang. Indonesia.

Sugino,T,. Kobayashi, H. 2015. The Change and Challenges in Indonesian Agriculture and Rural Areas under the Economic Development: Special Focus on Job Diversification and Commercial Farming. *HortResearch* 69: 55-68.

Susanto, A. 2017. Kondisi Sosial Ekonomi Petani Karet Desa Simpang Mesuji Kecamatan Simpang Pematang. Bandar Lampung University.

Syarifa and Fatayati, Lina. (2013) : *Evaluasi Pengolahan dan Mutu Bahan Olah Karet Rakyat (BOKAR) di Tingkat Petani Karet di Sumatera Selatan* [Evaluation of Processing and Quality of Raw Rubber Material at Smallholder's Level in South Sumatra], Indonesian Journal National Rubber Res., Indonesia, Vol. 31, No. 2, pp. 139–148.

Syarifa, L. F., Agustina, D. S., Nancy, C., Supriadi, D. M. 2016. Low Rubber Prices Impact on Socio Economic Condition of Rubber Smallholders in South Sumatra. *Jurnal Penelitian Karet* 34(1): 119-126.

The Central Bureau of Statistics (BPS). 2017. *South Sumatra in Figures Year 2017, South Sumatra, Indonesia* https://sumsel.bps.go.id/publication/download.pdf (Accessed October 17, 2018).

The World Bank Commodity Market. 2018. https://www. worldbank.org/en/research/commodity-markets (accessed on July 12, 2019).

Wiyanto and Kusnadi, N. (2013) : *Faktor Yang Mempengaruhi Kualitas Karet Rakyat (Studi Kasus di Kecamatan Tulang Tengah, Kabupaten Tulang Bawang, Lampung, Indonesia* [Factors Affecting Rubber Quality in Smallholder Plantation (Case in Tulang Bawang Tengah Sub-district, Tulang Bawang District, Lampung, Indonesia], *Jurnal Agribisnis Indonesia*, Indonesia, Vol. 1, No. 1, pp. 39–58.

Yanita, M., M. Yazid., Zulkifli, A., Andy, M. 2016. Determinant Analysis for Rubber Export in Indonesia. *International Journal of Scientific and Research Publication*, Vol. 6 Issue 9 September 2016 pg. 478-48.